Appendix A

Policy and Memorandums

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

NOV 18 2002

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

SUBJECT: 2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, $PM_{2.5}$ and Regional Haze Programs

FROM: for Lydia N. Wegman, Director
Air Quality Strategies and Standards Division

Peter Tsirigotis, Director P Tsirigotis
Emissions, Monitoring, and Analysis Division

TO: Regional Air Division Directors

The EPA anticipates that nonattainment designations for the 8-hour ozone national ambient air quality standards (NAAQS) will occur in 2004, and the designations for the fine particles ($PM_{2.5}$) NAAQS will occur in the 2004-2005 time frame. Within 3-4 years after designations are promulgated, States will need to submit new attainment demonstration State implementation plans (SIPs) for the new NAAQS. A key element in the overall SIP planning process is the need for updated statewide emission inventories. This memorandum identifies 2002 as the anticipated emission inventory (EI) base year for the SIP planning process to address these pollutants. Identifying the base year at this time gives certainty to States, and the selection of 2002 harmonizes dates for other reporting requirements, e.g., EPA's Consolidated Emissions Reporting Rule (CERR) that requires submission of EI every three years; 2002 is one of the required years for such updates.

The Agency encourages States to take early action to reduce emissions of pollutants that cause violations of the NAAQS for ozone (the 8-hour standard) and $PM_{2.5}$, and that cause regional haze. States will be able to take credit for emission reductions that occur after the 2002 base year, including reductions that occur before the deadlines for submission of these SIPs. As a matter of policy, EPA seeks to avoid penalizing States for moving forward early to address these problems. Attached is additional information.

The EPA is aware that some areas have already begun on a voluntary basis to model for purposes of the 8-hour ozone standard. These areas may continue to use modeling from previous base years for each set of meteorological episode conditions for use in their SIP submittals if these studies are still applicable for an attainment demonstration. The 2002 EI, however, needs to be factored into this analysis. For example, the 2002 inventory would be a good choice for use in modeling "current" emissions. As described in the modeling guidance, predictions for the current emissions and predictions for the future year emissions are used in the modeled attainment test[1]. Furthermore, for reasonable further progress (RFP) purposes, the 2002 EI needs to be used as the base year.

Please make this guidance available to the appropriate contacts in your State and local air agencies. Questions on this should be directed to (for ozone) Annie Nikbakht at 919-541-5246 or (for $PM_{2.5}$) Rich Damberg at 919-541-5592.

cc: Lydia Wegman
Peter Tsirigotis
Rich Ossias
Kevin McLean

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[1]U.S. EPA, (1999), "*Guidance onthe use of models and other analyses in attainment demonstrations for the 8-hour ozone NAAQS,*" DRAFT, May 1999, Web site: http://www.epa.gov/tnn/scram, under Guidance/Support, file name: O3TEST.

Attachment

Background

The EPA anticipates that designations for the 8-hour ozone NAAQS will occur in 2004, and the designations for the $PM_{2.5}$ NAAQS will occur in the 2004-2005 time frame. The Clean Air Act (CAA) requires States to submit attainment demonstration SIPs for the 8-hour ozone standard within 3 to 4 years (depending on classification), and within 3 years for the $PM_{2.5}$ standard. Therefore, EPA anticipates that SIPs will be due in 2007 or 2008[2] for both NAAQS programs. For regional haze, most States (i.e., those participating in regional planning organizations) will have SIPs due at the same time as $PM_{2.5}$ SIPs. We anticipate that technical analyses in support of these SIPs, such as regional scale air quality modeling, will need to begin no later than the 2004 time frame. Updated statewide emissions inventories will be an important component used in these analyses. In addition, for many of the required SIPs, emissions in upwind States will also be an important input to necessary technical analyses.

For the 8-hour ozone, $PM_{2.5}$, and regional haze program areas, there are statutory and regulatory provisions related to prospective and/or retrospective demonstrations of progress in reducing emissions and/or improving air quality, although the exact provisions differ somewhat across programs. We have considered the statutory and regulatory provisions applicable to each of these program areas, and have concluded that in each case 2002 is an appropriate base year for program requirements related to progress. In addition, there are practical reasons for choosing 2002, as explained below.

Therefore, even though EPA has not developed final rules or guidance for implementation of either the 8-hour ozone NAAQS or the $PM_{2.5}$ NAAQS, EPA believes that 2002 should be the base year inventory for these SIP planning efforts, including for regional haze SIPs. Using the 2002 inventory as the base year will also ensure that the inventory reflects one of the years used for calculating the air quality design values on which designation decisions are based, as well as one of the years in the 2000-2004 period used to establish baseline visibility levels for the regional haze program. Our reasoning is explained in more detail below for each program area.

The year 2002 is also suitable as the principle or one of the principle years used for air quality model validation.

The practical reasons for choosing 2002 have to do with the requirements of the CERR (67 Federal Register 39602), which was finalized on June 10, 2002, and with the schedule of EPA's own work on the National Emissions Inventory. The CERR requires States to submit

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[2]The EPA is still working on the implementation guidance that will address the extent to which subparts 1 and 2 of the CAA apply for purposes of the 8-hour ozone NAAQS. Subpart 1 provides up to three years after nonattainment designation for States to submit attainment and reasonable further progress (RFP) SIPs, while subpart 2 provides 3 to 4 years, depending on an area's classification, for States to submit those plans.

emissions inventories for all criteria pollutants and their precursors every three years, on a schedule that includes the emissions year 2002. The due date for the 2002 emission inventory is established in the CERR as June 2004. Therefore, each State should have information available some time before this date to develop the in-state emissions inventory needed for technical analyses during 2004. In addition, EPA plans to make its initial version of the 2002 National Emission Inventory (NEI) available to the states by December 2003, based on 2002 data on emissions from electric generating units, preliminary 2002 vehicle miles traveled information from the Federal Highway Administration, and growth and control projections starting with the 1999 NEI for other source types. This preliminary 2002 NEI can be used in 2004 by each State needing emission estimates for upwind States. The EPA's final 2002 NEI, which will merge and augment the state-by-state inventories received in 2004, will be ready by the summer of 2005. Depending on where they are in their work, States may wish to switch to the newer estimates of upwind-states' emissions, and certainly should at least consider how the emission estimates for upwind States have changed.

Alternatively, some regional groupings of States may exchange and merge their 2002 inventories directly, prior to completion of EPA's final 2002 NEI. We will be consulting with multi-state organizations about the 2002 inventory process so that work is not duplicated unnecessarily.

<u>8-hour Ozone NAAQS</u>

Under the 8-hour ozone standard, EPA anticipates that many areas designated nonattainment for the 8-hour ozone NAAQS will need to comply with the rate of progress (ROP) requirement in Subpart 2 of the CAA, which applies to areas classified moderate or above. Any area not subject to the subpart 2 ROP requirement would be subject to the more general requirement under subpart 1 to make RFP. Both ROP and RFP consider progress made from a baseline inventory. As enacted in 1990, Subpart 2 provided that the base-year inventory would be 1990. See, CAA section 182(b)(1)(B). Thus, for 1-hour ozone nonattainment areas classified moderate or higher, ROP reductions for the target of 1996 were considered to be a 15 percent reduction of volatile organic compound (VOC) emissions from the 1990 baseline year. Similarly, for each three-year period following 1996 up to its attainment date, a serious or above nonattainment area was required to achieve an additional 9 percent reduction in VOC emissions.[3] Under the 8-hour ozone standard, EPA anticipates that, consistent with the above discussion, a 2002 base year emission inventory would be used as the baseline from which future target levels of emissions would be calculated. Therefore, any emission reductions that the State initiates after 2002 would be creditable toward the ROP or RFP requirements.

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[3] The CAA provides that nitrogen oxides (NO) emission reductions may be substituted for VOC emission reductions for these subsequent three-year periods under prescribed circumstances. See CAA section 182(c)(2)(C).

For areas subject to the subpart 2 ROP requirement, section 182(b)(1)(D) places constraints on the use of emission reduction credits from certain pre-1990 programs even though those programs might achieve additional reductions in the years following 1990, i.e., the federal motor vehicle emission control program, Reid Vapor Pressure programs, corrections required to pre-existing reasonably available control technology (RACT) rules, and inspection and maintenance (I/M) program corrections. While these limitations would still apply for purposes of credit for SIPs designed to meet the 8-hour ozone NAAQS, EPA does not believe it is legally required and does not plan to expand the list of programs for which credit is precluded. Subpart 1 does not establish any limits on the creditability of measures for purposes of RFP and EPA does not anticipate establishing any regulatory limits on the creditability of emission reductions. Thus, EPA does not anticipate establishing any additional constraints on crediting emission reductions achieved in years following the 2002 base year. Therefore, apart from those programs listed in the CAA, we believe that States can take credit for other emission reductions that occur after the 2002 base year.

$PM_{2.5}$ NAAQS

The EPA anticipates that States will be required to implement the $PM_{2.5}$ NAAQS under Subpart 1 since the more specific provisions in Subpart 4 that address particulate matter expressly apply only to PM_{10}. As provided above, Subpart 1 does not place limits on the types of controls that are creditable for purposes of the RFP requirement. As with the 8-hour ozone NAAQS, EPA does not anticipate establishing any regulatory constraints limiting creditability of emission controls. Subpart 1 generally calls for States to submit plans including emission reduction measures designed to attain the NAAQS within 3 years after a nonattainment designation. It also includes a reasonable further progress (RFP) requirement, but does not have a specific percent reduction requirement as there is in the ROP requirement of Subpart 2. The exact form of the RFP requirement for $PM_{2.5}$ has yet to be established, but it is expected that any emission reductions that occur after the base year of 2002 would be credited toward the emission reductions needed by the State under its attainment demonstration and toward the reductions needed to meet the RFP requirement.

Regional Haze Program

The regional haze program calls for States participating in regional planning organizations to submit SIPs in 2007-8 that contain progress goals for every class I area and emission reductions strategies needed to meet these goals. Progress in improving visibility is tracked from baseline conditions (established using air quality monitoring for the 2000-2004 period). If 2002 is used as the base year for planning purposes, then States can take credit for emission reductions that are achieved before the 2007-2008 SIP due date.

Credits in General

It should be noted that EPA cannot provide "double credit" for an emission reduction for purposes of RFP or ROP. For instance, if a program or rule results in emission reductions prior to or in the base year, those reductions would be considered in calculating the base year emissions inventory and thus could not be counted as emission reductions from the base-year level. Such reductions would likely lower ambient pollutant concentrations, however, and would be important in terms of determining an area's designation and, if designated nonattainment, could affect the area's classification and thus its planning obligations. For example, emission reductions in NOx or VOC achieved prior to or during 2002 could have already resulted in the area having a lower ozone design value, which is the measure of whether the area is violating the 8-hour ozone standard and, if so, by how much. Reductions from such measures in years beyond the base year would be creditable towards ROP SIPs. These concepts of credit were discussed in the January 29, 2001, memorandum from John Seitz entitled "Near-Term Discretionary Emission Reductions for Ozone NAAQS–Clarification," which addressed the 1-hour ozone standard, but which are also conceptually applicable to implementation of the 8-hour ozone standard.

However, post-2002 emission reductions that benefit ozone, PM2.5 and regional haze can be credited toward the RFP requirements for each of these programs.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 01 2003

MEMORANDUM

OFFICE OF
AIR AND RADIATION

SUBJECT: Designations for the Fine Particle National Ambient Air Quality Standards

FROM: Jeffrey R. Holmstead
Assistant Administrator

TO: Regional Administrators, Regions I-X

This memorandum provides guidance to State and local air pollution control agencies and Tribes on the process for designating areas for the purpose of implementing the fine particle national ambient air quality standards. The EPA plans to issue final designations on December 15, 2004. This memorandum describes the process for developing State and Tribal recommendations on designations and the time line for EPA action leading to the final designations.

The EPA promulgated the air quality standards for fine particulate matter (known as $PM_{2.5}$) on July 18, 1997 (62 Federal Register 38652). The standards were based on a number of health studies showing that increased exposure to $PM_{2.5}$ is correlated with increased mortality and a range of serious health effects, including aggravation of lung disease, asthma attacks, and heart problems. Estimates show that attainment of these standards would result in tens of thousands fewer premature deaths each year and would prevent tens of thousands of hospital admissions and millions of work absences and respiratory illnesses in children annually. The designation process for $PM_{2.5}$ that is outlined below is the next step toward developing and implementing emission control programs that will address this important public health problem.

The first step in the designation process is the submittal of State and Tribal recommendations. The EPA requests that States and Tribes provide a list of recommended designations to EPA by February 15, 2004. The EPA plans to announce its intended designations in July 2004 and will provide 120 days for States and Tribes to comment on any modifications that EPA makes to the recommended designations. We plan to publish final $PM_{2.5}$ designations for all areas on December 15, 2004. We also intend to propose and finalize its implementation rule for $PM_{2.5}$ early enough to be taken into consideration during the designation process. The EPA hopes that by following a designation schedule for $PM_{2.5}$ similar to that for the 8-hour ozone program, the States and Tribes will be able to harmonize area boundaries and future control strategies to the extent possible.

As explained in this guidance, we intend to apply a presumption that the boundaries for urban nonattainment areas should be based on Metropolitan Area boundaries. A metropolitan area, as defined by the Office of Management and Budget, may consist of a single Metropolitan Statistical Area in some cases, and a Consolidated Metropolitan Statistical Area in other cases. These metropolitan areas provide presumptive boundaries for the geographic extent of urban areas. The presumptive use of metropolitan area boundaries to define urban nonattainment areas is based on recent evidence that violations of the $PM_{2.5}$ air quality standards generally include a significant urban-scale contribution as well as a significant larger-scale regional contribution. For rural areas that are identified as violating the $PM_{2.5}$ standards, the guidance sets forth EPA's presumption that the full county should be designated nonattainment. The approach taken in this guidance is similar to our approach to designations for the 8-hour ozone standard, and we urge States and Tribes to harmonize their ozone and $PM_{2.5}$ designation recommendations where appropriate.

Two attachments provide additional information and guidance. Attachment 1 is a time line of important dates in the fine particle NAAQS implementation process. Attachment 2 is a series of questions and answers providing more detailed guidance, including discussion of several factors to be considered in evaluating whether modifications to nonattainment area boundaries are appropriate.

This memorandum provides EPA's current views on how boundaries should be determined for designations. This guidance is not binding on States, Tribes, the public, or EPA. Issues concerning nonattainment area boundaries will be addressed in actions to designate nonattainment and attainment/unclassifiable areas under section 107 and section 301(d) of the Clean Air Act (Act). When EPA promulgates designations, that action will be final and binding on States, Tribes, the public, and EPA as a matter of law.

Staff in EPA's regional offices and the Office of Air Quality Planning and Standards are available for assistance and consultation throughout the designation process. Questions on this guidance may be directed to Tom Rosendahl at 919-541-5314 or Rich Damberg at 919-541-5592. The Regional Offices should make this guidance available to their States and Tribes and work closely with them to ensure they submit their area recommendations and supporting information by February 15, 2004.

Attachments: 2

cc: Stephen D. Page, OAQPS
Air Division Directors, Regions I-X
Margo Oge, OTAQ
Brian McLean, OAP
Elizabeth Cotsworth, ORIA

ATTACHMENT 1

TIME LINE FOR $PM_{2.5}$ NAAQS IMPLEMENTATION PROGRAM	
Date	**Item**
September 2003	EPA issues proposed $PM_{2.5}$ implementation rule
February 15, 2004	State and Tribal recommendations due for $PM_{2.5}$ designations - Recommendations can be based on 2000-2002 data
July 2004	EPA notifies States and Tribes concerning any modifications to their recommendations.
September 2004	EPA issues final $PM_{2.5}$ implementation rule
December 15, 2004	EPA issues final $PM_{2.5}$ designations.
December 2007	State implementation plans are due for $PM_{2.5}$ nonattainment areas (3 years after designation date).
December 2009-2014	Date for attaining $PM_{2.5}$ standards (5 years after designation date). - An extension of up to five years is possible with an adequate demonstration.

ATTACHMENT 2

GUIDANCE ON NONATTAINMENT AREA DESIGNATIONS FOR $PM_{2.5}$

1. What are the underlying requirements for designating areas for the $PM_{2.5}$ NAAQS?

Requirements for area designations are found in section 107 of the Clean Air Act (Act). Upon promulgation of a new or revised national ambient air quality standard (NAAQS)[1], States are required under section 107(d) of the Act to submit to EPA a recommended list of areas for designation as attainment, nonattainment, or unclassifiable. While the language of Section 107 specifically addresses States, EPA will follow the same process for Tribes to the extent practicable, pursuant to Sections 110(o) and 301(d) of the Act and the Tribal Authority Rule, or TAR.[2]

Section 107(d) specifies that nonattainment areas shall include "any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant." Interpretation of this requirement is a key purpose of this guidance.

Section 107 further specifies a timetable for action on designations. Under section 107(d)(1), States are to submit recommendations within one year after promulgation of a new or revised standard. Under section 107(d)(1)(B)(ii), if EPA intends to promulgate a designation that deviates from the State recommendation, it must notify the State at least 120 days before promulgating the modified designation, and EPA must provide the State the opportunity to comment on the potential modification. EPA should promulgate designations within two years after promulgation of a new or revised standard, with a possible one year extension if EPA has insufficient information.

The Transportation Equity Act for the 21st Century (TEA-21) of 1998 amended the timetable for $PM_{2.5}$ designations, based on the recognition that the monitoring network first needed to be deployed to collect sufficient monitoring data to designate areas. Under section 6102(c)(1) of TEA-21, States are required to submit recommended area designations to EPA within 1 year after receipt of 3 years of air quality monitoring data obtained with federal reference (or equivalent) monitoring methods. Section 6102(d) requires EPA to promulgate designations within 1 year after State recommendations are due, but no later than December 31, 2005. Although the TAR provides Tribes with flexibility in meeting the schedules set forth in

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[1] EPA promulgated the NAAQS for $PM_{2.5}$ on July 18, 1997. See 62 Federal Register 38652. The annual standard for $PM_{2.5}$ was set at a level of 15 $\mu g/m^3$, based on the 3-year average of annual arithmetic mean $PM_{2.5}$ concentrations. The 24-hour standard was set at a level of 65 $\mu g/m^3$, based on the 3-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations.

[2] The "Tribal Authority Rule," promulgated on February 12, 1998, specifies that Tribes shall be treated as States in selected cases as appropriate. See 63 FR 7254, codified at 40 Code of Federal Regulations (CFR) Part 49 (1998).

the Act, EPA has the obligation to designate areas consistent with the schedules in the Act. Therefore, EPA will designate Tribal areas, in consultation with the Tribes, on the same schedule as State designations. State implementation plans designed to meet the standards are then due within three years of the date of designation (e.g. December 2007) in accordance with section 172 of the Act.

2. What are the key milestones of the $PM_{2.5}$ designations process?

The milestones of the $PM_{2.5}$ designation process are listed in Attachment 1. In developing these milestones, we considered that implementation of the TEA-21 schedule for designations could be complicated by the variety of dates on which various locations first have 3 years of data available. Some sites had 3 years of data available as of July 2002, other sites did not have 3 years of data until later in 2002, and some sites will not have 3 years of data until July 2003. This approach could result in designations occurring between July 2004 and July 2005. EPA believes that a staggered designation schedule, which would yield staggered implementation plan deadlines, would hamper the regional and metropolitan area-based coordination that is needed among various governments and stakeholders. Therefore, this guidance contains single dates for State/Tribal recommendations and final designations by EPA.

EPA requests that all State and Tribal recommendations be submitted by February 15, 2004. Consistent with TEA-21 time frames, EPA plans to designate all areas by December 15, 2004. States and Tribes will be able to use the 2000-2002 data in their recommendations. Areas should be identified as "nonattainment" (violating a standard or contributing to nearby violations), or as "attainment/unclassifiable" (either meeting the standard or having insufficient data to determine air quality, and not contributing to nearby nonattainment). EPA intends to promulgate area designations in terms of these two categories. State recommendations do not apply to Indian country.

After EPA evaluates the recommendations it receives, EPA will notify States and Tribes of any modifications it intends to make to their recommendations at least 120 days before the designations are to be finalized.[3] If a State or Tribe disagrees with any change, it may provide information to EPA to demonstrate why it believes that the proposed modification is inappropriate, and EPA will consider this information in developing the final list of area designations. In their comments, States and Tribes may take into account the 2001 to 2003 monitoring data, which EPA expects to be available before comments are due. As noted above, EPA's policy is to use the most recent three years of data available at the time of designations.

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[3]EPA's legal obligation to provide 120 days notice of modifications applies only to those Tribes that have sought and received formal authority to recommend designations pursuant to the Tribal Authority Rule. However, EPA is soliciting Tribal recommendations and intends to provide 120 days notice of any modifications irrespective of whether a Tribe has this formal authority.

EPA plans to promulgate final designations on December 15, 2004 and intends to consider the 2001 to 2003 data in making these designations.

The EPA is committed to ensuring that all stakeholders have an opportunity to participate in the designation process for the $PM_{2.5}$ NAAQS, and that State, local and Tribal officials have ample time to comply with obligations that are triggered by designations. States and Tribes are encouraged to involve their stakeholders in developing their recommendations. Regional Offices should work with States and Tribes, particularly for areas where a monitor is recording a violation of the $PM_{2.5}$ standards. If a State or Tribe does not provide any designation recommendations for specific areas, EPA will promulgate the designations it deems appropriate.

3. How are violations identified?

The first step in defining nonattainment areas is to identify monitoring sites at which air quality does not meet either the annual or 24 hour standard for $PM_{2.5}$. Appendix N to 40 CFR Part 50 specifies the procedures to be used to analyze whether air quality at any site meets the air quality standards. Procedures associated with data handling and calculations for comparing data to the $PM_{2.5}$ standards are described in more detail in the "Guideline on Data Handling Conventions for the PM NAAQS" (EPA-454/R-99-008, 1999). The EPA's designation of areas will be based on the most recent 3 consecutive calendar years of air quality data from Federal reference or equivalent method monitors. Data used must be quality-assured and meet 40 CFR part 58 requirements (e.g., for monitor siting).

Many areas collect additional data on particulate matter composition using the Interagency Monitoring for Protecting Visual Environments (IMPROVE) protocol or using methods of the speciation trends network. These methods are not Federal reference methods or equivalent methods, and data collected according to these methods should not be used to determine the existence of a violation. However, as noted in 40 CFR 58 (Appendix C, section 2.9) with respect to IMPROVE protocol monitors, these methods may be used to estimate background concentrations and thus may be used to assess the geographic extent of the area contributing to a nonattainment situation.

The air quality standards for $PM_{2.5}$ specify two exceptional circumstances in which concentrations above the level of the standard are not to be interpreted as violating the standard. The first exception is that sites that monitor source-oriented hot spots in some cases should be assessed only with respect to the 24-hour standard, not the annual average standard. In 40 CFR Part 58 (Appendix D, section 2.8.1.2.3), EPA states that monitoring sites representing unique localized conditions not found elsewhere in the area should not be compared with the annual average standard. For sites that States or Tribes have designated as hot-spot sites, EPA must review whether available evidence confirms that the annual average concentrations at the site are in fact unrepresentative of conditions elsewhere in the region. If so, data from the site will not be compared against the annual standard, but it will be compared against the 24-hour standard.

The second exception arises when the option of spatial averaging is applied, which may result in a group of monitors collectively indicating attainment of the annual average standard, even though individual monitors in the group may show average concentrations which do not meet the standard. Conversely, spatial averaging could indicate nonattainment for the area even though some monitors show concentrations which meet the standard. Appendix N of 40 CFR Part 50 offers the option of applying spatial averaging in the analysis for the annual average standard. For a State or Tribe to apply spatial averaging, it must have previously designated $PM_{2.5}$ monitors for spatial averaging as an element of its $PM_{2.5}$ monitoring plan, and it must have provided a suitable opportunity for the public to comment on this intent.[4]

Monitors with data to be averaged must satisfy detailed criteria given in 40 CFR Part 58 (Appendix D, section 2.8.1.6). Sites within an identified area that meet these criteria will be addressed on a spatially averaged basis only if the State or Tribe opts to do so. For monitors that satisfy these criteria, the procedures for averaging the qualifying data are given in Appendix N to 40 CFR Part 50 and the aforementioned data handling guidance. A determination would be made as to whether the spatially averaged annual average meets or does not meet the annual average standard, irrespective of whether concentrations at any individual site meet or do not meet the annual standard.

4. How should boundaries of urban nonattainment areas be determined? Are there presumptive boundaries for nonattainment areas?

As noted above, a nonattainment area must be defined not only to include the area that is violating the standard, but also to include the nearby source areas that contribute to the violation. Thus, a key factor in setting boundaries for nonattainment areas is determining the geographic extent of nearby source areas contributing to the nonattainment problem. For each monitor or group of monitors that exceed a standard, nonattainment boundaries must be set that include a sufficiently large area to include both the area judged to violate the standard and the source areas that contribute to these violations. Evaluations of source areas must account for sources of $PM_{2.5}$ precursors (such as sulfur dioxide, nitrogen oxides, ammonia, and some volatile organic compounds) as well as sources of direct $PM_{2.5}$ emissions.

EPA has examined various evidence addressing the typical geographic scale of source areas that contribute to violations of the $PM_{2.5}$ standard. This evidence indicates substantial contributions to violations of the $PM_{2.5}$ standard both from long-range transport[5] and from the collection of urban sources dispersed within metropolitan areas. To assess the metropolitan scale

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[4] See 40 CFR Part 58.20(f) and 40 CFR Part 58.26(e) for information about public notification and public comment requirements associated with spatial averaging.

[5] See discussion of long-range transport of sulfate and nitrate particles in supporting materials for the Clear Skies Act at http://www.epa.gov/clearskies/.

contribution, EPA examined the geographic distribution of total $PM_{2.5}$ concentrations in and near many metropolitan areas. EPA found an association of higher $PM_{2.5}$ concentrations with greater levels of urban activity. Comparisons of rural versus urban concentrations of the components of $PM_{2.5}$ indicate that certain components (such as carbonaceous particles and nitrates) resulting in part from urban emissions are found in significantly higher concentrations in urban areas.[6] These "urban emissions" arise from human activities, such as motor vehicle use and home heating as well as industrial activities, that occur with greater density in more populated areas.

The metropolitan area, as delineated by the Office of Management and Budget (OMB), provides a presumptive definition of the populated area associated with a core urban area.[7] Accordingly, EPA believes that the metropolitan area provides a presumptive definition of the source area that contributes to a $PM_{2.5}$ nonattainment problem. For this reason, EPA believes that the Metropolitan Area should serve as the presumptive boundary for urban $PM_{2.5}$ NAAQS nonattainment areas. This presumption reflects EPA's view that, in the absence of evidence to the contrary, violations of the $PM_{2.5}$ NAAQS in urban areas may be presumed attributable at least in part to contributions from sources distributed throughout the Metropolitan Area. This approach parallels the presumptive metropolitan area boundaries established in the 1990 Amendments to the CAA for certain ozone nonattainment areas.

"Metropolitan areas" are defined by the Office of Management and Budget based on data collected by the U.S. Bureau of the Census. In each case, a metropolitan area includes a core urban area plus the full set of associated nearby communities. These areas in some cases include a single Metropolitan Statistical Area (MSA) that is not associated with and is typically not contiguous with any other MSA, and in other cases include multiple contiguous Primary Metropolitan Statistical Areas (PMSA) which collectively form a Consolidated Metropolitan Statistical Area. In Metropolitan Areas consisting of a single MSA, EPA presumes the entire MSA should be designated as nonattainment. In Metropolitan Areas consisting of multiple PMSA's which collectively form a Consolidated Metropolitan Statistical Area, EPA presumes the entire Consolidated Metropolitan Statistical Area should be designated nonattainment.

EPA anticipates that OMB will publish revised metropolitan area lists later in 2003. Unfortunately, this publication may not occur early enough for States and Tribes to consider the revised lists in the development of recommended designations for $PM_{2.5}$. Furthermore, EPA seeks to maximize consistency between designations for $PM_{2.5}$ and designations for the 8-hour ozone standard. The earlier timetable for ozone designations makes it even less likely that revised metropolitan area lists will be available for State and Tribal consideration in recommending

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[6] V. Rao, N. Frank, A. Rush, F. Dimmick, "Chemical Speciation of $PM_{2.5}$ in Urban and Rural Areas", in the Proceedings of the Air & Waste Management Association Symposium on Air Quality Measurement Methods and Technology, San Francisco, November 13-15, 2002.

[7] For further information on the definitions of metropolitan areas, see: http://www.census.gov/population/www/estimates/metroarea.html.

ozone designations. Therefore, EPA anticipates relying on the current metropolitan area definitions, published by OMB on June 30, 1999, in establishing presumptive nonattainment area boundaries.

EPA will consider State, local, and Tribal recommendations of nonattainment area boundaries that deviate from metropolitan area boundaries based on various factors. These factors are discussed in question 5 below. Consideration of these factors may warrant a nonattainment area that has additions and/or deletions relative to OMB's defined metropolitan area.

Boundaries used for implementation of the 8-hour ozone standard may also be an important factor in determining boundaries for $PM_{2.5}$ nonattainment areas. Indeed, there are many areas that violate both the 8-hour ozone and the $PM_{2.5}$ standards, and States and Tribes may wish the nonattainment boundaries for the two pollutants to be identical in order to coordinate air quality planning, control strategy development, and the implementation of the transportation conformity program.

We recognize that, unlike ozone nonattainment problems, there are situations where nonattainment of the $PM_{2.5}$ NAAQS can arise on a very localized basis. For example, violations can be caused by the emissions from a single major source or set of sources, in some cases exacerbated by severely restricted atmospheric dispersion (such as a narrow mountain valley). In such cases, the State or Tribe should further investigate the causes of the violation and the geographic extent of the violation. The recommended boundaries of the nonattainment area should then reflect a case-specific judgment of the area sufficient to include the areas violating the $PM_{2.5}$ NAAQS plus any additional source areas contributing to the violation. The State or Tribe will need to provide an adequate justification demonstrating that a smaller area would include the full area that is violating the standards and all nearby source areas that contribute to the violation. EPA expects there to be a limited number of situations of this type.

5. What factors will EPA consider as the basis for a State or Tribal request for an alternative urban area definition?

In some cases, a State or Tribe may find that a violation of the $PM_{2.5}$ standard is attributed to a significant metropolitan-scale component and yet believe that the Metropolitan Area does not appropriately define the area that should be designated nonattainment. EPA will consider requests for urban nonattainment area definitions that deviate from OMB's metropolitan area definitions on a case-by-case basis, considering the factors described below. These factors resemble the factors identified in previous EPA guidance on 8-hour ozone nonattainment boundaries, though EPA will make its decisions based on the distribution of sources contributing to $PM_{2.5}$ concentrations. EPA will apply these same factors in evaluating boundary modifications for both States and Tribes. $PM_{2.5}$ is a regional pollutant, and sources of $PM_{2.5}$ and its precursors are numerous and located over a broad area. For this reason, EPA believes it would be unlikely that we would designate any area as attainment that is surrounded on all sides by nonattainment areas.

EPA will consider the following factors in assessing whether to exclude portions of a metropolitan area and whether to include additional nearby areas outside the metropolitan area as part of the designated nonattainment area:

- Emissions in areas potentially included versus excluded from the nonattainment area
- Air quality in potentially included versus excluded areas
- Population density and degree of urbanization including commercial development in included versus excluded areas
- Traffic and commuting patterns
- Expected growth (including extent, pattern and rate of growth)
- Meteorology (weather/transport patterns)
- Geography/topography (mountain ranges or other air basin boundaries)
- Jurisdictional boundaries (e.g., counties, air districts, Reservations, etc.)
- Level of control of emission sources

Analyses of these factors may suggest nonattainment boundaries that are either larger or smaller than the metropolitan area. A demonstration supporting the designation of boundaries that are less than the full metropolitan area must show both that violations are not occurring in the excluded portions of the metropolitan area and that the excluded portions are not source areas that contribute to the observed violations. A State or Tribal submittal that only addresses whether violations are occurring throughout the area will not suffice as a justification for designating a nonattainment area smaller than the metropolitan area. States and Tribes are encouraged to justify such recommendations by addressing all of the factors identified above. Recommendations to designate a nonattainment area larger than the metropolitan area should also be based on an analysis of these factors. EPA will consider these factors in evaluating State and Tribal recommendations and assessing whether any modifications are appropriate.

Air quality dispersion modeling and data interpolation techniques can be useful tools to help assess how air quality in unmonitored areas compares to air quality at monitoring sites. Accordingly, these tools can help assess the geographic area violating and/or contributing to a violation of the standards. EPA and others are undertaking various efforts to improve the reliability of these tools. In determining whether an analysis appropriately justifies modified nonattainment area boundaries, EPA will give particular consideration to the reliability of the relevant modeling or interpolation technique.

6. How should designation recommendations, including boundaries, be addressed when more than one State or Tribe might be affected?

Where more than one State or Tribe is involved in an area, close coordination is needed among the affected States and Tribes prior to the time the recommendation is made. In addition, the EPA Regional Office should coordinate where an area may be located in States or tribal lands located in two or more regions. There is a strong presumption that interstate areas making up one metropolitan area will be designated as one nonattainment area. The EPA strongly encourages States and Tribes involved in multi-jurisdictional areas to make consistent and coordinated boundary recommendations.

7. How will EPA address rural areas?

Previous questions have addressed urban areas, presumptively defined as metropolitan areas surrounding core cities, with potential boundary adjustments based on a variety of factors. This question addresses rural areas, defined here to mean counties or areas not included in or adjacent to such urban areas. An area found to violate the standard that is adjacent to a metropolitan area will generally be designated as part of that urban nonattainment area and would not be treated as rural for purposes of this guidance.

As with urban areas, the first step in determining attainment status for rural areas is to evaluate available air quality data measured by Federal reference method monitors. The second step is to assess the boundaries of the airsheds represented by the rural monitors and determine the source areas contributing to air quality at these monitors. For cases in which rural data indicate nonattainment, the nonattainment area again must be sufficient to include the full area that is violating the standards as well as any nearby source areas that are contributing to the violation.

When a rural monitor violates the standard, EPA intends to apply a presumption that the nonattainment area shall include the full county in which the monitor is located. EPA will consider recommendations to adjust rural area nonattainment boundaries based on the same factors as it applies to urban areas, as discussed in question 5 above. Using these factors, a State or Tribe that recommends that a smaller area should be designated nonattainment should provide convincing evidence that the monitor is not representative of the full county, that the excluded portions of the county are not source areas contributing to the nonattainment, and that the excluded portions of the county are meeting the standard. Similarly, a State or Tribe may recommend that a larger area be designated nonattainment based on technical information relevant to these factors. Nevertheless, as discussed above, if nonattainment is demonstrably very localized and is attributable to localized sources, EPA intends to establish nonattainment area boundaries based on a case-specific evaluation of the nature and extent of the problem.

8. What additional documentation should a State or Tribal government submit concerning the nonattainment area recommendations?

In addition to technical information documenting the recommendation for area boundaries noted in question number 5 above, the EPA is requesting that each State or Tribe in its submission provide certain air quality data and geographic information to support its nonattainment area recommendation. The EPA is asking for the following information:

For nonattainment areas:

a. $PM_{2.5}$ design value for the area.
b. Three year period represented by the design value, e.g., 2000-2002
c. Design value monitoring site location(s) and identification number(s).

For attainment/unclassifiable AND nonattainment areas:

d. Names of counties and tribal lands included, and
e. If partial counties or portions of tribal lands are included, the boundary definition/description as outlined below.

If the recommended nonattainment area boundary is smaller than the metropolitan area definition, the State or Tribe should document its rationale for selecting the nonattainment area boundary. The documentation should address how all the factors discussed in question number 5 (such as population, traffic and commuting patterns, commercial development, projected growth, prevailing meteorology, nearby sources and air quality, and any other relevant or technical justification factors) affect the drawing of boundaries for each county or other sub-area not included in the recommended nonattainment area. In particular, where the recommended area boundary consists of parts of counties, metropolitan areas, or tribal lands, the State or Tribe must provide a technical analysis for its recommendation, explaining how the boundary is consistent with §107 (d)(1) of the Act.

If the recommendation includes any partial counties, the EPA is requesting a legal definition of the area, a detailed hard copy map, and, because EPA plans to map each area, a digitized latitude and longitude description. The submittal should include the names of contacts for this information.

The EPA envisions making information on designation recommendations available electronically. Therefore, EPA requests that each State submit its designation recommendations, supporting documentation, and boundary information and associated maps to EPA in both a detailed written form and in electronic form.

9. How is EPA addressing Tribal concerns about the designations process?

Tribes are encouraged, but not required, to submit designation recommendations for their reservations or other areas under their jurisdiction to EPA. The TAR offers flexibility to Tribes for specific plan submittal and implementation deadlines for NAAQS-related requirements, including but not limited to such deadlines in CAA sections 110(a)(1), 172(a)(2), 182, 187, 189, and 191. However, EPA is required by the Act to promulgate area designations according to a timetable. Therefore, if a Tribe wishes to participate in the designation process they must submit a recommendation in time for EPA to consider that recommendation when making a designation. In cases where Tribes do not make a recommendation, the EPA, upon consultation with the respective Tribe(s), will promulgate the designation it deems appropriate.

EPA has discussed designation issues with many Tribal representatives and we recognize that there are several issues of particular concern to Tribes. Some Tribes have expressed concern that where a violation is monitored in a metropolitan area that includes tribal lands, the tribal lands presumptively should not be part of the urban nonattainment area, because the tribal lands often are not politically and economically integrated with the urban area. EPA will address this concern on a case-by-case basis. Upon request, EPA will help any Tribe obtain relevant information addressing the factors described under question 5 above. As with State lands, EPA will use this information to help judge whether the tribal lands are meeting the air quality standards and whether the tribal lands are a source area contributing to nonattainment in the metropolitan area. EPA will designate the tribal lands based on this information.

Some Tribes have expressed concern about the use of monitors located on State lands to establish designations for tribal lands. Given EPA's obligation to promulgate designations for all locations, EPA by necessity must judge the air quality of unmonitored locations on the basis of monitoring data from other locations. Where a monitor indicates a violation of an air quality standard, EPA will designate a nonattainment area that includes unmonitored areas either that EPA judges also to be violating the standard or that EPA judges to be a nearby source area contributing to the nonattainment. Some Tribes have also raised concerns with the designation process that they may not have the resources to do the detailed analysis necessary to prepare their recommendations. EPA offers to work with Tribes on their recommendations upon request.

MEMORANDUM

SUBJECT: Additional Guidance On Defining Area Boundaries for PM-2.5 Designations

FROM: Lydia N. Wegman, Director
Air Quality Strategies and Standards Division (C504-01)

TO: Air Division Directors, Regions I-X

This memorandum provides additional guidance for determining boundaries of PM-2.5 areas in the PM-2.5 designations process. Our April 2003 boundary guidance establishes the metropolitan area (i.e. the larger of the Consolidated Metropolitan Statistical Area (CMSA) or Metropolitan Statistical Area (MSA)) as the presumptive boundary for PM-2.5 nonattainment areas[1]. The boundaries of CMSAs and MSAs, which were delineated by the Office of Management and Budget (OMB) in 1999, include populated areas associated with core urban areas. Our April 2003 guidance recognized that OMB planned to publish revised urban area definitions sometime in 2003, but, because the specific release date was not known at that time, the guidance stated that the Environmental Protection Agency (EPA) anticipated using the 1999 definitions for the PM-2.5 designation process.

OMB subsequently issued revised urban area definitions on June 6, 2003. The definitions established core-based statistical areas (CBSAs) (or CBSAs, comprised of "metropolitan" and "micropolitan" areas), and combined statistical areas (CSAs) (or CSAs, comprised of two or more core-based statistical areas)[2]. While we are not requiring States and Tribes to use the recently-defined CSA and CBSA as the presumptive boundaries for determining PM-2.5 nonattainment areas, we ask that in your review of State and Tribal recommendations that you assess all counties included in any relevant CSA or CBSA under the 2003 definitions, as well as
any adjacent counties, using the 9 factors identified in the April 1, 2003 guidance. We believe this approach is appropriate because the new OMB definitions group together counties having a

[1] Memorandum from Jeffrey R. Holmstead, Assistant Administrator, to EPA Regional Administrators, "Designations for the Fine Particle National Ambient Air Quality Standards," April 1, 2003.

[2] A list of the 2003 OMB metropolitan area definitions and associated information may be found at: http://www.census.gov/population/www/estimates/metroarea.html.

high degree of social and economic integration with a central core area, reflecting the latest technical information available about significant growth and commuting rates. While EPA is not requiring that States use the 2003 OMB boundary definitions as the presumptive boundaries, please ask that your respective States and Tribes fully document the basis for their recommendations, using the 9 factors identified in the April 2003 guidance.

All other information contained in the April boundary guidance continues to apply, and States and Tribes should continue to follow the guidance in making the boundary recommendations by February 15, 2004, as required in our guidance and the Consolidated Appropriations Bill for FY-2004.[3] In addition, as we requested in the April 2003 guidance we encourage States and Tribes to make every effort to process the 4th quarter 2003 air quality data as quickly as possible so it can be taken into account in the February recommendations. Also, stated in the April 2003 guidance, EPA will make available on our website information submitted in connection with designation recommendations. Therefore, we request that each State and Tribe submit to EPA its designation recommendations, description of the proposed area boundaries, associated maps, and other supporting documentation in electronic format as well as in a hard-copy format.

The Regional Offices should share this additional guidance with States and Tribes and work closely with them to resolve any issues related to the submittal of their area recommendations and supporting information. Staff in OAQPS are available to provide assistance and consultation throughout the designation process. Questions related to this memorandum may be directed to Larry Wallace of my staff at 919-541-0906 or Rich Damberg at 919-541-5592.

cc: Stephen D. Page, OAQPS
Margo Oge, OTAQ
Joe Paisie, OAQPS
Kevin McLean, OGC
Geoffrey Wilcox, OGC
Air Program Managers, Regions I-X

[3] The Consolidated Appropriations Bill for FY-2004 (Public Law 108-199), signed by the President on January 23, 2004, codifies the dates for State recommendations and final EPA action on PM-2.5 designations.

Reader File
Sec's signature

NCDENR

North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor | William G. Ross, Jr., Secretary

February 17, 2004

James I. Palmer, Jr., Esq.
Regional Administrator
U.S EPA, Region IV
61 Forsyth Street, SW
Atlanta, Georgia 30303-3104

RE: Recommendations for $PM_{2.5}$ Non-attainment Designations

Dear Mr. Palmer:

Pursuant to the requirements of the federal Clean Air Act and on behalf of Governor Michael F. Easley, I am submitting to you and your colleagues at EPA the State of North Carolina's recommendations for $PM_{2.5}$ designations.

The attached table presents North Carolina's recommendations for the designation status of each county within the State. These recommendations are based on the most recent three years of data (2001-2003). During this period, violations of the $PM_{2.5}$ standard occurred at only two monitors within the State. There is one violating monitor each in Davidson and Catawba counties.

Davidson County is located in the Greensboro-Winston-Salem-High Point metropolitan statistical area (MSA). All other monitors within the MSA have measured attainment of the standard, thus we recommend that only Davidson County be designated non-attainment.

Catawba County is located in the Unifour MSA. To be consistent with our 8-hour ozone designation, we are recommending that only the MPO planning boundary of Catawba County be designated non-attainment. The MPO planning boundary within this county captures eighty percent of the population. The remainder of the county is rural with an average township population density ranging from less than 100 to just over 200 persons/square mile. A more detailed technical discussion of the $PM_{2.5}$ boundary recommendations from our Division of Air Quality (DAQ) Director, Keith Overcash, will follow this letter by February 20, 2004.

With respect to these two counties, our $PM_{2.5}$ boundary recommendations are the same as our recommendations for 8-hour ozone boundaries. Also, as we did with the 8-hour ozone recommendations, we followed EPA's published guidance concerning the circumstances under which States may vary from the presumptive MSA boundary. Before the guidance was published, EPA accepted and approved in 1990 an approach that had partial MSA's and partial

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counties for the one-hour ozone designations.

As I stated in my February 6, 2004 8-hr ozone boundary recommendation letter, I believe that the presumptive use of MSA boundaries in a case like this fails to take into account the fact that MSAs are established for statistical data purposes which are different from air pollution control concerns. In the December 27, 2000 Federal Register notice, the Office of Management and Budget states:

> "In order to preserve the integrity of its decision making with respect to reviewing and revising the standards for designating areas, OMB believes that it should not attempt to take into account or anticipate any public or private sector non-statistical uses that may be made of the definitions. It cautions that Metropolitan Statistical Area and Micropolitan Statistical Area definitions should not be used to develop and implement Federal, state and local nonstatistical programs and policies without full consideration of the effects of using these definitions for such purposes."

An example of an air quality designation consequence that goes well beyond merely a "statistical" data purpose is the requirement that new or modified major sources of pollution must install the "lowest achievable emission rate" (LAER) level of control and must offset all emissions increases upon designation of non-attainment.

North Carolina is committed to conserving and protecting our natural resources and maintaining a high quality environment for the health, well-being and benefit of all. We believe that improving air quality is critical to the health of our citizens and that our future growth, prosperity and quality of life will be threatened if we do not remain diligent. We look forward to continuing to work with EPA and others to attain the $PM_{2.5}$ standard everywhere in North Carolina and to establish appropriate boundaries for $PM_{2.5}$ non-attainment areas.

Sincerely,

Bill

William G. Ross, Jr.

WGR/ko

attachment

cc: The Honorable Michael F. Easley, Governor, State of North Carolina
The Honorable Jim Fain, Secretary, NC Department of Commerce
The Honorable Lyndo Tippett, Secretary, NC Department of Transportation
The Honorable Britt Cobb, Commissioner, NC Department of Agriculture and Consumer Services
Beverly Banister, US EPA
Keith Overcash, Director, Division of Air Quality, NC DENR

North Carolina's Recommendations on Boundaries for $PM_{2.5}$ Non-attainment Areas

Designated Area	Designation Type
Greensboro-Winston-Salem-High Point Area:	
Alamance County	Attainment
Davidson County	Non-attainment
Forsyth County	Attainment
Guilford County	Attainment
Caswell County	Attainment
Davie County	Attainment
Randolph County	Attainment
Rockingham County	Attainment
Hickory-Newton-Conover Area:	
Alexander County	Attainment
Burke County	Attainment
Caldwell County	Attainment
Catawba County	Non-attainment
Unifour MPO Boundary	
Rest of State	Attainment

NCDENR

North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor | June 21, 2004 | William G. Ross Jr., Secretary

The Honorable Michael Leavitt
Administrator
US Environmental Protection Agency
401 M Street, Southwest
Washington, DC 20460

Re: North Carolina $PM_{2.5}$ Nonattainment Boundaries

Dear Administrator Leavitt:

I am writing to express concerns over the Environmental Protection Agency's recent proposal to use an emissions-weighted approach to define $PM_{2.5}$ nonattainment boundaries, which was announced three months after the states had submitted boundary recommendations. This late notice of a new approach is contrary to the spirit of the established nonattainment designation process under which states use their more thorough knowledge of the monitoring network as well as other local and regional circumstances to propose nonattainment boundaries based upon guidance provided by EPA. By departing from its original April 2003 guidance at this late point in the process, EPA is retroactively changing the rules we have followed.

While North Carolina is still reviewing the emissions-weighted approach, we already have concerns with its failure to take into account prevailing wind directions during the calendar quarters in which $PM_{2.5}$ values are higher, as well as its assumption that emissions impact a monitor equally throughout the year, regardless of the monitor's location and its distance from the source.

The most glaring immediate concern, however, is that boundary decisions based on this new approach would ignore the pollution reductions already required by the North Carolina Clean Smokestacks Act. According to staff in EPA Region 4, Rutherford County, which is neither an MSA county nor has a violating monitor, would be included as part of the Hickory nonattainment area simply because there is a power plant located in this largely rural county. There are apparently at least three other counties (Rowan and Rockingham outside the MSA and Stokes within the MSA) that are being considered for inclusion in the Triad nonattainment area for the same reason. This proposal ignores the landmark Clean Smokestacks legislation passed by the North Carolina General Assembly in 2002. What additional controls, other than those already prescribed by the Clean Smokestacks Act, would we as a state or you as EPA impose on these counties? In fact,

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the inclusion of these four counties in the nonattainment areas for North Carolina will not result in any change in our strategy to reduce emissions that cause the fine particle exceedances in this state and will only result in tagging the subject counties with the consequences of nonattainment.

In addition, EPA has indicated that two of our counties, Forsyth and Guilford, both with attaining monitors, would be part of the nonattainment area due to the violating monitor in Davidson County. Stokes County would also be named, as would Randolph County because of their weighted emission scores. Again, the emissions-weighted approach is not addressing the attaining ambient data in two of the counties, nor the wind direction during the quarters in which $PM_{2.5}$ values are higher.

I strongly encourage your consideration of these comments before the letters are sent to the States later this month. Please call me at (919) 715-4105 should you wish to discuss this issue further.

Sincerely,

William G. Ross, Jr.

cc: Jimmy Palmer
Beverly Banister
Jim Gulick
Keith Overcash

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

JUN 29 2004

4APT-APB

Honorable Mike F. Easley
Governor of North Carolina
State Capitol
20301 Mail Service Center
Raleigh, NC 27699-0301

Dear Governor Easley:

Fine-particle pollution represents one of the most significant barriers to clean air facing our nation today. These tiny particles – about 1/30th the diameter of a human hair – have been scientifically linked to serious human health problems. Their ability to be suspended in air for long periods of time makes them a public health threat far beyond the source of emissions. An important part of our nation's commitment to clean, healthy air deals with reducing levels of this fine particle or PM2.5 pollution.

In February, your State submitted its recommended boundaries for PM2.5 attainment and nonattainment areas. We have thoroughly reviewed your recommendations and the technical information you have submitted to support your recommendations. We appreciate the effort your State has made to develop this supporting information. Consistent with the Clean Air Act, this letter is to notify you that based on the information contained in your submittal, EPA intends to make modifications to recommended designations and boundaries in your State.

The detailed enclosure contains a description of areas where EPA intends to modify your State recommendations, and the basis for such modification. Should you have additional information that you wish to be considered by EPA in this process, we request that you provide it to us by September 1.

You will hear from us again in November when EPA takes the final step in the PM2.5 designation process and determines those areas that are in attainment and meet the fine particle standards and those areas that do not meet them. For areas in attainment, the challenge will be not only to maintain, but also to continue the progress you have made toward clean air. It is a commitment to no backsliding in your State's clean air status for fine particles. EPA will also issue a proposed fine particle implementation rule prior to final designations, which will allow you to proceed with planning to achieve clean air.

The Bush Administration is addressing fine particle pollution with a comprehensive national clean air strategy. This strategy includes EPA's recent rule to reduce pollution from nonroad diesel engines, and the proposed rule to reduce pollution from power plants in the eastern U.S. These two rules are important components of EPA's efforts to help States and localities meet the more protective national fine-particle and 8-hour ozone air quality standards. Together these rules will help all areas of the country achieve cleaner air.

Should you or your staff have any questions, I invite you to contact Beverly H. Banister, Director, Air Pesticides and Toxics Management Division, at 404/562-9077, or Kay T. Prince, Chief, Air Planning Branch, at 404/562-9026. We look forward to a continued dialogue with you as we work together to implement the PM2.5 standards.

Sincerely,

J. I. Palmer, Jr.
Regional Administrator

Enclosure

cc: Keith Overcash, NCDENR
William Ross, NCDENR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

JUN 2 9 2004

4APT-APB

William G. Ross, Secretary
North Carolina Department of Environment
and Natural Resources
1601 Mail Service Station
Raleigh, NC 27699-1601

Dear Mr. Ross:

Fine-particle pollution represents one of the most significant barriers to clean air facing our nation today. These tiny particles – about 1/30th the diameter of a human hair – have been scientifically linked to serious human health problems. Their ability to be suspended in air for long periods of time makes them a public health threat far beyond the source of emissions. An important part of our nation's commitment to clean, healthy air deals with reducing levels of this fine particle or PM2.5 pollution.

In February, your State submitted its recommended boundaries for PM2.5 attainment and nonattainment areas. We have thoroughly reviewed your recommendations and the technical information you have submitted to support your recommendations. We appreciate the effort your State has made to develop this supporting information. Consistent with the Clean Air Act, this letter is to notify you that based on the information contained in your submittal, EPA intends to make modifications to recommended designations and boundaries in your State.

Your Governor was sent a letter today notifying him that EPA is modifying the State's recommendation. This letter contains a more detailed enclosure containing a description of areas where EPA intends to modify your State recommendations, and the basis for such modification. Should you have additional information that you wish to be considered by EPA in this process, we request that you provide it to us by September 1, 2004.

You will hear from us again in November when EPA takes the final step in the PM2.5 designation process and determines those areas that are in attainment and meet the fine particle standards and those areas that do not meet them. For areas in attainment, the challenge will be not only to maintain, but also to continue the progress you have made toward clean air. It is a commitment to no backsliding in your State's clean air status for fine particles. EPA will also issue a proposed fine particle implementation rule prior to final designations, which will allow you to proceed with planning to achieve clean air.

The Bush Administration is addressing fine particle pollution with a comprehensive national clean air strategy. This strategy includes EPA's recent rule to reduce pollution from nonroad diesel engines, and the proposed rule to reduce pollution from power plants in the eastern U.S. These two rules are important components of EPA's efforts to help States and localities meet the more protective national fine-particle and 8-hour ozone air quality standards. Together these rules will help all areas of the country achieve cleaner air.

Should you or your staff have any questions, I invite you to contact Beverly H. Banister, Director, Air, Pesticides and Toxics Management Division, at 404/562-9077, or Kay T. Prince, Chief, Air Planning Branch, at 404/562-9026. We look forward to a continued dialogue with you as we work together to implement the PM2.5 standards.

Sincerely,

J. I. Palmer, Jr.
Regional Administrator

Enclosure

cc: Keith Overcash, NCDENR

Enclosure for 120 Day Letter
Justification for Modifications to State Recommendations
PM2.5 Nonattainment Areas
State of North Carolina

An Explanation of EPA's 9-Factor Analysis

Factor 1. Emissions in areas potentially included versus excluded from the nonattainment area:

The analysis for factor 1 looks at emissions of carbonaceous particles ("carbon"), inorganic particles ("crustal"), SO2 , and NOx. EPA computed a composite emission score for each county by multiplying the county's emissions as a fraction of the metropolitan area emissions for each of these pollutants times a corresponding air quality weighting factor. The air quality weighting factors for each area are given below and reflect the percentages of the total estimated "urban excess" value found as, respectively, carbonaceous particles, miscellaneous inorganic particles ("crustal material"), ammonium sulfate, and ammonium nitrate. These scores add to 100 for the metropolitan area counties. Composite scores were also calculated for counties adjacent to the metropolitan area. Tables presented under factor 1 present the emissions of carbonaceous particles, inorganic particles, SO2 , and NOx and the composite emission scores for the counties in the corresponding metropolitan area and adjacent counties. Metropolitan area counties are in bold. Emissions data indicate the potential for a county to contribute to observed violations, often making the emissions data the most important factor in assessing boundaries of nonattainment areas.

"Urban excess" values are derived by comparing urban monitored component concentrations against rural monitored component concentrations. Concentrations of the four PM2.5 components are obtained from local data if available (or, if necessary, from the nearest available urban site), and are compared to available rural concentrations. The monitoring sites used for this purpose are identified below. Although this information is air quality information, it is presented under Factor 1 due to its integration into the analysis of emissions information.

Factor 2. Air quality in potentially included versus excluded areas:

The air quality analysis looks at the annual averaged design value for each area based on data for 2001 to 2003. Counties without monitors are not listed.

Factor 3. Population density and degree of urbanization including commercial development in included versus excluded areas:

Tables presented under factor 3 show the 2003 population for each metropolitan area, as well as the population density for each county in that area. Population data indicate the likelihood of population-based emissions that might contribute to violations.

Factor 4. Traffic and commuting patterns:

The traffic and commuting analysis looks at the number of commuters in each county who drive to another county within the metropolitan area ("Number"), the percent of total commuters in each county who commute to other counties within the metropolitan area ("percent"), as well as the total Vehicle Miles Traveled (VMT) for each county in thousands of miles. A county with numerous commuters is generally an integral part of the area, and would be an appropriate part of the domain of some mobile source strategies, thus warranting inclusion in the nonattainment area.*

**Note that the percent of commuters traveling to counties within the metropolitan area is based on the total number of commuters from that county. This total includes commuters who may travel outside the metropolitan area from their county of origin.*

Factor 5. Expected growth:

The expected growth analysis looks at the percent growth for counties in each metropolitan area from 1990 to 2000.

Factor 6. Meteorology:

The meteorology analysis looks at wind data gathered over a ten year period by the National Weather Service. Tables presented under factor 6 list the year round average prevailing wind directions by quadrant for each county in the corresponding metropolitan area. These data show that annual average PM2.5 concentrations are influenced by emissions in any direction at various times, but these data may also suggest that emissions in some directions relative to the violation may be more prone to contribute than emissions in other directions.

Factor 7. Geography/topography:

The geography/topography analysis looks at physical features of the land that might have an effect on the airshed, and therefore, the distribution of particulate matter over an area. The State of North Carolina has no such features that significantly influenced EPA's recommended nonattainment areas.

Factor 8. Jurisdictional boundaries:

The analysis of jurisdictional boundaries looks at the planning and organizational structure of an area to determine if the implementation of controls in a potential nonattainment area can be carried out in a cohesive manner.

Factor 9. Level of control of emission sources:

The level of control analysis looks at what controls are currently implemented in each area.

Below is the nine factor analysis for Greensboro-Winston-Salem-High Point, NC. The Greensboro-Winston-Salem-High Point, NC Metropolitan Statistical Area (MSA) contains the counties of Stokes, Guilford, Davidson, Forsyth, Randolph, Alamance, Yadkin, and Davie.

In February 2004, North Carolina recommended that the entire county of Davidson, be designated as nonattainment for the Fine Particulate Matter Standard. The table below shows the State recommendations and EPA modifications for the Particulate Matter(PM 2.5) nonattainment area in Greensboro-Winston-Salem-High Point, NC. EPA is recommending Davidson County be designated nonattainment because it has a violating PM 2.5 monitor. The MSA counties of Guilford, Stokes, Forsyth and Randolph are also being recommended as nonattaiment. Guilford, Forsyth and Randolph counties are adjacent to Davidson County and have large populations and large emissions. Stokes has significant power plant emissions. EPA agrees that Alamance, Davie, Yadkin, Rowan, Chatham, Rockingham, and Iredell Counties be designated attainment/unclassifiable. Alamance is an MSA county with an attaining monitor of 13.7 micrograms per cubic meter ($\mu g/m^3$), 75 % of the commuters remain in Alamance County and the county has low emissions. Davie and Yadkin are MSA counties that do not contain PM 2.5 monitors, have low populations, and low commuting into Davidson. There is significant distance between the violating monitor and the counties of Iredell and Yadkin. Rowan and Iredell are adjacent to the MSA, do not contain PM 2.5 monitors and are a part of the Charlotte-Gastonia-Rock Hill nonattainment area for ozone. Rowan and Rockingham both have small power plants and there are attaining monitors in counties between the SO_2/NOx sources in Rowan and Rockingham counties and the violating monitor. Chatham is an adjacent county to the Greensboro-Winston-Salem-High Point MSA with an attaining monitor of 12.2 $\mu g/m^3$, has low population, and part of the county is in the Raleigh-Durham-Chapel Hill nonattainment area for ozone. The remaining adjacent counties all have low emissions, low population and low VMT, indicating they should be attainment/unclassifiable.

Area	EPA Recommendation	State Recommendation
Greensboro-Winston-Salem-High Point, NC	**Full Counties:** Stokes, Guilford, Davidson, Forsyth, and Randolph	**Full Counties:** Davidson

The following is a brief summary of the 9 criteria:

The following table has 2001 $PM_{2.5}$, SO_2, NOx, VOC, and Ammonia (Amm) emissions in tons, and weighted emissions scores for the Greensboro-Winston-Salem-High Point Area and surrounding counties. The MSA counties are in **bold**.

		PM 2.5	SO_2	NOx	VOC	Amm	Weighted emissions score	Cumulative Weighted emissions score
NC	**Stokes**	**4,821**	**83,409**	**35,936**	**2,566**	**357**	**32.8**	**32.8**
NC	**Guilford**	**2,418**	**2,833**	**19,068**	**34,464**	**1,178**	**17.6**	**50.4**
NC	**Davidson**	**1,951**	**1,398**	**11,281**	**14,970**	**632**	**12.9**	**63.3**
NC	**Forsyth**	**1,559**	**5,885**	**14,552**	**20,679**	**722**	**11.7**	**75.0**
NC	**Randolph**	**1,370**	**907**	**5,898**	**10,307**	**4,014**	**9.5**	**84.5**
NC	**Alamance**	**1,181**	**749**	**5,618**	**8,967**	**730**	**8.2**	**92.7**
NC	**Yadkin**	**606**	**318**	**2,061**	**2,247**	**896**	**4.0**	**96.7**
NC	**Davie**	**508**	**205**	**1,959**	**3,278**	**448**	**3.3**	**100.0**
NC	Rowan	2,012	12,465	11,681	11,323	726	13.4	
NC	Chatham	1,714	11,605	5,823	4,734	3,012	11.7	
NC	Rockingham	1,555	6,263	12,227	8,770	523	11.2	
NC	Iredell	1,537	1,365	11,065	10,346	2,090	10.8	
NC	Surry	1,224	1,238	5,055	7,478	1,811	8.5	
VA	Pittsylvania	980	1,828	7,490	4,149	581	7.2	
NC	Moore	956	409	3,197	6,519	2,396	6.9	
NC	Wilkes	966	647	2,890	5,097	5,300	6.6	
NC	Orange	857	756	6,264	6,751	572	6.4	
VA	Henry	818	535	3,811	10,517	197	5.6	
NC	Stanly	795	3,129	2,891	4,581	1,460	5.3	
NC	Montgomery	516	484	1,631	4,175	1,246	3.6	
NC	Caswell	483	199	1,071	1,622	155	3.2	
VA	Patrick	408	176	1,039	1,363	214	2.8	
VA	Carroll	378	509	2,305	1,986	441	2.7	
VA	Grayson	291	95	819	952	405	2.0	
NC	Alleghany	217	190	379	590	425	1.4	

Based on the analysis for this factor, there appears to be emissions in Stokes, Guilford, Forsyth, and Randolph counties that contribute to the air quality in Davidson County, resulting in a violating monitor there. This analysis shows that the adjacent counties of Rowan, Chatham, Rockingham, and Iredell have emissions that may contribute to the violation in Davidson County.

However, these counties are more distant from the violating monitor. Chatham County has an attaining monitor and is part of the Raleigh MSA. Rowan and part of Iredell County are in the Charlotte ozone nonattainment area.

Factor 2: Air Quality in potentially included versus excluded areas

		2001-2003 Design Value
NC	**Guilford**	**14.1**
NC	**Davidson**	**15.8**
NC	**Forsyth**	**14.6**
NC	**Alamance**	**13.7**
NC	Chatham	12.2
NC	Orange	13.1
NC	Montgomery	12.1
NC	Caswell	13.3

There are six monitors in the MSA (two in Guilford, and two in Forsyth counties and one in Davidson, and Alamance counties) and five monitors in the adjacent counties. The monitor in Davidson County, is violating the Particulate Matter Standard of 15.0 micrograms per cubic meter ($\mu g/m^3$). All other monitors in this area are attaining the Particulate Matter Standard.

Factor 3: Population Density and Degree of Urbanization including commercial development in included versus excluded areas

The following table has the populations for the counties in the Greensboro-Winston-Salem-High Point area and adjacent counties with significant weighted emissions scores.

		2002 Population	% Population of MSA	Population Density (pop./ mi^2)
NC	**Stokes**	**44,984**	**3.5**	**100**
NC	**Guilford**	**430,937**	**33.5**	**663**
NC	**Davidson**	**151,238**	**11.6**	**274**
NC	**Forsyth**	**314,933**	**24.5**	**768**
NC	**Randolph**	**134,217**	**10.4**	**170**
NC	**Alamance**	**135,893**	**10.6**	**315**
NC	**Yadkin**	**37,329**	**2.9**	**111**
NC	**Davie**	**36,734**	**2.9**	**139**
NC	Rowan	133,359		261
NC	Chatham	53,893		79
NC	Rockingham	92,778		164

NC	Iredell	130,178		227

Based on the analysis for this factor, there appears to be significant populations in Guilford, Forsyth, Davidson, Rowan, Iredell, Randolph and Alamance counties, indicating potential contribution.

Factor 4: Traffic and commuting patterns

Commuting Information

Total commuters in Davidson County: 72,893
Commuters in Davidson County, NC, who work in Davidson County: 40,621 (56%)

Total commuters in Forsyth County: 147,838
Commuters in Forsyth County, NC, who work in Forsyth County: 119,233 (81%)
Commuters from Forsyth County, NC to Davidson County, NC: 4,136 (3%)

Total commuters in Guilford County: 213,079
Commuters in Guilford County, NC, who work in Guilford County: 187,150 (88%)
Commuters from Guilford County, NC to Davidson County, NC: 2,982 (1%)

Total commuters in Randolph County: 65,803
Commuters in Randolph County, NC, who work in Randolph County: 38,637 (59%)
Commuters from Randolph County, NC to Davidson County, NC: 2,607 (4%)

Total commuters in Stokes County: 21,709
Commuters in Stokes County, NC, who work in Stokes County: 6,330 (29%)
Commuters from Stokes County, NC to Davidson County, NC: 252 (1%)

The counties of Davie and Rowan have a small number of commuters and very few of them commute to Davidson County. Chatham, Yadkin, Iredell, and Rockingham counties have a low number of commuters and most of them stay within their counties.

Based on commuting patterns, Forsyth and Guilford appear to have the most impact on the violating monitor in Davidson County. However, the impact on the monitor from commuting appears to be small.

The following table contains the vehicle miles traveled (VMT) for the counties in the Greensboro-Winston-Salem-High Point area and some adjacent counties with significant emissions. (MSA counties are in **bold**).

		2002 VMT (thousands of miles)
NC	**Stokes**	**415**
NC	**Guilford**	**5,096**
NC	**Davidson**	**1,765**
NC	**Forsyth**	**3,832**
NC	**Randolph**	**1,486**
NC	**Alamance**	**1,575**
NC	**Yadkin**	**520**
NC	Davie	476
NC	Rowan	1,654
NC	Chatham	434
NC	Rockingham	923
NC	Iredell	1,901

Based on total VMT, there appears to be contribution to air quality in Davidson County from Guilford, Davidson, Forysth, Rowan, Iredell, Randolph and Alamance counties. However, there is very low or no commuting into Davidson County from Rowan. Iredell, and Alamance Counties

Factor 5: Expected growth

The following table has the population and population growth on a percentage basis figures for counties in the Greensboro-Winston-Salem-High Point MSA and some adjacent counties with significant emissions. As noted above, Chatham County is part of the Raleigh MSA, and Iredell and Rowan Counties are in the Charlotte rather than the Greensboro ozone nonattainment area.

		2002 Population	Growth '90-'00	% Change '90-'00
NC	**Stokes**	**44,984**	**7,488**	**20**
NC	**Guilford**	**430,937**	**73,628**	**21**
NC	**Davidson**	**151,238**	**20,569**	**16**
NC	**Forsyth**	**314,933**	**40,189**	**15**
NC	**Randolph**	**134,217**	**23,908**	**22**
NC	**Alamance**	**135,893**	**22,587**	**21**
NC	**Yadkin**	**37,329**	**5,860**	**19**
NC	**Davie**	36,734	6,976	25
NC	Rowan	133,359	19,735	18
NC	Chatham	53,893	10,570	27
NC	Rockingham	92,778	5,864	7

NC	Iredell	130,178	29,729	32

Based on the analysis for this factor, there appears to be significant growth in Davidson, Guilford, Forsyth, Alamance, Randolph, Rowan, Chatham, and Iredell counties indicating a potential contribution to the air quality in Davidson County.

Factor 6: Meteorology

The following meteorological information was provided by North Carolina. This summarizes the wind directions for the MSA during the time periods when PM2.5 values are the highest.

Summertime: southwesterly winds and recirculating patterns dominate. Main urban areas of influence include Charlotte, the Triad, and Hickory.

Wintertime: More northerly and stronger northwesterly winds observed that during the summer. High PM2.5 is generally observed prior to frontal passages when high pressure is in control or during strong nocturnal low-level temperature inversions. Year-round trajectories indicate influence from nearby states.

The information provided is not sufficient to provide a compelling argument to exclude counties based on prevailing winds.

Factor 7: Geography/topography

There are no significant topographical issues associated with this MSA. Chatham, Iredell, and Rockingham counties are one or more counties away from Davidson county. Additionally, there is one or more attaining monitors between the major emissions sources in these counties and the violating monitor, indicating no contribution.

Factor 8: Jurisdictional boundaries

The 8-hour nonattainment boundary designation for the Greensboro-Winston-Salem-High Point area includes the entire counties of Davidson, Davie, Forsyth, Guilford, Alamance, Caswell, Randolph, and Rockingham. Davie, Alamance, Caswell, and Rockingham were designated nonattainment for ozone because they contained violating monitors not because they were found to be contributing. Rowan county and a portion of Iredell county were designated nonattainment for the ozone standard as apart of the Charlotte-Gastonia-Rock Hill MSA area. Due to significant NOx controls, Stokes County was determined not to contribute to the ozone violations.

Factor 9: Level of control of emission sources

Belews Creek is the largest coal-burning station owned by Duke Power located in Stokes County, NC. Duke Power completed the first phase of its massive Selective Catalytic Reduction (SCR) project at Belews Creek Steam Station that will reduce the power plant's nitrogen oxide emissions by over 90 percent. No scrubbers are installed at this time, but are scheduled to be installed in 2009.

The state initiatives are listed below:
NOx SIP Call
The Clean Smokestacks Act
Clean Air Bill
On Board Diagnostics II Emissions Inspection Program
$PM_{2.5}$ Forecasting

Hickory-Morganton-Lenoir, NC

The following is the nine factor analysis for Hickory-Morganton-Lenoir, NC. The Hickory-Morganton-Lenoir, NC Metropolitan Statistical Area (MSA) contains the counties of Catawba, Caldwell, Burke, and Alexander.

In February 2004, North Carolina recommended that the Unifour Metropolitan Planning Organization's (MPO) Planning Boundary in Catawba County, be designated as nonattainment. The table below shows State Recommendations and EPA recommended modifications for the Particulate Matter 2.5 (PM 2.5) nonattainment area in the Hickory-Morganton-Lenoir area. EPA is modifying the recommendation to include the entire county of Catawba and partial county boundaries in Burke and Caldwell Counties. Catawba County has a violating PM 2.5 monitor. The partial county boundaries in Burke and Caldwell Counties follow the MPO boundary lines which were the boundaries determined in the 8-hour ozone designation in April 2004 for the two counties. Over 20 percent of the commuters from Burke and Caldwell counties commute to Catawba County and both counties contain population levels that indicate contribution. EPA agrees that the MSA county of Alexander and the adjacent counties of Rutherford, Iredell, Cleveland, and Wilkes be designated attainment/unclassifiable. These counties have low population, and are low commuting into Catawba County, distant from the violating monitor in Catawba County. The remaining adjacent counties all have low emissions and low population, indicating they should be attainment/unclassifiable.

Area	EPA Recommendation	State Recommendation
Hickory-Morganton-Lenoir	**Full Counties:** Catawba, **Partial Counties:** Burke and Caldwell	**Full Counties:** None **Partial Counties:** Catawba

The following is a brief summary of the 9 criteria for the Hickory-Morganton-Lenoir MSA and surrounding counties . These analyses were based on existing available data.

Factor 1: Emissions in areas potentially included versus excluded from the nonattainment area

The following table has 2001 $PM_{2.5}$, SO2, NOx, VOC, and Ammonia (Amm) emissions in tons, and weighted emissions scores for the Hickory-Morganton-Lenoir Area and surrounding counties. The Metropolitan Statistical Area (MSA) counties are in **bold**.

	PM 2.5	SO_2	NOx	VOC	Amm	Weighted emissions score	Cumulative Weighted emissions score
Catawba	**5,153**	**78,620**	**27,968**	**19,760**	**886**	**59.7**	**59.7**
Caldwell	**1,104**	**634**	**3,530**	**11,122**	**391**	**18.1**	**77.8**
Burke	**1,198**	**877**	**4,601**	**7,721**	**562**	**17.0**	**94.8**
Alexander	**365**	**349**	**988**	**3,312**	**1,217**	**5.1**	**99.9**
Rutherford	2,323	30,023	12,135	4,847	254	28.4	
Iredell	1,537	1,365	11,065	10,346	2,090	25.3	
Cleveland	1,258	1,261	4,975	6,591	1,240	18.4	
Wilkes	966	647	2,890	5,097	5,300	15.3	
Mc Dowell	751	373	3,675	4,230	214	13.6	
Lincoln	785	513	2,880	4,556	645	10.8	
Watauga	541	352	1,523	2,370	341	8.5	
Avery	269	163	730	985	77	4.4	

Based on the analysis for this factor, there appears to be emissions in the MSA counties of Caldwell and Burke, counties that contribute to the violation in Catawba County. Although there are large SO_2 emissions in Rutherford county, adjacent to Burke, the source is distant from the violating monitor.

Factor 2: Air Quality in potentially included versus excluded areas

	2001-2003 Design Value
Catawba	**15.5**
Mc Dowell	14.2
Watauga	10.9

There is one monitor in this area, in Catawba County, which is violating the particulate matter standard of 15.0 micrograms per cubic meter ($\mu g/m^3$). Two adjacent counties contain monitors attaining the standard.

Factor 3: Population Density and Degree of Urbanization

The following table has the populations for the counties in the Hickory-Morganton-Lenoir area and adjacent counties with significant emissions. (MSA counties are in **bold**.)

	2002 Population	% Population of MSA	Population Density (pop./ mi^2)
Catawba	**146,690**	**42.0**	**367**
Caldwell	**78,513**	**22.5**	**166**
Burke	**89,638**	**25.7**	**177**
Alexander	**34,400**	**9.8**	**132**
Rutherford	63,287		112
Iredell	130,178		227
Cleveland	97,960		211
Wilkes	66,773		88

Based on the analysis for this factor, there appears to significant populations in Catawba, Iredell, Cleveland, Caldwell and Burke counties, indicating potential contribution.

Factor 4: Traffic and commuting patterns

Commuting Information

Total commuters in Catawba County: 73, 984
Commuters in Catawba County, NC, who work in Catawba County: 62, 459 (84%)

Total commuters in Rutherford County: 27, 673
Commuters in Rutherford County, NC, who work in Rutherford County: 21, 812 (79%)
Commuters from Rutherford County, NC to Burke County, NC: 305 (1%)

Total commuters in Caldwell County: 38, 970
Commuters in Caldwell County, NC, who work in Caldwell County: 26, 932 (69 %)
Commuters from Caldwell County, NC to Catawba County, NC: 8,011 (21 %)

Total commuters in Burke County: 42,214
Commuters in Burke County, NC, who work in Burke County: 29, 123 (69%)

Commuters from Burke County, NC to Catawba County, NC: 8,366 (20%)

Total commuters in Alexander County: 31, 041
Commuters in Alexander County, NC, who work in Alexander County: 24, 270 (51%)
Commuters from Alexander County, NC to Catawba County, NC: 5,679 (32%)

Most of the commuters in Iredell, Cleveland and Wilkes counties commute within their counties and very few of them commute to Davidson County.

Based on commuting patterns, Caldwell, Alexander and Burke counties appear to have the most potential impact on the violating monitor in Catawba county.

The following table contains the vehicle miles traveled (VMT) for the counties in the Hickory-Morganton-Lenoir MSA and some adjacent counties with significant weighted emissions scores. (MSA counties are in **bold**.)

	2002 VMT (thousands of miles)
Catawba	**2,048**
Caldwell	**738**
Burke	**1,112**
Alexander	**229**
Rutherford	606
Iredell	1,901
Cleveland	1,125
Wilkes	619

Based on the analysis for this factor, Burke County has VMT that appears to contribute to the air quality in Catawba County. Although the adjacent counties of Iredell and Cleveland have significant levels of VMT, there is little commuting to Catawba County from these counties.

Factor 5: Expected growth

The following table has the population and population growth figures for counties in the Hickory-Morganton-Lenoir MSA and some adjacent counties with significant emissions.

	2002 Population	Growth '90-'00	Pct change '90-'00
Catawba	**146,690**	**23,273**	**20**
Caldwell	**78,513**	**6,706**	**9**
Burke	**89,638**	**13,404**	**18**
Alexander	**34,400**	**6,059**	**22**
Rutherford	63,287	5,981	11
Iredell	130,178	29,729	32
Cleveland	97,960	11,573	14
Wilkes	66,773	6,239	11

Based on the analysis for this factor, there appears to be significant growth on a percentage in Catawba and Alexander Counties in the MSA and adjacent Iredell County, indicating a potential contribution to the air quality in Catawba County. Although the percentage growth is high for the Iredell County, it is more closely associated with the Charlotte area.

Factor 6: Meteorology

The following meteorological information was provided by North Carolina. This summarizes the wind directions for the MSA during the time periods when $PM_{2.5}$ values are the highest.

Summertime: southwesterly winds and recirculating patterns dominate. Main urban areas of influence include Charlotte, the Triad, and Hickory.

Wintertime: More northerly and stronger northwesterly winds observed that during the summer. High PM2.5 is generally observed prior to frontal passages when high pressure is in control or during strong nocturnal low-level temperature inversions. Year-round trajectories indicate influence from nearby states.

The information provided is not sufficient to provide a compelling argument to exclude counties based on prevailing winds.

Factor 7: Geography/topography

There are no significant topographical issues associated with this MSA.

Factor 8: Jurisdictional boundaries

The 8-hour nonattainment boundary designation for the Hickory-Morganton-Lenoir area includes the entire counties of Alexander and Catawba and partial counties of Burke and Caldwell. The nonattainment designation in Burke and Caldwell counties are along the Unifour Metropolitan Planning Organization boundaries. Catawba County is located geographically between Alexander and Lincoln Counties, which both have monitors violating the 8-hour ozone standard.

In Catawba County, a second monitor was operated approximately 10 miles southwest of the current violating Hickory monitor. This monitor was further removed from a major highway. The location of this monitor at a rescue squad and was not able to continue at that location. While in existence for seven quarters, this monitor showed an average of 1.89 $\mu g/m^3$ lower than the current violating monitor. Therefore, the state believes that this monitor would have continued to show attainment/unclassifiable if it remained in existence to collect three years of data.

Factor 9: Level of control of emission sources

Duke Power - Marshall Steam Station (Catawba County)

No scrubbers are installed at this time. However, in 2004, Duke Power began installation of flue gas desulfurization (scrubber) equipment. This equipment will lower sulfur dioxide emissions by approximately 90 percent. The project is scheduled for completion in 2007.

The state initiatives are listed below:
NOx SIP Call
The Clean Smokestacks Act
Clean Air Bill
On Board Diagnostics II Emissions Inspection Program
$PM_{2.5}$ Forecasting

NCDENR
North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor

William G. Ross Jr., Secretary

September 8, 2004

Mr. James I. Palmer, Jr.
Regional Administrator
U.S EPA, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

RE: $PM_{2.5}$ Non-attainment Designations

Dear Mr. Palmer:

In your June 29, 2004 letter, you provided North Carolina with EPA's response to our state's $PM_{2.5}$ non-attainment boundary recommendations. North Carolina has been a leader among states with regard to improving air quality and remains committed to the continued improvement of air quality and the protection of its citizens. The non-attainment boundary recommendations made by EPA include several counties that North Carolina continues to believe should be designated attainment for $PM_{2.5}$. Below, I state why North Carolina believes that these counties should be designated attainment. I also urge you to consider again the discussion and technical documents presented in our initial February 2004 submissions. In addition, please find attached our $PM_{2.5}$ Designation Response Technical Support Document.

In the Greensboro/Winston-Salem/High Point area, EPA recommends that the entire counties of Stokes, Guilford, Davidson, Forsyth and Randolph be designated non-attainment. North Carolina originally recommended Davidson County only as the $PM_{2.5}$ non-attainment boundary. We continue to believe that only Davidson County should be designated as non-attainment.

North Carolina believes that Stokes County should be designated attainment for the following reasons. While Stokes County contains the Belews Creek power plant, an analysis of forward trajectories indicates that emissions from Belews Creek do not frequently impact the $PM_{2.5}$ monitor in Davidson County. There are also $PM_{2.5}$ monitors currently attaining the standard in Forsyth County that lie between Stokes County and the non-attaining monitor in Davidson County. Even if the Belews Creek facility is affecting the Lexington area, significant NOx controls have already been installed on the plant. Selective catalytic reduction systems have already been installed on units 1 and 2 at the Belews Creek facility, and additional burner technology has been added at unit 2. This NO_x control technology began operation in 2003 and 2004. Consequently, the NO_x emissions will decrease from 43,567 tons per year to 7,022 tons per year and new SO_2 controls will be installed over the next several years as a result of the Clean Smokestacks Act. SO_2 emissions from Belews Creek will be reduced by nearly 90% in the next several years as these controls become fully operational.

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Also, Stokes County is an extremely rural county, and therefore has very little mobile emissions. North Carolina believes that the current and future controls on the Belews Creek facility, the apparent small impact of Belews Creek on Davidson County, and the rural nature of the county support designating Stokes County in attainment for $PM_{2.5}$. If EPA continues to believe that Stokes County should be designated non-attainment because of Belews Creek, North Carolina recommends that only the Sauratown Township where the Belews Creek power plant is located be designated non-attainment.

North Carolina believes that Randolph County should be designated attainment for several reasons. The EPA L-Factor ranking for Randolph County is the lowest of the counties recommended by EPA to be designated non-attainment. Randolph County is also predominately downwind of Davidson County during the summer months when $PM_{2.5}$ concentrations are the highest and therefore emissions from Randolph County would not be expected to contribute significantly to $PM_{2.5}$ concentrations in Davidson County during those months. The majority of emissions within Randolph County are mobile emissions and less than 5% of the workforce commutes into Davidson County. Furthermore, the mobile source emissions will be addressed by federal rules such as heavy-duty engine standards and low sulfur diesel.

Guilford and Forsyth counties each contain $PM_{2.5}$ monitors that are attaining the standard based on current design values. The counties also lie to the north and northeast of Davidson County, which makes Guilford and Forsyth counties predominately downwind of Davidson County during the summer months when $PM_{2.5}$ is the highest. The majority of emissions from these counties are mobile, and therefore these counties and surrounding counties will benefit from federal rules addressing mobile emissions as well as the expanded North Carolina motor vehicle inspection program. They will also benefit from local measures aimed at reducing mobile emissions as part of the Early Action Compact (EAC) effort in the Triad area.

North Carolina has an analysis that shows $PM_{2.5}$ concentration and its relationship to population density in the Triad area. The Lexington monitor does not behave the same as surrounding monitors when considering the population around the monitoring site. The analysis suggests that the higher concentrations of $PM_{2.5}$ in Davidson County are the result of local factors rather than broader population-related regional influences and therefore the addition of counties beyond just Davidson County will not help the monitor attain the standard. Please see appendix for details.

Finally, with regard to the Lexington monitor, there has been a downward trend in the $PM_{2.5}$ concentrations since 1999. We believe that this in considerable part reflects some reductions in the emission of pollutants in certain upwind states over that period. EPA itself has already concluded that these out-of-state sources contribute significantly to elevated $PM_{2.5}$ in North Carolina. We expect that the downward trend should continue at this site as more emissions reductions are expected due to implementation of the Clean Smokestacks Act, NOx SIP call rules, federal heavy-duty engine standards and new fuel standards. We anticipate further improvement in Lexington monitor air quality will result from positive action by EPA on North Carolina's section 126 petition, as well as actual promulgation of the proposed Clean Air

Interstate Rule, both of which will further reduce the contribution from upwind, out-of-state sources to the Lexington area's non-attainment and maintenance problems.

For the reasons stated herein, North Carolina believes that only Davidson County should be designated non-attainment, while Stokes, Randolph, Guilford and Forsyth counties should be designated as attainment for $PM_{2.5}$.

With regard to the non-attaining monitor in Hickory, North Carolina continues to oppose a non-attainment designation for any area beyond the metropolitan planning organization boundary of Catawba County. There is little to be gained by including the partial counties of Burke and Caldwell in the non-attainment area for the Hickory region for several reasons. Catawba County emissions are significantly higher than both Burke and Caldwell counties in the L-Factor analysis. The bulk of emissions from these counties is from the mobile sector and therefore will benefit from state and federal rules addressing mobile emissions. There would be little to no additional opportunity to reduce mobile emissions by designating Burke and Caldwell counties as non-attainment.

A non-attainment designation for $PM_{2.5}$ would place significant additional burdens on Burke and Caldwell counties since these counties are already participating in an EAC for ozone. These counties are making progressive strides to reduce emissions as part of the EAC effort and North Carolina feels that a designation of non-attainment for these counties would do little to reduce $PM_{2.5}$ in Catawba County. North Carolina believes the recommendation to designate only Catawba County as non-attainment is appropriate, while Burke, Caldwell and the non-MPO parts of Catawba counties should be designated as attainment for $PM_{2.5}$.

Furthermore, on the basis of air quality data for 2004 gathered to date, North Carolina believes there is a significant probability that the Hickory monitor will attain the standard based on complete 2002-2004 data. We expect that it will be possible to maintain this attainment status as more emissions reductions are expected due to implementation of the Clean Smokestacks Act, NOx SIP call rules, federal heavy-duty engine standards and new fuel standards. We are also anticipating needed reductions from upwind out-of-state sources from the proposed Clean Air Interstate Rule, North Carolina's section 126 petition and other initiatives, which will help Davidson County as well. EPA already has concluded that these out-of-state sources contribute significantly to elevated PM2.5 in North Carolina.

North Carolina therefore suggests that EPA designate the Hickory area as "unclassifiable", if the designation is made before December 31, 2004. The designation for this area as attainment can then be finalized in February 2004 using the 2002-2004 data, assuming that it in fact shows what we anticipate. Alternatively, if the designation is made after December 31, 2004, the designation should be based on the 2002-2004 data. This approach would conserve significant federal, state and local resources by avoiding the need for the redesignation demonstration, as well as transportation conformity, in an area that is already attaining the $PM_{2.5}$ standard.

Finally, on June 21, 2004, I wrote to the Administrator to register our concerns regarding the recently introduced emissions-weighted approach for nonattainment boundary delineation. I reiterate those comments here. In particular, the emissions-weighted analysis fails to account for prevailing wind directions during the periods when $PM_{2.5}$ values are higher, assumes incorrectly that emissions impact a monitor equally throughout the year, fails to consider distance between emissions and the monitors, and fails to recognize any effects from the significant reductions resulting from North Carolina's Clean Smokestacks Act. The most glaring demonstration of the weakness of the emissions-weighted approach is that some counties EPA intends to designate as nonattainment under this approach actually are in attainment according to monitors located in those counties. Moreover, this emissions-weighted analysis was introduced late and so could not be addressed by the Governors in their initial recommendations. This runs counter to the state-federal interactive process prescribed by law. For these reasons, the State believes that the use of the emissions-weighted approach is arbitrary and should not influence the final delineation of nonattainment area boundaries.

North Carolina is proud to be a leader in the improvement of air quality and is committed to the continued improvement of air quality within its borders. We have invested significant resources in understanding the nature of our air quality issues and feel confident that our recommendation to designate only Davidson and Catawba counties is sufficient for the state and EPA to continue the work toward protecting the health of our citizens. We know that you and your colleagues will give these comments careful attention as EPA evaluates and makes the final decisions on $PM_{2.5}$ boundaries later this year. We appreciate that careful attention because we also appreciate the nature and extent of the challenge EPA faces in making these decisions across the nation.

Sincerely,

William G. Ross, Jr.

Attachment: *$PM_{2.5}$ Designation Response Technical Support Document*

cc: Secretary Lyndo Tippett (w/o attachment)
Secretary James Fain (w/o attachment)
Keith Overcash (w/o attachment)

STATE OF NORTH CAROLINA
OFFICE OF THE GOVERNOR
20301 MAIL SERVICE CENTER
RALEIGH, NC 27699-0301

MICHAEL F. EASLEY
GOVERNOR

September 9, 2004

The Honorable Michael Leavitt
Administrator
US Environmental Protection Agency
1200 Pennsylvania Ave., N.W.
Washington, D.C. 20460

Dear Administrator Leavitt:

I am writing concerning your agency's response to North Carolina's PM 2.5 non-attainment boundary recommendations. As you know, North Carolina has been a leader among states in improving air quality through aggressive programs to cut emissions from both coal-fired power plants and mobile sources. No state in America is more committed to solving the problems posed by particulate emissions and other harmful pollutants. But we are committed to doing so wisely, in a manner that does not unnecessarily harm our state's favorable business climate.

In its letter of June 29, 2004, EPA has provided flawed analysis to support far-reaching PM 2.5 nonattainment designations surrounding two isolated, non-attaining monitors in Hickory and Lexington, North Carolina. According to North Carolina's analysis, which is included in the attached letter from Secretary of Environment Bill Ross, these broad designations will not help solve the non-attainment problem at these two monitors. In fact, they are unlikely to have an appreciable effect on North Carolina's efforts to improve air quality.

These excessive non-attainment designations will, however, have a significant dampening effect on economic development efforts in the Triad and further west in the Hickory/Morganton/Lenoir area. These two areas of our state have been hit particularly hard by manufacturing job losses associated with unfair federal trade policies. Both areas are turning a corner now, but they can ill afford non-attainment designations that can undermine their ability to bring jobs to their communities – particularly when there is no beneficial effect.

With this in mind, I urge you to narrow your non-attainment designation to Davidson County and the MPO portion of Catawba County surrounding the Hickory monitor. Thank you for your attention to this request. If there is anything that my office can do to assist you in your decisionmaking process in the coming months, I trust that you will let me know.

With kindest regards, I remain

Very truly yours,

Michael F. Easley

MFE: rht

cc: North Carolina Congressional Delegation
James I. Palmer, Regional Administrator, US EPA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

DEC 14 2004

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Clean Data Policy for the Fine Particle National Ambient Air Quality Standards

FROM: Stephen D. Page, Director
Office of Air Quality Planning and Standards

TO: Air Division Directors, Regions I-X

Purpose

In December 2004, EPA is designating areas as nonattainment with the national ambient air quality standards (NAAQS) for fine particles. This policy memorandum addresses the requirements for those nonattainment areas that, prior to the date that their State Implementation Plans (SIPs) are due, demonstrate that they are attaining the fine particle standard. Specifically, it addresses whether such areas must submit certain portions of the plans – those addressing reasonable further progress (RFP), attainment demonstrations and contingency measures as required in section 172 (c) of the Clean Air Act (CAA). This memorandum also describes the process by which EPA will determine whether an area is attaining the PM2.5 standard.

Background & Policy

EPA established NAAQS for fine particles in 1997. EPA expects to make final attainment, unclassifiable, and nonattainment designations in December 2004. Nonattainment areas must submit their SIPs within 3 years of the effective date of the designations (i.e. March 2008). Areas must attain the standard as expeditiously as practicable. Presumptively, attainment should be achieved within 5 years of designation, although EPA may grant an attainment date extension of up to 5 additional years based on the severity of the nonattainment problem and the availability of emissions controls. Thus, attainment dates will range from 5 to 10 years from the date of designation (i.e. 2010 to 2015). Attainment must be determined based on the 3 calendar years prior to the attainment date.

Because PM2.5 exposure is linked to significant health effects, EPA encourages States to achieve reductions in PM2.5 and its precursor emissions as early as possible, especially in areas that are expected to be designated as nonattainment. Public health in these areas will improve as levels of fine particles decline. By meeting the standard, they will reduce the incidence of premature mortality, hospital admissions, missed days of work and school, and other adverse respiratory and cardiac effects in children and adults.

With these benefits in mind, we have reviewed the CAA to determine whether an area that is originally designated as nonattainment must still submit certain SIP requirements if the area has 3 consecutive calendar years of air quality data showing that it meets the PM2.5 standards prior to its required SIP submittal date. We believe that such areas may be exempt from making submissions for RFP, attainment demonstrations, and contingency measures – as long as those areas continue to meet the standard. However, if such an area is determined to violate the standards prior to being redesignated to attainment, the area will be required to address the pertinent requirements when it submits its SIP to EPA. EPA encourages States to take action to redesignate areas that are attaining the standard as expeditiously as practicable. In order to assist in this process, EPA will be reviewing the possibility of developing a "Limited Maintenance Plan Policy" for PM2.5 areas, which may be used in conjunction with the Clean Data Policy to assist States in getting areas redesignated to attainment in an expeditious manner.

Interpretation and Legal Rationale

The SIP provisions that are the subject of this policy are those addressing RFP, attainment demonstrations, and contingency measures. EPA previously has interpreted that the general provisions of the CAA subpart 1, part D (§§171 and 172) do not require an ***ozone*** nonattainment area to include these provisions in its SIP if that area meets the ozone standard. We believe it is appropriate to make the same interpretation for PM2.5. Our rationale is as follows:

1) **Reasonable Further Progress:** Section 171 (1) states that, for the purposes of part D, Reasonable Further Progress means:

   "such annual incremental reductions in emissions of the relevant air pollutant as are required by this part or may reasonably be required by the Administrator for the purpose of ensuring attainment of the applicable NAAQS by the applicable date."

If an area has 3 consecutive calendar years of air quality data showing it has attained the standard before the SIP due date, the purpose of the RFP requirement will have been fulfilled, and we believe the area does not have to address RFP in its SIP.

We took this view with respect to the general RFP requirement [CAA §172(c)(2)] in the "General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990" (General Preamble) (see 57 FR 13498, April 16, 1992), and we are now extending that interpretation to PM2.5. In the General Preamble, EPA stated that:

> *"requirements for RFP will not apply in evaluating a request for redesignation to attainment since, at a minimum, the air quality data for the area must show that the area has already attained. A showing that the State will make RFP toward attainment will, therefore, have no meaning at that point"* (see 57 F R 13564).

2) Attainment Demonstrations

This interpretation also is consistent with our previous interpretation of §172(c) requirements in the General Preamble as they pertain to ozone attainment demonstrations. EPA stated that no other measures to provide for attainment would be needed by areas seeking redesignation to attainment since *"attainment will have been reached"* (see 57 FR 13564; also Calcagni memorandum, September 4, 1992). If an area has attained the standard before the SIP due date, we believe the area does not have to include an attainment demonstration in its SIP.

3) Contingency Measures

Similar reasoning applies to the contingency measures SIP requirement, which is linked with both the attainment demonstration and RFP requirements. EPA previously has interpreted the contingency measures requirement of §172(c)(9) as no longer being applicable once an area has attained the standard, because those *"contingency measures are directed at ensuring RFP and attainment by the applicable date"* (see 57 FR 13564). Areas attaining the PM2.5 standard before their SIP due dates will not have to address contingency measures in their SIPs.

Each of these interpretations applies only as long as a nonattainment area continues to monitor attainment of the standard. If such an area violates the PM2.5 NAAQS, the area would again be required to submit the pertinent SIP sections. Therefore, a determination that an area need not submit one or more parts of a SIP **amounts to a suspension of the requirement <u>as long as the area continues to attain the standard</u>.** If EPA ultimately redesignates the area to attainment, then the area will be entirely relieved of these requirements (to the extent they are not the basis for the area's maintenance plan).

<u>**Consequences for Redesignations, Sanctions and Conformity**</u>

Redesignation: A determination that an area has met the PM2.5 NAAQS is not equivalent to a redesignation to attainment. Attainment of the standard is only one of the criteria an area must satisfy in order to be redesignated [CAA §107(d)(3)(E)]. The State also must submit, and receive full approval of a request that satisfies all of the criteria for redesignation, including the requirements to:

- demonstrate that the improvement in the area's air quality is due to permanent and enforceable reductions;

- have a fully approved SIP that meets all of the applicable requirements under section 110 and part D; and
- have a fully approved maintenance plan.

The SIP submissions for RFP, attainment demonstration, and contingency measures discussed in this memorandum would not be required in order for an area's redesignation request to be approved, provided that the area is attaining the PM2.5 standard. However, if an area again violates the standard before EPA takes final action on that area's redesignation request, EPA could not redesignate the area, and the SIP requirements would once again apply. Areas that are redesignated are relieved of all nonattainment requirements.

Sanctions: If EPA determines that an area is attaining the PM2.5 standard, thereby suspending the SIP submission requirements discussed above would be suspended, and any sanction clock related to those SIP requirements would be stopped.

Conformity: An area determined to be attaining the standard under this policy will be required to use the applicable regional emissions test, as required in the transportation conformity rule at 69 FR 40004 (July 1, 2004). This rule addresses the specific emissions tests for transportation plan and TIP conformity determinations that occur before and after a PM2.5 SIP having motor vehicle emissions budgets is established.

<u>**New Source Review (NSR)**</u>

An attainment determination pursuant to this policy will not relieve an area of its responsibility to meet the requirements of EPA's NSR regulations. All NSR requirements would continue to apply to any area designated as nonattainment.

<u>**Process for Determining Attainment**</u>

Regional offices make determinations – EPA Regional Offices will conduct individual rulemakings for each area seeking an attainment determination under this policy. Once the area has demonstrated that it is meeting the PM2.5 standard, the Regional Office will issue a binding determination that the area has attained the standard and need not make the SIP submittals discussed above.

Three years of clean data required – To demonstrate that it is meeting the standard, a nonattainment area must have 3 consecutive years of air quality monitoring data (e.g. 2004-2006, for areas that have a SIP submittal date of February 2008) that show the area had clean air quality that precede the areas required SIP submittal date. The data must be complete and quality-assured, consistent with 40 CFR part 58 requirements, and other relevant EPA guidance. The State also must ensure that the data are properly submitted to the Air Quality Subsystem of

EPA's Aerometric Information Retrieval System. The State should notify its EPA Regional Office that it believes a nonattainment area is attaining the PM2.5 standard and petition for an attainment determination under this policy. EPA believes that the determination of attainment for an area should be consistent with the manner that the area was designated as nonattainment[1].

Entire multi-state areas must have clean air to be eligible – Multi-state nonattainment areas must demonstrate attainment for the entire nonattainment area in order for EPA to suspend any of the SIP requirements covered by this policy. EPA will not suspend any requirements based on a determination that part of a nonattainment area is monitoring attainment. If the multi-state nonattainment area involves more than one EPA Region, the appropriate Regional Offices should coordinate these efforts in making any attainment determinations.

Areas must continue to meet PM2.5 standard – Areas that are determined to attain the PM2.5 standard under this policy must continue to monitor clean air. The State must continue to operate an appropriate air quality monitoring network, in accordance with EPA regulations, to verify the attainment status of the area (see 40 CFR part 58).

A violation means SIP requirements apply – If EPA determines that an area has violated the PM 2.5 standard, the area would again be required to submit the pertinent requirements under the SIP for the area. EPA would notify the State of that determination and would also provide notice to the public in the Federal Register. Areas subject to such a determination would receive a reasonable amount of time to address the RFP, attainment demonstration and/or contingency measure requirements and submit revisions to their SIPs. EPA would establish this SIP submittal date on a case-by-case basis, taking into account individual circumstances surrounding the particular SIP provisions at issue.

Areas remain subject to other EPA requirements – Attainment determinations under this policy do not shield an area from other required actions, such as provisions to address pollution transport, which could require emission reductions at sources or other types of emission activities contributing significantly to nonattainment in other areas or States, or interfering with maintenance in those areas. EPA has the authority to require emissions reductions as necessary and appropriate to deal with transported air pollution [see CAA §§110(a)(2)(D) and 110(a)(2)(A).]

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[1] Areas that are designated based upon violations identified at specific monitors located within a given area should also be used in the determination of attainment for the area. The use of spatial averaging should only be used in determinations of attainment for an area where the technique was also used in designating the area as nonattainment initially.

If you have any questions about this policy, please contact Larry Wallace of my staff, at (919) 541-0906, or Rich Damberg at (919) 541-5592.

cc: Rob Brenner
Bill Harnett
Rich Ossias
Joe Paisie
Sally Shaver
Peter Tsirigotis
Lydia Wegman

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

December 17, 2004

THE ADMINISTRATOR

The Honorable Michael Easley
Governor, State of North Carolina
20301 Mail Service Center
Raleigh NC 27699-0301

Dear Governor Easley:

Thirty-four years ago this month, the first Clean Air Act signaled the beginning of our country's resolve to dramatically improve air quality. Today, we celebrate our accomplishments which have enabled us to breathe the cleanest air we have ever measured. As 2004 comes to a close, I am pleased to report that this has been a remarkable year for protecting and improving the country's air quality.

The Bush Administration has made implementation of a national clean air strategy a top priority by implementing more protective air quality standards for ozone and fine particles and designing national tools to help meet those standards. Legislation and regulation will be the centerpiece of the President's clean air and clean energy strategy as we move forward. Together, we are on the path to make this generation one of the most productive periods of air quality improvement in our nation's history.

An important part of our nation's commitment to clean, healthy air is reducing the levels of fine-particle or PM2.5 pollution. Fine-particle pollution represents one of the most significant barriers to clean air facing our nation today. These tiny particles, about $1/30^{th}$ the diameter of a human hair, lodge deep in our lungs, and have been associated with heart attacks, chronic bronchitis, asthma attacks and missed days of school and work.

Key to the reduction of particle pollution is implementation of the fine particle standards and identification of the areas of the country needing additional work to meet the standards. We take the first of those important steps today, identifying the areas in your state that do not meet the fine particle standards. Those parts of your state designated as "nonattainment" will require more actions to achieve a common goal of cleaner, healthier air (a list of nonattainment areas is attached). For areas in your state that attain the standard you will need to continue your progress to sustain clean air.

To assist you, we have both proposed and instituted rules as part of our national clean air strategy that will bring the vast majority of the country into attainment with the standards over the next decade. Our clean air/clean energy strategy, including Clear Skies legislation and the Clean Air Rules, will cut power plant emissions of sulfur dioxides, nitrogen oxides and mercury by nearly 70 percent when fully implemented, and will reduce emissions from off-road diesel fuels, vehicles and engines by over 90 percent — those black puffs of exhaust smoke are going to be a thing of the past. Together, these Clean Air Rules will build on the tremendous progress made in previous decades, and do it in record time.

The last several decades have seen a growing commitment to clean air coupled with a progression of science and technology that has informed our decision-making and driven our actions. I think of our clean air history as a relay where a baton is passed from generation to generation and from Administration to Administration. This Administration has made a commitment to accelerate our clean air progress so that all Americans live healthier, longer, more productive and prosperous lives.

Sincerely,

/s/

Michael O. Leavitt

cc (with attachment):
Mr. William G. Ross, Jr.
Secretary
North Carolina Environment and Natural
Resources Department

Ms. Robin Smith
Assistant Secretary for Environmental Protection
North Carolina Environment and Natural
Resources Department

Mr. James I. Palmer, Jr.
Regional Administrator, Region IV

Attachment

Nonattainment Areas

State	Area Name	Counties
North Carolina	Greensboro-Winston Salem–High Point, NC	Davidson Guilford
	Hickory–Morganton–Lenoir, NC	Catawba

NCDENR
North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor

William G. Ross Jr., Secretary

February 22, 2005

Mr. James I. Palmer, Jr.
Regional Administrator
U.S EPA, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

RE: $PM_{2.5}$ Non-attainment Designations

Dear Mr. Palmer:

In the January 5, 2005 Federal Register notice on $PM_{2.5}$ non-attainment boundaries, EPA indicated that State submittal of complete, quality assured, certified 2004 data for the purpose of showing a change in the non-attainment boundary was appropriate. Therefore, North Carolina would like to provide the data for the three counties that were designated as non-attainment for $PM_{2.5}$: Catawba, Davidson, and Guilford[1]; and to request that Guilford be re-designated as attainment.

Despite the fact that the Guilford County monitor attained the $PM_{2.5}$ standard with a 2001-2003 design value of 14.0 $\mu g/m^3$, a value significantly below the ambient standard, this county was designated as non-attainment. The 2002-2004 data show a design value of 13.7 $\mu g/m^3$, which demonstrates that the air quality in Guilford County is well below the NAAQS. As I stated in earlier correspondence on the $PM_{2.5}$ non-attainment boundary issue, I believe that Guilford County should be designated attainment. We have indicated previously our reasons why we believe including Guilford

[1] Catawba County's monitor is located in Hickory. The 2001-2003 design value for this monitor is 15.5 micrograms per cubic meter ($\mu g/m^3$). The 2002-2004 design value for this monitor is 15.1 $\mu g/m^3$. North Carolina had anticipated this area would attain the $PM_{2.5}$ standard with the 2004 data. The values are very close to the $PM_{2.5}$ standard, but unfortunately still violating. However, North Carolina believes it is likely that this area will attain with the 2005 data. North Carolina will begin work on the re-designation package as early as September 2005. We request that if EPA intends to issue re-designation guidance, that this be accomplished by mid-2005 so that the guidance is available when we are beginning the re-designation process. In any event, we intend to consult with EPA early in the process in order to ensure that our request can be processed as quickly as possible.

The Davidson County monitor has a similar downward trend in $PM_{2.5}$ values. The 2001-2003 design value for the Lexington site is 15.8 $\mu g/m^3$. The 2002-2004 design value for this site is 15.4 $\mu g/m^3$. Again, while this site did not attain the $PM_{2.5}$ standard, the value is still on a downward trend. We are hopeful that air quality will continue to improve in Davidson County and the Lexington monitor will attain the $PM_{2.5}$ standard with the inclusion of 2005 data. If so, we intend, as with Catawba County, to seek expeditious re-designation of the area. We reiterate that, if EPA intends to issue re-designation guidance, it should release such guidance before September 2005.

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-733-4984 \ FAX: 919-715-3060 \ Internet: www.enr.state.nc.us/ENR

County in the non-attainment area is arbitrary and unlawful. I request that you again review my September 8, 2004 letter, in light of the fact that the design value in Guilford continues to be well below the standard.

From our previous comments, I reiterate that, while the mobile source emissions in Guilford County are greater than in other counties in this area, mobile source emissions will continue to decrease through implementation of federal rules addressing mobile sources as well as the expanded North Carolina motor vehicle inspection program. The mobile emissions will also decrease due to local measures included as part of the Early Action Compact (EAC) effort in the Triad. The most direct influence of these reductions will be reduced ambient concentrations in Guilford County at the monitor already demonstrating compliance with the $PM_{2.5}$ standard.

Unfortunately for the citizens of Guilford County, EPA has reached the puzzling conclusion that sources in this attaining county are contributing to pollution in another county which lies in a direction opposite the prevailing winds. This conclusion is supported neither by the facts nor reason, and therefore I ask that it be withdrawn. The EPA analysis appears to rely primarily on the fact that Guilford County has a relatively larger and more urban population and produces relatively larger quantities of $PM_{2.5}$ and $PM_{2.5}$ precursors. But EPA fails to adequately consider that, for example, Guilford County's air quality complies with the $PM_{2.5}$ NAAQS and, indeed, is improving with respect to the pollutant $PM_{2.5}$. The only evidence shows that federal, state, and local controls already in place continue to reduce $PM_{2.5}$ concentrations in Guilford County and surrounding counties. While we share a common interest in assuring clean air in Davidson County, it is entirely unclear what additional measures you would recommend be imposed and how those measures would have a meaningful impact on air quality in Davidson County.

EPA's own data indicate that regional sources account for a great deal of the elevated $PM_{2.5}$ levels in the east and southeast. For this reason, EPA has in fact proposed to find that power plant emissions throughout the region should be regulated -- by the Clean Air Interstate Rule. All available data and analysis indicate that a non-attainment designation for Guilford County will have little if any effect on the $PM_{2.5}$ levels in Davidson County, and whatever effect it does have will be dwarfed by other emissions reductions programs. A more sensible approach would be to require significant regional emission reductions from large sources in the near term, which would help both Davidson County and Catawba County attain and then maintain the $PM_{2.5}$ standard. I ask that EPA not penalize Guilford County for a problem that it can do little if anything to rectify.

North Carolina is proud to be a leader in the improvement of air quality and is committed to the continued improvement of air quality within its borders. Part of our successful strategy in North Carolina has been the deployment of our limited resources in an efficient manner. Unfortunately, the designation of Guilford County as nonattainment will result in the expenditure of unnecessary resources in an area that has already demonstrated compliance with the NAAQS. I want to see all areas of the State attain the $PM_{2.5}$ standard as quickly as possible. I trust that these comments will be considered as EPA moves forward with implementation of the $PM_{2.5}$ standard.

Sincerely,

Bill

William G. Ross, Jr.

cc: Secretary Lyndo Tippett
Secretary James Fain
Keith Overcash

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 5 2005

THE ADMINISTRATOR

William G. Ross, Jr., Secretary
North Carolina Department of Environment
and Natural Resources
1601 Mail Service Station
Raleigh, NC 27699-1601

Dear Secretary Ross:

Thank you for your letter of February 22, 2005, concerning fine particulate matter (PM2.5) designations and Guilford County, North Carolina. In your letter, you provided 2004 monitoring data for Davidson, and Guilford Counties, and requested that the Environmental Protection Agency (EPA) designate Guilford County as attainment for the PM2.5 National Ambient Air Quality Standard (NAAQS). For the reasons set forth herein, EPA denies your request.

In determining an area's designation, we rely on the Clean Air Act (CAA) definition of a nonattainment area in section 107(d)(1)(A)(i): an area that is violating an ambient standard or an area that is contributing to a nearby area that is violating the standard. If an area meets this definition, EPA is obligated to designate the area as nonattainment. On April 1, 2003, EPA issued guidance for states and tribes to use in identifying areas that meet or do not meet EPA's national air quality standards for PM2.5. In making designations, we used the most recent 3 years of monitoring data. Once we determined that a monitor was recording a violation, the next step was to determine if there were any nearby areas that were contributing to the violation and include them in the designated nonattainment area. In making this determination, we reviewed all available technical data related to nine factors set out in the April 1, 2003, guidance such as air quality, source locations and emissions, meteorology, terrain, population, commuting, and growth in the area. The technical support analyses for all nonattainment areas are located on EPA's web site at: http://epa.gov/pmdesignations/documents/final/TSD/Ch6.pdf.

Based on the analysis of all factors for the Greensboro area, EPA determined that Guilford County was contributing to the violating monitor in adjacent Davidson County. Our analysis showed that Guilford County had sufficient emissions and emission sources to contribute to the ambient air quality in Davidson County. For example, Guilford County has the largest population of any county in the area, accounting for over one third of the metropolitan statistical area's total population, as well as significant population growth. Additionally, Guilford County commuters total by far the highest vehicle miles traveled in the area. These factors indicate that Guilford County has significant sources of emissions. EPA further found that Guilford County has sufficient emissions of PM2.5

and precursor pollutants sulfur dioxide (SO2), nitrogen oxides (NOx), and volatile organic compounds (VOC) to contribute to the ambient air quality in Davidson County.

2002-2004 Data

In EPA's January 5, 2005, Final Designation Notice, we invited states to submit, by February 22, 2005, complete, quality assured, certified 2004 data that suggests a change in designation of an entire nonattainment area is appropriate for any area within the State. EPA stated that it would change an area's designation if inclusion of 2004 data showed that every county in an area was neither monitoring a violation of the standards nor contributing to a violation of the standards of a nearby area. We stated this because as long as there is a continuing violation of the standards, those areas that are contributing to the violation need to be part of the nonattainment area for controls designed to achieve the standard.

In your February 22, 2005, letter, you provided complete, quality assured, certified 2004 data for Davidson and Guilford Counties and noted that data from the PM2.5 monitor in Guilford County was below the annual average PM2.5 standard of 15.0 $\mu g/m^3$. Your letter did not conform to EPA's January 5 offer to revisit designations based on 2004 data and was not addressed in EPA's April 5, 2005, Supplemental Notice. Instead, EPA has evaluated your letter and is responding to it separately here as a petition for reconsideration.

The 2004 data provided in your letter, while being new in the sense that it was not available to be considered in EPA's final designation of Guilford County, does not provide any new information that would compel EPA to reach a different conclusion regarding Guilford County's nonattainment status based upon its contribution to air quality in Davidson County. While the 2004 data show a decrease in Guilford County's design value, this demonstrates the continuation of a trend already in existence at the time EPA made its final designations. EPA is pleased that this monitor continues to show decreasing design values; however, nothing about the 2004 monitor data changes EPA's evaluation of Guilford County's contribution to Davidson County's air quality.

Meteorology

In your letter, you characterize as "puzzling" EPA's finding that emission sources in Guilford County contribute to the ambient air quality of Davidson County, which "lies in a direction opposite the prevailing winds." We understand your perspective and believe that EPA and North Carolina are viewing the wind data differently.

North Carolina submitted information prior to EPA making the final determination of the nonattainment boundary for the Greensboro area which included a discussion of wind patterns and other meteorology. The State's analysis showed that wind direction varies based on season, with influence coming from different directions at different times of year. In your letter, you focused on the wind pattern during the summer months, which shows prevailing winds from Guilford County generally away from Davidson County.

EPA analyzed the wind patterns, from all times of the year, in the area and found that there is influence on the Davidson County monitor from varying directions, including from the direction of Guilford County. While your assertion that the prevailing wind patterns from Guilford County are away from Davidson County is generally true in the summer months, EPA's analysis of year-round wind patterns found that the second strongest contribution to Davidson County is from the northeast, the direction of Guilford County. Attachment 1 is a pollution rose diagram for the violating monitor located in Davidson county. Each dot in the diagram represents a daily PM2.5 concentration (from the 2001-3 period) and the average wind direction and wind speed for that day. It shows that there were a number of days in the period when PM2.5 contributions toward the Davidson county monitor came from the northeast (the direction of Guilford county).

Regional Controls

In your letter, you discussed future regional controls, such as EPA's Clean Air Interstate Rule (CAIR), as providing reductions in PM2.5 levels in the east and southeast. EPA agrees that regional controls, such as CAIR, will provide reductions in elevated PM2.5 levels in the southeast, and we agree that CAIR will provide an important tool for reducing ambient PM2.5 levels across the region. However, regional control programs do not substitute for area-specific attainment demonstrations and are not designed to achieve to help a specific nonattainment area attain the national standards. For nonattainment areas, we rely on an area-specific control strategy developed by the State which should include a combination of significant regional controls along with specific local controls. In addition, the PM2.5 designations were based on current violations of the standard and associated contributions, not projected future conditions.

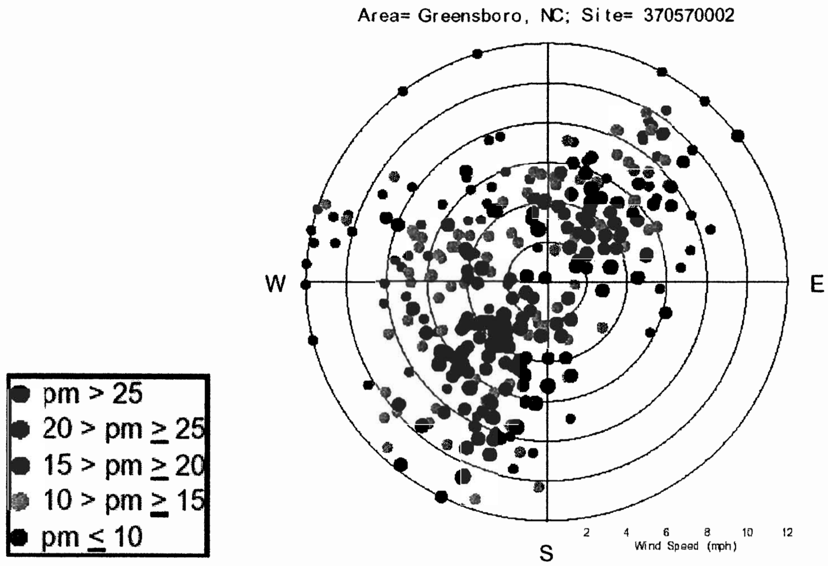
EPA understands North Carolina's preference for a smaller nonattainment boundary for the Greensboro-Winston Salem-High Point area and appreciate your commitment to continued improvement of air quality. However, your letter did not provide information that persuades EPA to reconsider its decision. Therefore, your petition for reconsideration is denied.

Sincerely,

Stephen L. Johnson

Enclosure: Attachment 1
Pollution Rose for Davidson County, NC Monitor

Attachment 1
Pollution Rose for Davidson County, NC Monitor



Plot indicates PM2.5 concentration, wind direction, and wind speed for days in 2001-2003 with PM2.5 monitoring data.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

OCT 2 2007

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Guidance on SIP Elements Required Under Sections 110(a)(1) and (2) for the 1997 8-hour Ozone and $PM_{2.5}$ National Ambient Air Quality Standards

FROM: for William T. Harnett, Director
Air Quality Policy Division (C539-01)

TO: Air Division Directors, Regions I-X

The purpose of this memorandum is to provide guidance on the "infrastructure" elements for State Implementation Plans (SIPs) required under section 110(a)(1) and (2) of the Clean Air Act (CAA) for the 1997 8-hour ozone and fine particulate matter ($PM_{2.5}$) national ambient air quality standards (NAAQS). Attachment A to this memo provides a list of the basic elements that States must include in their SIPs. To the extent that existing SIPs for ozone and particulate matter already meet these requirements, States need only certify that fact to the Environmental Protection Agency (EPA). To the extent that existing SIPs for ozone and particulate matter fail to address any of these requirements for purposes of the 1997 8-hour ozone or $PM_{2.5}$ NAAQS, States need to make timely SIP submissions to EPA to address these requirements. We anticipate that States will already have approved SIPs in place for ozone that meet the basic requirements of sections 110(a)(1) and (2). For $PM_{2.5}$, however, we anticipate that many States may need to make SIP revisions to ensure that their existing SIPs for prior particulate matter NAAQS are revised to include the new particle size indicator.

Background

On July 18, 1997, the EPA promulgated new and revised NAAQS for ozone and particulate matter. For ozone, EPA revised the NAAQS to provide an 8-hour averaging period (versus a 1-hour averaging period for the pre-existing NAAQS), and set the level of the standard at 0.08 ppm (versus 0.12 ppm for the pre-existing NAAQS). For PM, EPA promulgated a new 24-hour and a new annual NAAQS for $PM_{2.5}$ (particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers).[1]

Under sections 110(a)(1) and (2) of the CAA, all States are required to submit plans to provide for the implementation, maintenance, and enforcement of the 8-hour ozone and $PM_{2.5}$ standards. Sections 110(a)(1) and (2) require States to address basic SIP requirements, including emissions inventories, monitoring, and modeling to assure attainment and maintenance of the standards. By statute, SIPs meeting the requirements of sections 110(a)(1) and (2) are to be submitted by States within 3 years after promulgation of a new or revised standard. This being the case, States were required to submit such SIPs for the 1997 standards to EPA no later than July 2000. However, intervening litigation over the 1997 8-hour ozone and $PM_{2.5}$ NAAQS, created uncertainty about how to proceed and, to date, States have not submitted SIPs to meet the basic or infrastructure requirements enumerated in sections 110(a)(1) and (2).

In March of 2004, Earth Justice initiated a lawsuit against EPA for failure to take action against States that had not made SIP submissions to meet the requirements of sections 110(a)(1) and (2), i.e., failure to make a "finding of failure to submit." On March 10, 2005, EPA entered into a Consent Decree with Earth Justice that obligates EPA to make official findings whether States have made required SIP submissions by dates certain. The Consent Decree obligates EPA to determine whether States have made SIP submissions required to meet CAA section 110(a)(2)(D)(i) relating to interstate transport by no later than March 15, 2005. The Consent Decree also obligates EPA to make a determination whether States have made submissions necessary to meet the remaining 110(a)(1) and (2) requirements by December 15, 2007, for the 8-hour ozone NAAQS, and by October 5, 2008, for the $PM_{2.5}$ NAAQS.[2] It should be noted that the latter determinations pertain only to whether the submissions are complete, pursuant to section 110(k)(1)(A), and do not constitute EPA approval or disapproval of such submissions. In addition, the determinations required by the Consent Decree explicitly exclude any determinations regarding: (i)

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[1] More recently, on December 18, 2006, EPA again revised the standards for particulate matter, tightening the 24-hour $PM_{2.5}$ standard from 65 micrograms per cubic meter ($\mu g/m^3$) to 35 $\mu g/m,^3$ and retaining the current annual fine particle standard at 15 $\mu g/m^3$. EPA also decided to retain the existing 24-hour PM_{10} standard of 150 $\mu g/m^3$ and to revoke the annual PM_{10}. This guidance document applies only to the SIP submission requirements for the 1997 8-hour Ozone and $PM_{2.5}$ NAAQS. EPA will address SIP requirements for the 2006 NAAQS separately, although the Agency notes that the statutory requirements for SIPs for new or revised NAAQS are comparable.

[2] The dates specified in the Consent Decree reflect the anticipated dates for submission of nonattainment area SIPs for each NAAQS, plus six months for EPA evaluation. EPA presumed that States would make SIP submissions meeting the basic requirements of sections 110(a)(1) and (2) for each NAAQS contemporaneously with, or not later than, SIPs meeting the nonattainment area plan requirements. EPA notes that recent decisions by the U.S. Court of Appeals for the District of Columbia concerning the implementation rule for the 8-hour Ozone NAAQS have affected certain nonattainment area SIP requirements. These judicial decisions do not, however, affect States' obligations under the CAA or EPA's obligations under the Consent Decree concerning the infrastructure SIP requirements of sections 110(a)(1) and (2).

submissions required by section 110(a)(2)(C) to the extent that subsection pertains to a nonattainment area new source permit program in part D Title I of the CAA; and (ii) submissions required by section 110(a)(2)(I) for Part D Title I nonattainment area plans.

In accordance with the Consent Decree, EPA has already published a finding that all States had failed to submit new SIPs addressing interstate transport for the 8-hour ozone and $PM_{2.5}$ NAAQS, as required by section 110(a)(2)(D)(i) of the CAA (70 FR 21147, April 25, 2005). That finding initiated a 2-year deadline for the promulgation of a Federal Implementation Plan (FIP) by EPA for each such State unless, prior to that time, each State makes a submission to meet the requirements of Section 110(a)(2)(D)(i) and EPA approves such submission. On May 12, 2005, EPA published the Clean Air Interstate Rule (CAIR) which identifies the degree to which emissions of SO_2 and NO_x in certain States significantly contribute to nonattainment of, or interfere with maintenance of, the 1997 8-hour ozone and $PM_{2.5}$ NAAQS in downwind States, and the reductions that must be achieved in those States to eliminate such contributions.

On August 15, 2006, EPA issued guidance entitled "Guidance for State Implementation Plan (SIP) Submissions to Meet Current Outstanding Obligations Under Section 110(a)(2)(D)(i) for the 8-hour Ozone and $PM_{2.5}$ National Ambient Air Quality Standards." The section 110(a)(2)(D)(i) guidance indicates that States within the CAIR region can satisfy 110(a)(2)(D) by satisfying the requirements of the CAIR, and addresses what other States that are outside of the CAIR region should consider doing to meet the "significant contribution" and "interfere with maintenance" requirements of section 110(a)(2)(D)(i) for the 1997 standards. The section 110(a)(2)(D)(i) guidance also addresses what all States (whether inside or outside of the CAIR region) should consider in making SIP submissions to meet the "prevention of significant deterioration" and "protect visibility" requirements of section 110(a)(2)(D)(i). The SIP submissions addressed by the section 110(a)(2)(D)(i) guidance are those that are necessary to rectify the finding of failure to submit that EPA has already issued for all States for section 110(a)(2)(D)(i).

The guidance contained in this memorandum is intended as a reminder that States must have SIPs for the 1997 8-hour ozone and $PM_{2.5}$ NAAQS that meet all of the requirements of sections 110(a)(1) and (2). Pursuant to the Consent Decree, EPA has an obligation to take action to determine whether States have made such submissions by the dates noted above. Because States should currently be in the process of submitting nonattainment SIPs for the 8-hour ozone standard and working on nonattainment area SIPs for the $PM_{2.5}$ standard, we want to alert them to be sure that their SIPs also meet the basic requirements of sections 110(a)(1) and (2).

Guidance

The EPA believes that the currently-approved section 110 SIPs for ozone may already be adequate in most cases to implement the 8-hour ozone NAAQS. Many of the required section 110(a)(1) and (2) SIP elements relate to the general information and authorities that constitute the "infrastructure" of the ozone air quality management program, and these have been in place since the initial SIPs were submitted in response to the 1970 Clean Air Act. For particulate matter, however, EPA believes that some States may need to adopt language specific to the $PM_{2.5}$ NAAQS to ensure that they have adequate SIP provisions to implement the $PM_{2.5}$ NAAQS, e.g., existing State laws may refer to PM_{10} specifically or to particulate matter more generally, rather than to $PM_{2.5}$. We believe that with one exception, the infrastructure requirements of sections 110(a)(1) and (2) are relatively self explanatory, and past experience with SIPs for other NAAQS should enable States to meet these requirements with assistance from EPA Regions. The one exception is section 110(a)(2)(G) relating to emergency episodes, for which EPA intends to take additional regulatory action to provide necessary numerical limits and concentration levels for emergency episode action plans for $PM_{2.5}$.

States should review and revise, as appropriate, their existing ozone and particulate matter SIPs to ensure that they are adequate to address the 8-hour ozone and $PM_{2.5}$ NAAQS. If a State determines that its existing SIP is adequate, then the State needs to certify, via a letter to the Agency from the Governor or his/her designee, that the existing SIPs contain provisions that address the requirements for the 8-hour ozone and $PM_{2.5}$ NAAQS. If a State determines that its existing ozone or particulate matter SIPs are inadequate, however, then the State needs to submit a SIP revision to make the appropriate changes.

With respect to $PM_{2.5}$, States may find it more advantageous to revise the language in their SIPs to identify "particulate matter" as the pollutant being implemented and define the size fractions as "those that EPA has currently set for the NAAQS" to the extent such an approach would be authorized by State law. This will ensure that the provisions remain adequate in the event that future changes occur to the particulate matter standards. States could also specify both PM_{10} and $PM_{2.5}$ as the size fractions if a State prefers to be more specific.

As an aid to the States in addressing the $PM_{2.5}$ related requirements of Section 110(a)(2)(G) pertaining to emergency episode provisions, EPA intends to take action to revise 40 CFR, Part 51, subpart H (sections 51.150). The rule changes will establish the priority classifications which determine the emergency episode plan requirements for each area and establish a significant harm level (SHL) for $PM_{2.5}$. Until these changes are final, EPA recommends that States rely on relevant information contained in upcoming EPA rule proposals or other EPA-issued interim guidance to satisfy the section 110(a)(2)(G) requirements for $PM_{2.5}$. After EPA issues final rules, EPA will work with States to revise SIP submissions that were based on interim information, as appropriate. States may wish to take advantage of the parallel processing mechanism for making their section 110(a)(2)(G) submittal in the interim while EPA completes rulemakings on the SHL and the emergency episode plan requirements under 40 CFR 51.150.

The SHL for the 8-hour ozone NAAQS will remain unchanged as 0.60 ppm ozone, 2-hr average, as indicated in 40 CFR Part 51.151. EPA believes that the existing ozone-related provisions of 40 CFR Subpart H remain appropriate. Therefore, EPA expects that for purposes of the 1997 8-hour ozone NAAQS, States need only to confirm that they have existing emergency episode plan provisions consistent with EPA's existing regulatory requirements.

By statute, States are required to make SIP submissions to meet the basic requirements of CAA sections 110(a)(1) and (2) within 3 years after promulgation of any new or revised standards. For the 1997 8-hour ozone and $PM_{2.5}$ standards, this deadline was July 2000. By Consent Decree, as noted above, EPA has agreed to make a determination whether or not States have submitted SIPs to meet these requirements by a date certain. In the case of 8-hour ozone SIPs, this date is December 15, 2007. For $PM_{2.5}$ SIPs, this date is October 15, 2008. In order for EPA to evaluate the submissions adequately, EPA requests that States make their certifications of SIP adequacy or SIP revisions as soon as possible and to the extent feasible sufficiently in advance of these dates to allow EPA time to determine whether complete submissions have been made.

If you have any questions concerning this guidance, please contact Mr. David Sanders at (919) 541-3356. Please ensure that the appropriate air agency officials for States in your Region are made aware of this guidance.

Attachments

cc: Margo Oge, OTAQ
Steve Page, OAQPS
Brian McLean, OAP
Richard Wayland, OAQPS
Lydia Wegman, OAQPS
Peter Tsirigotis, OAQPS

Attachment A: Required Section 110 SIP Elements

The SIP elements listed below are required under section 110(a)(1) and (2). Section 110(a)(1) provides the procedural and timing requirements for SIPs. Section 110(a)(2) lists the basic or "infrastructure" elements that all SIPs must contain. We note that this list is not intended to constitute an interpretation of these provisions, or a change of past practice with respect to these provisions, merely a brief description of the required SIP elements.

Emission limits and other control measures: Section 110(a)(2)(A) requires SIPs to include enforceable emission limits and other control measures, means or techniques, schedules for compliance and other related matters. EPA notes that the specific nonattainment area plan requirements of section 110(a)(2)(I) are subject to the timing requirement of section 172, not the timing requirement of section 110(a)(1), and also that SIPs to meet this section are not covered by the Consent Decree.

Ambient air quality monitoring/data system: Section 110(a)(2)(B) requires SIPs to include provisions to provide for establishment and operation of ambient air quality monitors, collecting and analyzing ambient air quality data, and making these data available to EPA upon request.

Program for enforcement of control measures: Section 110(a)(2)(C) requires States to include a program providing for enforcement of all SIP measures and the regulation of construction of new or modified stationary sources to meet prevention of significant deterioration (PSD) and nonattainment NSR requirements.

Interstate transport: Section 110(a)(2)(D) requires SIPs to include provisions prohibiting any source or other type of emissions activity in one State from contributing significantly to nonattainment, or interfering with maintenance, of the NAAQs in another State, or from interfering with measures required to prevent significant deterioration of air quality or to protect visibility in another State. EPA has already issued CAIR to assist States in developing SIPs to meet this requirement for purposes of the 8-hour Ozone and $PM_{2.5}$ NAAQS, and has issued separate guidance to all States on how to comply with each prong of this statutory provision.

Adequate resources: Section 110(a)(2)(E) requires States to provide for adequate personnel, funding, and legal authority under State law to carry out its SIP, and related issues.

Stationary source monitoring system: Section 110(a)(2)(F) requires States to establish a system to monitor emissions from stationary sources and to submit periodic emissions reports.

Emergency power: Section 110(a)(2)(G) requires States to provide for authority to address activities causing imminent and substantial endangerment to public health, including contingency plans to implement the emergency episode provisions in their SIPs.

Future SIP revisions: Section 110(a)(2)(H) requires States to have the authority to revise their SIPs in response to changes in the NAAQS, availability of improved methods for attaining the NAAQS, or in response to an EPA finding that the SIP is substantially inadequate.

Consultation with government officials: Section 110(a)(2)(J) requires States to provide a process for consultation with local governments and Federal Land Managers carrying out NAAQS implementation requirements pursuant to section 121 relating to consultation.

Public notification: Section 110(a)(2)(J) further requires States to notify the public if NAAQS are exceeded in an area and to enhance public awareness of measures that can be taken to prevent exceedances.

PSD and visibility protection: Section 110(a)(2)(J) also requires States to meet applicable requirements of part C related to prevention of significant deterioration and visibility protection.

Air quality modeling/data: Section 110(a)(2)(K) requires that SIPs provide for performing air quality modeling for predicting effects on air quality of emissions from any NAAQS pollutant and submission of such data to EPA upon request.

Permitting fees: Section 110(a)(2)(L) requires SIPs to require each major stationary source to pay permitting fees to cover the cost of reviewing, approving, implementing and enforcing a permit.

Consultation/participation by affected local entities: Section 110(a)(2)(M) requires States to provide for consultation and participation in SIP development by local political subdivisions affected by the SIP.

Appendix B

Stakeholder Correspondence Regarding Motor Vehicle Emission Budgets

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Table of Contents

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NCDENR

North Carolina Department of Environment and Natural Resources
Division of Air Quality

Michael F. Easley, Governor

William G. Ross, Jr., Secretary
B. Keith Overcash, P.E., Director

September 16, 2005

Subject: Development of Motor Vehicle Emissions Budgets

Dear Transportation Partner:

The North Carolina Division of Air Quality (NCDAQ) is developing the attainment demonstrations for 8-hour ozone and PM2.5 nonattainment areas in North Carolina. The State Implementation Plan (SIP) attainment demonstration submitted to the U. S. Environmental Protection Agency (USEPA) establishes the motor vehicle emissions budgets (MVEBs) that will be used in future transportation conformity demonstrations once approved or deemed adequate by the USEPA. At stakeholder meetings held throughout 2005, NCDAQ presented different approaches for setting MVEBs. As a result of the feedback received by NCDAQ during the stakeholder meetings, the decision was made to develop a policy memo that provides an explanation of NCDAQ's preference for the geographical basis of MVEBs in nonattainment areas and clearly outlines the procedures and timelines for setting those MVEBs.

NCDAQ believes that the MVEBs should be set at the county level. The reason NCDAQ believes this is appropriate is as follows:

- The motor vehicle emissions generated for SIP attainment demonstration are by county; therefore, developing county level MVEBs would maintain consistency with the attainment modeling. County level sub-area MVEBs provide additional assurance that future conformity determinations, transportation plans, and TIPs will produce emission patterns that will achieve and maintain the National Ambient Air Quality Standards (NAAQS).
- County level sub-area MVEBs preserve the growth projected by Metropolitan Planning Organizations (MPOs)/Rural Planning Organizations (RPOs)/North Carolina Department of Transportation (NCDOT). NCDAQ has relied on MPOs/RPOs/NCDOT to provide these future projections of vehicle miles traveled (VMT) in the SIP process and will continue to rely on MPOs/RPOs/NCDOT as the source of this data throughout the MVEB setting process.
- County level sub-area MVEBs would eliminate the requirement for a new conformity analysis for all MPOs/RPOs in the nonattainment area if one of the MPOs/RPOs revises or updates their respective long range transportation plan or transportation improvement program when there are conforming plans in place for the other areas. In a situation where there are conforming plans in place and there are county level sub-area MVEBs, if one MPO in the nonattainment area had a conformity lapse, the neighboring MPOs/RPOs would not be impacted until their next conformity determination was due.

Planning Section
1641 Mail Service Center, Raleigh, North Carolina 27699-1641
2728 Capital Blvd., Raleigh, North Carolina 27604
Phone: 919-715-7670 / FAX 919-715-7476 / Internet: www.ncair.org

- If an area-wide MVEB involving multiple MPOs/RPOs is set and conformity cannot be demonstrated, it could take significantly longer to resolve which projects should be removed from the various plans. If resolution is not reached in a timely manner, it could result in a conformity lapse for the entire nonattainment or maintenance area.

An important component to the SIP development process is interagency consultation. Therefore, NCDAQ requests feedback from the transportation partners on MVEBs development. NCDAQ's preference is not to set MVEBs for areas less than a county boundary since the emission estimates are made on a county level basis. The exception to this would be partial counties designated as nonattainment. Additionally, NCDAQ prefers not setting MVEBs based on MPO/RPO boundaries since this would result in having to update the MVEBs every time the MPO/RPO boundaries change. The process for recommending other approaches is provided below.

- Transportation partners are invited to provide in writing their preferred approach to setting MVEBs. If setting MVEBs for area-wide or multi-county sub-area is the desired approach, then it must be agreed upon by all of the transportation partners that are responsible for conducting conformity analyses for that area. This includes the MPO(s) and NCDOT after consultation with the RPO(s).
- NCDAQ requests that all written submittals outlining a MVEB approach that consists of more than one county (i.e., area-wide or multi-county sub-areas) include a technical explanation as to why the MVEBs should be set as such. This explanation should include information that illustrates the similarities between the counties listed in the approach such as, but not limited to: degree of urbanization, commuting patterns, expected population and VMT, and expected population and VMT growth rates.
- All requests should be submitted for consideration to NCDAQ by **January 16, 2006**. This will allow NCDAQ time to review and respond to the requests prior to finalizing the documentation for the SIP in February 2006.
- Requests should be submitted to the attention of the Attainment Planning Branch Chief, Laura Boothe, 1641 Mail Service Center, Raleigh, NC 27699-1641.

NCDAQ is responsible for submitting the SIP attainment demonstration and ensuring that the measures in the demonstration will allow the area to attain, as well as maintain the NAAQS. Transportation conformity was designed to help ensure that transportation plans, programs, and projects do not produce new air quality violations, worsen existing violations, or delay timely attainment of NAAQS. NCDAQ will take into consideration the recommended approaches from the transportation partners when developing the MVEBs. The transportation partners will have an opportunity to review the draft final MVEB approach prior to the SIP going through the public hearing process.

NCDAQ is committed to working with all of our partners during this process to determine the best course of action in achieving and maintaining air quality goals. If you should have any questions, please contact Laura Boothe of my staff at (919) 733-1488 or laura.boothe@ncmail.net.

Sincerely,

B. Keith Overcash, P.E.

BKO:lab

cc: Sheila Holman, NCDAQ
Laura Boothe, NCDAQ
Mike Abraczinskas, NCDAQ
Lynorae Benjamin, USEPA
Amanetta Wood, USEPA
Eddie Dancausse, FHWA
Loretta Barren, FHWA

GREENSBORO URBAN AREA
METROPOLITAN PLANNING ORGANIZATION

September 29, 2005

Laura Boothe, Attainment Planning Branch Chief
NCDENR- DAQ
1641 Mail Service Center
Raleigh, NC 27699-1641

Re: Development of Motor Vehicle Emissions Budgets

Dear Ms. Boothe:

The Greensboro Urban Area Metropolitan Planning Organization (MPO) welcomes the opportunity to comment on the development of the Motor Vehicle Emission Budgets (MVEB) for 8 hour ozone and PM 2.5.

The MPO is in agreement with the methodology laid out in the letter dated September 16, 2005 regarding the development of the MVEB. The MPO agrees that development of motor vehicle emissions at a county-level allows for easier data transference and flexibility in the conformity process.

Thank you for the opportunity to comment and please contact me at (336) 373-3117 should you have any questions or need any additional information.

Sincerely,

Lydia M. McIntyre
Transportation Planning Engineer

Attachment

Cc: Sandy Carmany, Chair, Transportation Advisory Committee
Jim Westmoreland, PE, Director, GDOT
Eddie Dancusse, Air Quality Specialist, FHWA
Cynthia Muldrow, Transportation Engineer, NCDOT
Tyler Meyer, AICP, Planning Division Manager, GDOT

City of Greensboro Department of Transportation, Lead Planning Agency
P.O. Box 3136 Greensboro, NC 27402-3136 Telephone (336) 373-2332 FAX (336) 412-6171

Subject: Support for County-Level MVEB
From: roland tilley <ron_d_tilley@yahoo.com>
Date: Sun, 19 Feb 2006 09:30:00 -0800 (PST)
To: laura.boothe@ncmail.net

Laura,
On behalf of citizens for Smrth Growth, I am writing to express our support for county level MVEBs and urge you to continue with your traditional method foe setting budgets.
Thanks
Ron

Yahoo! Mail
Use Photomail to share photos without annoying attachments.

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Air Quality

Michael F. Easley, Governor

William G. Ross, Jr., Secretary
B. Keith Overcash, P.E., Director

June 21, 2006

Lydia M. McIntyre
Transportation Planning Engineer
Greensboro Urban Area Metropolitan Planning Organization
PO Box 3136
Greensboro, NC 27402-3136

Dear Ms. McIntyre:

Thank you for your letter about setting motor vehicle emission budgets (MVEBs) for the Greensboro-Winston-Salem-High Point fine particulate matter nonattainment area. We greatly appreciate your feedback on the setting of the MVEBs.

We have decided to set county level MVEBs for transportation conformity purposes in this nonattainment area and appreciate your support of this. We believe that county level MVEBS better serve our goals of attaining and maintaining the standard in order to protect public health.

The North Carolina Division of Air Quality is committed to working with all our partners during the State Implementation Plan (SIP) process to determine the best course of action in achieving and maintaining air quality goals. If you should have any questions, please contact Laura Boothe of my staff at (919) 733-1488 or laura.boothe@ncmail.net.

Sincerely,

B. Keith Overcash, P.E.

BKO:lab

cc: Sheila Holman, NCDAQ
Laura Boothe, NCDAQ
Sandy Carmany, Chair, Transporation Advisory Committee
Jim Westmoreland, PE, Director, GDOT
Eddie Dancausse, USDOT FHWA
Dan Thomas, NCDOT Transportation Planning Branch
Tyler Meyer, AICP, Planning Division Manager, GDOT

Planning Section
1641 Mail Service Center, Raleigh, North Carolina 27699-1641
2728 Capital Blvd., Raleigh, North Carolina 27604
Phone: 919-715-7670 / FAX 919-715-7476 / Internet: www.ncair.org

Subject: Consultation Plan with MVEB for the Hickory NA Area
From: "Phyllis.D.Jones" <Phyllis.D.Jones@ncmail.net>
Date: Tue, 29 Jan 2008 11:12:17 -0500
To: john.tippett@wpcog.org, john.marshall@wpcog.org, lnguyen@dot.state.nc.us, sarahsmith@dot.state.nc.us, "Alena Cook \(Cook, Alena\)" <arcook@dot.state.nc.us>, "Stark, Jill" <Jill.Stark@fhwa.dot.gov>
CC: "Dancausse, Edward" <edward.dancausse@fhwa.dot.gov>, george.bridgers@ncmail.net, janice.godfrey@ncmail.net, keith.melton@dot.gov, tarellano@dot.state.nc.us, Wood.Amanetta@epamail.epa.gov, Benjamin.Lynorae@epamail.epa.gov, ward.nacosta@epa.gov, Laura Boothe <laura.boothe@ncmail.net>

Good Morning All,

As you know, the NCDAQ is planning on pursuing insignificance for Primary PM_2.5 , NOx, NH_3 , SO_2 , VOC and road dust for the Hickory NA area. When the NCDAQ submits the PM_2.5 SIP for public comment (currently scheduled for 2/11/08), the draft SIP will have two options, one with a Primary PM_2.5 MVEB for Catawba County, and an option without a MVEB. If the option without a MVEB is not approved by EPA, the NCDAQ will have to establish a MVEB for Catawba County. Attached is the consultation plan outlining the MOBILE6.2 parameters used to develop the Primary PM_2.5 MVEB for the Hickory NA area with the MVEB for Catawba County. The MVEB is calculated using the latest speeds, VMT, vehicle age distribution and vehicle count data (used to calculate the vehicle mix) supplied by NCDOT.

MOBILE6.2 is insensitive to the such parameters as temperature, RVP, anti-tampering and I/M commands when calculating PM_2.5 emission factors, therefore, the Primary PM_2.5 emission factor was calculated for a typical summer day (using summertime temperatures, RVP, etc.) and multiplied by 365 days to calculate an annual emission of kg/year. We performed various sensitivity runs with MOBILE6.2 to verify this.

Please provide comments to me by **2/05/08**. I can be reached via phone at 919-715-1246 or e-mail Phyllis.D.Jones@ncmail.net.

Thanks,
Phyllis D. Jones, EIT
Environmental Engineer II
NCDENR, Division of Air Quality
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www.ncair.org

PM2.5 SIP MVEB Mobile inputs.doc	**Content-Type:** application/msword **Content-Encoding:** base64

Subject: Consultation Plan with MVEB for the Triad NA Area
From: "Phyllis.D.Jones" <Phyllis.D.Jones@ncmail.net>
Date: Tue, 29 Jan 2008 10:53:05 -0500
To: Scott Rhine <scottr@partnc.org>
CC: Eddie Dancausse <edward.dancausse@fhwa.dot.gov>, Lynorae Benjamin <Benjamin.Lynorae@epamail.epa.gov>, "Terry Arellano, PE" <tarellano@dot.state.nc.us>, George Bridgers <George.Bridgers@ncmail.net>, Amanetta Wood <Wood.Amanetta@epamail.epa.gov>, ward.nacosta@epa.gov, Laura Boothe <laura.boothe@ncmail.net>, Janice Godfrey <Janice.Godfrey@ncmail.net>

Good Morning Scott,

As you know, the NCDAQ is planning on pursuing insignificance for Primary PM_2.5 , NOx, NH_3 , SO_2 , VOC and road dust for the Triad NA area. When the NCDAQ submits the PM_2.5 SIP for public comment (currently scheduled for 2/11/08), the draft SIP will have two options, one with a Primary PM_2.5 MVEB for Davidson and Guilford Counties, and an option without MVEBs. If the option without MVEBs is not approved by EPA, the NCDAQ will have to establish MVEBs for Davidson and Guilford Counties. Attached is the consultation plan outlining the MOBILE6.2 parameters used to develop the Primary PM_2.5 MVEBs for the Triad NA area with MVEBs for each county. The MVEBs are calculated using the latest speeds, VMT, vehicle age distribution and vehicle count data (used to calculate the vehicle mix) supplied by NCDOT.

I would like to note that there are slight differences in the MOBILE6.2 parameters used to develop the MVEBs and the current conformity demonstration. MOBILE6.2 is insensitive to the such parameters as temperature, RVP, anti-tampering and I/M commands when calculating PM_2.5 emission factors. We performed various sensitivity runs with MOBILE6.2 to verify this. Therefore, the Primary PM_2.5 emission factors were calculated for a typical summer day (using summertime temperatures, RVP, etc.) and multiplied by 365 days to calculate an annual emissions of kg/year.

Can you please share this with the Triad NA area partners? Please provide comments to me by **2/05/08**. I can be reached via phone at 919-715-1246 or e-mail Phyllis.D.Jones@ncmail.net.

Thanks,
Phyllis D. Jones, EIT
Environmental Engineer II
NCDENR, Division of Air Quality
1641 MSC, Raleigh, NC 27699
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PM2.5 SIP MVEB Mobile inputs.doc	**Content-Type:** application/msword **Content-Encoding:** base64

Mobile Model Settings for Developing the 2009 MVEB in the $PM_{2.5}$ Attainment Demonstration for Catawba, Davidson, and Guilford Counties

Parameter	Details
a. ***Emissions Model Version(s):***	MOBILE6.2
b. ***Emission Model Runs:***	Average annual weekday.
c. ***Time Periods:***	Used daily data from TRM and Rural areas to calculate the annual emissions.
d. ***Pollutants Reported:***	$PM_{2.5}$
e. ***Emissions Budget Year:***	2009
f. ***Vehicle Classes:***	16
g. ***Max/Min Temperatures:***	Annual average 2002 max/min temperatures based upon the data from the Hickory Regional Airport (KHKY) and the Piedmont Triad International Airport (KGSO).

County	2002 Annual Average Max (F)	2002 Annual Average Min (F)
Catawba	70	50
Davidson	70	49
Guilford	70	49

h. ***VMT Mix:*** 2009 statewide vehicle mix based upon the 2006 count data provided by NCDOT using the method in the August 2004 USEPA Emissions Inventory Technical Guidance.

2009 State Vehicle Mix

```
Rural
   LDV       LDT1      LDT2      LDT3      LDT4     HDV2B      HDV3      HDV4
   HDV5      HDV6      HDV7     HDV8a     HDV8b      HDBS      HDBT        MC
Interstate
0.3030    0.0718    0.2389    0.0736    0.0339    0.0880    0.0086    0.0072
0.0054    0.0197    0.0233    0.0253    0.0900    0.0045    0.0023    0.0045
Principal Arterial
0.3591    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0458    0.0023    0.0012    0.0053
Minor Arterial
0.3668    0.0869    0.2894    0.0892    0.0410    0.0389    0.0038    0.0032
0.0024    0.0087    0.0103    0.0112    0.0398    0.0020    0.0010    0.0054
Major Collector
0.3827    0.0906    0.3018    0.0930    0.0428    0.0267    0.0026    0.0022
0.0017    0.0060    0.0071    0.0077    0.0274    0.0014    0.0007    0.0056
Minor Collector
0.3821    0.0905    0.3014    0.0929    0.0427    0.0272    0.0027    0.0022
0.0017    0.0061    0.0072    0.0078    0.0278    0.0014    0.0007    0.0056
Local
0.3805    0.0901    0.3001    0.0925    0.0425    0.0284    0.0028    0.0023
0.0018    0.0064    0.0075    0.0082    0.0291    0.0015    0.0007    0.0056

Urban
LDV       LDT1      LDT2      LDT3      LDT4      HDV2B     HDV3      HDV4
HDV5      HDV6      HDV7      HDV8a     HDV8b     HDBS      HDBT      MC
Interstate
0.3442    0.0815    0.2714    0.0836    0.0384    0.0564    0.0055    0.0046
0.0035    0.0126    0.0149    0.0162    0.0577    0.0029    0.0015    0.0051
```

```
Freeway
0.3699    0.0876    0.2918    0.0899    0.0413    0.0366    0.0036    0.0030
0.0023    0.0082    0.0097    0.0105    0.0374    0.0019    0.0009    0.0054
Principal Arterial
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056
Minor Arterial
0.3930    0.0931    0.3100    0.0956    0.0439    0.0188    0.0018    0.0015
0.0012    0.0042    0.0050    0.0054    0.0192    0.0010    0.0005    0.0058
Collector
0.3967    0.0939    0.3127    0.0964    0.0443    0.0161    0.0016    0.0013
0.0010    0.0036    0.0043    0.0046    0.0165    0.0008    0.0004    0.0058
Local
0.3872    0.0917    0.3054    0.0941    0.0433    0.0233    0.0023    0.0019
0.0014    0.0052    0.0062    0.0067    0.0238    0.0012    0.0006    0.0057
```

i. ***Speeds:*** From TDM and Rural spreadsheet provided by NCDOT.

Catawba County Speeds

Road Type	Model Area	Non-Model Area
Rural Interstate	0	66
Rural Principal Arterial	0	47
Rural Minor Arterial	0	44
Rural Major Collector	0	43
Rural Minor Collector	0	42
Rural Local	0	42
Urban Interstate	60	63
Urban Freeway	57	56
Urban Principal Arterial	27	29
Urban Minor Arterial	29	32
Urban Collector	33	31
Urban Local	29	31

Davidson County Speeds

Road Type	Model Area	Non-Model Area
Rural Interstate	68	65
Rural Principal Arterial	60	44
Rural Minor Arterial	44	43
Rural Major Collector	44	43
Rural Minor Collector	48	42
Rural Local	46	42
Urban Interstate	66	62
Urban Freeway	52	56
Urban Principal Arterial	40	28
Urban Minor Arterial	40	32
Urban Collector	37	31
Urban Local	43	32

Guilford County Speeds

Road Type	Model Area
Rural Interstate	59
Rural Principal Arterial	57
Rural Minor Arterial	45
Rural Major Collector	47
Rural Minor Collector	46
Rural Local	44
Urban Interstate	60
Urban Freeway	54
Urban Principal Arterial	40
Urban Minor Arterial	38
Urban Collector	38
Urban Local	37

j. ***Vehicle Age Distribution:*** Based on 2005 vehicle registration data provided by NCDOT. NCAge05.prn is used for Davidson and Catawba Counties and TrdAge05.prn is used for Guilford County.

NCAge05.prn

```
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
```

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* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)


RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV          M5 LDGV
       1   0.061   0.064   0.063   0.065   0.064   0.072   0.069   0.063   0.061   0.056
           0.061   0.049   0.043   0.035   0.029   0.025   0.023   0.019   0.015   0.011
           0.009   0.006   0.004   0.002   0.030
* LDT1         M5 LDGT1
       2   0.040   0.050   0.047   0.047   0.052   0.058   0.056   0.055   0.057   0.047
           0.051   0.054   0.039   0.032   0.029   0.028   0.034   0.033   0.028   0.028
           0.021   0.018   0.012   0.007   0.078
* LDT2         M5 LDGT1
       3   0.040   0.050   0.047   0.047   0.052   0.058   0.056   0.055   0.057   0.047
           0.051   0.054   0.039   0.032   0.029   0.028   0.034   0.033   0.028   0.028
           0.021   0.018   0.012   0.007   0.078
* LDT3         M5 LDGT2
       4   0.071   0.079   0.060   0.049   0.053   0.061   0.059   0.047   0.053   0.041
           0.050   0.040   0.030   0.023   0.021   0.025   0.031   0.028   0.019   0.021
           0.018   0.014   0.009   0.006   0.090
* LDT4         M5 LDGT2
       5   0.071   0.079   0.060   0.049   0.053   0.061   0.059   0.047   0.053   0.041
           0.050   0.040   0.030   0.023   0.021   0.025   0.031   0.028   0.019   0.021
           0.018   0.014   0.009   0.006   0.090
* HDV2B        M5 HDVs (Combined HDGV and HDDV)
       6   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV3         M5 HDVs (Combined HDGV and HDDV)
       7   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV4         M5 HDVs (Combined HDGV and HDDV)
       8   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV5         M5 HDVs (Combined HDGV and HDDV)
       9   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV6         M5 HDVs (Combined HDGV and HDDV)
      10   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV7         M5 HDVs (Combined HDGV and HDDV)
      11   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV8a        M5 HDVs (Combined HDGV and HDDV)
      12   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDV8b        M5 HDVs (Combined HDGV and HDDV)
      13   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
```

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* HDBS          M5 HDVs (Combined HDGV and HDDV)
      14   0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
           0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
           0.018   0.014   0.008   0.007   0.116
* HDBT          M5 HDDVs
      15   0.093   0.074   0.064   0.051   0.071   0.087   0.089   0.051   0.063   0.044
           0.051   0.037   0.027   0.019   0.020   0.027   0.026   0.025   0.021   0.014
           0.013   0.009   0.004   0.004   0.016
* Motorcycles   M5 MC
      16   0.122   0.092   0.104   0.087   0.076   0.066   0.056   0.042   0.038   0.037
           0.028   0.024   0.019   0.013   0.010   0.010   0.010   0.010   0.011   0.018
           0.016   0.013   0.013   0.015   0.070
```

TrdAge05.prn

```
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                        RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV           M5 LDGV
       1   0.071   0.067   0.067   0.069   0.069   0.076   0.073   0.066   0.062   0.055
           0.059   0.046   0.040   0.032   0.026   0.023   0.020   0.016   0.012   0.009
           0.007   0.005   0.003   0.001   0.024
* LDT1          M5 LDGT1
       2   0.041   0.052   0.054   0.052   0.055   0.061   0.058   0.058   0.059   0.048
           0.053   0.055   0.037   0.032   0.027   0.024   0.031   0.030   0.024   0.024
           0.017   0.014   0.008   0.006   0.081
* LDT2          M5 LDGT1
       3   0.041   0.052   0.054   0.052   0.055   0.061   0.058   0.058   0.059   0.048
           0.053   0.055   0.037   0.032   0.027   0.024   0.031   0.030   0.024   0.024
           0.017   0.014   0.008   0.006   0.081
* LDT3          M5 LDGT2
       4   0.091   0.081   0.078   0.052   0.062   0.070   0.079   0.062   0.060   0.044
           0.052   0.042   0.029   0.019   0.017   0.018   0.019   0.020   0.013   0.013
           0.011   0.007   0.005   0.004   0.053
* LDT4          M5 LDGT2
       5   0.091   0.081   0.078   0.052   0.062   0.070   0.079   0.062   0.060   0.044
           0.052   0.042   0.029   0.019   0.017   0.018   0.019   0.020   0.013   0.013
           0.011   0.007   0.005   0.004   0.053
* HDV2B         M5 HDVs (Combined HDGV and HDDV)
       6   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
           0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
           0.011   0.008   0.005   0.005   0.059
* HDV3          M5 HDVs (Combined HDGV and HDDV)
       7   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
           0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
           0.011   0.008   0.005   0.005   0.059
```

```
* HDV4          M5 HDVs (Combined HDGV and HDDV)
      8   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV5          M5 HDVs (Combined HDGV and HDDV)
      9   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV6          M5 HDVs (Combined HDGV and HDDV)
     10   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV7          M5 HDVs (Combined HDGV and HDDV)
     11   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV8a         M5 HDVs (Combined HDGV and HDDV)
     12   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV8b         M5 HDVs (Combined HDGV and HDDV)
     13   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDBS          M5 HDVs (Combined HDGV and HDDV)
     14   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDBT          M5 HDDVs
     15   0.114   0.090   0.059   0.056   0.082   0.102   0.100   0.047   0.055   0.045
          0.049   0.033   0.023   0.018   0.018   0.021   0.022   0.016   0.015   0.011
          0.008   0.006   0.002   0.002   0.008
* Motorcycles   M5 MC
     16   0.098   0.088   0.105   0.092   0.081   0.073   0.058   0.043   0.038   0.039
          0.030   0.026   0.023   0.015   0.012   0.010   0.010   0.008   0.012   0.017
          0.017   0.012   0.011   0.016   0.069
```

k. ***Anti-tampering Applicability:*** Applies to vehicles 35 years and newer starting with MY 1975.

l. ***RVP:*** RVP does not impact the MOBILE6.2 $PM_{2.5}$ emission factors, therefore, NCDAQ is using the summertime RVP.

County	**Average Annual RVP (psi)**
Catawba	9.0
Davidson	7.8
Guilford	7.8

m. ***I/M Fraction:*** Will assume 100 percent penetration since MOBILE6.2 $PM_{2.5}$ emission factors are not impacted by I/M.

n. ***Evaluation month:*** July

o. ***VMT:*** TRM and rural spreadsheet where applicable.

Catawba County VMT

Road Type	Model Area	Non-Model Area
Rural Interstate	0	56,490
Rural Principal Arterial	0	75,274
Rural Minor Arterial	0	73,290
Rural Major Collector	0	56,815
Rural Minor Collector	0	90,945
Rural Local	0	68,374
Urban Interstate	1,068,778	165,606
Urban Freeway	318,096	39,019
Urban Principal Arterial	762,827	167,088
Urban Minor Arterial	1,132,744	152,147
Urban Collector	261,444	26,271
Urban Local	514,186	123,328

Davidson County VMT

Road Type	Model Area	Non-Model Area
Rural Interstate	306,105	443,207
Rural Principal Arterial	249,163	287,385
Rural Minor Arterial	269,215	301,987
Rural Major Collector	172,846	427,935
Rural Minor Collector	156,314	215,492
Rural Local	301,453	157,910
Urban Interstate	333,251	371,816
Urban Freeway	676,186	199,204
Urban Principal Arterial	448,118	372,564
Urban Minor Arterial	293,172	298,549
Urban Collector	192,524	57,169
Urban Local	242,868	131,653

Guilford County VMT

Road Type	Model Area
Rural Interstate	992,132
Rural Principal Arterial	587,329
Rural Minor Arterial	198,365
Rural Major Collector	688,901
Rural Minor Collector	289,515
Rural Local	440,324
Urban Interstate	4,925,953
Urban Freeway	2,341,290
Urban Principal Arterial	2,405,902
Urban Minor Arterial	2,698,219
Urban Collector	1,143,015
Urban Local	1,884,921

p. ***Diesel Sulfur Content:*** USEPA Technical Guidance: Use of MOBILE6.2 for Emissions Inventory Preparation (August 2004).

County	2009 Diesel Sulfur (ppm)
Catawba	43
Davidson	43
Guilford	43

s. ***Annual Emissions:*** Annual 2009 $PM_{2.5}$ emissions will be calculated by multiplying average daily county emissions by 365 days.

t. ***Emissions analysis units:*** Units = Kilograms/day

NOTE: NO_x has been deemed insignificant for mobile; therefore there is no NO_x MVEB.

MVEBs

County	MVEB (Kilograms/year)
Catawba	48,132
Davidson	71,152
Guilford	164,286

Subject: RE: Consultation Plan with MVEB for the Hickory NA Area
From: "John Tippett" <john.tippett@wpcog.org>
Date: Tue, 29 Jan 2008 11:59:49 -0500
To: "Phyllis.D.Jones" <Phyllis.D.Jones@ncmail.net>, "John Marshall" <john.marshall@wpcog.org>, <lnguyen@dot.state.nc.us>, <sarahsmith@dot.state.nc.us>, "Alena Cook (Cook, Alena)" <arcook@dot.state.nc.us>, "Stark, Jill" <Jill.Stark@fhwa.dot.gov>
CC: "Dancausse, Edward" <edward.dancausse@fhwa.dot.gov>, <george.bridgers@ncmail.net>, <janice.godfrey@ncmail.net>, <keith.melton@dot.gov>, <tarellano@dot.state.nc.us>, <Wood.Amanetta@epamail.epa.gov>, <Benjamin.Lynorae@epamail.epa.gov>, <ward.nacosta@epa.gov>, "Laura Boothe" <laura.boothe@ncmail.net>, "Taylor Dellinger" <taylor.dellinger@wpcog.org>

The Mobile 6 factors look reasonable to us at the MPO and we have no other comments. Our knowledge is limited in this area so we will defer to others.
John Tippett
Greater Hickory MPO

-----Original Message-----
From: Phyllis.D.Jones [mailto:Phyllis.D.Jones@ncmail.net]
Sent: Tuesday, January 29, 2008 11:12 AM
To: John Tippett; John Marshall; lnguyen@dot.state.nc.us; sarahsmith@dot.state.nc.us; Alena Cook (Cook, Alena); Stark, Jill
Cc: Dancausse, Edward; george.bridgers@ncmail.net; janice.godfrey@ncmail.net; keith.melton@dot.gov; tarellano@dot.state.nc.us; Wood.Amanetta@epamail.epa.gov; Benjamin.Lynorae@epamail.epa.gov; ward.nacosta@epa.gov; Laura Boothe
Subject: Consultation Plan with MVEB for the Hickory NA Area

Good Morning All,

As you know, the NCDAQ is planning on pursuing insignificance for Primary PM_2.5 , NOx, NH_3 , SO_2 , VOC and road dust for the Hickory NA area. When the NCDAQ submits the PM_2.5 SIP for public comment (currently scheduled for 2/11/08), the draft SIP will have two options, one with a Primary PM_2.5 MVEB for Catawba County, and an option without a MVEB. If the option without a MVEB is not approved by EPA, the NCDAQ will have to establish a MVEB for Catawba County. Attached is the consultation plan outlining the MOBILE6.2 parameters used to develop the Primary PM_2.5 MVEB for the Hickory NA area with the MVEB for Catawba County. The MVEB is calculated using the latest speeds, VMT, vehicle age distribution and vehicle count data (used to calculate the vehicle mix) supplied by NCDOT.

MOBILE6.2 is insensitive to the such parameters as temperature, RVP, anti-tampering and I/M commands when calculating PM_2.5 emission factors, therefore, the Primary PM_2.5 emission factor was calculated for a typical summer day (using summertime temperatures, RVP, etc.) and multiplied by 365 days to calculate an annual emission of kg/year. We performed various sensitivity runs with MOBILE6.2 to verify this.

Please provide comments to me by **2/05/08**. I can be reached via phone at 919-715-1246 or e-mail Phyllis.D.Jones@ncmail.net.

Thanks,
Phyllis D. Jones, EIT
Environmental Engineer II
NCDENR, Division of Air Quality
1641 MSC, Raleigh, NC 27699
Phone-(919) 715-1246
Fac-(919) 715-7476

www.ncair.org

Appendix C
Air Quality Data

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Appendix C.1
Historical Air Quality Data

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Table 1. Quarterly Average $PM_{2.5}$ Values ($\mu g/m^3$) for the Hickory and Greensboro-Winston Salem-High Point Nonattainment Areas

Monitoring Site	County	Quarter	2000	2001	2002	2003	2004	2005	2006	2007	2008
Hickory	Catawba	Q1	**16.1**	**15.3**	13.3	12.9	13.1	13.6	13.1	12.5	12.9
		Q2	**16.6**	**16.6**	14.3	**16.1**	14.9	**16.7**	**15.5**	14.7	13.0
		Q3	**18.9**	**18.8**	**21.1**	**19.3**	**19.6**	**20.6**	**19.8**	**20.0**	14.8
		Q4	**18.9**	13.2	12.7	11.8	12.4	12.8	12.4	11.0	10.8
Lexington	Davidson	Q1	**17.1**	14.8	14.9	12.6	13.9	13.2	12.9	13.1	13.2
		Q2	**17.8**	**18.6**	15.0	**16.1**	**15.7**	**15.8**	14.3	13.5	13.7
		Q3	**18.4**	**18.8**	**19.3**	**19.1**	**18.0**	**20.3**	**19.8**	**20.1**	**16.1**
		Q4	**18.9**	13.6	14.3	12.9	13.2	12.3	13.6	11.8	11.6
Mendenhall	Guilford	Q1			11.7	11.6	11.8	11.5	10.6	11.0	10.7
		Q2			13.1	13.6	14.4	13.1	13.7	12.8	12.1
		Q3			**18.3**	**16.5**	**16.5**	**19.3**	**19.1**	**17.8**	13.9
		Q4			11.7	11.7	13.2	12.2	*12.9*	10.6	9.0

Quarterly average $PM_{2.5}$ values are presented in micrograms per meter cubed ($\mu g/m^3$).

Bolded values represent quarters whose average values exceed the level of the annual PM2.5 National Ambient Air Quality Standard (i.e. greater than 15.0 $\mu g/m^3$).

The Mendenhall site was not in operation during 2000 or 2001.

Italics value represents estimated 4th quarter 2006 data at Mendenhall. There was an extended loss of monitoring data at the Mendenhall site during the 4th quarter of 2006. The NCDAQ has performed an extensive data imputation study to estimate a 4th quarter average concentration such that an appropriate annual average concentration and design value could be calculated. This study, titled "Mendenhall PM2.5 Data Imputation for 4Q2006" can be found in Appendix C.3.

Table 2. Annual Average $PM_{2.5}$ Values ($\mu g/m^3$) for the Hickory and Greensboro-Winston Salem-High Point Nonattainment Areas

Monitoring Site	County	Annual Averages								
		2000	2001	2002	2003	2004	2005	2006	2007	2008
Hickory	Catawba	**17.6**	**16.0**	**15.4**	15.0	15.0	**15.9**	**15.2**	14.5	12.8
Lexington	Davidson	**18.0**	**16.5**	**15.9**	**15.2**	**15.2**	**15.4**	**15.1**	14.6	13.7
Mendenhall	Guilford			13.7	13.3	14.0	14.0	*14.1*	13.0	11.4

Annual average $PM_{2.5}$ values are presented in micrograms per meter cubed ($\mu g/m^3$).

Bolded values represent annual average values that exceed the level of the annual PM2.5 National Ambient Air Quality Standard (i.e. greater than 15.0 $\mu g/m^3$).

The Mendenhall site was not in operation during 2000 or 2001.

Italics value represents a 2006 annual average that used estimated 4th quarter 2006 data at Mendenhall. There was an extended loss of monitoring data at the Mendenhall site during the 4th quarter of 2006. The NCDAQ has performed an extensive data imputation study to estimate a 4th quarter average concentration such that an appropriate annual average concentration and design value could be calculated. This study, titled "Mendenhall PM2.5 Data Imputation for 4Q2006" can be found in Appendix C.3.

Table 3. 3-year Current $PM_{2.5}$ Design Values ($\mu g/m^3$) for the Hickory and Greensboro-Winston Salem-High Point Nonattainment Areas

Monitoring Site	County	Design Values						
		2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008
Hickory	Catawba	**16.3**	**15.5**	**15.1**	**15.3**	**15.4**	**15.2**	14.2
Lexington	Davidson	**16.8**	**15.8**	**15.4**	**15.2**	**15.2**	**15.1**	14.5
Mendenhall	Guilford			13.7	13.8	*14.0*	*13.7*	*12.9*

$PM_{2.5}$ design values are presented in micrograms per meter cubed ($\mu g/m^3$).

Bolded values represent design values that exceed the level of the annual PM2.5 National Ambient Air Quality Standard (i.e. greater than 15.0 $\mu g/m^3$).

The Mendenhall site was not in operation during 2000 or 2001. So, the first design value period that can be calculated is 2002-2004.

Italics values represent design values that used estimated 4th quarter 2006 data at Mendenhall. There was an extended loss of monitoring data at the Mendenhall site during the 4th quarter of 2006. The NCDAQ has performed an extensive data imputation study to estimate a 4th quarter average concentration such that an appropriate annual average concentration and design value could be calculated. This study, titled "Mendenhall PM2.5 Data Imputation for 4Q2006" can be found in Appendix C.3.

Table 4. Summary table of $PM_{2.5}$ Values used in for Designations in the Hickory and Greensboro-Winston Salem-High Point Nonattainment Areas

County	FRM Monitoring Site	Year	1st Quarter (Q1)	2nd Quarter (Q2)	3rd Quarter (Q3)	4th Quarter (Q4)	Annual Average	Design Value
Catawba	Hickory	2001	**15.3**	**16.6**	**18.8**	13.2	**16.0**	**15.5**
		2002	13.3	14.3	**21.1**	12.7	**15.4**	
		2003	12.9	**16.1**	**19.3**	11.8	**15.0**	
Davidson	Lexington	2001	14.8	**18.6**	**18.8**	13.6	**16.5**	**15.8**
		2002	14.9	15.0	**19.3**	14.3	**15.9**	
		2003	12.6	**16.1**	**19.1**	12.9	**15.2**	
Guilford	Mendenhall	2001	12.0	**16.7**	**18.0**	12.9	14.9	14.0
		2002	11.7	13.1	**18.3**	11.7	13.7	
		2003	11.6	13.6	**16.5**	11.7	13.3	

$PM_{2.5}$ design values are presented in micrograms per meter cubed ($\mu g/m^3$).

Bolded values represent design values that exceed the level of the annual PM2.5 National Ambient Air Quality Standard (i.e. greater than 15.0 $\mu g/m^3$).

Underline values represent values that incorporate data from the Edgeworth & Bellmeade (37-081-0009) monitoring site. The Mendenhall site replaced the Edgeworth & Bellmeade site in 4th quarter 2001.

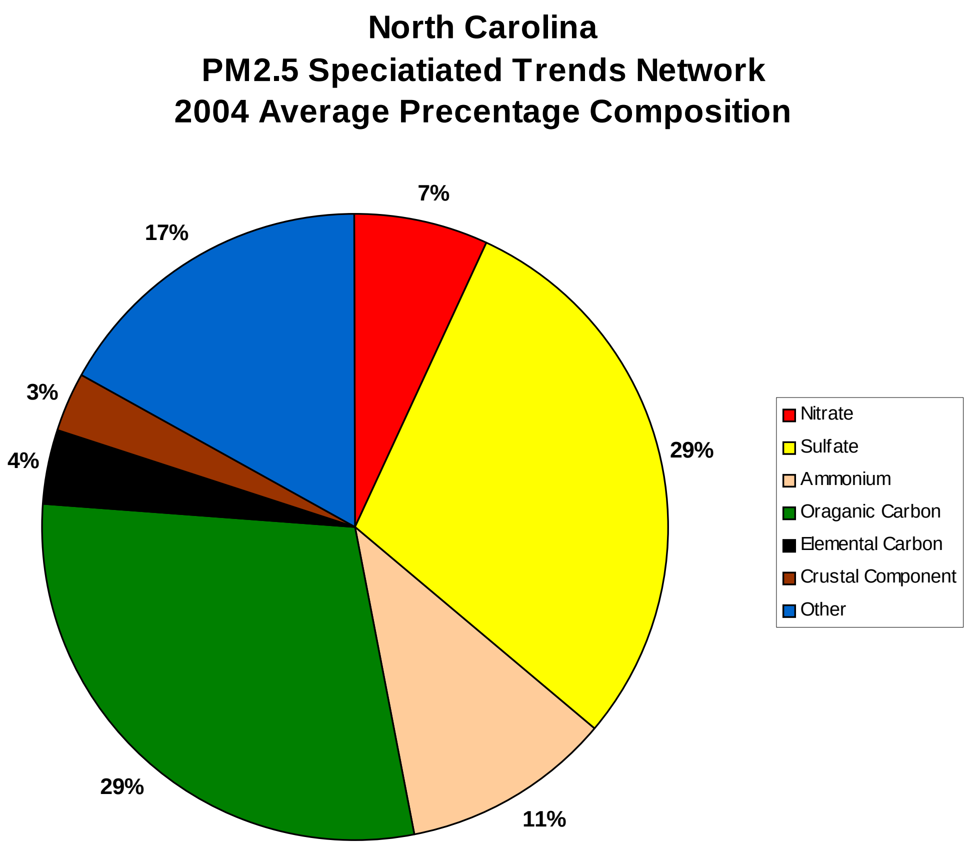

Figure 1. The 2004 Average Percent Composition of $PM_{2.5}$ for North Carolina, as Determined by Data from Speciated Trends Network Monitors.

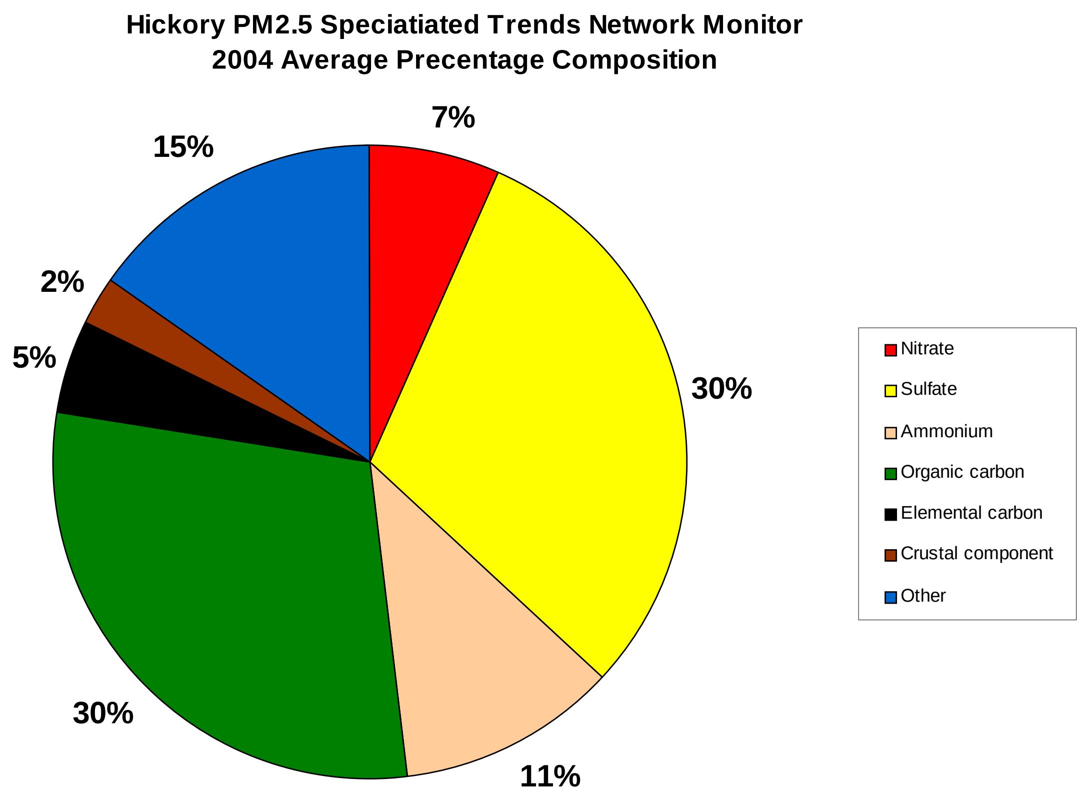

Figure 2. The 2004 Average Percent Composition of $PM_{2.5}$ for Hickory, North Carolina as Determined by Data from the Hickory Speciated Trends Network Monitor

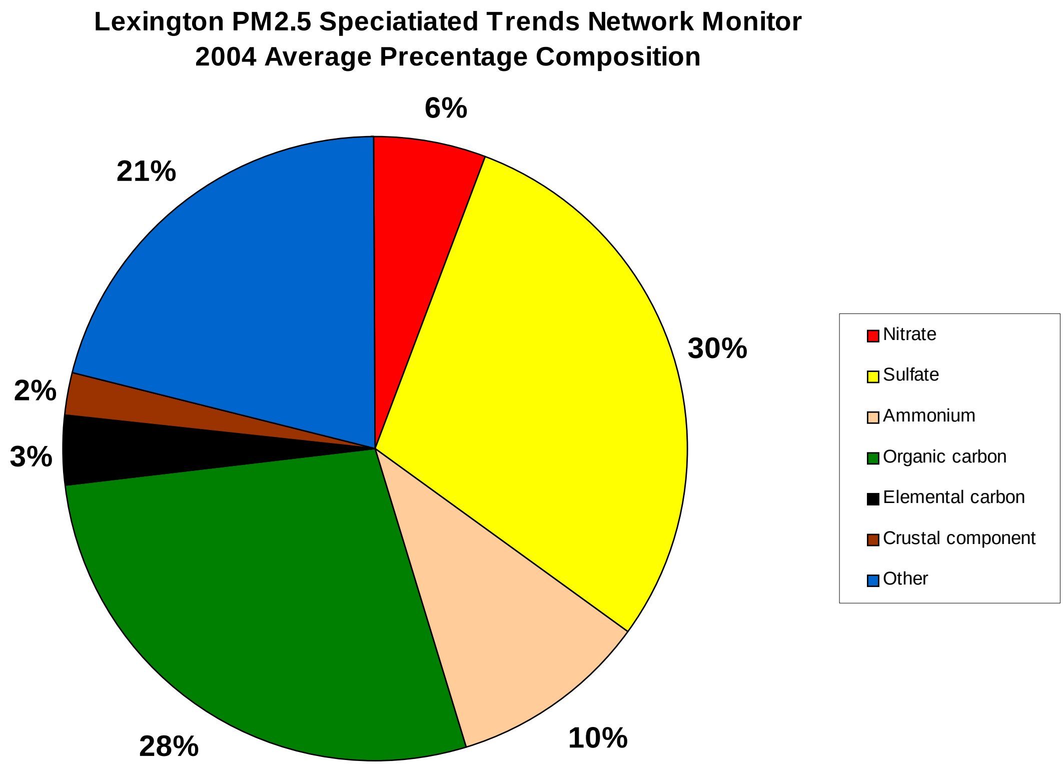

Figure 3. The 2004 Average Percent Composition of $PM_{2.5}$ for Lexington, North Carolina as Determined by Data from the Lexington Speciated Trends Network Monitor

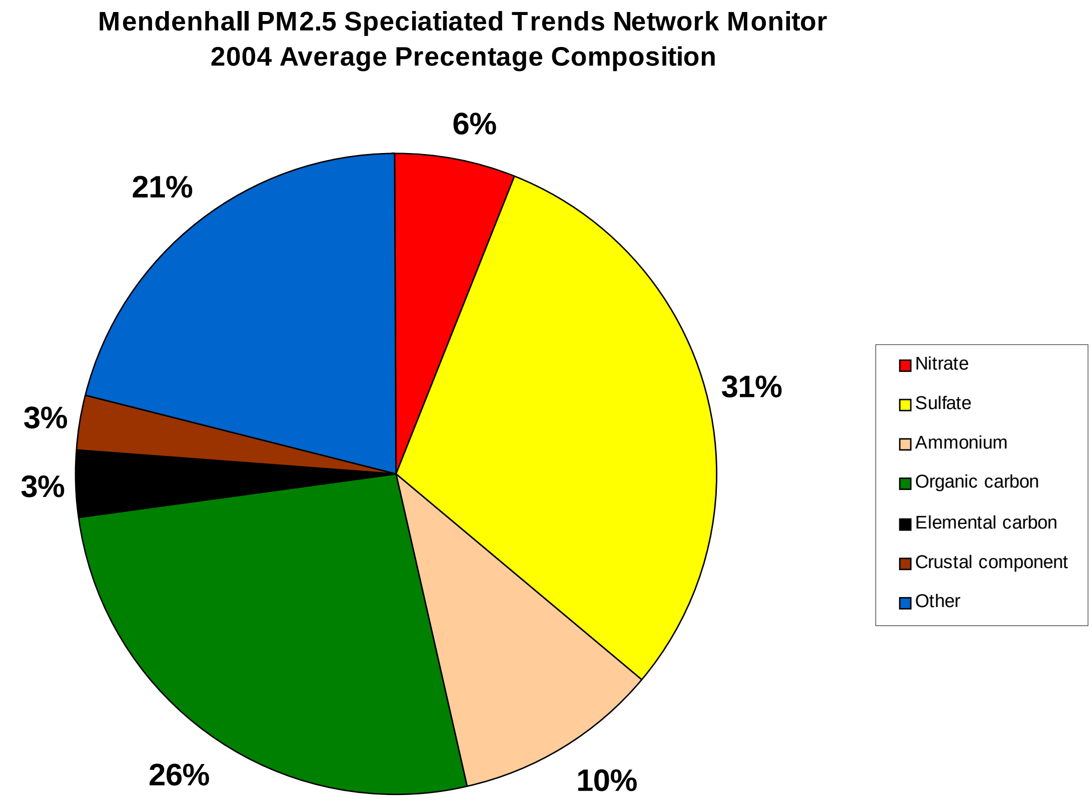

Figure 4. The 2004 Average Percent Composition of $PM_{2.5}$ for Greensboro, North Carolina as Determined by Data from the Mendenhall Speciated Trends Network Monitor

Appendix C.2
Air Quality Data Used For Modeling

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1. Air Quality Data for 2002

As part of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) Phase I modeling study, the VISTAS emissions and air quality modeling team of ENVIRON International Corporation, Alpine Geophysics (AG) and the University of California at Riverside (UCR) compiled ambient monitoring data for both gas and particulate species to be used in the VISTAS regional haze model performance evaluation. UCR took the lead in this activity. The contractor's report (found in Attachment C.1) describes the sources of the ambient data and the steps taken in the processing and quality assurance (QA) of the data. In addition, the ambient data is being processed and formatted in preparation for use in software packages designed for the model performance evaluation.

The goal was to preprocess the ambient data and present plots of ambient data on the project website so model performance evaluations when the model simulations were completed. The ambient data are available from the following 9 monitoring networks or databases:

- EPA's AQS (Environmental Protection Agency's Air Quality System) database
- PAMS (Photochemical Assessment Monitoring Stations)
- IMPROVE (The Interagency Monitoring of Protected Visual Environments)
- SEARCH (Southeastern Aerosol Research and Characterization)
- EPA's STN (Speciation Trends Network)
- NADP (National Atmospheric Deposition Program)
- CASTNET (Clean Air Status and Trend Network)
- PM Supersites
- NARSTO SOS99 Aircraft data (for the July 1999 episode only)
- TVA measurement network
- Georgia Institute of Technology Assessment of Spatial Aerosol Composition in Atlanta (ASACA) monitors.

Note that there is some overlap in the above monitoring networks. For example, some data from PAMS (such as ozone and nitrogen oxides) are included in the AQS database, and it appears that the STN network may also include speciated particulate matter data from IMPROVE and other monitoring networks. Attachment C.1 contains maps of many of the existing and planned (as of January 2002) urban and rural fine particulate matter speciation networks. The available data from the above monitoring networks for the three episodes of VISTAS regional haze modeling (July 9-22, 1999, July 7-28, 2001 and January 1- 21, 2002) was obtained. The attempt was made to reconcile data from the various networks and to perform a high level QA of the ambient data. The monitoring networks, the available data, and QA efforts are described in their entirety in the previously mentioned VISTAS report.

Additional data used in the air quality modeling include the Total Ozone Mapping Spectrometer (TOMS). TOMS data is available for 24-hour average and is obtained from http://toms.gsfc.nasa.gov/eptoms/ep.html. The TOMS data is used in the CMAQ radiation model (JPROC) to calculate photolysis rates.

1.1 Quality Assurance – Overview

The VISTAS Phase II emissions and air quality modeling team received emissions, meteorological and air quality data from other VISTAS contractors or other sources. As a first line of QA, a Gatekeeper function was defined to assure the data have been received correctly, evaluate the quality of the data, and document the data received. Separate air quality, meteorological and emissions Gatekeepers have been identified whose roles are defined below. In addition, a Data Management Gatekeeper has been defined who will post data, reports and results to the project website and archive all key data generated in the project.

- **Air Quality Data Gatekeeper**. Obtain air quality data as appropriate for model input development and model performance evaluation and assure quality of all air quality data obtained, consistent with approved QA plan. This gatekeeper will also provide documentation of evaluation and generate IC/BC inputs for CMAQ for all modeling runs.
- **Meteorological Gatekeeper**. Obtain meteorological data, as MM5 or MCIP files, as appropriate for annual 2002 modeling runs and other episode periods and perform data quality checks as approved in QA plan together with appropriate documentation of model performance evaluation activities.

1.2 Quality Assurance of Air Quality Data

In gathering data from the monitoring networks it is assumed that the agency or researcher responsible for collecting the data performed quality assurance on the data. However, it is possible that the data sets may contain erroneous data (i.e., missing data, zeros during calibration, unrealistic values, etc). Due to poor documentation or poor formatting of some data sets it is also possible that mistakes may be made in our processing of the data. To guard against this possibility, a plan to perform a high level QA by visually inspecting time-series plots and scatter plots of the ambient data was developed and is outlined as follows:

<u>Plots of Time Series:</u>

Time series plots are generated for PAMS species. The plots should be inspected for the following:

- Large "jumps" or "dips" in the concentrations
- Periodicity of peaks, calibration carryover
- Unexpected diurnal behavior (i.e., isoprene)
- Unexpected relationships among species
- High single-hour concentrations of less abundant species

Scatter Plots:

Scatter plots may be prepared for the following:

- Total NMOC vs. species group totals, vs. individual species
- Benzene vs. Toluene, Acetylene, Ethane
- Scatter plots comparing data for a single species measured with different sampling methods
- Plots of reconstructed mass versus measured mass (to reveals if anything unusual is happening with the chemical measurements)
- Plots of molal particulate ammonium versus the molal sum of sulfate and particulate nitrate (as a sanity check on the ion balance in the PM chemical measurements)

If data is identified that appears flawed it will be flagged and either corrected if the error is in the processing step, or removed from the data set.

Further detail on the quality assurance of air quality data modeling data can be found in the VISTAS document in Attachment C.1. Additional information on quality assurance procedures can be found in the QAPP, as referenced in Appendix G of the SIP.

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Attachment C.2-1

Review and Assessment of Available Ambient Air Quality Data to Support Modeling and Modeling Performance Evaluation for the Three VISTAS Phase I Episodes

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**Draft VISTAS Emissions and
Air Quality Modeling—
Phase I Task 3 Report:**

**Review and Assessment of Available Ambient
Air Quality Data to Support Modeling and
Modeling Performance Evaluation for the
Three VISTAS Phase I Episodes**

Prepared by:

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Revised July 22, 2003

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APPENDICES

TABLES

FIGURES

1.0 SUMMARY

As part of the VISTAS Phase I modeling study, the VISTAS emissions and air quality modeling team of ENVIRON International Corporation, Alpine Geophysics (AG) and the University of California (UC) are compiling ambient monitoring data for both gas and particulate species to be used in the VISTAS regional haze model performance evaluation. The University of California at Riverside (UCR) is taking the lead in this activity. This report describes the sources of the ambient data and the steps that will be used in the processing and quality assurance (QA) of the data. In addition, the ambient data is being processed and formatted in preparation for use in software packages designed for the model performance evaluation. Our goal is to preprocess the ambient data and present plots of ambient data on the project website so that we can rapidly complete model performance evaluations when the model simulations are completed. As the processing of ambient data are completed, plots of the data are being made available at the project website: http://pah.cert.ucr.edu/vistas/ambient.shtml. A large amount of this data is currently available at the project website, and we are continuing to develop the website to facilitate the display of time series plots.

The ambient data are available from the following 9 monitoring networks or databases:

- EPA's AQS (Air Quality System) database
- PAMS (Photochemical Assessment Monitoring Stations)
- IMPROVE (The Interagency Monitoring of Protected Visual Environments)
- SEARCH (Southeastern Aerosol Research and Characterization)
- EPA's STN (Speciation Trends Network)
- NADP (National Atmospheric Deposition Program)
- CASTNET (Clean Air Status and Trend Network)
- PM Supersites
- NARSTO SOS99 Aircraft data (for the July 1999 episode only)
- TVA measurement network
- Georgia Institute of Technology Assessment of Spatial Aerosol Composition in Atlanta (ASACA) monitors.

Note that there is some overlap in the above monitoring networks. For example, some data from PAMS (such as O3 and NOx) are included in the AQS database, and it appears that the STN network may also include speciated PM data from IMPROVE and other monitoring networks. Appendix A shows maps of many of the existing and planned (as of January, 2002) urban and rural $PM_{2.5}$ speciation networks.

We have obtained most of the available data from the above monitoring networks for the three episodes of VISTAS regional haze modeling (July 9-22, 1999, July 7-28, 2001 and January 1-21, 2002). Although a comprehensive quality assurance and validation effort is beyond the scope of this effort, we are attempting to reconcile data from the various networks and to perform a high level QA of the ambient data. The monitoring networks, the available data, and QA efforts are described below. We expect that during the next two months we will continue to gather and process ambient data, and will rely on expertise from other team members and VISTAS in identifying ambient data. We have not yet investigated the possibility of systematic bias among different analytical methods used in the various networks. However, this is an important subject to be addressed because of the possibility that networks employ different sampling methods.

Measurement data from monitors operated by the Tennessee Valley Authority (TVA) and Georgia Technology's ASACA monitors have not yet been acquired. ASACA has been operating three Particle Composition Monitors and three TEOMS in Atlanta since early 1999. When acquired, these data will be documented on the project website.

2.0 EPA'S AIR QUALITY SYSTEM (AQS)

The Air Quality System (AQS) database is EPA's repository of "**criteria air pollutant**" monitoring data since the 1970s. The **criteria air pollutants** are:

- Carbon Monoxide (CO)
- Nitrogen Dioxide (NO2)
- Sulfur Dioxide (SO2)
- Ozone (O3)
- Particulate Matter (PM_{10} and $PM_{2.5}$)
- Lead (Pb)

Ambient concentrations of these pollutants from more than 4000 monitoring stations are reported to AQS on weekly or monthly basis. While several other monitoring networks (e.g. PAMS, IMPROVE, CASTNet, and etc.) owned and operated by different agencies collect various air pollutants, only **criteria air pollutants** are reported to AQS (as shown in Figure 2-1).

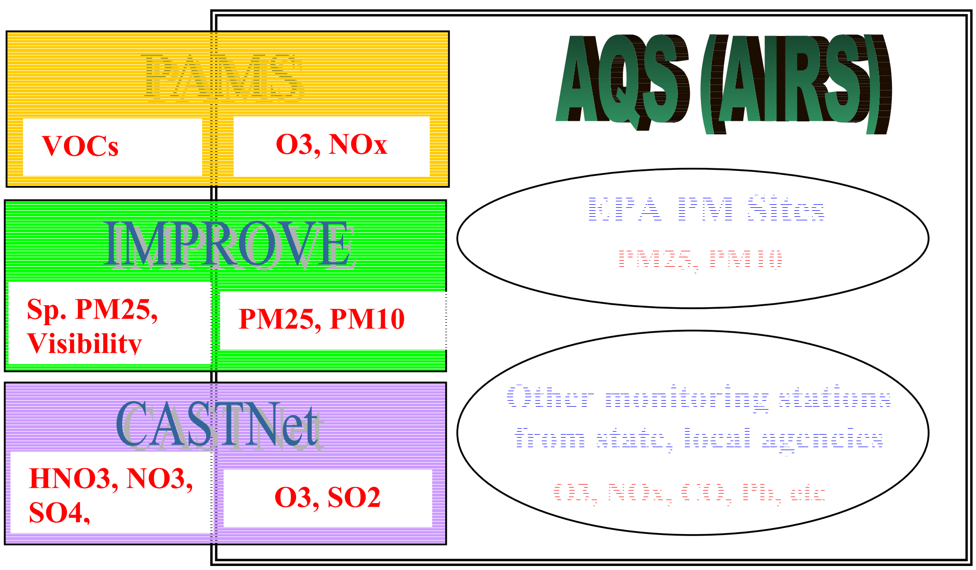


Figure 2-1. Overlap among ambient data collected from several monitoring networks.

Although direct access to full AQS raw data is currently not available, several archived data files can be downloaded from EPA's website http://www.epa.gov/ttn/airs/airsaqs/. Table 2-1 summarizes the data that are currently available and processed for hourly average concentration data from AQS for three VISTAS episodes. We have requested the remaining AQS data from EPA and will process them upon arrival. Note that the AQS includes O3 data from the State/Local/National Air Monitoring Stations (SLAMS).

Table 2-1. Currently* available hourly concentration data from AQS for three VISTAS episode selections.

Period	O_3	$PM_{2.5}$	NO_2	CO	SO_2
July 9-22, 1999	X	X	X	X	X
July 7-28, 2001	X	X			
Jan. 1-21, 2002	X	X			

* Efforts are underway to acquire the NO_2, CO and SO_2 measurements for the July 2001 and January 2002 episodes.

These data are presented on the VISTAS project website, http://www.cert.ucr.edu/vistas/ambient.shtml, under the title of "Ambient data for Model Evaluation", as animated figures that show spatial variation of O_3, $PM_{2.5}$, NO_2, CO and SO_2 concentrations. These data will also be made available as time series plots for each monitor site. The spatial distributions for average species concentrations within each VISTAS episode are shown in Figures 2-2 through 2-10. These plots are intended to be illustrative of the results on the project web page, and for more detailed evaluation please see the ambient data page: http://pah.cert.ucr.edu/vistas/ambient.shtml.
Note that the web page also includes plots that zoom in on the southeastern US domain.

July 9-22, 1999

Hourly O_3 concentrations were available at 1113 stations over USA for July 9-22, 1999. Figure 2-2 shows the distribution of average O_3 concentrations for these stations.

Hourly $PM_{2.5}$ concentrations were available at 25 stations over USA for July 9-22, 1999. Figure 2-3 shows the distribution of average $PM_{2.5}$ concentrations for these stations.

Hourly NO2 concentrations were available at 170 stations over USA for July 9-22, 1999. Figure 2-4 shows the distribution of average NO2 concentrations for these stations.

Hourly CO concentrations were available at 442 stations over USA for July 9-22, 1999. Figure 2-5 shows the distribution of average CO concentrations for these stations.

Hourly SO2 concentrations were available at 563 stations over USA for July 9-22, 1999. Figure 2-6 shows the distribution of average SO2 concentrations for these stations.

July 7-28, 2001

Hourly O_3 concentrations were available at 1113 stations over USA for July 7-28, 2001. Figure 2-7 shows the distribution of average O_3 concentrations for these stations. Hourly $PM_{2.5}$ concentrations were available at 148 stations over USA for July 7-28, 2001. Figure 2-8 shows the distribution of average $PM_{2.5}$ concentrations for these stations.

January 1-21, 2002

Hourly O_3 concentrations were also available at 501 stations over USA for January 1-21, 2002. Figure 2-9 shows the distribution of average O_3 concentrations for these stations.

Hourly $PM_{2.5}$ concentrations were available at 180 stations over USA for January 1-21, 2002. Figure 2-10 shows the distribution of average PM2.5 concentrations for these stations.

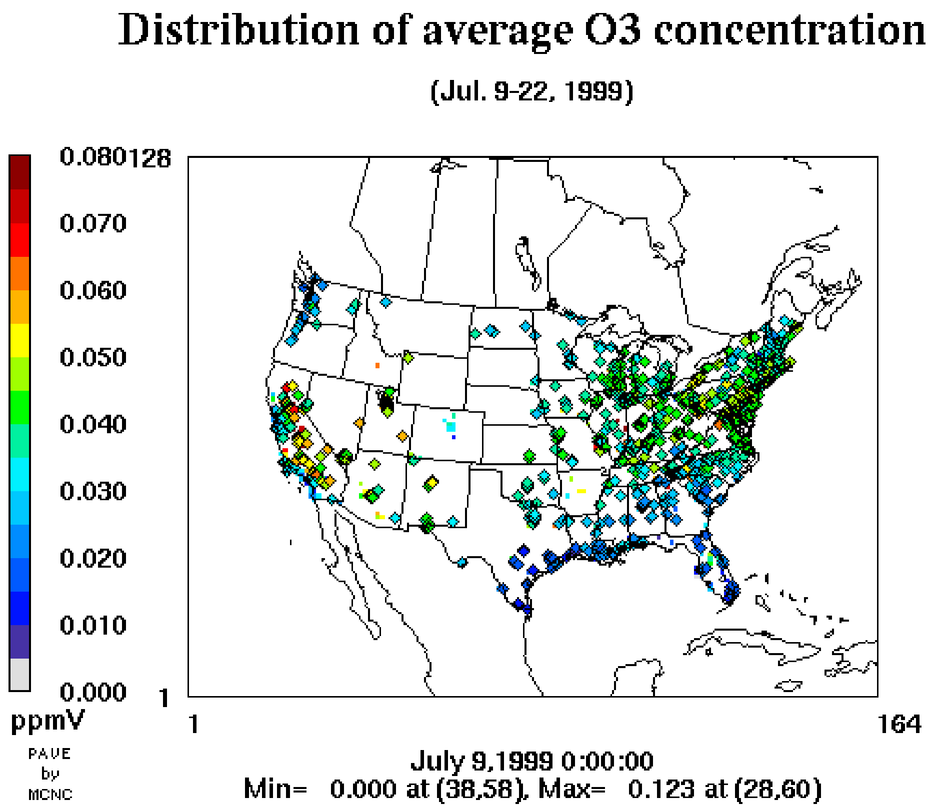


Figure 2-2. Distribution of average ambient O3 concentrations (July 9-22, 1999).

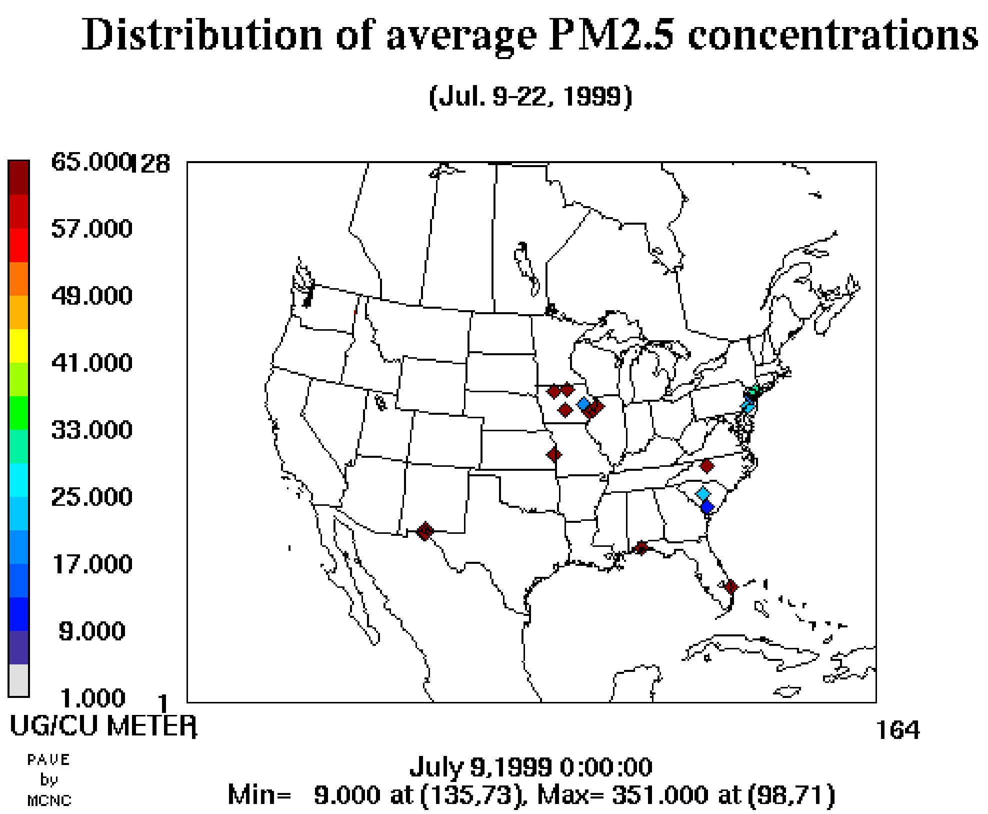


Figure 2-3. Distribution of average ambient $PM_{2.5}$ concentrations (July 9-22, 1999).

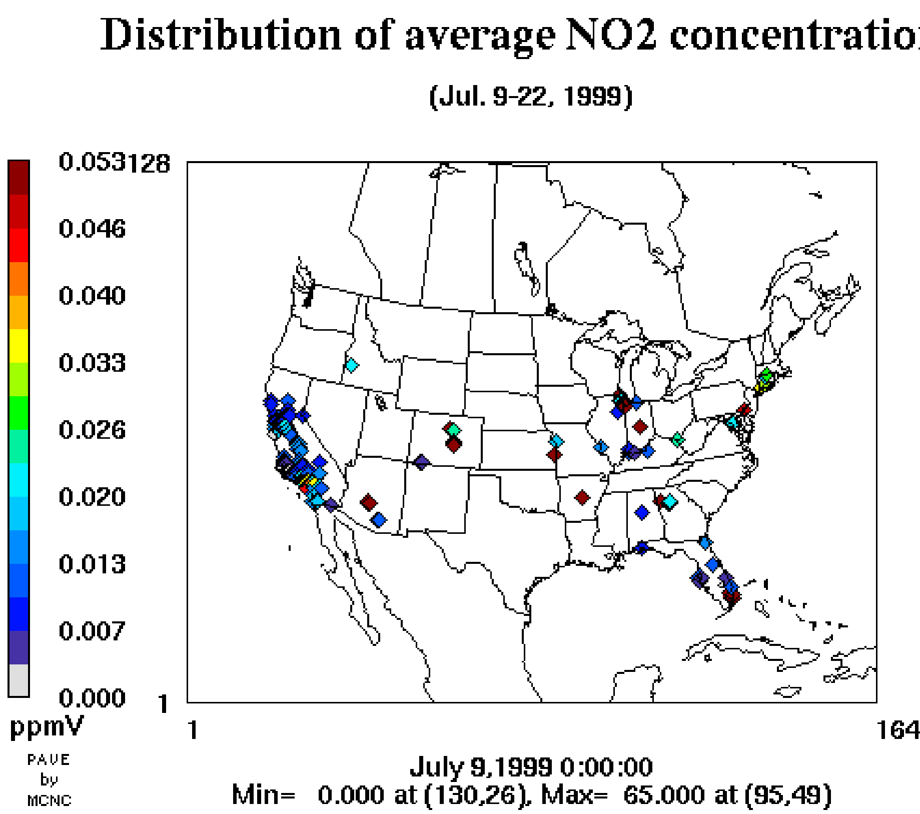


Figure 2-4. Distribution of average ambient NO_2 concentrations (July 9-22, 1999).

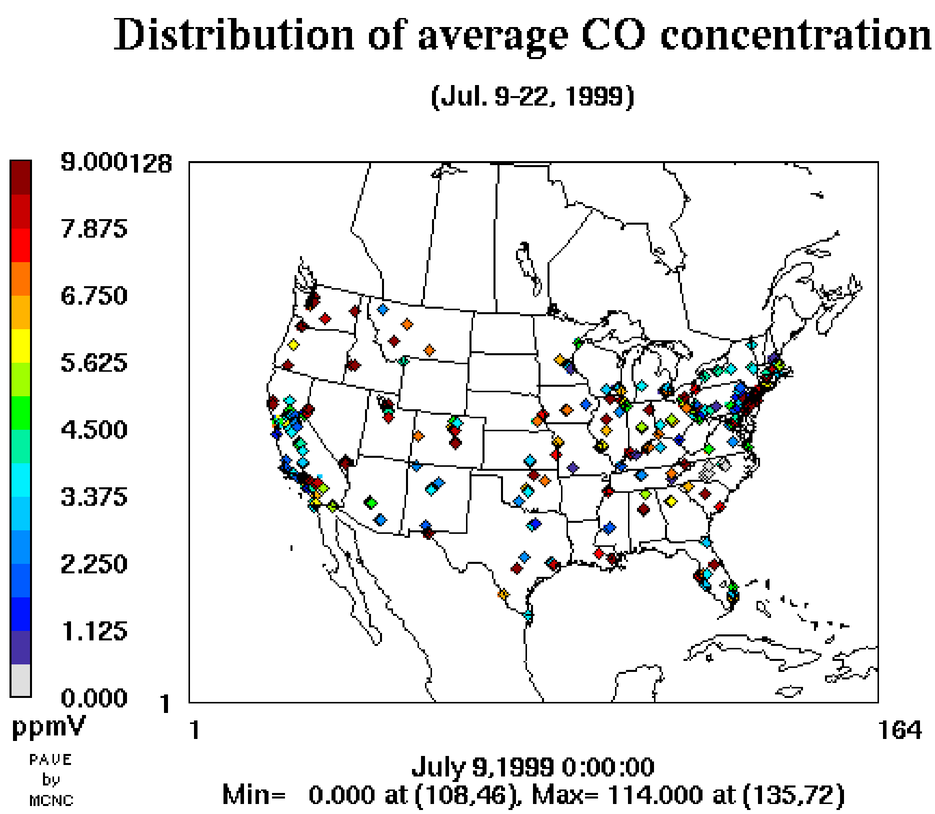


Figure 2-5. Distribution of average ambient CO concentrations (July 9-22, 1999).

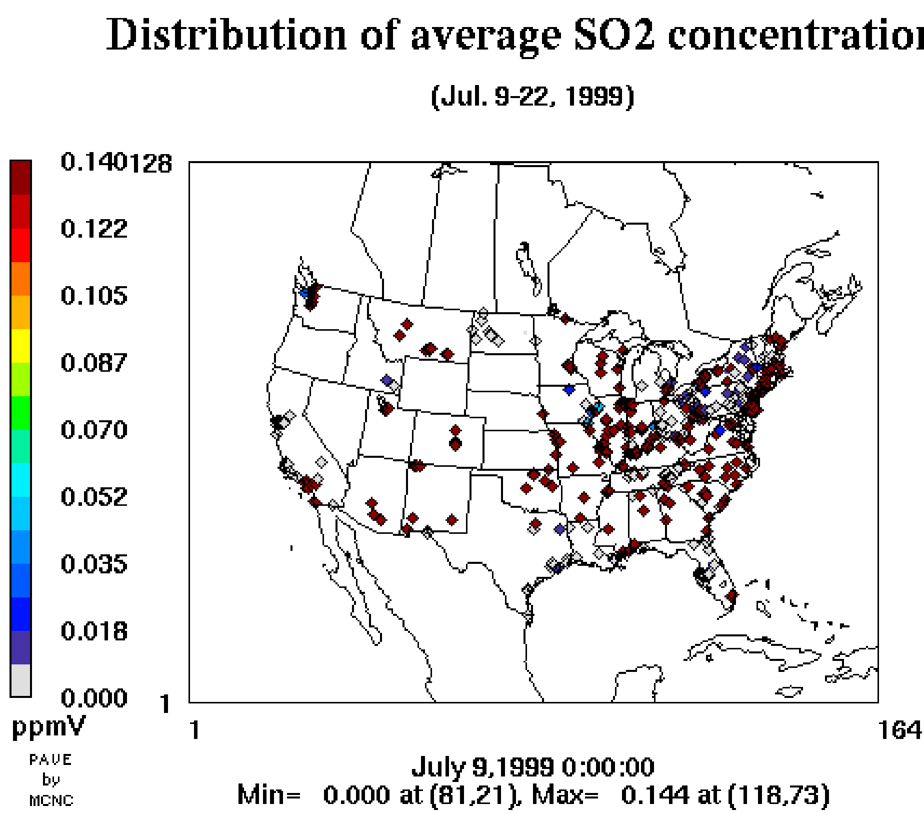


Figure 2-6. Distribution of average ambient SO2 concentrations (July 9-22, 1999).

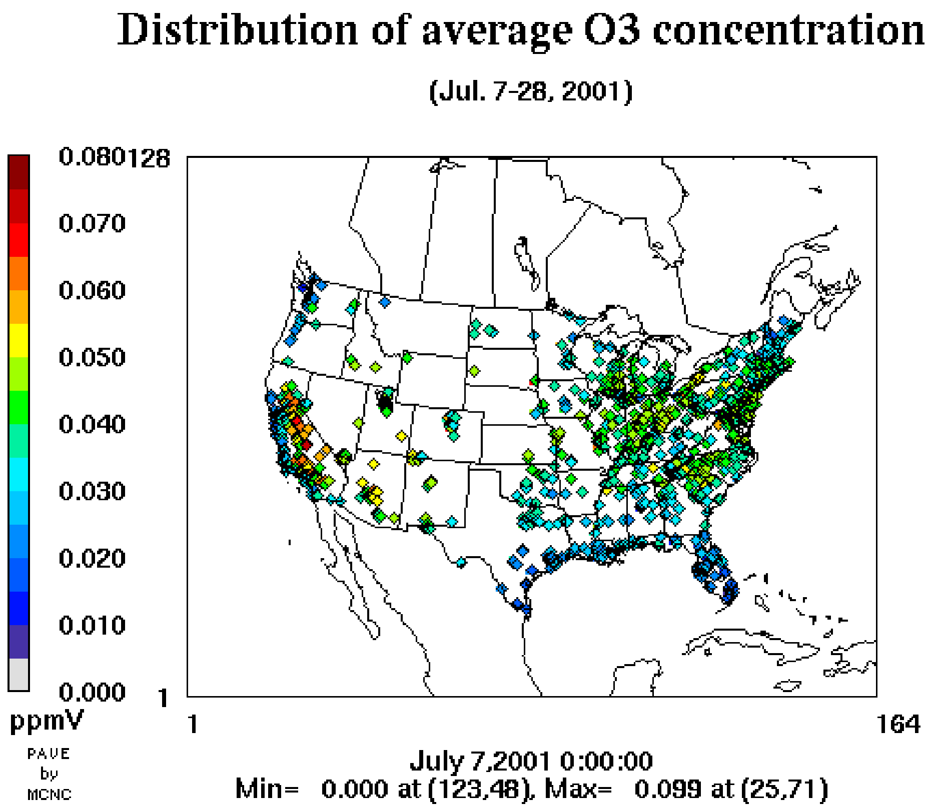


Figure 2-7. Distribution of average ambient O3 concentrations (July 7-28, 2001).

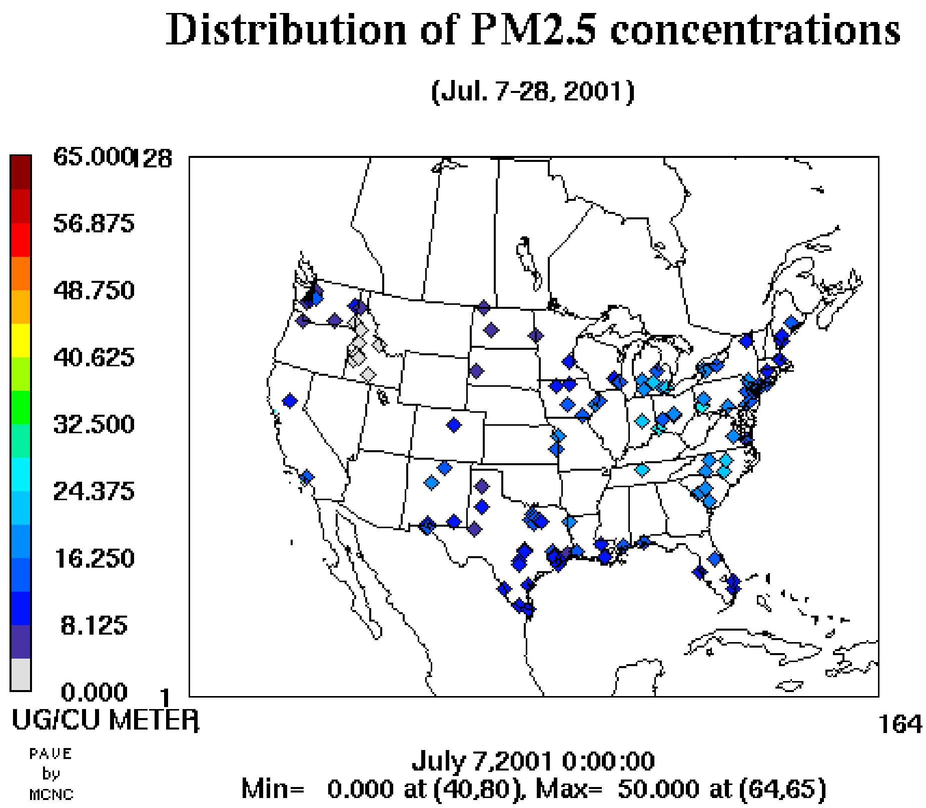


Figure 2-8. Distribution of average ambient PM2.5 concentrations (July 7-28, 2001).

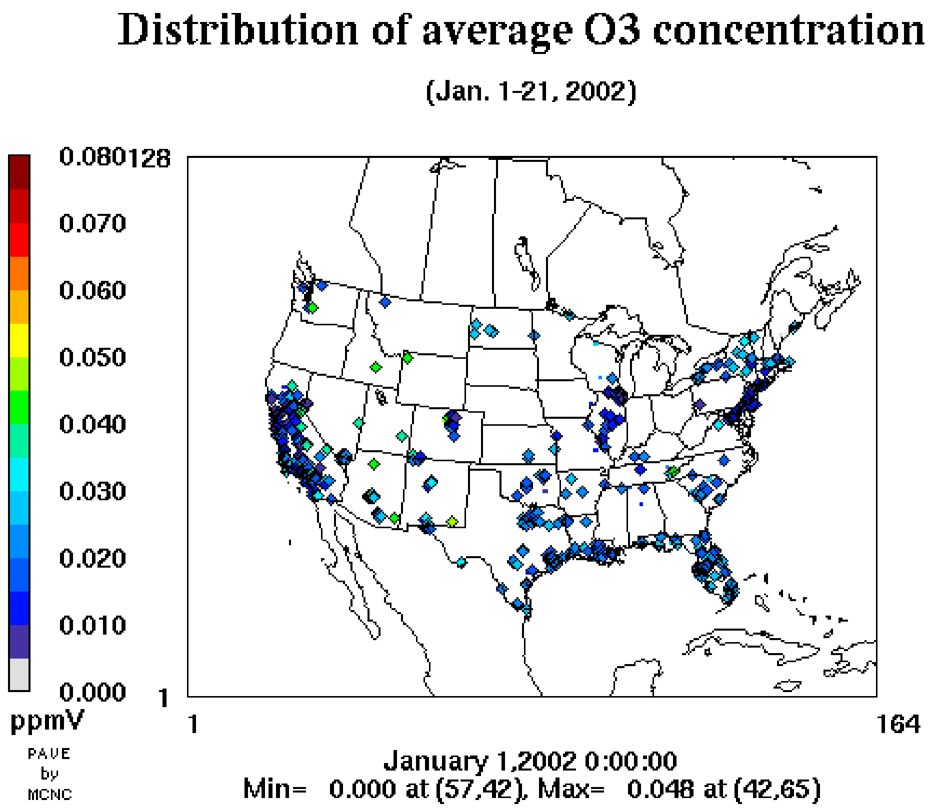


Figure 2-9. Distribution of average ambient O3 concentrations (January 1-21, 2002).

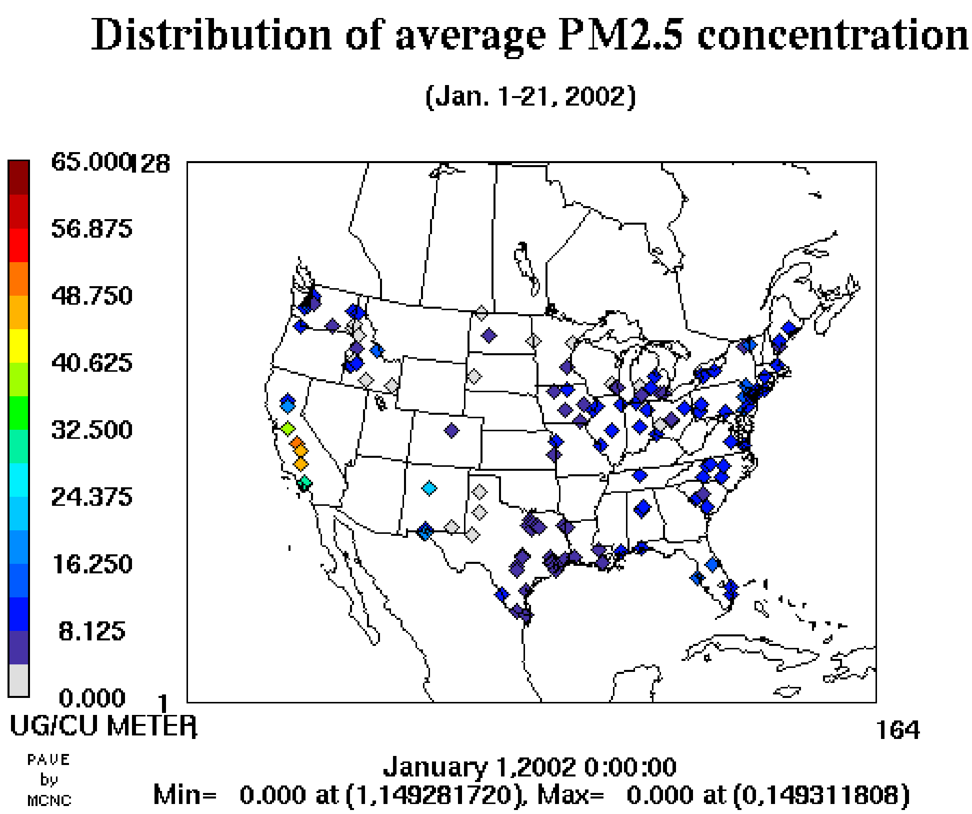


Figure 2-10. Distribution of average ambient PM2.5 concentrations (January 1-21, 2002).

3.0 PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

In response to the 1990 Clean Air Act Amendments, EPA has required more extensive monitoring of ozone and its precursors in areas with persistently high ozone levels. Photochemical Assessment Monitoring Stations (PAMS) have been established by the States to collect and report detailed data for volatile organic compounds, nitrogen oxides, ozone and meteorological parameters. The EPA lists five objectives for the PAMS program:

1. Provide a speciated ambient air database which is both representative and useful for ascertaining ambient profiles and distinguishing among various individual VOC.
2. Provide local, current meteorological and ambient data to serve as initial and boundary condition information for photochemical grid models, a method that simulates meteorological and physical processes that affect air pollution emissions in the atmosphere.
3. Provide a representative, speciated ambient air database which is characteristic of source emission impacts.
4. Provide ambient data measurements which would allow later preparation of unadjusted and adjusted pollutant trends reports.
5. Provide additional measurements of selected criteria pollutants.

Because different types of ambient monitoring data are required to characterize regional background concentration, emissions sources, and peak pollutant levels, four different types of PAMS sites are used:

- Type I: Upwind and background characterization
- Type II: Maximum ozone precursor emissions impact
- Type III: Maximum ozone concentration
- Type IV: Extreme downwind monitoring

Hourly average concentrations of O_3, NO, NO2, NOx and about 60 species of VOC (volatile organic compounds) are measured at each PAMS station. Archived data files can be downloaded from the website: http://www.epa.gov/ttn/airs/airsaqs/archived%20data/archivedaqsdata.htm. Table 3-1 shows the species names, carbon numbers and molecule weights for 60 species of VOC measured in PAMS. The PAMS data are currently available for VISTAS' two modeling periods of July 9-22, 1999 and Jan. 1-21, 2002. Since some data, such as O3, NO, NO2 and NOx may also be included in the AQS database, we are still considering the best approach to treat these data (i.e., present them with the AQS data only, or with the PAMS data only, or both).

For the data from selected PAMS sites, hourly average concentrations are available for 64 species (Table 2-1) for July 9-22, 1999 and Jan. 1-21, 2002. The animated graphics that show five species (TNMOC, THC, HCHO, acetaldehyde and acetone) concentrations have been put on the VISTAS project website (http://pah.cert.ucr.edu/vistas/ambient.shtml, under the title of "Ambient data for Model Evaluation". Example plots of average concentrations for two important species (HCHO and acetone) are shown in Figures 3-1 through 3-4.

Table 3-1. Species measured in PAMS network.

Name	Description	Carbon number	MWt
NO	NITRIC OXIDE		
NO2	NITROGEN DIOXIDE		
NOX	OXIDES OF NITROGEN		
PAMHC	SUM OF PAMS TARGET COMPOUNDS		
TNMOC	TOTAL NMOC		
ETHAN	ETHANE AKA-METHYLMETHANE	2	30.07
ETHYL	ETHYLENE AKA-ETHENE	2	62.07
PROPA	PROPANE AKA-DIMETHYLMETHANE	3	44.10
PRPYL	PROPYLENE AKA-PROPENE	4	102.09
ACETE	ACETYLENE AKA-ETHYNE	2	26.04
NBUTA	N-BUTANE AKA-BUTANE	4	58.12
ISBTA	ISOBUTANE AKA-2-METHYLPROPANE	4	58.12
T2BTE	TRANS-2-BUTENE	4	56.11
C2BTE	CIS-2-BUTENE	4	56.11
NPNTA	N-PENTANE AKA-AMYL HYDRIDE	5	72.15
ISPNA	ISOPENTANE AKA-2-METHYLBUTANE	5	72.15
1PNTE	1-PENTENE AKA-PROPYLETHYLENE	5	70.14
T2PNE	TRANS-2-PENTENE	5	70.14
C2PNE	CIS-2-PENTENE AKA-CIS-B-N-AMYLENE	5	70.14
3MPNA	3-METHYLPENTANE AKA-DIETHYLMETHYLMETHANE	16	226.45
NHEXA	N-HEXANE	6	86.18
NHEPT	N-HEPTANE AKA-DIPROPYLMETHANE	7	100.21
NOCT	N-OCTANE	8	114.23
NNON	N-NONANE AKA-NONYL HYDRIDE	9	128.26
NDEC	N-DECANE	10	142.29
CYPNA	CYCLOPENTANE AKA-PENTAMETHYLENE	5	70.14
ISPRE	ISOPRENE AKA-3-METHYL-1,3-BUTADIENE	5	68.12
22DMB	2,2-DIMETHYLBUTANE AKA-NEOHEXANE	6	86.18
2M1PE	2-METHYL-1-PENTENE AKA-1-METHYL-1-PROPYLETHYLENE	6	84.16
24DMP	2,4-DIMETHYLPENTANE	7	100.21
CYHXA	CYCLOHEXANE AKA-HEXAMETHYLENE	6	84.16
3MHXA	3-METHYLHEXANE	7	100.21
224TM	2,2,4-TRIMETHYLPENTANE AKA-ISOOCTANE	8	114.23
234TM	2,3,4-TRIMETHYLPENTANE	8	114.23
3MHEP	3-METHYLHEPTANE	8	114.23
MCYHX	METHYLCYCLOHEXANE AKA-HEXAHYDROTOLUENE	7	98.19
MCPNA	METHYLCYCLOPENTANE	6	84.16
2MHXA	2-METHYLHEXANE AKA-ISOHEPTANE	8	
1BUTE	1-BUTENE AKA-ETHYLETHYLENE	4	56.11
23DMB	2,3-DIMETHYLBUTANE AKA-DIISOPROPYL	6	86.18
2MPNA	2-METHYLPENTANE AKA-ISOHEXANE	7	
23DMP	2,3-DIMETHYLPENTANE	7	100.21
FORM	FORMALDEHYDE AKA-OXYMETHYLENE	1	30.03

Name	Description	Carbon number	MWt
ACETA	ACETALDEHYDE AKA ACETIC ALDEHYDE	2	44.05
ACET	ACETONE AKA-DIMETHYLKETONE	3	58.08
NUNDC	N-UNDECANE	11	156.31
2MHEP	2-METHYLHEPTANE	8	
O3	OZONE		
M/PXY	M/P XYLENE	8	106.17
BZ	BENZENE	6	78.11
TOLU	TOLUENE AKA METHYLBENZENE	7	92.14
EBENZ	ETHYLBENZENE AKA-PHENYLETHANE	8	106.17
OXYL	O-XYLENE AKA-1,2-DIMETHYLBENZENE	8	106.17
135TB	1,3,5-TRIMETHYLBENZENE AKA-MESITYLENE	9	120.20
124TB	1,2,4-TRIMETHYLBENZENE AKA-PSEUDOCUMENE	9	120.20
NPBZ	N-PROPYLBENZENE AKA-1-PHENYLPROPANE	9	120.20
ISPBZ	ISOPROPYLBENZENE AKA CUMENE	9	120.20
OETOL	O-ETHYLTOLUENE	8	
METOL	M-ETHYLTOLUENE	8	
PETOL	P-ETHYLTOLUENE (AKA 4-ETHYLTOLUENE)	8	
MDEB	M-DIETHYLBENZENE	8	
PDEB	P-DIETHYLBENZENE AKA-1,4-DIETHYLBENZENE	6	147.01
STYR	STYRENE AKA ETHENYLBENZENE	8	104.15
123TB	1,2,3-TRIMETHYLBENZENE	9	120.20

July 9-22, 1999

Hourly HCHO concentrations are available at 92 stations over USA for July 9-22, 1999. Figure 2-11 shows the distribution of average HCHO concentrations during that period of time for these stations.

Hourly Acetone concentrations are available at 130 stations over USA for July 9-22, 1999. Figure 2-12 shows the distribution of average acetone concentrations for these stations.

Jan. 1-21, 2002

Hourly HCHO concentrations are available at 57 stations over USA for Jan. 1-21, 2002. Figure 2-13 shows the distribution of average HCHO concentrations for these stations.

Hourly Acetone concentrations are available at 67 stations over USA for Jan. 1-21, 2002. Figure 2-14 shows the distribution of average Acetone concentrations for these stations.

We have recently obtained more speciated VOC data for additional PAMS sites and are currently evaluating these data.

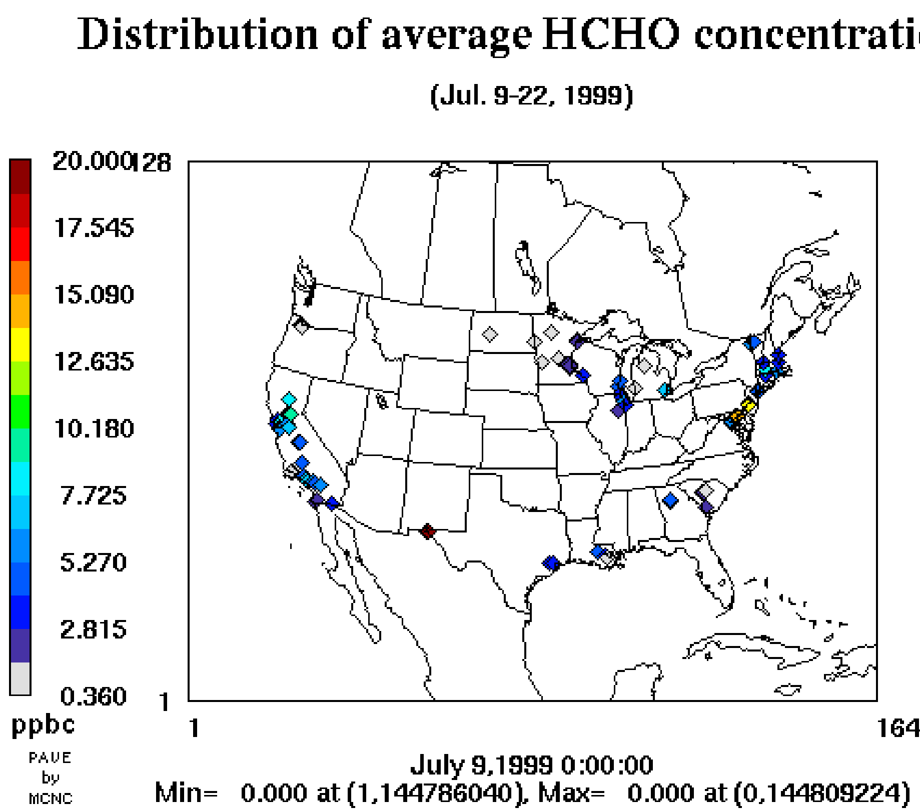


Figure 3-1. Distribution of average ambient HCHO concentrations (July 9-22, 1999) from the PAMS network.

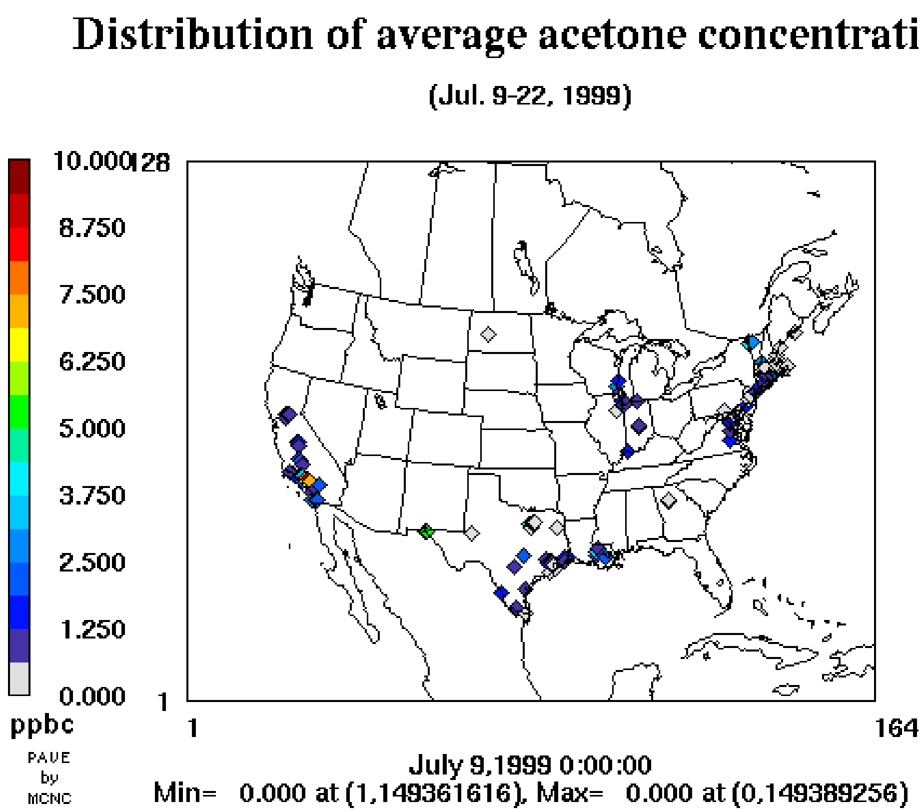


Figure 3-2. Distribution of average ambient acetone concentrations (July 9-22, 1999) from the PAMS network.

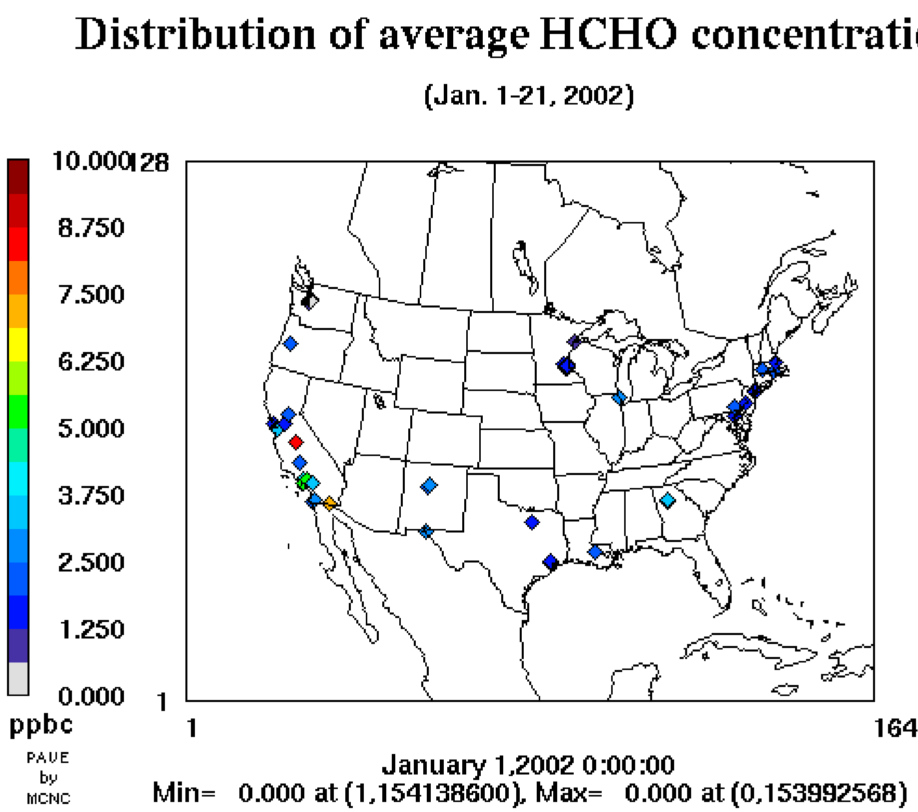


Figure 3-3. Distribution of average ambient HCHO concentrations (January 1-21, 2002) from the PAMS network.

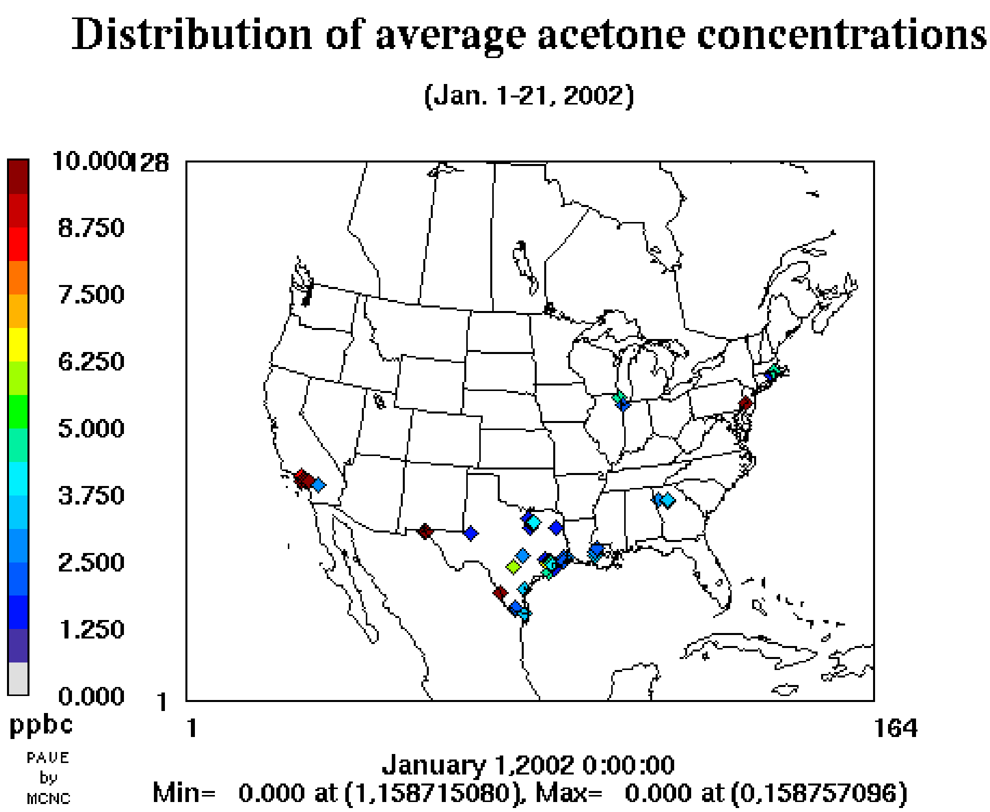


Figure 3-4. Distribution of average ambient acetone concentrations (January 1-21, 2002) from the PAMS network.

4.0 INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS (IMPROVE)

The Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network consists of air quality data from Class I areas that include national parks and wilderness areas where visibility is deemed an important attribute. There are also IMPROVE protocol monitoring sites that are not located in Class I areas (see Appendix A for locations). This monitoring program is an interagency effort with the U.S. Environmental Protection Agency (USEPA) and the U.S. Department of the Interior (USDOI), including the U.S. Forest Service, U.S. Fish and Wildlife Service, and the Bureau of Land Management. The IMPROVE fine particle network collects $PM_{2.5}$ and PM_{10} samples over a twenty four hour using IMPROVE samplers. The current network consists of over 160 monitoring sites, mainly located in Class I ("Clean Air") areas. Some of the earliest sites have been in operation since March 1988, although most sites were installed in the mid 1990's or later. The PM samples are analyzed for $PM_{2.5}$ mass and its elemental constituents, organics, ions, light absorption and PM_{10} mass.

The objectives of IMPROVE are: (1) to establish current visibility and aerosol conditions in mandatory class I areas; (2) to identify chemical species and emission sources responsible for existing man-made visibility impairment; (3) to document long-term trends for assessing progress towards the national visibility goal; (4) and to provide regional haze monitoring representing all visibility-protected federal class I areas where practical. In 1999 there were 70 IMPROVE sites including 30 sites in Class I areas and an additional 40 sites using the IMPROVE protocol. By 2002 there were approximately 110 IMPROVE sites and 53 IMPROVE Protocol sites.

The standard IMPROVE sampler has four sampling modules, listed below, although some sites only include the Module A:

Module A: $PM_{2.5}$ particles on Teflon are analyzed at UC Davis using the following methods:

- gravimetric mass for $PM_{2.5}$
- hybrid integrating plate/sphere method for optical absorption
- Proton Elastic Scattering Analysis (PESA) for hydrogen
- Proton Induced X-ray Emission (PIXE) for Na-Mn
- X-Ray Fluorescence (XRF) for Fe-Pb

Module B: $PM_{2.5}$ particles on nylon. A denuder before the nylon filter removes nitric acid vapors. These are analyzed by ion chromatography (IC) at Research Triangle Institute for nitrate (NO_3^-), chloride (Cl^-), sulfate (SO_4^{2-}), and nitrite (NO_2^-).

Module C: $PM_{2.5}$ particles on quartz. These are analyzed at Desert Research Institute for carbon using the Thermal Optical Reflectance (TOR) combustion method. A secondary filter at selected sites is used to determine artifacts. These are reported in 8 temperature categories.

Module D: PM_{10} particles on Teflon. All are measured for PM_{10} mass. Approximately 4% are analyzed by the other four methods listed for Module A.

For selected IMPROVE sites, there also are transmissometer data to directly measure light extinction and nephelometer data to provide direct measurements of light scattering.

The IMPROVE data have passed the "Level 0 and Level 1" quality assurance and control procedure conducted by the Crocker Nuclear Laboratory at UC Davis, and are added to the online database after a 30 day period to allow the States, Tribes, FLM's or any other organization a chance to review and comment on the accuracy, credibility, and/or representativeness of aerosol speciation data collected and the reconciliation of any issues these organizations may find. In the past, we have not performed any additional QA of the IMPROVE data, and have simply used the data obtained from the Cooperative Institute for Research in Atmosphere (CIRA) website: http://vista.cira.colostate.edu/improve.

A 24 hour averaging period is used for IMPROVE data. Prior to 2000, two 24 hour samples were collected twice a week, on Wednesday and Saturday. After 2000, 24 hour samples were collected every three days.

Table 4-1 lists the 41 species measured at IMPROVE sites. The IMPROVE data are available for all three VISTAS modeling episodes. The downloaded data have been formatted for evaluation software, and time series plots are also available for download on the project website. Additional QA of these data can be performed, as discussed in Section 10, using time series and scatter plots of these data.

Table 4-1. Species of $PM_{2.5}$ measured in IMPROVE network.

CODE	NAME	CODE	NAME
AL	Aluminum: Fine	NH4	Ammonium ion: Fine
AS	Arsenic: Fine	NI	Nickel: Fine
BR	Bromine: Fine	NO3	Nitrate: Fine
CA	Calcium: Fine	OC1	Carbon: Fine organic (OC1)
CHL	Chloride: Fine	OC2	Carbon: Fine organic (OC2)
CL	Chlorine: Fine	OC3	Carbon: Fine organic (OC3)
CR	Chromium: Fine	OC4	Carbon: Fine organic (OC4)
CU	Copper: Fine	OP	Carbon: Fine organic (OP)
EC1	Carbon: Fine elemental (EC1)	P	Phosphorus: Fine
EC2	Carbon: Fine elemental (EC2)	PB	Lead: Fine
EC3	Carbon: Fine elemental (EC3)	RB	Rubidium: Fine
FE	Iron: Fine	S	Sulfur: Fine
H	Hydrogen: Fine	SE	Selenium: Fine
K	Potassium: Fine	SI	Silicon: Fine
MASS	PM2.5: mass	SO4	Sulfate: Fine
MASS	PM_{10}: mass	SR	Strontium: Fine
MG	Magnesium: Fine	TI	Titanium: Fine
MN	Manganese: Fine	V	Vanadium: Fine
MO	Molybdenum: Fine	ZN	Zinc: Fine
N2	Nitrite: Fine	ZR	Zirconium: Fine

CODE	NAME	CODE	NAME
NA	Sodium: Fine		

For most species, the IMPROVE data cannot be matched directly to the model gas and PM species because of lumping schemes in the model chemistry. Therefore, it is necessary to convert the ambient data and model species into forms that can be directly compared. Table 4-2 shows the mapping scheme used for the IMPROVE comparison to the model species. Table 4-3 list definitions for CMAQ model species. Definitions for compounds in Table 4-2 include the following: OC is organic carbon; EC is elemental carbon or soot; CM is coarse mass; RCFM is reconstructed fine mass; and Bext_Recon is reconstructed extinction coefficient.

We note that in previous model evaluation for WRAP the sulfate and nitrate were assumed to be full neutralized and that ammonium sulfates and nitrate were represented in CMAQ as 1.375*(ASO4J + ASO4I) +1.29*(ANO3J + ANO3I), respectively. This was used for consistency with the formula used to calculate the model reconstructed extinction coefficient. For VISTAS we propose to use the CMAQ model ammonium mass (ANH4J+ANH4J) explicitly because this provides a more accurate estimate of modeled fine mass.

In previous modeling studies we have not had access to direct measurements of ammonium ion (NH_4^+). VISTAS is funding the Research Triangle Institute (RTI) to measure $NH4^+$ at 10 sites beginning in September, 2002. Prior to September, NH_4^+ data will be available for only 3 sites: Great Smokey Mountains (GRSM), Shenandoah (SHEN), Class I areas, and Dolly Sods (DOSO).

Concerns have been raised regarding the accuracy of the IMPROVE HNO3 data, and we have found that it tends to be lower than HNO3 data from the CASTNET network. However, we do not have a basis for adjusting or rejecting the IMPROVE HNO3 data, and further evaluation of HNO3 data from all monitoring networks is required. In September 2003 EPA will conduct a field study intercomparison of HNO3 methods using a Chemical Ionization Mass Spectrometer as a reference method. This may provide insight into the accuracy of HNO3 methods employed at the different monitoring networks, however, it is unlikely that results from this study will be available in 2003 to affect the VISTAS Phase I modeling.

There are concerns that the coarse mass (CM) IMPROVE measurements may also include some sulfate, nitrate and other species (e.g., sea salt and organics) that occur in the coarse mode. There are two different mechanism by which NO3 can be transferred to the coarse mode: formation of coarse mode sodium nitrate or calcium nitrate, and the ammonium nitrate distributions that can extend in to the coarse mode. In previous CMAQ performance evaluations, all nitrate has been assumed to be in the fine mode. If substantial fractions of nitrate are in the coarse mode, CMAQ would be expected to over predict the mass of fine nitrate. Speciation of the CM fraction is ongoing at several IMPROVE sites to investigate this issue. A coarse mode speciation measurement program was begun in spring, 2002, and it is possible that initial results will be available in fall, 2002.

We are also investigating the modal distributions of the Aitken and accumulation modes in CMAQ. Although these modes are typically assumed to be entirely $PM_{2.5}$, we have found that some of the mass does extend in to the coarse mode.

Table 4-2. Species mappings for IMPROVE species. Note that CMAQ represents fine PM species in two size modes: Aitken nuclei (0.03 to 0.5 µm) and accumulation mode (0.5 to 2.5 µm) and in CMAQ by represented by J and I, respectively. Compounds listed include coarse mass (CM);

Compound	IMPROVE Species	CMAQ Mapping
SO4	SO4	ASO4J + ASO4I
NO3	NO3	ANO3J + ANO3I
NH4$^+$	NH4$^+$	ANH4J + ANH4I
OC	1.4*(OC1+OC2+OC3+OC4+OP)	AORGAJ + AORGAI + AORGPAJ + AORGPAI + AORGBJ + AORGBI
EC	EC1+EC2+EC3-OP	AECJ + AECI
SOIL	2.2*Al + 2.49*Si + 1.63*Ca + 2.42*Fe + 1.94*Ti	A25I +A25J
CM	MT – FM	ACORS + ASEAS + ASOIL
PM25[a]	FM	ASO4J + ASO4I + ANO3J + ANO3I + ANH4J + ANH4I + AORGAJ + AORGAI + AORGPAJ + AORGPAI + AORGBJ + AORGBI + AECJ + AECI + A25J + A25I
RCFM	1.375*SO4 + 1.29*NO3 + **EC** + **OC** + **SOIL**	Same for PM25
PM10	MT	ASO4J + ASO4I + ANO3J + ANO3I + ANH4J + ANH4I + AORGAJ + AORGAI + AORGPAJ + AORGPAI + AORGBJ + AORGBI + AECJ + AECI + A25J + A25I + ACORS + ASEAS + ASOIL
Bext_Recon (1/Mm)	10[b] + 3*f(RH)[c](1.375*SO4 + 1.29*NO3) + 4***OC** + 10***EC** + **SOIL** + 0.6***CM**	10[b] + 3*f(RH)[c][1.375*(ASO4J + ASO4I) + 1.29*(ANO3J + ANO3I)] + 4*1.4*(AORGAJ + AORGAI + AORGPAJ + AORGPAI + AORGBJ + AORGBI) + 10*(AECJ + AECI) + 1*(A25J + A25I) + 0.6*(ACORS + ASEAS + ASOIL)

[a] Measured; [b] Rayleigh scattering correction; [c] f(RH) site and day specific relative humidity adjustment factor.

Table 4-3. Definitions of CMAQ species names used in Table 4-2.

CMAQ Mapping	
ASO4	Aerosol sulfate
ANO3	Aerosol nitrate
ANH4	Ammonium ion
AORGPA	Organic aerosols from primary organic emissions
AORGA, AORGB	Secondary organic aerosols from anthropogenic sources (aromatics, paraffin) and biogenic source, respectively.
AEC	Elemental Carbon
A25	Unspecified fine mass including fine crustal material (fine soil)
ASOIL	Soil-derived (crustal) coarse materials
ASEAS	Sea salt (only in coarse mode)
ACORS	Unspecified anthropogenic coarse mass
RCFM	Reconstructed fine mass
MT	Mass total
CM	Coarse mass
Bext_recon	Reconstructed extinction coefficient

5.0 SOUTHEASTERN AEROSOL RESEARCH AND CHARACTERIZATION (SEARCH)

SEARCH is a monitoring network for Southeastern Aerosol Research and Characterization. There are 8 monitoring sites located in four states in the SEARCH network whose locations are shown in Figure 5-1. Daily $PM_{2.5}$ data are measured for 46 species, while daily coarse PM data are measured for 18 species in SEARCH network. Archived data file can be downloaded from the website (http://www.atmospheric-research.com/public/index.html). Tables 5-1 and 5-2 show the names for 46 $PM_{2.5}$ species and 18 coarse PM species. The SEARCH data are currently available for two of the VISTAS Phase I modeling episodes (July 9-22, 1999 and July 7-28, 2001).

The frequency of the $PM_{2.5}$ measurements of SEARCH has varied from 1998 to the present. Measurements were made daily at all sites for a little over one year. Subsequently, the measurements frequency varies from daily to every third or sixth day depending on the specific site of interest. Semi-continuous TEOM $PM_{2.5}$ mass measurements have been available since the onset of the program and are reported as hourly averages. Semi-continuous measurements of PM chemical components have been phased in over the years, initially at Jefferson Street (Atlanta) and later at other sites. However, the ARS Data Gap report indicates that such hourly data have not yet been made generally available on the SEARCH web site. We need to determine whether the modeling team has this data or how best to get access to this data.

Table 5-1. $PM_{2.5}$ species measured in SEARCH network.

Name	Name	Name	Name
FRM Mass	PM25 Major Metal Oxides	XRF Pb	Al2O3
FRM SO4	PCM2 SO4	XRF Sb	SiO2
FRM NO3	PCM2 NO3	XRF Se	K2O
FRM NH4	PCM2 NH4	XRF Sn	CaO
PCM1 Mass	PCM2 CL	XRF Ti	TiO2
PCM1 SO4	PCM3 EC	XRF Zn	Fe2O3
PCM1 NO3	PCM3 OC	WS Chromium	XRF S
PCM1 Vol NO3	XRF As	WS Copper	TEOM Mass
PCM1 Teflon NO3	XRF Ba	WS Iron	BackupPCM3 EC
PCM1 NH4	XRF Br	WS Manganese	BackupPCM3 OC
PCM1 Vol NH4	XRF Cu	WS Nickel	
PCM1 Teflon NH4	XRF Mn	WS Vanadium	

Table 5-2. Coarse PM species measured in SEARCH network.

Name	Name	Name	Name
Coarse Mass	Chromium	Vanadium	TiO2
Coarse SO4	Copper	Al2O3	Fe2O3
Coarse NO3	Iron	SiO2	Coarse S
Coarse NH4	Manganese	K2O	
CoarseMajorMetalOxides	Nickel	CaO	

For the data from SEARCH network, daily average $PM_{2.5}$ concentrations for 46 species (Table 5-1) and daily coarse PM concentration for 18 species (Table 5-2) are available for two modeling episodes (July 9-22, 1999 and July 7-28, 2001).

We are working with the SEARCH sponsors and scientists to obtain data suitable for model performance evaluation and obtain data for the January 2002 episode. Locations of the SEARCH monitors are shown in Figure 5-1.

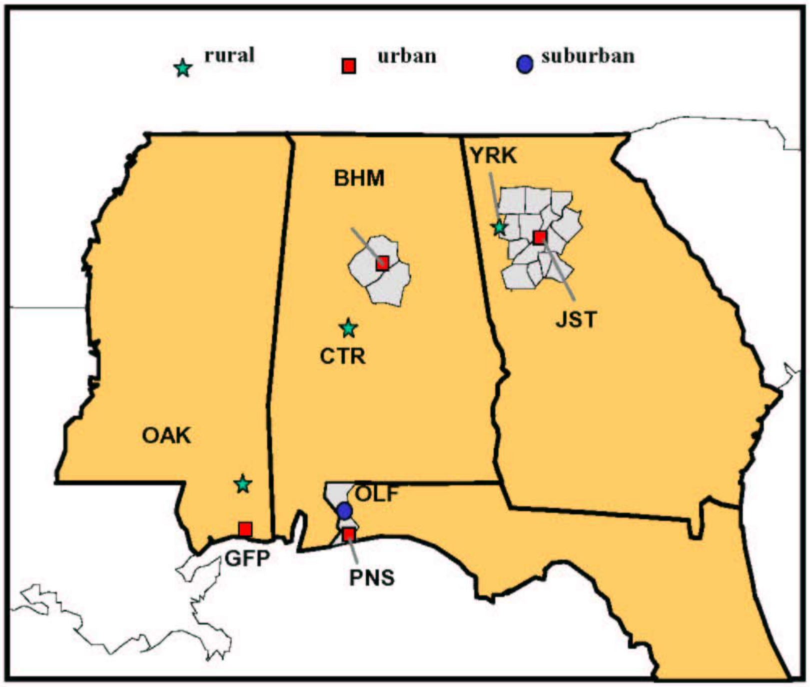


Figure 5-1. Locations of the SEARCH monitoring sites (Source: Atmospheric Research and Analysis, Inc., www.atmopheric-research.com).

6.0 SPECIATION TRENDS NETWORK (STN)

EPA's Speciation Trends Network (STN) includes about 215 monitoring stations nationwide. It appears that among these 215 sites may include IMPROVE sites or other data from other networks. This, however, needs to be verified. Daily $PM_{2.5}$ data are measured for 64 species in the STN network. Some archived STN data files were obtained from the website:http://www.epa.gov/ttn/airs/airsaqs/archived%20data/archivedaqsdata.htm. Additional documentation of the STN and descriptions of the data are still needed. Table 6-1 shows the codes and names for 64 species measured in STN. Locations of the STN monitors, as well as other specified PM monitors, are shown in Appendix A.

Table 6-1. Species of $PM_{2.5}$ measured in STN network.

Code	Description	Code	Description
88101	PM2.5 - Local Conditions	88160	Tin PM2.5 LC
88102	Antimony PM2.5 LC	88161	Titanium PM2.5 LC
88103	Arsenic PM2.5 LC	88162	Samarium PM2.5 LC
88104	Aluminum PM2.5 LC	88163	Scandium PM2.5 LC
88105	Beryllium PM2.5 LC	88164	Vanadium PM2.5 LC
88107	Barium PM2.5 LC	88165	Silicon PM2.5 LC
88109	Bromine PM2.5 LC	88166	Silver PM2.5 LC
88110	Cadmium PM2.5 LC	88167	Zinc PM2.5 LC
88111	Calcium PM2.5 LC	88168	Strontium PM2.5 LC
88112	Chromium PM2.5 LC	88169	Sulfur PM2.5 LC
88113	Cobalt PM2.5 LC	88170	Tantalum PM2.5 LC
88114	Copper PM2.5 LC	88172	Terbium PM2.5 LC
88115	Chlorine PM2.5 LC	88176	Rubidium PM2.5 LC
88117	Cerium PM2.5 LC	88179	Uranium PM2.5 LC
88118	Cesium PM2.5 LC	88180	Potassium PM2.5 LC
88121	Europium PM2.5 LC	88183	Yttrium PM2.5 LC
88124	Gallium PM2.5 LC	88184	Sodium PM2.5 LC
88126	Iron PM2.5 Lc	88185	Zirconium PM2.5 LC
88127	Hafnium PM2.5 LC	88186	Tungsten PM2.5 LC
88128	Lead PM2.5 LC	88301	Ammonium Ion PM2.5 LC
88131	Indium PM2.5 LC	88302	Sodium Ion Pm2.5 LC
88132	Manganese PM2.5 LC	88303	Potassium Ion PM2.5 LC
88133	Iridium PM2.5 LC	88304	OCX Carbon
88134	Molybdenum PM2.5 LC	88305	Organic Carbon PM2.5 LC
88136	Nickel PM2.5 LC	88306	Total Nitrate PM2.5 LC
88140	Magnesium PM2.5 LC	88307	Elemental Carbon PM2.5 LC
88142	Mercury PM2.5 LC	88308	Carbonate Carbon PM2.5 LC
88143	Gold PM2.5 LC	88309	Volatile Nitrate PM2.5 LC
88146	Lanthanum PM2.5 LC	88310	Non-volatile Nitrate PM2.5 LC
88147	Niobium PM2.5 LC	88311	OCX2 Carbon
88152	Phosphorus PM2.5 LC	88312	Total Carbon PM2.5 LC
88154	Selenium PM2.5 LC	88403	Sulfate PM2.5 LC

7.0 NATIONAL ATMOSPHERIC DEPOSITION PROGRAM (NADP)

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is designed to measure wet deposition. The network is a cooperative effort between State Agricultural Experiment Stations, the U.S. Geological Survey, U.S. Department of Agriculture, and other governmental and private entities. It includes over 200 sites in the continental United States, Alaska, and Puerto Rico, and the Virgin Islands whose locations are shown in Figure 7-1. The purpose of the network is to collect data on the chemistry of precipitation for monitoring of geographical and temporal long-term trends. The precipitation at each station is collected weekly is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium). The NADP network includes a quality assurance program, so we expect to use this data without any additional QA.

The major wet deposition network -- the National Atmospheric Deposition Program (NADP) -- has a large array of about 200 stations. Weekly samples of precipitation are collected at these stations and then sent to a single central laboratory for chemical analysis. The weekly sampling network has three severe drawbacks:

Because the NADP program uses a weekly sampling period the data has poor temporal resolution and the sample chemistry can be affected by chemical and biological activity. The NADP also includes the Atmospheric Integrated Research Monitoring Network (AIRMoN) which was designed to study precipitation chemistry trends with greater temporal resolution. Precipitation samples are collected daily from a network of nine wet deposition sites and analyzed for the same constituents as the NADP/NTN samples. AIRMoN also includes a dry deposition network and these are described next. NADP measures weekly deposition of compounds in units of mg/l as well as precipitation in units of l. The PM models will output deposition in terms of hourly mass flux per grid cell (e.g., 12 km x 12 km). The modeled results will be accumulated to weekly deposition fluxes per unit area (e.g., gm/km^2/week). Using the NADP precipitation and information on the NADP Sampler, the NADP deposition measurements will be converted to the same units as the modeled values.

AIRMoN Dry Deposition Data

The AIRMoN program includes both dry and wet deposition components. Figure 7-2 shows the locations of monitoring sites for both programs. The dry deposition data is described at their web page: http://www.arl.noaa.gov/research/projects/airmon_data.html. The description of the AIRMoN dry deposition data from the website is included verbatim here for convenience:

> Dry deposition rates are computed in the AIRMoN network by combining estimates of site-specific and time-evolving deposition velocities with measurements of air concentrations obtained using a weekly sampling protocol. The intent has been to mirror the 0900 Tuesday sample change standards adopted by the National Atmospheric Deposition Program. At times, the AIRMoN dry samples are obtained over substantially different periods, because of

operator absence or problems with instrumentation. The data summaries have been arranged so that each sequential week is represented, even though some of the initial data represent periods longer than a single week.

The AIRMoN concentration sampler is a three-element filterpack, with a leading teflon filter to remove particles, a middle nylon filter to extract nitric acid vapor, and a final doped cellulose filter intended primarily to sample sulfur dioxide. An inlet tube is used to impose a small amount of heat on the incoming air stream, to protect against liquid formation on the filters in periods of high humidities. There is no doubt that this influences the measurement of ammonium nitrate. In practice, any temperature change imposed on collected ammonium nitrate particles will cause some change in the sample, so that any long-term accumulative measurement of related species (such as that reported here) will be susceptible to error because of the effects of the diurnal cycle in air temperature. Tests of the AIRMoN sampling system indicate that particulate ammonium nitrate deposited on the teflon filter is incompletely disassociated with minor consequences on the measurement of nitric acid vapor and of sulfur dioxide, but with major influence on the measurement of nitrate on the doped cellulose filter. For this reason, measurements of nitrate reported here are considered to be unreliable.

It should also be noted that tests indicate that the values associated with nitric acid vapor are underestimates, on the average by 25%. The values listed should be increased accordingly, to correct for this error (due to deposition on the walls of the inlet tube).

Deposition velocities tabulated here are derived using a multi-layer numerical model, driven by field observations of selected key variables (such as wind speed, the standard deviation of the wind direction, surface wetness, incident solar radiation, temperature, humidity, plant species distribution, etc.) It is estimated that these deposition velocities might be in error by as much as 30%.

Weekly average deposition rates are computed as the product of the weekly average deposition velocities and the weekly average concentration, thus omitting consideration of a correlation term that can be significant when air concentrations display a consistent and significant diurnal cycle.

Regarding the last paragraph above, there are in fact large diurnal variations in several trace species of interest, and the errors introduced by this approach should be further investigated. Omitting consideration of a correlation term is likely to introduce additional errors greater than the 30% error mentioned above.

As noted on the AIRMoN web page, there is very large uncertainty in dry deposition estimates, and it is possible that the data on the website will be modified as more is learned about the processes that control dry deposition.

UCR is currently investigating the availability of the NADP and AIRMoN data. We expect to obtain the AIRMoN data from the website, but we still need to determine if other NADP data is available.

AIRMoN Wet Deposition Data:

The AIRMoN wet deposition program is described at the web page:
http://www.arl.noaa.gov/research/projects/airmon_wet.html
The AIRMoN wet deposition monitoring employs a daily sample collection protocol, thus differentiating itself from the weekly operations of the mainstream NADP stations. In practice, daily sampling provides a greatly improved quantification of ammonium deposition. At the National Atmospheric Deposition Program Technical Committee Meeting in 1994 (October 24-27) final decisions were made regarding the AIRMoN-wet quality assurance plan; a system of flags will be used to alert data users to specific problems.

UCR is currently downloading data from both wet and dry AIRMoN networks.

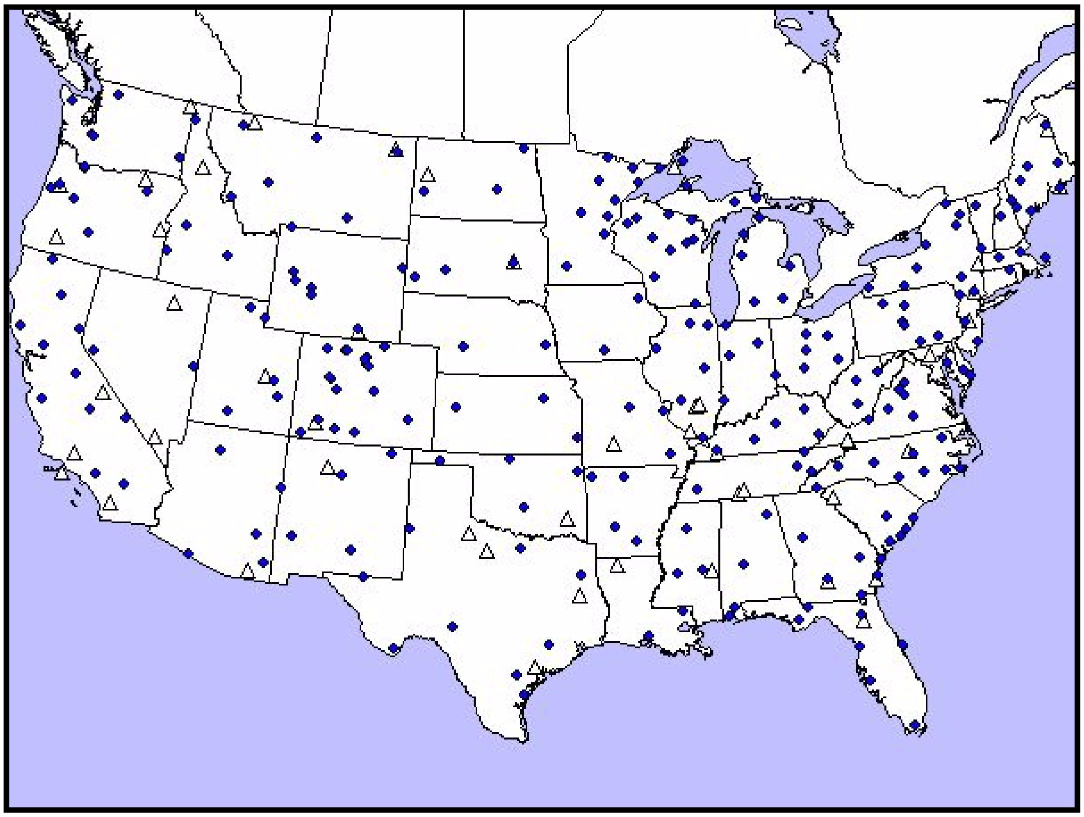


Figure 7-1. Locations of NADP National Trends Network (NTN) monitors (Figure obtained from the EPA NADP website).

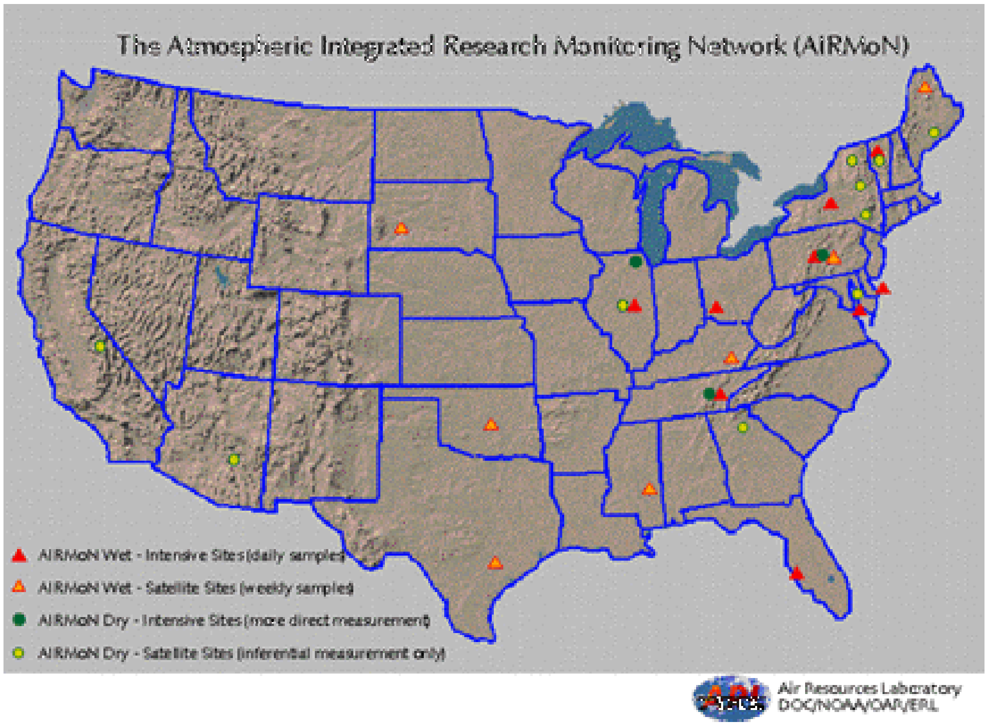


Figure 7-2. Locations of the AIRMoN wet and dry deposition monitoring sites (Figure obtained from the EPA AIRMoN website).

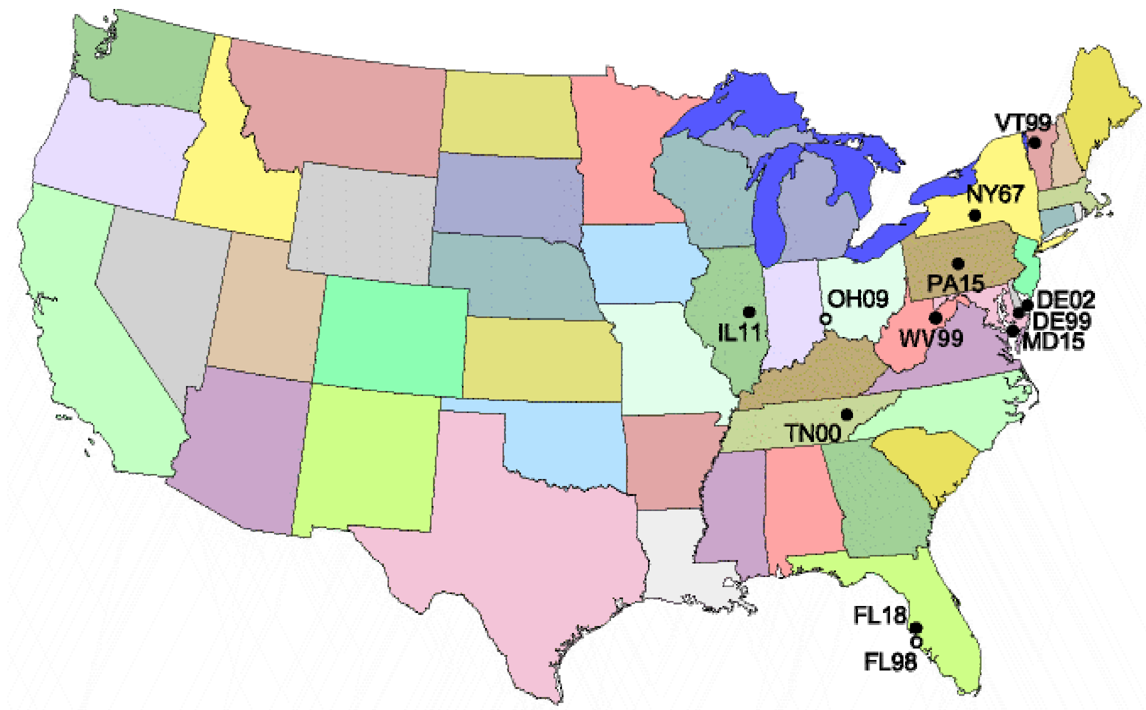


Figure 7-3. Locations of the AIRMoN wet deposition monitoring sites (Figure obtained from the EPA AIRMoN website).

8.0 CLEAN AIR STATUS AND TREND NETWORK (CASTNET)

CASTNET is designed to measure dry deposition and it is comprised of 123 sites across the United States as shown in Figure 8-1. It includes measurements of ambient concentration and meteorology and land use which are then used to calculate dry deposition rates. For the model performance evaluation we will use the ambient concentration measurements to compare with the model. Dry deposition data are measured for 13 species including: TOTAL SO4, TOTAL NO3, TOTAL NH4, CA, MG, NA, K, NSO4, NHNO3, WSO2, WNO3, TOTAL SO2, and TOTAL NO3.

Detailed data collection procedures are described at the EPA CASTNET website: http://www.epa.gov/castnet. In short, atmospheric concentration data are collected at each site with open-faced, 3-stage filter packs. The filter pack contains a Teflon filter for collection of particulate species, a nylon filter for nitric acid and a base-impregnated cellulose (Whatman) filter for sulfur dioxide. Filter packs are exposed for 1-week intervals (i.e., Tuesday to Tuesday) at a flow rate of 1.5 liters per minute (3.0 liters per minute for western sites), and sent to the Harding ESE, Gainesville, FL laboratory for chemical analysis.

All three filters are extracted and analyzed for certain species:

Teflon filter: SO_4^{2-}, NO_3^-, NH_4^+
Nylon filter: SO_4^{2-}, NO_3^-
Cellulose filter (Whatman): SO_4^{2-}, NO_3^-

The sulfate, nitrate and ammonium in the teflon filter extract are interpreted as particulate species (listed above as TSO4, TNO3 and TNH4). The nitrate in the nylon filter extract is interpreted as nitric acid. The sum of sulfate in the nylon and cellulose filter extracts is interpreted as sulfur dioxide (SO2). Any nitrate detected in the cellulose filter extract is not interpreted, since it likely represents a host of oxidized nitrogen species.

Because aerosol nitrate on the teflon filter can revolatilize, the nitrate on the teflon filter represent those particles that have not volatilized during the sampling period. The nitrate on the nylon back filter represents nitric acid that was originally in the atmosphere plus any that was produced through revolatilization of the nitrate particles on the teflon filter. Thus, because of the volatilization losses, the CASTNet particulate nitrate is less than the IMPROVE nitrate. Also, because IMPROVE uses a nitrate denuder to remove ambient nitric acid, the CASTNet total nitrate (the sum of the teflon and nylon filter nitrates) is greater than the IMPROVE nitrate. Details are provided in Appendix G of the 2000 IMPROVE Report and by Ames and Malm [Ames R.B and W.C. Malm, Comparison of sulfate and nitrate particle mass concentrations measured by IMPROVE and the CDN, Atmospheric Environment, 2001, 905-916.] Thus, the IMPROVE and CASTNet nitrate values cannot be directly compared. Moreover, the CASTNet NO3 and HNO3 data cannot be directly compared to the modeled species. In previous applications we have compared the CASTNet data to the model for the sum NO3+HNO3 and we propose to use the same approach for the VISTAS model evaluation.

The CASTNet data have been downloaded from: http://www.epa.gov/castnet/data.html. The CASTNET data are available for all three modeling episodes. The actual start time and collection period varies among sites, so this makes it difficult to automate the model performance evaluation, and additional effort is required to match the sample period with the model output period.

As in the case of the IMPROVE data, measured species can not be compared directly to the models species, and Table 8-1 shows the mapping scheme to be used for comparing the CASTNET data to model species.

Table 8-1. Species mappings for CASTNet species.

Compound	CASTNet Species	CMAQ Mapping
Gaseous HNO_3	NHNO3 (nylon filter)	2176.9*DENS[a]*HNO3
Particulate NO_3	TNO3 (Teflon filter)	ANO3J + ANO3I
Total HNO_3 + NO_3	NHNO3 (nylon filter) + TNO3 (Teflon filter)	2176.9*DENS[a]*HNO3 + ANO3J + ANO3I
Particulate NH_4	TNH4 (Teflon filter)	ANH4I + ANH4J
Gaseous SO_2	TOTAL_SO2	2211.5*DENS*SO2
Particulate SO_4	TSO4 (Teflon filter)	ASO4I + ASO4J

[a] Air density obtained from MCIP outputs

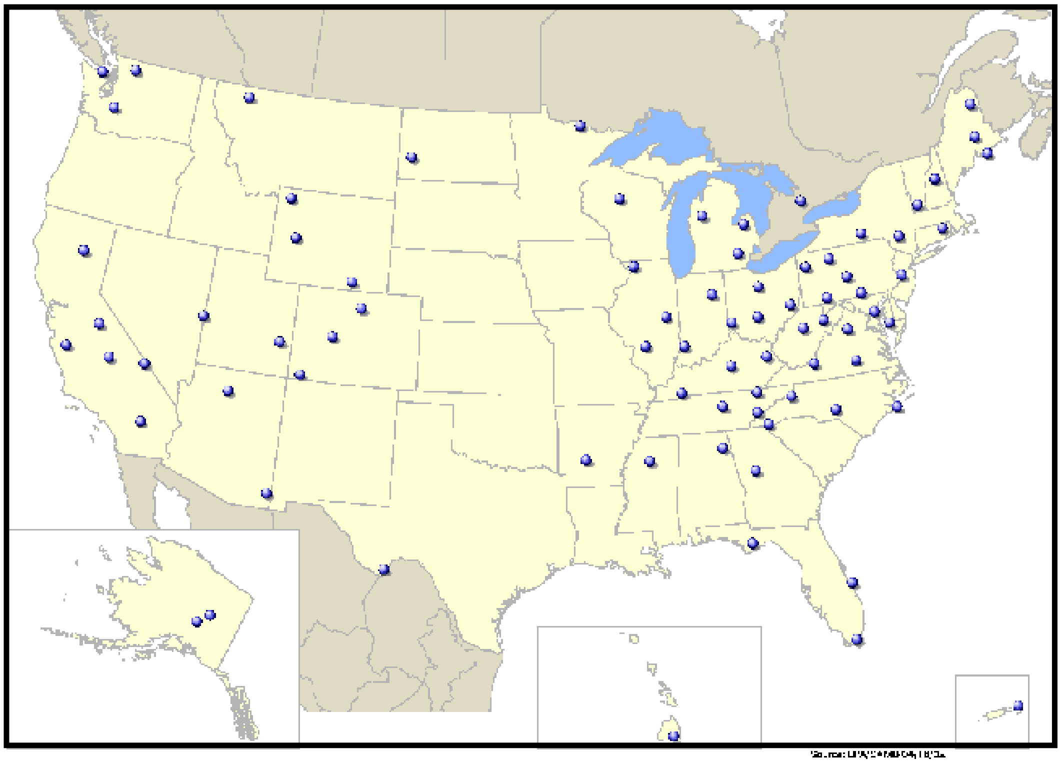


Figure 8-1. Locations of CASTNet monitoring sites (Figure obtained from EPA CASTNet website).

9.0 PM SUPERSITES

There are 8 PM Supersites. The locations of these sites are listed in Table 9-1. The data includes PM size distribution, ions, metal elements, EC, OC, radical, and gaseous pollutants is measured in Supersites. Available data varies with the site. The archived data files can be downloaded from the website (ftp://ftp.supersitesdata.umd.edu).

Eastern Supersites Program (ESP01)

The ESP01 was initially planned as an effort to coordinate an intensive monitoring in July 2001 among the three PM Supersites projects (New York, Pittsburgh, and Baltimore). As other researchers expressed interest in the program it grew in scope and eventually over 30 groups were involved in ESP01. The intensive monitoring program was planned for June 30, 2001 at 0000 hrs to July 29, 2001 at 2400 hrs. The program included an extensive set of gas, PM, PM precursor, photochemical, visibility, and meteorological measurements. The study also included an extensive network of Radar Profilers (NOAA FSL) which will be useful for evaluating transport within and above the boundary layer. EPA plans to centralize all air quality and meteorological data in one location within several relational databases to allow for easy access to the data and to help ensure that modelers and data analysts will be working with uniform databases. Details on data collected at the PM Supersites can be found at www.epa.gov/ttn/amtic/supersites.html. We have contacted Paul Solomon and Marc Pitchford to determine the schedule for releasing this database.

Table 9-1. Locations of PM Supersites.

Location	Institution
Atlanta GA	Georgia Institute of Technology
Baltimore, MD	University of Maryland at College Park
Fresno, CA	Desert Research Institute
Houston, TX	University of Texas at Austin
Los Angeles, CA	University of California, Los Angeles
New York, NY	University at Albany, State University of New York
Pittsburgh, PA	Carnegie Mellon University
St. Louis, MO	Washington University

10.0 AIRCRAFT DATA

Of the three episodes selected for Phase I, only during episode 3 (13-21 July 1999) were there research aircraft flights performed that provide aloft meteorological and air quality data suitable for model performance testing. These data were collected during the Southern Oxidants Study (SOS) intensive field program performed principally in Nashville, TN during the summer of 1999. An overview of the SOS/Nashville 1999 aircraft data has been submitted to VISTAS as Appendix A to the Task 2 report (ENVIRON, 2003) and is not repeated here.

Aircraft data are available through the NARSTO Archive and are available online at: http://eosweb.larc.nasa.gov/project/narsto/table_narsto.html. We have downloaded the NOAA WP3 data, but have not yet attempted to process this data for model evaluation. The Brookhaven/DOE data does not appear to be accessible through the NARSTO archive, and we will contact Brookhaven directly to access this data.

11.0 DATA QUALITY ASSURANCE

In gathering data from the monitoring networks we have assumed that QA was performed by the agency or researcher responsible for collecting the data. However, it is possible that the data sets may contain erroneous data (i.e., missing data, zeros during calibration, unrealistic values, etc). Due to poor documentation or poor formatting of some data sets it is also possible that we will make mistakes in our processing of the data. To guard against this possibility, we plan to perform a high level QA by visually inspecting time-series plots and scatter plots of the ambient data as follows:

Plots of Time Series

Time series plots are generated for PAMS species. The plots should be inspected for the following:

- Large "jumps" or "dips" in the concentrations
- Periodicity of peaks, calibration carryover
- Unexpected diurnal behavior (i.e., isoprene)
- Unexpected relationships among species
- High single-hour concentrations of less abundant species

Scatter Plots

Scatter plots may be prepared for the following:

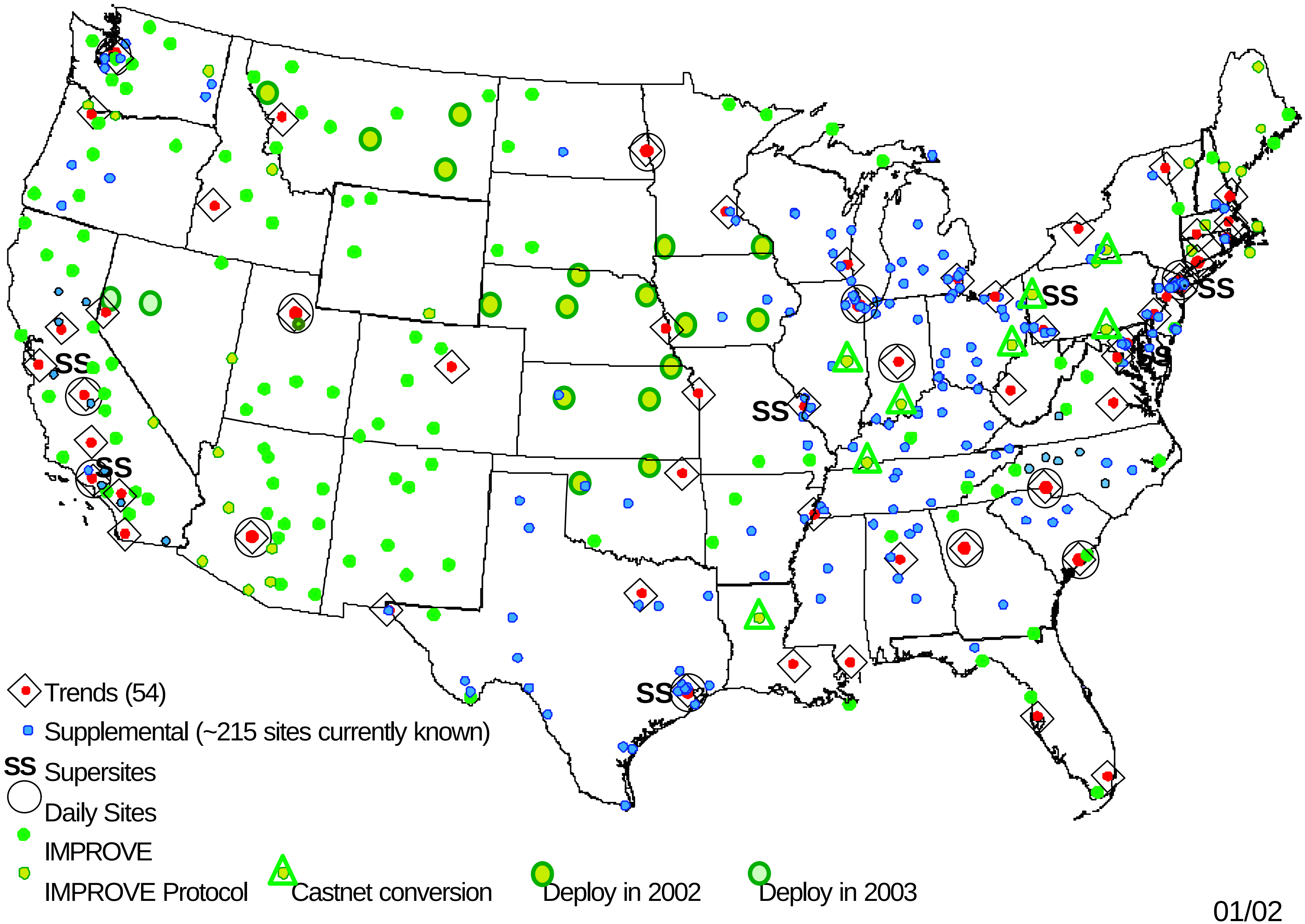
- Total NMOC vs. species group totals, vs. individual species
- Benzene vs. Toluene, Acetylene, Ethane
- Scatter plots comparing data for a single species measured with different sampling methods
- Plots of reconstructed mass versus measured mass (to reveals if anything unusual is happening with the chemical measurements)
- Plots of molal particulate ammonium versus the molal sum of sulfate and particulate nitrate (as a sanity check on the ion balance in the PM chemical measurements)

If we identify data that appears flawed it will be flagged and either corrected if the error is in the processing step, or removed from the data set.

Appendix A

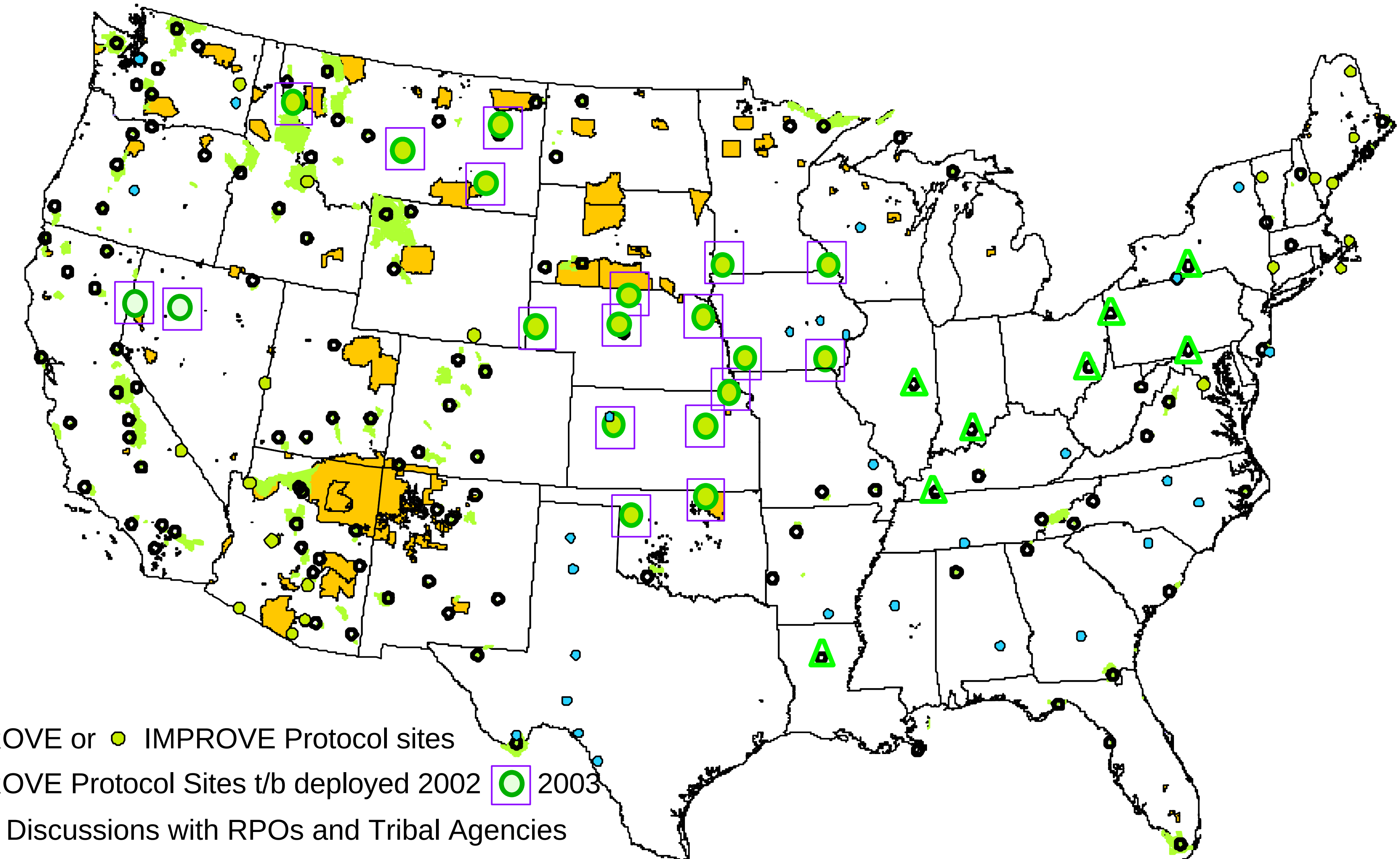
Locations of Speciated PM and IMPROVE Monitors

Current/Planned
Urban & Rural $PM_{2.5}$ Speciation Networks



01/02

Current/Planned IMPROVE, IMPROVE Protocol & Rural Supplemental $PM_{2.5}$ Speciation Sites



IMPROVE or IMPROVE Protocol sites

IMPROVE Protocol Sites t/b deployed 2002 / 2003

From Discussions with RPOs and Tribal Agencies

Castnet sites converted to IMPROVE

Supplemental Speciation Sites

Class I Areas

Tribal Lands

2/02

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Appendix C.3
Mendenhall PM2.5 Data Imputation for 4Q2006 Memorandum

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Memorandum

To: Hoke Kimball

CC: Joelle Burleson, George Bridgers

From: Wayne L. Cornelius

Date: 2007-05-09 (revised 2008-12-16 and 2009-04-14)

Re: **Mendenhall PM2.5 Data Imputation for 4Q2006**

Contents

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Introduction

The North Carolina Division of Air Quality (DAQ) is in nonattainment for Davidson County for PM2.5 from the monitoring station in the city of Lexington (AQS Site ID: 370570002). DAQ has performed design value calculations with the PM2.5 data for 2005-2008 for Lexington. These calculations indicate that the design value for this monitor will be in attainment for this time period and thus DAQ will be applying for PM2.5 nonattainment redesignation. Redesignation requires assessing the PM2.5 data from PM2.5 monitors at Mendenhall (Guilford Co., ID 370810013), Lexington (Davidson Co., ID 370570002) and Hattie (Forsyth Co., ID 370670022).

The design value calculations for 2005-2008 for the Mendenhall site are incomplete because no valid PM2.5 data were collected during the fourth quarter of 2006. This happened because of major complications in having to move the site. DAQ moved the site about 100 yards because a 2 story field house that was constructed immediately adjacent to the monitoring site (unpublished letter to Artra Cooper, 12 December 2006). The construction was started without DAQ's knowledge. When DAQ realized what was happening it was too late to stop the project, the new field house was built, and the site no longer met ambient siting criteria.

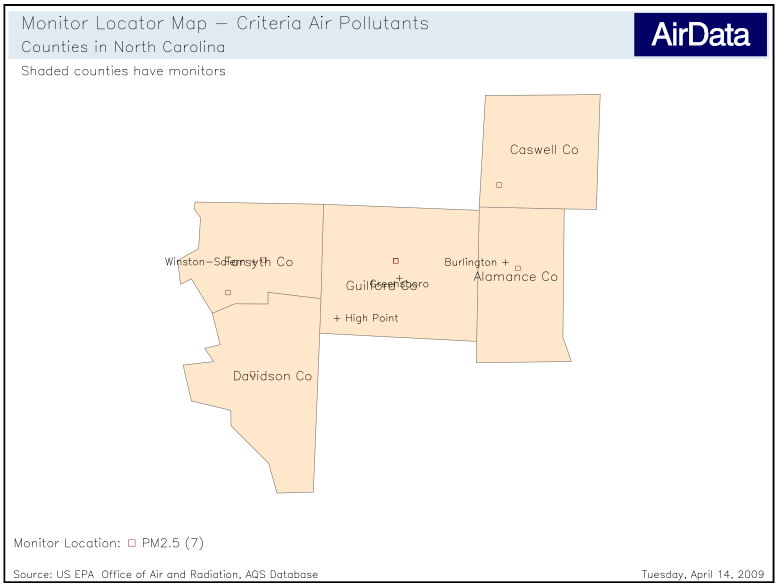

Figure 1 Map of Monitor Locations

Since there were no 4Q2006 data with which to calculate a proper Mendenhall Design value, the DAQ Planning and Ambient staff decided to present to EPA Region IV an estimate of what the missing Mendenhall PM2.5 sample values would have been if they had been properly observed, along with the resulting Design value summary statistics. The estimate is based on linear regression using data acquired during the four years, 2002 through 2005 at surrounding sites including those in the MSA and also Hopedale (Alamance County, ID 370010002) and Cherry Grove (Caswell Co., ID 370330001). These monitor locations are shown in Figure 1 (an extraneous PM2.5 monitoring site at Clemmons, southwest Forsyth County, is also shown for reference but was not used in the analysis).

.

Methods

The estimation procedure is as follows:

1. Fit a linear regression to the 2002-2005 PM2.5 data of the regressors to determine equation coefficients
2. Estimate missing sample values for Mendenhall by substituting the corresponding observed PM2.5 data in 4Q2006 into the regression equation
3. Compute quarterly averages for Mendenhall including the imputed 4Q2006 data using actual data where available and imputed data where provided by the regression procedure
4. Compute weighted averages for each year
5. Compute the completed Design value for Mendenhall derived by averaging the weighted annual means

Results

I applied two regression fits to the data, starting with the most inclusive possible model, using Lexington, Cherry Grove, Hopedale and Hattie Avenue all as predictors. Estimates from this model are shown in Table 1. In this combination, Lexington, Cherry Grove and Hattie Avenue are not significant predictors for Mendenhall.

Table 1 Regression Analysis using the Lexington, Cherry Grove, Burlington and Hattie Avenue PM2.5 data

Call: lm(formula = MH ~ LX + UC + HD + HA, data = MH4q.md3, na.action = na.exclude)

Residuals:

Min	1Q	Median	3Q	Max
-3.763	-1.161	-0.3787	0.5814	11.34

Coefficients:

Regressor	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	0.6105	0.5347	1.1417	0.2565
LX	0.1615	0.1165	1.3861	0.1690
UC	0.0791	0.0947	0.8346	0.4061
HD	0.4782	0.1495	3.1982	0.0019
HA	0.2466	0.1414	1.7445	0.0844

Residual standard error: 2.111 on 93 degrees of freedom
Multiple R-Squared: 0.8798

The second regression removed Cherry Grove and Hattie Avenue from the model. The resulting model had a residual standard error of 2.094 and R^2= 0.877. Both Lexington and Hopedale were significant in this regression, but the intercept term was not significant, so I fit the model with its intercept forced to zero. This model's estimates are shown in Table 2. The regression equation is shown as equation (1)

$$MH = 0.3464 * LX + 0.6322 * HD$$ **(Equation 1)**

I fit (1) to the Lexington and Mendenhall data values acquired during 4Q2006. Table 3 shows the regressors for the 22 days with valid data for both regressors, and the resulting Mendenhall estimates. The average of the 22 imputed samples is 12.92.

Table 2 Regression Analysis using the Lexington and Hopedale PM2.5 data

Call: lm(formula = MH ~ -1 + LX + HD, data = MH4q.md3, na.action = na.exclude)

Residuals:

Min	1Q	Median	3Q	Max
-4.258	-0.9024	-0.1271	0.915	11.67

Coefficients:

Regressor	Value	Std. Error	t value	Pr(>|t|)
LX	0.3464	0.0891	3.8873	0.0002
HD	0.6322	0.0957	6.6042	0.0000

Residual standard error: 2.103 on 107 degrees of freedom

Table 4 shows the quarterly averages for 2004, 2005 and 2006, including the imputed value for 4Q2006 and the 11 actual values for the remaining quarters. Finally Table 5 shows the 3 annual means and the overall Design value result that obtains from them, 14.01.

Table 3 Imputed Raw Data

Sampling_Date	Mendenhall	Hopedale	Lexington
10/02/2006	11.485813	11.1	12.9
10/05/2006	23.900103	24.6	24.1

Sampling_Date	Mendenhall	Hopedale	Lexington
10/08/2006	6.785218	7.5	5.9
10/11/2006	13.710670	14.4	13.3
10/20/2006	11.761229	11.7	12.6
10/26/2006	11.848665	11.4	13.4
11/01/2006	16.130242	16.2	17.0
11/04/2006	12.507779	13.1	12.2
11/07/2006	10.703944	12.0	9.0
11/16/2006	4.536147	4.6	4.7
11/22/2006	3.983631	4.0	4.2
11/25/2006	16.255683	14.7	20.1
11/28/2006	18.157377	15.9	23.4
12/01/2006	4.790717	4.4	5.8
12/04/2006	9.893171	8.8	12.5
12/10/2006	16.526730	14.8	20.7
12/13/2006	25.615500	24.3	29.6
12/19/2006	18.599245	18.9	19.2
12/22/2006	8.990912	9.4	8.8
12/25/2006	6.246493	6.1	6.9
12/28/2006	14.394680	13.4	17.1
12/31/2006	17.455206	17.2	19.0

Table 4 Quarterly Summaries

Period	CY2004	CY2005	CY2006
1Q	11.76	11.45	10.55
2Q	14.40	13.12	13.71
3Q	16.54	19.25	19.07
4Q	13.19	12.21	12.92

Table 5 Weighted Annual Means and Design Value

Period	CY2004	CY2005	CY2006	2004-2006 D.V.
Mean	13.97	14.01	14.06	14.01

Discussion

I maintain that the estimated Design value presented in Table 5 is an accurate prediction of the result that would have been obtained from Mendenhall for 2004-2006, had siting conditions not changed during 4Q2006. The imputed average is also the most accurate and appropriate value to use for the 2006-2008 Design value calculations at Mendenhall to assist with the redesignation package for the Lexington site.

Recommendations

Design value calculations for the Greensboro-Winston-Salem-High Point MSA (or any subsequently redefined area that includes Greensboro) for any group of years that includes 2006 should use the imputed 4Q2006 value as a surrogate for the missing “actual” 4Q2006 at the Mendenhall site.

For future consideration, we can *apply* (1) to data acquired after 2006 from Lexington, Hopedale and Mendenhall. We can also repeat the regression fitting exercise using data acquired from the regressor sites in 2007 and later instead of 2002-2005 Either of these actions can be used to demonstrate how well the moved site location “represents” the original location.

Appendix D
Modeling Protocol

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Appendix D.1

NC Division of Air Quality

Modeling Protocol

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Modeling Protocol

for the

Hickory and Greensboro/Winston-Salem/High Point

Annual Fine Particulate Matter

Nonattainment Areas

Prepared by:

North Carolina Department of Environment and Natural Resources
Division of Air Quality

February 11, 2008

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1.0 Overview of Fine Particulate Matter Modeling/Analysis Project

1.1. Policy Overview of Fine Particulate Matter National Ambient Air Quality Standards

In July 1997, the United States Environmental Protection Agency (USEPA) issued National Ambient Air Quality Standards (NAAQSs) for fine particulate matter ($PM_{2.5}$). The NAAQSs include an annual standard set at 15 micrograms per cubic meter ($\mu g/m^3$), based on the 3-year average of annual mean $PM_{2.5}$ concentrations and a 24-hour standard of 65 $\mu g/m^3$, based on the 3-year average of the 98^{th} percentile of 24-hour concentrations. A number of events delayed the implementation of the $PM_{2.5}$ NAAQSs.

The new $PM_{2.5}$ standards were challenged by the American Trucking Association, the U.S. Chamber of Commerce, and other state and business groups. The Transportation Equity Act for the Twenty-first Century (TEA-21) delayed the deadline to publish nonattainment designations in order to provide additional time to collect three years of air quality monitoring data.

In February 2001, the United States Supreme Court upheld the USEPA's authority under the Clean Air Act (CAA) to set NAAQSs that protect the American public from harmful effects of air pollution. The United States Supreme Court also sent the case back to the D.C. Circuit Court of Appeals to resolve several additional issues. In March 2002, the D.C. Circuit Court rejected all remaining legal challenges to the 1997 NAAQSs for $PM_{2.5}$.

1.2. Designations

In April 2003, the USEPA provided guidelines to states and tribes for recommending nonattainment area boundaries for the $PM_{2.5}$ NAAQSs. Consistent with the CAA, the guidance instructed states and tribes to begin their analysis of attainment and nonattainment area boundaries based on Metropolitan Area boundaries. A Metropolitan Area was defined as a single Metropolitan Statistical Area (MSA) or a Consolidated MSA, depending on the area. The guidance instructed states to include in nonattainment areas any nearby counties with sources contributing to fine particle pollution in those metropolitan areas. In addition, the guidance recommended that states and tribes consider using common boundaries for areas to be designated as nonattainment for both the $PM_{2.5}$ and 8-hour ozone standards, which will help states and tribes facilitate future planning and implementation activities.

In mid-February 2004, states and tribes recommended $PM_{2.5}$ nonattainment area boundaries to the USEPA. The USEPA revised these recommendations and responded to the states and tribes in late June 2004. On December 17, 2004, the USEPA designated areas for the $PM_{2.5}$ NAAQSs. Two areas in North Carolina were designated nonattainment for the annual $PM_{2.5}$ NAAQS under Section 172 of the CAA as amended. These areas were Hickory (Catawba County) and Greensboro/Winston-Salem/High Point (Davidson and Guilford Counties). The Greensboro/Winston-Salem/High Point area is referred to as the Triad area. Figure 1.2-1 shows the USEPA's final designation of $PM_{2.5}$ nonattainment areas in North Carolina.

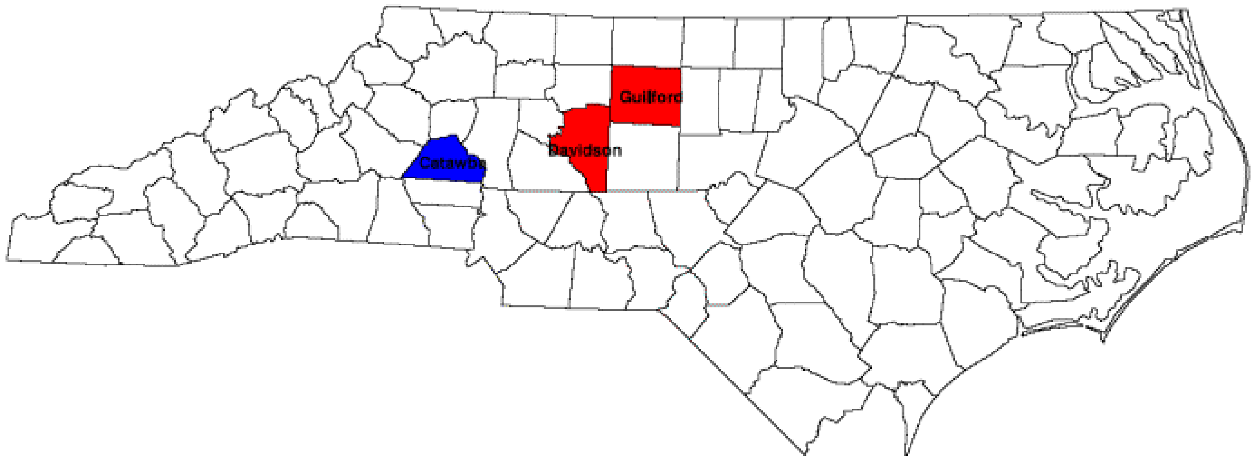

Figure 1.2-1: Designated Annual $PM_{2.5}$ nonattainment areas in North Carolina.

1.3. Participating Organizations

From the conceptual model of $PM_{2.5}$ formation, it is clear that $PM_{2.5}$ is a regional problem, which results in attainment demonstration State Implementation Plan (SIP) modeling to be a substantial undertaking that relies on the interaction of many groups that are affected by overall air quality and that impact the air shed of the affected states. It is imperative to include groups of "stakeholders" from industry, government, and the private sector during the modeling/analysis project. As each group involved brings its own perspective, knowledge, and experience to the modeling process, the ability to model and develop strategies for $PM_{2.5}$ reduction is greatly enhanced. The following organizations were invited to participate in developing the Hickory/Triad $PM_{2.5}$ SIP:

- North Carolina Division of Air Quality (NCDAQ)
- Carolina Environmental Programs – University of North Carolina Chapel Hill
- Barons Atmospheric Modeling Systems
- University of North Carolina at Chapel Hill
- North Carolina State University
- Sonoma Technology, Inc.
- Mecklenburg County Department of Environmental Protection
- USEPA Region 4
- USEPA Office of Air Quality Planning and Standards
- USEPA Office of Research and Development
- North Carolina Department of Transportation
- North Carolina Department of Commerce
- North Carolina Department of Agriculture
- North Carolina State Energy Office
- Progress Energy
- Duke Energy
- Transcontinental Natural Gas Company
- Environmental Defense

- Sierra Club
- Charlotte Department of Transportation
- Furniture Manufacturing Representative
- Chemical Manufacturing Representative
- North Carolina Petroleum Council
- North Carolina Petroleum Marketers' Association
- Centralina Council of Governments
- Catawba Council of Governments
- Representatives from city and county governments in the nonattainment areas

Data and available expertise from participating agencies, organizations, and universities will be utilized in determining projected emissions and control strategies. All data and information will be reviewed and evaluated by the NCDAQ. All stakeholders are invited to contribute emissions projections and control strategy information.

North Carolina will coordinate with various states and other parties as regional modeling is initiated to address the $PM_{2.5}$ standards. Various other regional modeling applications, such as Visibility Improvement and Tribal Association of the Southeast (VISTAS) regional haze modeling, will also be considered. These interactions should provide a forum for discussing the latest improvements and refinements to air quality modeling.

1.3.1. Communication

Communication between the stakeholders is an integral part of completing the modeling/analysis project. Stakeholders need the opportunity to review and comment on documentation, control strategies, and modeling analysis. The NCDAQ will host periodic technical coordination meetings on the SIP process. Consultation meetings on control strategy development and contingency plans will be held as necessary during the process. In general, as issues arise among the participants, special studies will be defined to help resolve all pertinent issues. Documentation will be developed concerning these issues, including methods of resolution and any remaining uncertainties, which will be submitted as part of the SIP.

Due to the far-reaching effects of the $PM_{2.5}$ attainment demonstration, it is important that all interested parties are kept informed on the progress of the modeling. Industries or organizations not directly represented on a modeling committee can monitor progress through the VISTAS website. The NCDAQ will also host several public meetings and focus groups with potentially impacted parties in order to get the most objective and comprehensive input in the development of the final control strategies.

1.3.2. Protocol Modification Procedures

The model configuration, as well as the source of input data and evaluation process, will be determined at the beginning of the process. In the event that the protocol needs to be revised to incorporate new tools or methodologies, an issue paper stating the need for modification will be developed and circulated to all organizations participating in the study. The issue paper will be discussed at the next scheduled technical coordination meeting. The revised protocol would then be developed and submitted to the USEPA for their review.

1.4. Selection of Future Year

A key decision from both a modeling and control strategy standpoint is the selection of the future year by which attainment will be modeled. The future modeling year has been chosen to meet the schedule previously put forth. The time line set by the CAA requires attainment of the annual $PM_{2.5}$ NAAQS be met by April 5, 2010. Since this date is set prior to the completion of the 2010, attainment of the NAAQS would have to be met by at least the end of the 2009. The NCDAQ plans to use 2009 as the future year for attainment modeling, as it would coincide with future year modeling for the annual $PM_{2.5}$ and 8-hour ozone attainment demonstration SIPs and VISTAS regional haze modeling effort.

1.5. Schedule

The NCDAQ will follow the schedule outlined by the CAA, where an attainment demonstration SIP is due for submittal by April 5, 2008. Using a 2009 modeling year, attainment will be demonstrated by at least April 5, 2010 or as expeditiously as practicable.

1.6. Organization of Air Quality Modeling Protocol

The remainder of the protocol documentation is broken down into nine additional sections as follows:

- Section 2 provides a conceptual description of $PM_{2.5}$ formation in North Carolina.
- Section 3 presents details of the $PM_{2.5}$ episode selection process.
- Section 4 details the models that will be used during this modeling project.
- Section 5 describes the model grid specifications.
- Section 6 discusses the emission inventory development.
- Section 7 lays out the quality assurance plan and procedures.
- Section 8 details the tools and procedures for model performance evaluation.
- Section 9 discusses how the control strategies will be designed.
- Section 10 focuses on the model attainment test and supplemental analyses.
- Section 11 lists the references.
- Acronym Attachment follows the final section.

2.0 Conceptual Description of Fine Particulate Matter in North Carolina

2.1. General Description of Particulate Matter

Particulate matter is generally subdivided into two categories, coarse and fine particles, based on the aerodynamic diameter (D_a) of the particle, as opposed to the actual diameter. Actual particles are irregularly shaped, making a diameter measurement problematic. To ease the process, particles are measured base on their D_a, which is defined as the diameter of a spherical particle with equal gravitational settling velocity as the irregularly shaped particle, but with material density of 1gram per cubic centimeter (g/cm^3).

The division between the fine and course categories occurs in the D_a size range between 1 and 3 micrometers (µm), where concentrations are at a minimum. Particles with a D_a greater than the minimum are coarse particles, while those particles less than the minimum are categorized as fine particles. Fine particle are further broken down into the accumulation mode, which includes diameters less than the minimum, but greater than 0.1 µm, and ultrafine mode, which are diameters less than 0.1 µm. The ultrafine mode is further broken down into Aitken mode and nucleation mode. Figure 2.1-1 illustrates the differences between the particle size divisions.

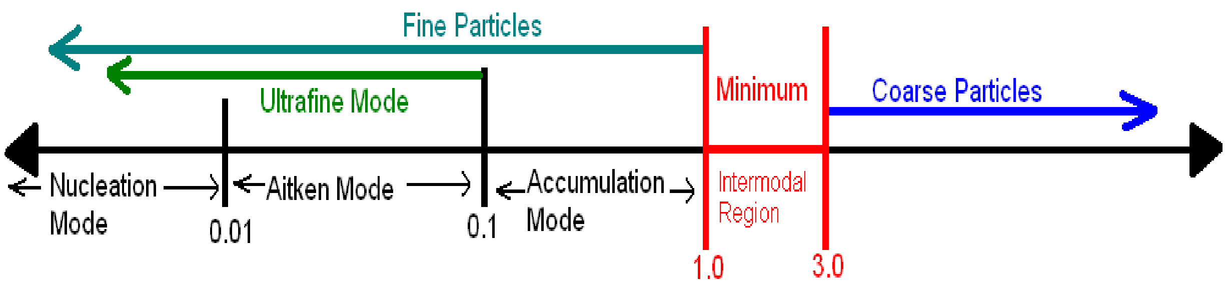

Figure 2.1-1: This figure illustrates the size categories or modes for particulate matter. Values are in units of micrometer.

The ambiguity in the cutoff between fine and coarse particles revolves around the hygroscopic properties of the accumulation mode particles. Under high relative humidity conditions, the particle can grow to sizes on the coarse end of the spectrum due to particle bound water. Under low relative humidity conditions, coarse particles can be fragmented, and the resulting particle will have a $D_a < 2.5$ µm. The USEPA chose the cutoff of 2.5 µm for the development of a NAAQS based on the use of $PM_{2.5}$ in epidemiological studies, and the desire to include the accumulation-mode particles, while recognizing that some coarse particles can occur under particular conditions.

2.2. Composition

Particulate matter can be liquid, solid, or can have a solid core surrounded by liquid. Particulate matter can include material produced by combustion, photochemical reactions, and can contain salt from sea spray and soil like particles. Particles are distinguished based on the method of formation. Primary particles are particles directly emitted into the atmosphere and retain the same chemical composition as when they were released. Secondary particles are those formed through chemical reactions involving atmospheric oxygen (O_2), water vapor, hydroxyl radical (OH), nitrate (NO_3), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and organic gases from natural and anthropogenic sources.

Particulate matter components can include:

- Sulfate
  For fine particles, sulfate is generally a secondary particle, and is usually found in the form of ammonium sulfate.
- Nitrate
  For fine particles, nitrate is generally a secondary particle, and is usually found in the form of ammonium nitrate.
- Ammonium
- Hydrogen ion
- Particle bound water
- Elemental carbon
- Organic compounds
  - Primary organic species (from cooking and combustion)
  - Secondary organic compounds
- Organic materials
  Generally, in the coarse particle and intermodal range, organic materials are primary particulates from organic material includes pollen, spores, and animal debris.
- Crustal material
  Predominately found in coarse particle range, crustal material includes calcium, aluminum, silicon, magnesium, and iron.
- Sea salt
  Sea salt is generally only found at coastal monitoring sites.
- Transitional metals
- Potassium
  For fine particulates, potassium is generally from wood burning or cooking.

2.3. Spatial and Temporal Patterns

2.3.1. Spatial

North Carolina currently has two nonattainment areas for the annual $PM_{2.5}$ NAAQS, which are associated with the Hickory and Lexington monitoring sites located in Catawba and Davidson Counties, respectively. The nonattainment designations were based on the 2001-2003 monitoring data. For that period, the Hickory monitor had an annual $PM_{2.5}$ design value of 15.5 $\mu g/m^3$ and the USEPA designated all of Catawba County as nonattainment. The Lexington monitor had an annual $PM_{2.5}$ design value of 15.8 $\mu g/m^3$, and all of Davidson and Guilford Counties were designated as nonattainment. These two monitoring sites are only tenths of micrograms above the current NAAQS of 15.0 $\mu g/m^3$. The rest of the state was below the NAAQS, with annual averages ranging from 9.6 to 14.9 $\mu g/m^3$. Figure 2.3.1-1 shows a map of

North Carolina with the 2001-2003 annual $PM_{2.5}$ design values. Across the majority of the monitoring sites, including the two violating monitors, the annual average of $PM_{2.5}$ has been on the decline since 1999.

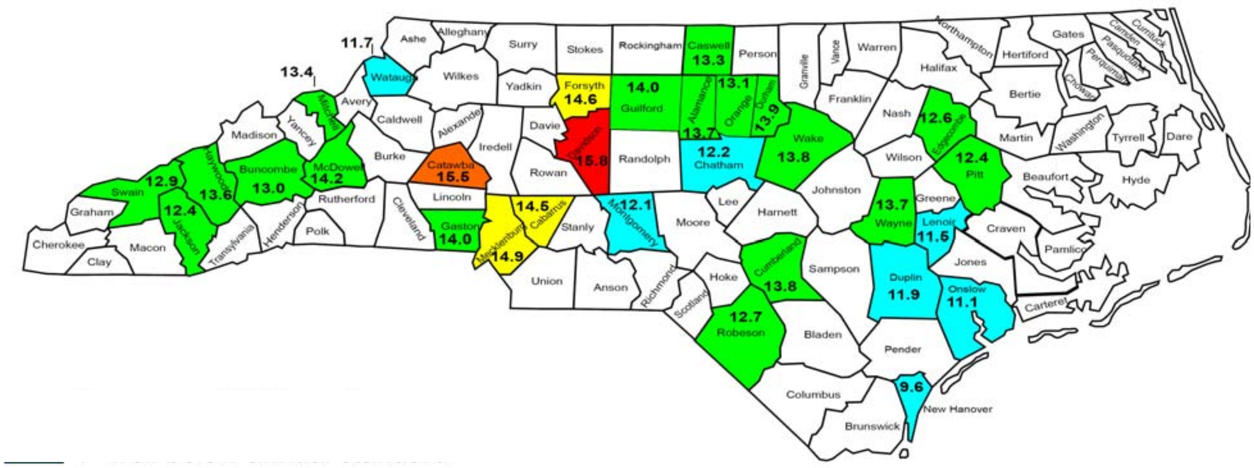

Figure 2.3.1-1: 2001-2003 annual $PM_{2.5}$ design values.

Given that annual average $PM_{2.5}$ concentrations at sites across the state, one can reasonable conclude that $PM_{2.5}$ is a regional issue for North Carolina. An examination of the daily $PM_{2.5}$ conditions across North Carolina again shows similar values across the state on a consistent basis. It is very rare that a site becomes notably higher than a surrounding site, as well as experiences an exceedance of the 24-hour $PM_{2.5}$ NAAQS.

Both nonattainment areas are in the western portion of the state known as the Piedmont Crescent. This portion of the state has the intersection of three major highways, and a higher concentration of coal-fired electric generating boilers than the rest of the state.

2.3.2. Diurnal

The most distinct pattern $PM_{2.5}$ presents is its diurnal pattern. $PM_{2.5}$ levels often increase in the overnight hours and drop off during the day. This increase is, in part, due to the formation of temperature inversions in the lowest layers of the atmosphere near the surface. Inversions commonly form when the air near the surface cools during the overnight period. Once the sun sets, the ground loses heat very quickly, which cools the air that is in contact with the ground. Air is a very poor conductor of heat, which allows the air just above the surface to remain warm. These inversions are referred to as nocturnal inversions.

Conditions commonly found in association with high-pressure systems, namely calm winds and clear skies, contribute to the formation of surface inversions. Calm winds prevent warmer air above the surface from mixing down to the ground, and clear skies increase the rate of radiational cooling at the earth's surface. Additionally, the length of the overnight period greatly affects inversion formation. Winter typically has stronger and more frequent inversions, since the nights are longer and provide a longer period for radiational cooling to occur.

Inversions generally weaken and disappear as the sun rises and warms the surface. However, under certain meteorological conditions, such as strong high pressure over the area, these inversions can persist for several days. In addition, local topographical features can enhance the formation of inversions, especially in valley locations.

Therefore, inversions create a very stable atmosphere where pollutants, such as $PM_{2.5}$, become trapped near the surface. Air quality conditions under the inversion layer are greatly affected by the emissions from electric generating units and other industrial sources. Most electric generating units are in operation 24-hours a day, with a large portion of industrial source operating with either two shifts or around the clock. The second shift production from these facilities occurs just as the nocturnal inversion is setting up. Emissions from production are spewed the atmosphere where they become trapped in the very stable layer created by the inversion. With little mixing occurring, the pollutants begin to build up and concentrations rise as more pollutants are pumped into the atmosphere with overnight production. Pollutants continue to build until the sun warms the surface enough to ‘break’, or mix out, the inversion.

Air quality conditions are further aggravated under the inversion by ‘rush hour’ traffic. The evening commute occurs just as the nocturnal inversion is setting up, contributing some additional $PM_{2.5}$ components to the load from industrial sources. The remnants of the nocturnal inversion are still in place during the bulk of the morning rush hour, allowing for additional vehicle contribution during this time.

2.3.3. Weekly

Preliminary statistical studies indicate both the Hickory Federal Reference Method (FRM) monitoring site and the Lexington FRM site experience similar weekly patterns in $PM_{2.5}$ concentrations. Concentrations generally build from low weekend values to a peaks concentration at week’s end. Figures 2.3.3-1 and 2.3.3-2 show the concentration of $PM_{2.5}$ stratified by day of the week. The black circle on the graph indicates the average concentration for that particular day of the week.

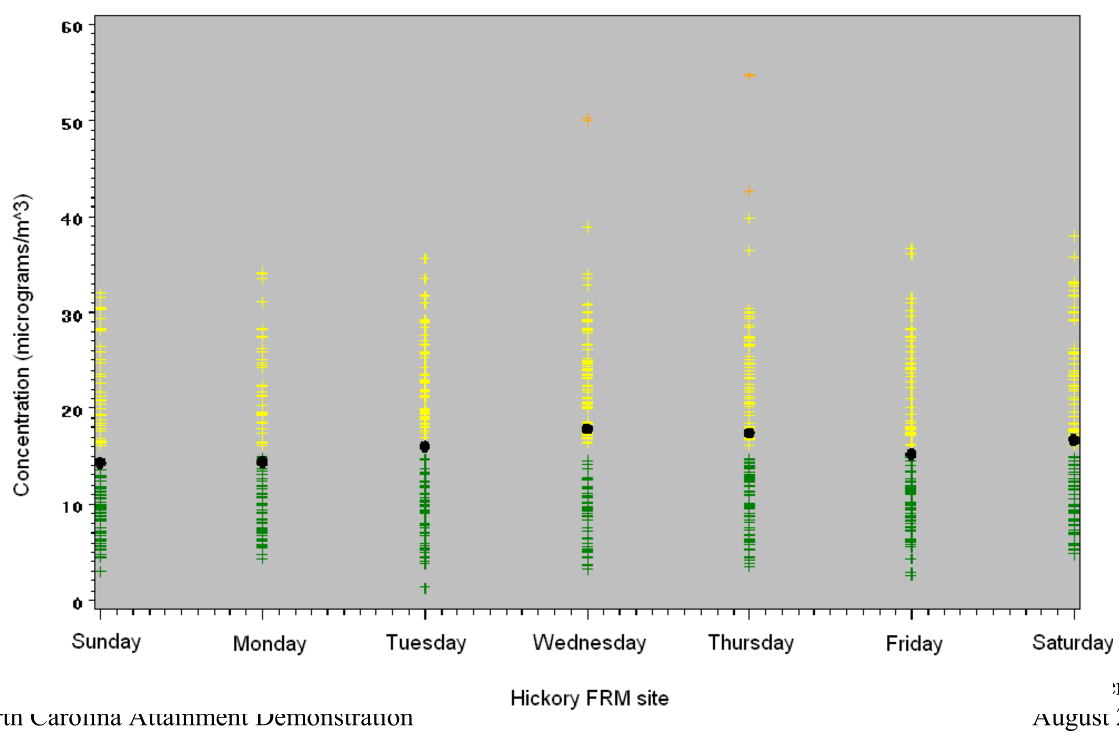

Figure 2.3.3-1: 24-hour average $PM_{2.5}$ concentrations at the Hickory FRM monitor by days of the week. The black circle represents the average concentration for the day.

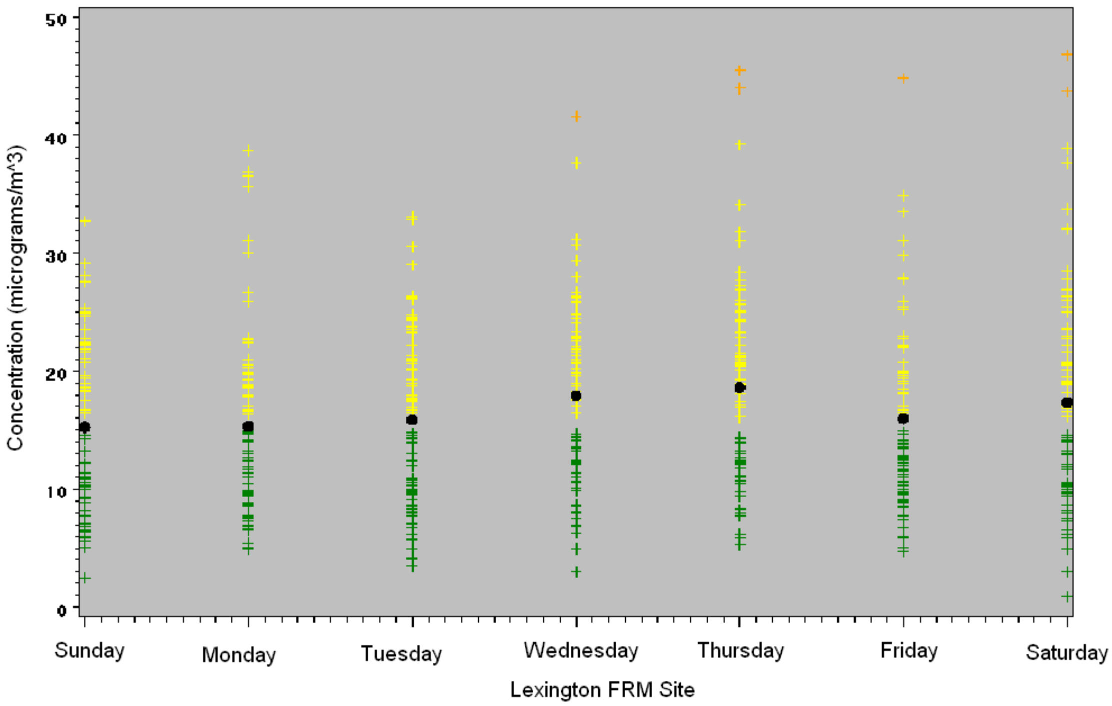

Figure 2.3.3-2: 24-hour average $PM_{2.5}$ concentrations at the Lexington FRM monitor by days of the week. The black circle represents the average concentration for the day.

2.3.4. Seasonal

<u>Summer/Fall</u>

High $PM_{2.5}$ values generally correspond to high temperatures and high atmospheric moisture content (i.e., high relative humidity). Some constituents of particulate matter are hygroscopic, and will collect more water as relative humidity increases. This can lead to very hazy conditions, which limit visibility. Since high temperature and high relative humidity are prevalent in the southeastern United States during the summer and early fall, some of North Carolina's worst particulate matter episodes occur in the months from June to September.

The 24-hour concentrations are typically between 10 and 30 $\mu g/m^3$ during the summer, with spikes as high as 50 $\mu g/m^3$. The season generally has its peak $PM_{2.5}$ concentration in the July to August timeframe, with ammonium sulfate as the primary constituent of $PM_{2.5}$ during this period. Ozone is also of great concern during the summer months. Generally, the same meteorological scenarios responsible for high ozone days also lead to high $PM_{2.5}$ days. Typically, those conditions are characteristic of a surface high pressure area. The approach of a tropical system or a frontal system can also lead to an increase in either pollutant.

High-pressure systems can act to block cold fronts from passing through the area, which would cause an exchange in air mass leading to improved air quality conditions. Regardless of their origin, high-pressure systems produce light winds and little precipitation. These conditions can persist for days allowing for an intense build up of pollutants in the area. Conditions similar to a high-pressure system can be produced by tropical cyclones. Tropical cyclones produce subsidence on their outer edges, which results in light winds, warm temperatures and subsequently, high $PM_{2.5}$ concentrations. Systems that lurk just off the coast, or take a path that grazes the coast can cause subsidence in the western portion of the state.

Pre-frontal conditions can also cause increased $PM_{2.5}$ concentrations as the leading edge of the front acts to collect $PM_{2.5}$, driving up concentrations along its path. During an event with enough steady precipitation, $PM_{2.5}$ can "washout", or remove particulates from the atmosphere, reducing concentrations. However, relief from high $PM_{2.5}$ usually comes after frontal passage when a new air mass enters into the area.

Winter/Spring

$PM_{2.5}$ episodes during the winter and early spring are typically lower in magnitude than those episodes experience in summer and early fall, and are largely driven by nitrates and to a lesser extent by black carbon from combustion. Peak 24-hour averages of particle pollution are generally around 20 to 25 $\mu g/m^3$. The highest $PM_{2.5}$ occurs when high pressure moves overhead, creating and environment of light winds and clear skies. At night, temperatures at the surface cool rapidly and a steep nocturnal temperature inversion forms. Particle pollution accumulates under this inversion, with 1-hour values rising to 25 to 30 $\mu g/m^3$. $PM_{2.5}$ drops the next morning after the sun rises and convective mixing disperses the low level pollutants. The highest daily $PM_{2.5}$ occurs when conditions are clear and calm through the nighttime hours, then cloud cover moves overhead at or just after sunrise, reducing convective mixing and leaving pollution trapped at the surface.

Longer lasting episodes may occur when inversions are created by cold air damming (CAD). CAD events occur frequently during the winter and early spring and are a phenomenon unique to the geography of the Southeast. In a CAD event, a layer of cold air at the surface gets pushed up against the Appalachian Mountains. A low-pressure system to the south then circulates warm moist air over the cold air, creating an inversion. These events are generally accompanied by cloudy skies, little precipitation, and light wind. The stable atmosphere created by CAD events provides an environment conducive for the continual build up of pollution near the surface with little mixing.

Snow and ice cover can also lead to higher concentrations of particle pollution. A snow pack intensifies the radiational cooling at the surface, enhancing the nocturnal temperature inversion and allowing a greater build up of particulates. With the cold temperatures, a greater amount of combustion for heating takes place, which adds more particulates to the air. During the day, the high albedo of the snow suppresses surface heating and convective mixing, preventing the nocturnal inversion from mixing out and keeping particle pollution at high concentrations.

3.0 $PM_{2.5}$ Episode Selection

A crucial step to attainment demonstration modeling is the selection of episodes to model. Several considerations need to be weighed before settling on not only which days to model, but how many days for each episode. This section details the guidance and process by which episodes were selected for the Hickory/Triad $PM_{2.5}$ attainment demonstration SIP.

3.1. Overview of the USEPA Guidance on Particulate Matter

The USEPA's draft guidance for Demonstrating Attainment of Air Quality Goals for $PM_{2.5}$ and Regional Haze (EPA, 2001) sets out specific criteria for the selection of episodes for modeling the attainment of the $PM_{2.5}$ NAAQS. First, episodes should include days encompassing a variety of meteorological conditions. Episodes should also be chosen around days for which there are extensive database air quality and meteorology measurements, including measurements speciated data, and upper air measurements. Finally, a sufficient number of days should be selected to ensure robust attainment tests at violating monitoring sites.

In addition to these primary criteria, the USEPA also suggests a set of secondary criteria that may be used in the selection of episodes. This set of criteria allows states to give preference to previously modeled episodes. This is a very valuable consideration, as the USEPA points out, since it can save modeling resources and effort. The USEPA also recommends selecting episodes that occur during the period corresponding to the 5 year current design value, 2000-2004. Additional considerations include selecting episodes that include weekends and the selection of episodes meeting primary and secondary criteria in all other nonattainment areas, when participating in regional modeling. Using these criteria laid out by the USEPA, the NCDAQ systematically examined the data available to determine the best episodes for modeling.

The USEPA suggests three approaches to $PM_{2.5}$ modeling. The first, and preferred approach, is to use a photochemical model to model an entire year (or more). As an alternative to the preferred modeling, states can model a minimum number of days (at least 15) from each quarter. A second alternative is to classify observed air quality data into groups defined by differences in meteorological conditions, modeling at least three days from each of the identified groups.

3.2. $PM_{2.5}$ Episode Selection

With the advances in computing and storage technologies, and aided by regional modeling efforts, the NCDAQ will model an entire year for the Hickory/Triad $PM_{2.5}$ attainment demonstration, using a photochemical model. By modeling the whole year, several criteria are covered, including the modeling of weekends and a sufficient number of days to ensure a robust modeled attainment test. Modeling a whole year will also accomplish the goal of encompassing a myriad of meteorological conditions that may influence $PM_{2.5}$ concentrations.

Efforts were made to determine an appropriate year to model. One of the secondary criteria would suggest using episodes drawn from 2001-2003, as this period corresponds to the design value period for which nonattainment designations were based. By selecting 2002, the base case year would be the same as our base line (typical) year. This would mean the 2002 emissions inventories would not have to be adjusted to correspond to a different base case year during modeling efforts. Differences between the base case and base line (typical) inventories are explained in Section 6.

Additionally, the selection of 2002 as the base case year also fulfills the secondary criteria, which suggests states give preferential treatment of previously modeled episodes. Through the NCDAQ's work with the VISTAS, the 2002 calendar year is in the process of being modeled as a base case year for regional haze reduction goals.

Though the VISTAS modeling is geared towards Regional Haze on a regional scale, the modeling can easily be applied to the $PM_{2.5}$. The VISTAS modeling employs "one atmosphere" modeling, or modeling of all atmospheric constituents, including particulate matter and ozone. This modeling is done in parallel to capture interactions between various compounds. Since $PM_{2.5}$, along with ozone and regional haze, is being modeled as part of the VISTAS modeling efforts, its data can easily be extracted from the modeling results.

The USEPA guidance suggests that when selecting a representative year, one should examine the annual mean concentration and the pattern of the quarterly mean concentrations. The mean annual concentration of the year chosen as the base case should be close to the 3-year design value at all or most of the monitoring sites. Table 3.2-1 shows the annual average for the Hickory and Triad areas, as compared to both the 2001-2003 design values and the 2002-2004 design values. The mean annual average concentration for the 2002 calendar year is generally close to either design value, usually within ± 0.5 μg/m^3. When examining the patterns of the mean quarterly concentrations, the representative year should follow a similar pattern. Table 3.2-2 shows the mean quarterly concentrations for 2002 and the average of the quarterly mean concentrations from 1999 through 2004. The ambient data for 2002 generally follows the same trends as the quarterly averages; specifically the third quarter has the highest mean concentration, with the lowest concentrations in the first or fourth quarter.

Table 3.2-1: Annual mean concentration and design value for sites in nonattainment areas

Monitoring Site	County	Annual Mean				Design Values		2002 – DV(01-03)	2002 – DV(02-04)
		2001	2002	2003	2004	2001-2003	2002-2004		
Hickory	Catawba	**15.98**	**15.36**	**15.04**	15.00	**15.5**	**15.1**	-0.10	0.22
Lexington	Davidson	**16.45**	**15.88**	**15.17**	**15.18**	**15.8**	**15.4**	0.05	0.47
Mendenhall-1	Guilford		13.72	13.32	13.97	13.2	13.7	0.55	0.05
Mendenhall-2	Guilford		13.79	13.15	14.18	12.9	13.7	0.85	0.08

Note: The last two columns show the difference between the annual average for 2002 and the 2001-2003 design value (DV) and the 2002-2004 DV.

Table 3.2-2: Quarterly mean concentrations for 2002 compared to mean quarterly averages

Monitoring Site	County	1Q.2002	2Q.2002	3Q.2002	4Q.2002	Q1	Q2	Q3	Q4
Hickory	Catawba	13.25	14.32	**21.12**	**12.73**	14.64	15.82	**20.00**	**13.82**
Lexington	Davidson	14.94	15.00	**19.28**	**14.29**	14.67	16.67	**19.42**	**14.61**
Mendenhall-1	Guilford	**11.71**	13.14	**18.29**	11.72	**11.67**	13.70	**17.10**	11.73
Mendenhall-2	Guilford	13.03	14.17	**18.87**	**9.08**	11.95	14.45	**16.84**	**10.87**

Note: Blue numbers indicate the minimum quarter, red numbers indicate highest quarter.

2002 was an active year with numerous poor air quality episodes. Across the Carolinas, instances of high $PM_{2.5}$ values generally coincide with high ozone values since both need similar atmospheric condition to accumulate. Both $PM_{2.5}$ and ozone thrive in stagnant air masses in the summer, which result from reduced wind conditions that limit vertical mixing in the atmosphere. The limited mixing allows pollutants to collect near the surface, driving the concentration of both pollutants up. The 2002 season was examined to verify that it was representative of the nature of $PM_{2.5}$ formation in the Hickory and Triad areas to further support its use in modeling. The following section details the results of the study.

3.3. Episode Classification

Since the NCDAQ is moving towards modeling an entire calendar year, a general discussion of episodes is presented in this section. The same categories of meteorological scenarios exist through out the year.

3.3.1. Definition of a $PM_{2.5}$ Episode

Monitoring sites across North Carolina rarely see instances where the 24-hour NAAQS for $PM_{2.5}$ is violated; making it is difficult to define $PM_{2.5}$ episodes. Further complicating the issue is the fact that North Carolina rarely has days with a 24-hour average $PM_{2.5}$ concentration greater then 40.5 $\mu g/m^3$, which is the lower end cutoff of the Code Orange range of the Air Quality Index (AQI). As an arbitrary method to classify episodes to ensure various meteorological scenarios were selected, days with a 24-hour $PM_{2.5}$ concentration greater than 15 $\mu g/m^3$ (the lower end of the Code Yellow range of the AQI) were flagged for closer examination.

Table 3.3.1-1 lists the 24-hour $PM_{2.5}$ concentrations for the year, with each block as a separate month. Days with a 24-hour concentration greater than 15 $\mu g/m^3$, but less than 30 $\mu g/m^3$, are shade light gray. Days greater than 30 $\mu g/m^3$ are shaded dark gray, and the stippling indicates no data. The tables include the Mendenhall (MNDHL) site in Guilford County, the Lexington (LEX) site in Davidson County and the Hickory (HKY) site in Catawba County. Both the Lexington and Hickory monitors are FRM monitors that report every three days. The Mendenhall is a Tapered Element Oscillating Microbalance (TEOM) monitoring site and reports everyday.

Table 3.3.1-1: 2002 PM2.5 Concentrations and Meteorology Episodes

January

Day	MNDHL	LEX	HKY	Met
01	10.9			
02	11.5	13.6	18.3	Ls
03				
04				WS
05	25.5	28.5	22.3	WS
06	23.9			Ho
07	7.2			
08	8.5	10.6	6.8	
09	10.9			
10	13			
11	6.8	8.5	6.3	
12	12.8			
13	8.1			
14	17.1	15.8		H-F
15	9			
16	8.5			
17	13.9	18.8	17.6	Fsl
18				
19	9.4			
20	12	11.3	10.7	
21	17.7			Ls
22	6.5			
23	8.1	10.1		
24	7.5			
25	7			
26	13.7	18.2	11.5	Ho
27	12.9			
28	11.4			
29	14.6	15.8	17.4	Hs
30	10.9			
31	15.8			Ho

February

Day	MNDHL	LEX	HKY	Met
01	7.7		8.6	
02	9.1			
03	14.2			
04	8.1	12.3	6.7	
05	4.9			
06	10.8			
07	6.8	10.8	10.1	
08	11.1			
09	12.1			
10	17.6	22.3	19.4	CAD
11	7.4			
12	12			
13	8	8.1	10.3	
14	11.2			
15	18.2			Ho
16	12.3	13.2		
17	4.4			
18	6.5			
19	14.3	16.9	14.7	Ho
20	15.5			Ho
21	7.4			
22	11.5	13.5	10.2	
23	14.6			
24	16.5			Ho
25	18.8	20.3	21.4	Ho
26	16.6			Ho
27	5.5			
28	10.5	10.4	9.6	

March

Day	MNDHL	LEX	HKY	Met
01	10.9			
02	12.4			
03	7.6	7.8	7.1	
04	6.9			
05	11.3			
06	15.6	22.8	24.8	Ho
07	22.3			Ho
08	17.5			Ho
09	7		12.2	
10	4.3			
11	6.5			
12	16.2	19.3	22	F
13	10.3			
14	12.1			
15	21.2	23	20	Hs
16	14			
17	7.4			
18	5.2		7.2	
19	13.6			
20	14.4			
21	10.2	11.8	9.6	
22	5.2			
23	10.3			
24	12.3	16.5	11	Hs
25	12.7			
26	14.5			
27	10.3	8.7	9.5	
28	14			
29	21.4			Hs
30	12.4	14.6	12.4	
31	9.8			

April

Day	MNDHL	LEX	HKY	Met
01	8.1			
02	11.3	14.4	12.4	
03	11.8			
04	7.5			
05	10.7	11	11.2	
06	9.2			
07	11			
08	12.1	12.7	13	
09	8.3			
10	11.3			
11	11.2	12.7	14.3	
12	11.1			
13	8.7			
14	8.5		6.7	
15	9.8			
16	13.5			
17	15.9		15.4	Hs
18				Hs
19				Hs
20			15.3	Hs
21				
22	11.9			
23	7.9	8.5	7.6	
24	15.3			Ho
25	12.4			
26	7	7.7	7.1	
27	12			
28	17.3			F
29	8		5.8	
30	12.3			

May

Day	MNDHL	LEX	HKY	Met
01	11.2			
02	18.3	25.1	25	Fsl
03	10.2			
04	8.8			
05	6.3	7.7	9.2	
06	9.1			
07	18.1			
08	18.2	24.1	20.2	CAD
09	25			H-F
10	11.2			
11	11.5	15.3	11.1	F
12	16.2			He
13	9.5			
14	8.7	9.1	9.2	
15	10.5			
16	16.5			Ho
17	16.6	16.5	18	He
18	8.8			
19	9.7			
20	11.2	11.9	11.6	
21	12.9			
22	12.2			
23	11.1	13.2	16	Ho
24	17.3			Ho
25				
26		25.3	22.6	Fst
27				
28				
29	13.8	14.5	18.3	He
30	9.1			
31	13.1			

June

Day	MNDHL	LEX	HKY	Met
01	18.8	19.1	19.6	Hs
02	20			Hs
03	22.2			CAD
04	26	26.4	29	He
05	20.9			He
06	19.6			F
07	6.3	8.9	8.7	
08	7.2			
09	13.8			
10	23.5	22.4	27.5	Ho
11	23.4			Ho
12	19.3			Ho
13	25.8	26.9	23.1	H-F
14	14.2			
15	9			
16	9	10.2	10.5	
17	14.4			
18	20.4			Fst
19	17.7	20.2		Fst
20	14.7			
21	13.6			
22	8.3	8	10.5	
23	3.9			
24	6.5			
25	6.5	7.8	9	
26	11.3			
27	12.9			
28	9.2	10.3	7.3	
29	17.9			Fst
30	25.2			Fst

Note: Mendenhall (MNDHL) is a TEOM monitor, with measurements every day. Lexington (LEX) and Hickory (HKY) are FRM monitors, with measurements every 3rd day. White blocks denote $PM_{2.5} < 15\ \mu g/m^3$, light gray 15-30 $\mu g/m^3$, dark gray > 30 $\mu g/m^3$, and stippling denotes missing data.

Meteorological Scenarios (Met) are as follows: Ho – Surface high over NC; Hs – Surface high south of NC; He – Surface high east of NC; Ls – Low pressure passing south of NC; F – Frontal approach; Fst – Front stalled near/over NC; Fsl – slow frontal approach; H-F – High pressure followed by frontal approach; CAD – Cold Air Damming; WS – Winter Storm; T – Tropical system near NC

Table 3.3.1-1 (cont.): 2002 PM2.5 Concentrations and Meteorology Episodes

July

Day	MNDHL	LEX	HKY	Met
01	32.9	31.1	33.5	Ho
02	37.7			Ho
03	30.8			Ho
04	29.7	26	24.6	Ho
05	28.8			Fsl
06	15			Fsl
07	20.5	21.1	28.3	Ho
08	31.1			Ho
09	34.9			Ho
10	23.9	25.8	27.8	Fsl
11	10.3			
12	8.5			
13	9	9.8	16.5	Fst
14	8.2			
15	10.9			
16	34.8	33.1	33.5	Ho
17	41.8			Ho
18	41.8			Ho
19	12.7	13.8	11.4	
20	17			Fst
21	28.9			Ho
22	21.9	20.5	24.7	He
23	17.4			He
24	23.2			Fst
25	24.4	23.3	27.3	Fst
26	18.8			He
27	15.5			He
28	18.3		17.6	He
29	17.3			Hs
30	13.6			
31	20.3	22.8	21.9	Fst

August

Day	MNDHL	LEX	HKY	Met
01	28.7			Ho
02	31.4			Ho
03	17.4	19.5	30	Fst
04	10.9			
05	16.7			Ho (T)
06	21	23.6	23	F (T)
07	4.9			
08	13.3			
09	17	19.6	22.2	Ho
10	27			Ho
11	33.4			Ho
12		36.9	40.7	Ho
13				Ho
14	8.7			
15	13.3	12.1	12.2	
16	12.7			
17	12.7			
18	10.8	10.3	8.7	
19	11.8			
20	17.4			Fsl
21	24.9	24.9	23.5	Ho
22	31.1			Ho
23	33.2			Ho
24	22.6	22.2	19.7	Fsl
25	15.4			Fst
26	15.9			Fst
27	14.4	15	18.1	Fst
28	5.7			
29	5.7			
30		7.4	7.6	
31	7.6			

September

Day	MNDHL	LEX	HKY	Met
01	3.1			
02	7.9	7.7	11.9	
03	15			Ho (T)
04	22.9			Fsl (T)
05	19.7	20.8	24.2	Fst
06	19.5			Fst
07	18.8			Ho (T)
08	15	14.6	20.8	Ho (T)
09	14.1			
10	12.9			
11	21.5	20.7	18.4	F (T)
12	8.8			
13	15.6			Fst
14	11.9		12	
15	7.3			
16	7.8			
17	21.2		27.6	Fsl
18	30.5			Ho
19	23.5			Ho
20	14	14.9	21	He
21	7.9			
22	11.6			
23	16.7	17.8	21.3	F
24	11.9			
25	16.1			F
26	5.6	7.7	6.1	
27	6.3			
28				
29		16.7	18.5	Ho
30				Ho

October

Day	MNDHL	LEX	HKY	Met
01	17.3			Ho
02	17.5	22.1	17.8	Ho
03	18.5			Ho
04	24.1			Ho
05	17.8	19.2	14.1	F
06	12.8			
07	15.5			F
08	9.7	10.8	11.2	
09	11.3			
10	10.6			
11	3.8	5.1	5.6	
12	7.4			
13	10.2			
14	6.8	8.5	9	
15	6.3			
16	2.5			
17	10.3	13.9	14.7	
18	11.9			
19	14.8			
20	19.7	21.1	19.2	H-F
21	13.3			
22	10.3			
23	11.7	17.9	12.8	F
24	20			F
25	10.5			
26	5.9	8.2	5.8	
27	10			
28	7.9			
29	3.8	4.9	5	
30	4			
31	5.7			

November

Day	MNDHL	LEX	HKY	Met
01	10.2	12.6	11.9	
02	8.9			
03	11.8			
04	8.8	11	8.1	
05	9			
06	4.4			
07	14.5	14.4	12.5	
08	14.5			
09	12.3			
10	8.5		10.5	
11	7.3			
12	3			
13	9.4		10.8	
14	9.2			
15	13.6			
16	10.8	11.7	8.5	
17	3.5			
18	11			
19	17.9	18.7	21.1	Ho
20	16.8			Fst
21	26.6			Ho
22	7.8	9.8	5.8	
23	10.5			
24	15.6			Ho
25	19.9	25.9	19.3	Fsl
26	22.3			Fsl
27	10.8			
28	10.6	10.7	12.8	
29	9.2			
30	8.2			

December

Day	MNDHL	LEX	HKY	Met
01	12	9.2	8.7	
02	16.8			H-F
03	10.8			
04	6.6	8.5	10.1	
05	11.8			WS
06				Ho
07	49.2	43.7	29.2	Ho
08				Ho
09	15.3			Ho
10	15.3	12.3	18.3	Ho
11	10.4			
12				
13	7.8	9.1	8.6	
14	5			
15	11.5			
16	10.3	14.9	9	
17	9.1			
18	10.5			
19	18.8	21.3	25	H-F
20	5.2			
21	5.9			
22	6.1	10.9	6.4	
23	6.8			
24	4.5			
25	4.1	14.1	4.5	
26	8.6			
27	13.8			
28	9.9	4.9	9.4	
29	13			
30	25.1			CAD
31	20.5	18.9	28.9	CAD

Note: Mendenhall (MNDHL) is a TEOM monitor, with measurements every day. Lexington (LEX) and Hickory (HKY) are FRM monitors, with measurements every 3rd day. White blocks denote $PM_{2.5} < 15\ \mu g/m^3$, light gray 15-30 $\mu g/m^3$, dark gray > 30 $\mu g/m^3$, and stippling denotes missing data.

Meteorological Scenarios (Met) are as follows: Ho – Surface high over NC; Hs – Surface high south of NC; He – Surface high east of NC; Ls – Low pressure passing south of NC; F – Frontal approach; Fst – Front stalled near/over NC; Fsl – slow frontal approach; H-F – High pressure followed by frontal approach; CAD – Cold Air Damming; WS – Winter Storm; T – Tropical system near NC

3.3.2. Episode Classification of the 2002 Season

In reviewing the data in Table 3.3.1-1, it becomes apparent the months of May through October have the days with the highest $PM_{2.5}$ concentrations. The peak concentrations of the year occur during the months of July and August, and remain below 40.7 μg/m^3. There is one isolated episode on December 7, 2002, which had a 24-hour $PM_{2.5}$ concentration of 49.2 and 43.7 μg/m^3 at the Mendenhall and Lexington monitoring sites, respectively. These high values are likely in association with a winter storm that struck North Carolina on December 4th and 5th, and will be discussed further below under the winter storm section.

The column labeled "Met" contains a classification of the weather pattern on that day. The meteorological scenarios are broken down into several categories. One set of categories is based on the location of surface high-pressure systems. Systems are defined as either over North Carolina, to the south of the State, or east of North Carolina. In addition, episodes can be defined by various frontal passage scenarios.

An additional set is defined by the type of frontal approach experienced. A typical frontal approach is capable of producing elevated $PM_{2.5}$, as well as a front stalled near/over North Carolina, slow frontal approach, and high pressure followed by a frontal approach. Winter storms, cold air damming, low-pressure system passing to the south, and tropical systems near North Carolina are additional meteorological scenarios that occur less frequently, but have an impact on $PM_{2.5}$ concentrations in North Carolina. Tropical influence is noted in combination with the main surface feature on land. The following sections discuss the major categories of meteorological scenarios responsible for elevated particulate matter. Table 3.3.2-1 contains a count of each the meteorological scenarios by month for the identified episodes. Several seasonal patterns can be ascertained from Table 3.3.1-1.

Table 3.3.2-1: Count based on the meteorological scenarios associated with elevated $PM_{2.5}$

Met scenario		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
High to south	Hs	1		3	4		2	1						11
High to east	He					3	2	5						10
High overhead	Ho	3	6	3	1	3	3	11	11	7	4	3	5	60
High followed by front	H-F	1				1					1		2	5
Frontal approach	F			1	1	1	1		1	3	4			12
Front Stalled	Fst					1	4	5	4	3		1		18
Front Slow	Fsl	1				1		3	1	2		2		10
Low passing to south	Ls	2												2
Winter Storm	WS	2											1	3
Cold Air Damming	CAD		1			1	1						2	5
Tropical system influence	T								2	5				7
	Total	10	7	7	6	11	13	25	19	20	9	6	10	143

High Pressure

Stagnation under high pressure is responsible for, roughly 57% of the noted $PM_{2.5}$ episodes in 2002 (see Table 3.3.2-1). High pressure builds into the southeast, settling nearly over North Carolina. The high leads to clear and calm conditions across the state and most of the region. With light or calm winds and clear skies, the nocturnal surface temperature inversion grows very strong. Particle pollution builds under the inversion, reaching a maximum in the morning hours before the sun induces surface heating to mix out the inversion. Highest particle pollution may occur when clouds build in shortly after sunrise. The clouds diminish the daytime surface heating and reduce the amount of atmospheric mixing, allowing the nighttime inversion layer to persist well into the daylight hours. High-pressure episodes may be quickly followed by a frontal approach (see section below), which can lead to a further rise in particle pollution. If high pressure can remain overhead for 2 to 3 days, $PM_{2.5}$ can rise to 20 to 25 $\mu g/m^3$ in the winter, and as high as 40 $\mu g/m^3$ in the summer.

A milder rise in $PM_{2.5}$ may occur if high pressure is positioned further south, over northern Florida or to the east of Jacksonville. A west to southwest flow develops over North Carolina. The flow has a long history over land, originating from the central Gulf coast region to the lower Mississippi River valley. Since the high pressure is centered further south and/or east, winds remain light to moderate, preventing a strong nocturnal inversion from developing. The winds also mix pollutants within a deeper layer of the atmosphere. Under this scenario, $PM_{2.5}$ generally reaches a maximum between 15 to 20 $\mu g/m^3$.

The winter episodes due to high pressure tend to be transient, lasting 1 to 2 days, because of the farther south position of the jet stream this time of year. Most summertime episodes tend to be of the high overhead or high just to the east variety (see Table 3.3.2-1). This is not surprising that all the eastern high episodes occur during the summer when the Bermudas high positions itself off North Carolina's coast for most of the summer, sometime drifting closer to shore.

Frontal Approach

The second most common meteorological scenarios of the 2002 season involved frontal passage. Approximately 31% of the elevated episodes of 2002 were either classified as frontal approach, front stalled near/over North Carolina, slow frontal approach, or high pressure followed by a frontal approach (See Table 3.3.2-1).

North Carolina experiences numerous frontal passages during the year. Mass convergence ahead of a cold front typically yields a rise in particle pollution. Winds are predominantly from the south and southwest ahead of the front. The level of particle pollution with a frontal approach depends on the speed of the front. The slower moving the front, the more time pollution levels have to rise in an area. The typical fast moving front may cause a rise in $PM_{2.5}$ for a few hours, causing a spike in 1-hour concentrations and a slight surge in the 24-hour concentration.

Slow moving and stalled fronts are slightly less common (see Table 3.3.2-1), but can lead to a more extended rise in $PM_{2.5}$ concentration, leading to elevated 24-hour concentrations. In North Carolina, a fronts tend to slow when a long-wave upper level trough is located over the eastern United States, between the Appalachian Mountains and the Mississippi River. As a cold front plunges southward from Canada into Alabama and Mississippi, it then slows down as it becomes oriented parallel to the upper level flow. In this situation, North Carolina remains within the dirtier air just to the east of the frontal boundary, where mass convergence leads to a buildup of particle pollution. Eventually the cold front pushes south and east of North Carolina, bringing cleaner air into the state. An example of this type of event occurred on November 25, 2002.

Occasionally, an approaching cold front will completely stall over the state and then dissipate. As the front moves into the region, the upper level trough weakens, leaving no upper level dynamics to support the frontal boundary. The high particle pollution associated with the leading edge of the front remains in the region as a weak high-pressure area develops overhead. The stagnant conditions underneath the high pressure cause particle pollution concentrations to remain elevated, and can lead to increased concentrations. An example of this type of event occurred on November 20, 2002.

Winter Storm Followed by High Pressure

In this scenario, low pressure develops along the Gulf coast, and tracks east-northeastward off the Carolina coast. With cold air in place, moderate to heavy snow falls to the north of the storm track, over the Appalachian Mountains and Piedmont. In the wake of the departing storm, high pressure builds over the southeast. The snowfall intensifies the radiational cooling at the surface, enhancing the overnight inversion and allowing a greater build up of particulates. During the day, the high albedo of the snow suppresses surface heating and convective mixing, preventing the nocturnal inversion from mixing out and keeping particle pollution at high concentrations.

Especially severe winter storms may cause extreme rises in $PM_{2.5}$. Severe winter weather may knock out power across a wide region, causing people to use alternative means, such as wood burning, to keep warm. North Carolina experienced a severe ice storm on December 4, 2002. Power was knocked out for several days across a wide swath of the Piedmont. Wood combustion for both residential heating and debris removal caused $PM_{2.5}$ to top out above 40 $\mu g/m^3$. Due to the anomalous nature of severe winter storms, it is not appropriate to include $PM_{2.5}$ concentrations for days immediately following these events.

Cold Air Damming, CAD

Longer lasting episodes may occur with the passage of a 'backdoor' cold front in a moderate CAD regime, which stalls in or near North Carolina. In a CAD scenario, the wind flow around a surface high pressure located over the northeast will push colder air southward to the east of the Appalachian mountains, down into the Carolinas. Meanwhile, low pressure to the west of North Carolina advects warm moist air over the cold air, creating a stable inversion layer at the surface. A stratus cloud layer usually forms as the warm air overrides the cold air. Particle pollution is able to build within the inversion layer, and cloudiness and light wind prevents much significant mixing. Recirculation of pollutants often occurs at the end of CAD events, as the backdoor cold front pushes north.

Lows and Tropical Influence

The final two categories are less common (see Table 3.3.2-1). The presence of tropical system offshore during the late summer to early fall can degrade $PM_{2.5}$ conditions. The systems generally cause subsidence at their outer edge, which acts much like a high-pressure system. Skies are generally clear and calm winds prevail far out from the system's center, allowing pollutants to build up. The subsidence caused by the presence of a tropical system combines with the meteorology present on land (usually a high-pressure system over North Carolina) to drive $PM_{2.5}$ concentration to levels between 15 and 25 $\mu g/m^3$.

The final category involves a low-pressure system passing to the south of the State. These events produce slight elevations in $PM_{2.5}$, with concentrations on the order of 18 $\mu g/m^3$. With only two instances of this type of scenario, it is hard to pin point the exact cause for the slight elevation. The increase in concentration is likely due to the clear conditions setting up the night preceding the low-pressure system passage, leading to the formation of an inversion layer. The low-pressure system approach by morning shrouds the area in cloud cover, making it difficult to erode the inversion layer. The pollutants are trapped at the surface by the inversion layer, but dissipate after the low-pressure system moves east.

4.0 Models and Modeling Configurations

The NCDAQ intends to utilize the same configuration of regional meteorological, emissions processing, and photochemical air quality models used by the VISTAS regional haze modeling study. The underlying science behind each component of the overall modeling system are identified and discussed briefly in this section. Although the configuration of each of the modeling components has been selected as the culmination of intensive study by VISTAS, there remains the possibility that certain algorithms and parameter settings may still be updated prior to the running of the final annual 2002 base case simulation and subsequent model performance testing.

The NCDAQ modeling team will remain in close contact with the VISTAS, as well as other Regional Planning Organization (RPO) regional modeling initiatives throughout the attainment demonstration modeling study, to determine appropriate refinements to the model codes, input databases, and post-modeling analysis procedures. Notable limitations of the models, relevant to their intended purpose in this attainment modeling analysis, will also be evaluated in detail.

4.1. Recommended Models

Based on extensive research of available documentation of the VISTAS Regional Haze modeling analysis, it has been determined by the NCDAQ that the $PM_{2.5}$ attainment demonstration omodeling should utilize the following suite of models:

- **MM5:** The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5) is a nonhydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate matter, and regional haze regulatory modeling studies.

- **SMOKE**: The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad mobile, area, point, fire, and biogenic emission sources for photochemical grid models.

- **CMAQ:** The USEPA's Models-3/ Community Multiscale Air Quality (CMAQ) modeling system is a "One-Atmosphere" photochemical grid model capable of addressing ozone, fine particulate matter, visibility, and acid deposition at regional scale for periods up to one year.

4.2. MM5 – Mesoscale Prognostic Model

Over the past decade, researchers at the Pennsylvania State University (PSU) and the National Center for Atmospheric Research (NCAR) have collaborated in the refinement and extension of the PSU Mesoscale Meteorological Model leading to the current version of the system, MM5 (version 3.6, MPP). Originally developed in the 1970s at PSU and first documented by Anthes and Warner (1978), the MM5 modeling system has maintained its status as a state-of-the-science model through enhancements provided by a broad user community (e.g., Chen and Dudhia, 2001; Stauffer and Seaman, 1990, 1991; Xiu and Pleim, 2000). The MM5 modeling system is routinely employed in forecasting projects as well as refined investigations of severe weather. Utilization of MM5 within air quality applications is also a common practice. In recent years, the MM5 modeling system has been successfully applied in continental scale annual simulations for the years 1996 (Olerud et al., 2000), 2001 (McNally and Tesche, 2003), and 2002 (Johnson, 2003). Due to its ongoing scientific development worldwide, extensive historical applications, broad user community support, public availability, and established performance record compared with other applications-oriented prognostic models, MM5 has been selected as the preferred meteorological model for this effort. This section provides an overview of the MM5 and its data input requirements.

4.2.1. MM5 Overview

The non-hydrostatic MM5 model (Dudhia, 1993; Grell et al., 1994) is a three-dimensional, limited-area, primitive equation, prognostic model that has been used widely in regional air quality model applications (Seaman, 2000). The basic model has been under continuous development, improvement, testing, and has been openly peer-reviewed for more than 20 years (Anthes and Warner, 1978; Anthes et al., 1987). It has been used world-wide by hundreds of scientists for a variety of mesoscale studies, including cyclogenesis, polar lows, cold-air damming, coastal fronts, severe thunderstorms, tropical storms, subtropical easterly jets, mesoscale convective complexes, desert mixed layers, urban-scale modeling, air quality studies, frontal weather, lake-effect snows, sea-breezes, orographically induced flows, and operational mesoscale forecasting.

MM5 is based on the prognostic equations for three-dimensional wind components (u – zonal wind component, v – meridional wind component, and w – vertical wind component), temperature, water vapor mixing ratio, and the perturbation pressure. Use of a constant reference-state pressure increases the accuracy of the calculations near steep terrain. The model uses an efficient semi-implicit temporal integration scheme and has a nested-grid capability that can use up to ten different domains of arbitrary horizontal and vertical resolution. The interfaces of the nested grids can be either one-way or two-way interactive. The model is also capable of using a hydrostatic option, if desired, for coarse-grid applications.

MM5 uses a terrain-following non-dimensionalized pressure, or "sigma," vertical coordinate similar to that used in many operational and research models. In the non-hydrostatic MM5 (Dudhia, 1993), the sigma levels are defined according to the initial hydrostatically-balanced reference state so that the sigma levels are also time-invariant. The gridded meteorological fields produced by MM5 are directly compatible with the input requirements of "one atmosphere" air-quality models using this coordinate (e.g., CMAQ). MM5 fields can be easily used in other regional air quality models with different coordinate systems (e.g., Comprehensive Air Quality Model with Extensions - CAMx) by performing a vertical interpolation, followed by a mass-conservation re-adjustment.

Distinct planetary boundary layer (PBL) parameterizations are available for air-quality applications, both of which represent sub-grid-scale turbulent fluxes of heat, moisture and momentum. These parameterizations employ various surface energy budget equations to estimate ground temperature based on the insolation, atmospheric path length, water vapor, cloud cover, and longwave radiation. The surface physical properties of albedo, roughness length, moisture availability, emissivity and thermal inertia are defined as functions of land-use for numerous categories via a look-up table. One scheme uses a first-order eddy diffusivity formulation for stable and neutral environments and a modified first-order scheme for unstable regimes. The other scheme uses a prognostic equation for the second-order turbulent kinetic energy while diagnosing the other key boundary layer terms.

Initial and lateral boundary conditions are specified from mesoscale three-dimensional analyses performed at 12-hour intervals on the outermost grid mesh selected by the user. Additional surface fields are analyzed at three-hour intervals. A Cressman-based technique is used to analyze standard surface and radiosonde observations, using the National Meteorological Center's (NMC) spectral analysis as a first guess. The lateral boundary data are introduced into MM5 using a relaxation technique applied in the outermost five rows and columns of the most coarse grid domain.

A major feature of the MM5 is its use of state-of-science methods for Four Dimensional Data Assimilation (FDDA). The theory underlying this approach and details on how it has been applied in a variety of applications throughout the country are described in depth elsewhere (Stauffer and Seaman, 1990, 1991; Seaman et al., 1992, 1997). Results of detailed performance evaluations of the MM5 modeling system in regulatory air quality application studies have been widely reported in the literature (e.g., Emery et al., 1999; Tesche et al., 2000, 2003), and many studies have involved comparisons with other prognostic models such as the Regional Atmospheric Modeling System (RAMS) and the Systems Application International Mesoscale Model. The MM5 enjoys a far richer application history in regulatory modeling studies compared with RAMS or other models. Furthermore, in evaluations of these models in over 60 recent regional scale air quality application studies since 1995, it has generally been found that the MM5 model tends to produce somewhat better photochemical model inputs than alternative models. For these and other reasons set forth in the MM5 modeling protocol developed by the contractor performing the meteorological modeling, Barons Advanced Meteorological Systems, LLC (BAMS) (Olerud and Sims, 2003), MM5 was selected as the meteorological modeling system for this study.

4.2.2. MM5 Configuration

Based on the extensive sensitivity testing carried out by Olerud and Sims (2003), the MM5 (version 3.6, MMP) configuration to be used by BAMS modelers will consist of the following:

- Nested 36/12 kilometer (km) grids, with 34 vertical layers
- Two way nesting, no feedback
- Initialization and boundary conditions from Eta analysis fields
- Pleim-Xiu (PX) soil model
- Asymmetric Convective Mixing (ACM) PBL model
- Kain-Fritsch 2 cumulus parameterization
- Mixed phase (Reisner 1) cloud microphysics
- Rapid Radiative Transfer Model radiation
- Snow effect turned on
- ETA model sea surface temperature
- 24-category United States Geological Survey (USGS) vegetation datasets
- Thermal roughness by the Garratt method

- Standard FDDA analysis nudging on 36-km and 12-km grid nests

4.2.3. MM5 Evaluation

The MM5 modeling results will be evaluated using plots and statistical analyses to determine if the model performance is adequate for the air quality modeling exercise. Some of the plots and statistics to be generated include:

- Spatial plots of model predictions with the appropriate observations overlaid. These will provide a visual to determine how well such meteorological parameters as temperature, mixing ratios, and winds are being captured by the model.

- Graphical statistical plots for surface temperature, mixing ratio, wind speeds, wind direction, and cloud cover. These will include time series of modeled/observed means, bias/error, and index of agreement.

- Daily accumulated precipitation plots of modeled versus observed.

- Tabular statistics for temperature, winds, mixing ratio, and cloud cover for various domains.

- Comparison of satellite versus modeled cloud images.

- Comparison of surface analysis maps to the MM5 pressure/wind maps

- Comparison of profiler observations with modeled winds

4.2.4. Meteorological Data

Meteorological data are being generated using the MM5 prognostic meteorological model by BAMS. BAMS is operating the MM5 at 5-day increments for 2002 on the 36-km and 12-km grid with a 14-day spin up period for the end of December 2001. The meteorological observations to be used for statistics come primarily from University Corporation for Atmospheric Research's (UCAR's) ds472.0 archive. These data are quality controlled and converted to NetCDF format, thus allowing the data to be visualized on the model fields via Package for Analysis and Visualization of Environmental data (PAVE). Due to the unreliability in precipitation values in the UCAR dataset, precipitation statistics are calculated from the 24-hour gridded accumulations available from the Climate Prediction Center (CPC). However, these fields undergo grid transformation to match our 36-km and 12-km domains from their original 0.25- degree resolution. The statistics are only calculated over cells that MM5 deems to be land since the CPC analyses are derived primarily from rain gauges.

For aloft analyses, standard sounding observations from the National Center for Environmental Predictions (NCEP) ds353.4 archive are processed. These observations are quality controlled and used to produce model/observation skewT sounding plots for selected sites. Additionally, the observations are integrated into sigma levels that match the MM5 specifications and subsequently can be statistically analyzed for performance at sigma levels 9, 17, and 22 (~500m, ~1600m, ~3400m, respectively). Qualitative profiler plots showing model/observed hourly winds are also created based upon the data stored at the Forecast Systems Lab.

4.3. SMOKE Emissions Modeling System

The SMOKE Emissions Processing System Prototype was originally developed at the Micro-computing Center of North Carolina (Coats, 1995; Houyoux and Vukovich, 1999). As with most "emissions models," SMOKE is principally an *emission processing system* and not a true *emissions modeling system* in which emissions estimates are simulated from "first principles." This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting emissions inventory data into the formatted emission files required by an air quality simulation model. For mobile sources, SMOKE actually simulates emissions rates based on input mobile-source activity data, emission factors and outputs from transportation travel-demand models.

SMOKE was originally designed to allow emissions data processing methods to utilize emergent high-performance-computing as applied to sparse-matrix algorithms. Indeed, SMOKE is the fastest emissions processing tool currently available to the air quality modeling community. The sparse matrix approach utilized throughout SMOKE permits both rapid and flexible processing of emissions data. The processing is rapid because SMOKE utilizes a series of matrix calculations instead of less efficient algorithms used in previous systems. The processing is flexible because the processing steps of temporal projection, controls, chemical speciation, temporal allocation, and spatial allocation have been separated into independent operations wherever possible. The results from these steps are merged together at a final stage of processing.

SMOKE supports area, mobile, fire and point source emission processing and includes biogenic emissions modeling through a rewrite of the Biogenic Emission Inventory System, version 3 (BEIS3). SMOKE has been available since 1996, and it has been used for emissions processing in a number of regional air quality modeling applications. In 1998 and 1999, SMOKE was redesigned and improved with the support of the USEPA for use with the USEPA's Models-3/CMAQ. The primary purposes of the SMOKE redesign were support of: (a) emissions processing with user-selected chemical mechanisms and (b) emissions processing for reactivity assessments.

SMOKE contains a number of major features that make it an attractive component of the modeling system (Seppanen, 2003). The model supports a variety of input formats from other emissions processing systems and models including the Inventory Data Analyzer (IDA), Emissions Modeling System – 2003 (EMS), and the Emissions Preprocessor System 2.x (EPS). It supports both gridded and county total land use scheme for biogenic emissions modeling. Although it is not necessary for our purposes, SMOKE can accommodate emissions files from up to 10 countries and any pollutant can be processed by the system.

Recent computational improvements to SMOKE include:

- Enhanced disk space requirements compared with other emissions processing software

- Run-time memory allocation, eliminating any need to recompile the programs for different inventories, grids, or chemical mechanisms
- Updated Input/Output Applications Programming Interface libraries

A number of science features have been incorporated into the latest version of SMOKE (version 2.0), including:

- Any chemical mechanism can be used to partition pollutants to model species, as long as the appropriate input data are supplied
- Integration with the MOBILE6.2 on-road mobile source emissions model including link based processing
- Support of plume-in-grid processing
- Integration of the BEIS3 emissions factors in SMOKE

Notable features of SMOKE from an applications standpoint include:

- Improved control strategy input formats and designs
- Control strategies can include changes in the reactivity of emitted pollutants, a useful capability, for example, when a solvent is changed in an industrial process
- No third party software is required to run SMOKE, although some input file preparation may require other software
- Integration with Models-3 file formats and settings
- Improved data file formats
- Support of various air quality model emissions input formats (e.g., CMAQ, MAQSIP, UAMIV, UAM-V, REMSAD and CAMx)
- Enhanced quality assurance pre- and post-processing
- Fully integrated with Models-3, which will provide the SMOKE Tool for SMOKE input file preparation
- Enhanced treatment of growth and control factors
- Improved emissions reporting and Quality Assurance (QA) capabilities
- Improved temporal allocation

The Carolina Environmental Program at the University of North Carolina is continuing model development activities with SMOKE. The emissions modeling will employ the SMOKE version 2.0, released on September 30, 2003. The SMOKE executables, scripts and databases may be downloaded through the Community Modeling and Analysis (CMAS) center's Model Clearinghouse.

4.4. CMAQ Modeling System

4.4.1. CMAQ Overview

For more than a decade, the USEPA has been developing the Models-3 CMAQ modeling system with the overarching aim of producing a "One-Atmosphere" air quality modeling system capable of addressing ozone, fine particulate matter, visibility and acid deposition within a common platform (Dennis et al., 1996; Byun et al., 1998a; Byun and Ching, 1999; Pleim et al., 2003). The original justification for the Models-3 development emerged from the challenges posed by the 1990 CAA as amended and the USEPA's desire to develop an advanced modeling framework for "holistic" environmental modeling utilizing state-of-science representations of atmospheric processes in a high performance computing environment (Ching et al., 1998). The USEPA completed the initial stage of development with Models-3 and released the CMAQ model in mid 1999 as the initial operating science model under the Models-3 framework (Byun et al., 1998b). The most recent rendition is CMAQ version 4.4, which was released in October 2004.

CMAQ consists of a core Chemical Transport Model (CTM) and several pre-processors including the Meteorological-Chemistry Interface Processor (MCIP), initial and boundary conditions processors (ICON and BCON), and a photolysis rates processor (JPROC). The USEPA is continuing to improve and develop new modules for the CMAQ model and typically provides a new release each year. In the past, the USEPA has also provided patches for CMAQ as errors are discovered and corrected. More recently, the USEPA has funded the CMAS center to support the coordination, update and distribution of the Models-3 system.

Another reason for choosing CMAQ as the atmospheric model is the ability to do one-atmospheric modeling. Since the NCDAQ will be using the same modeling exercise for both the ozone and $PM_{2.5}$ attainment demonstrations SIPs, as well as the regional haze SIP, having a model that can handle both ozone and fine particulate matter is essential. A number of features in CMAQ's theoretical formulation and technical implementation make the model well-suited for annual particulate matter modeling. In CMAQ, the model approach has been adapted to dynamically represent the particulate matter size distribution using three log-normal modes (two fine and one coarse). Transfer of mass between the aerosol and gas phases is assumed to be in equilibrium and all secondary aerosols (sulfate, nitrate, secondary organic aerosols) are assumed to be in the fine modes. The thermodynamics of inorganic aerosol composition are treated using the ISORROPIA module. Aerosol composition is coupled to mass transfer between the aerosol and gas phases. For aqueous phase chemistry, the Regional Acid Deposition Model (RADM) is currently employed. This scheme includes oxidation of SO_2 to sulfate by ozone, hydrogen peroxide, oxygen catalyzed by metals and radicals. The impact of clouds on the particulate matter size distribution is treated empirically. For wet deposition processes, CMAQ uses the RADM/Regional Particulate Model approach. Particle dry deposition is included as well. CMAQ contains three options for treating secondary organic aerosol (SOA), latest being the Secondary Organic Aerosol Model (SORGAM) that was updated in August 2003 to be a reversible semi-volatile scheme whereby VOC emissions can be converted to condensable gases that can then form SOA and then evaporate back into condensable gases depending on atmospheric conditions.

4.4.2. CMAQ Configuration

The NCDAQ proposes to run CMAQ (version 4.4). The model would be set up and exercised on a nested 36/12-km grid domain, employing one-way grid nesting. That is, boundary conditions for the 12-km grid simulation are extracted from the 36-km run using the CMAQ BCON processor. A total of 19 vertical layers would be implemented, extending up to a region top of 100 mb (approximately 15 km above ground level).

The Piecewise Parabolic Method advection solver would be used along with the spatially varying (Smagorinsky) horizontal diffusion approach and K-theory for vertical diffusion. MM5 meteorological output based on the Pleim-Xiu Land-Surface Model (LSM) and the ACM PBL scheme will be used, and the recently updated CMAQ MCIP2.3 would process the MM5 data using the "pass through" option. The Carbon Bond version 4 (CB4) gas-phase, RADM aqueous-phase, and AERO3/ISORROPIA aerosol chemistry schemes will be used. Treatment of reversible secondary organic aerosols would be simulated by the SORGAM implementation in CMAQ (version 4.4).

Testing completed with VISTAS evaluated three photochemical mechanisms: CB4, CB4-2002 and SAPRC99. CB4-2002 produced nearly identical results as CB4 but took much longer to run since it is only implemented in the slower SMVGEAR (Sparse Matrix Vectorized Gear) chemistry solver, compared to CB4 that is also implemented in the faster Euler Backward Iterative chemistry solver. Thus, CB4-2002 was dropped from consideration. Comparisons of CB4 and SAPRC99 found they produced mostly similar but different model performance. However, no one mechanism performed better than any other mechanism across all species, sites, and periods. The testing only evaluated the mechanism's base case performance, not their response to emission reductions. Given that CB4 runs twice as fast as SAPRC99, the CB4 mechanism was chosen for use.

4.4.3. Initial and Boundary Condition Data

The CMAQ default Initial Concentrations (ICs) will be used along with a ~15 day spin up period to eliminate any significant influence of the ICs. The CMAQ Boundary Conditions (BCs) for the initial simulations will be based on seasonal averages of 3-hour 2001 GEOS-CHEM global simulation model output. VISTAS and other RPOs are finding a 2002 GEOS-CHEM simulation that would be used to define days specific high time resolved (e.g., 3-hourly) CMAQ BCs.

4.5. Model Limitations

All mathematical models possess inherent limitations owing to the necessary simplifications and approximations made in formulating the governing equations, implementing them for numerical solution on fast computers, and in supplying them with input datasets and parameters that are themselves approximations of the full state of the atmosphere and emissions processes. The more important limitations of the various modeling systems to be employed are noted in this section.

4.5.1. MM5

Four different configurations of the MM5 LSM and PBL were evaluated. Depending on the meteorological variable (e.g., winds, temperature, moisture) and location (e.g., mountains, coastal, east, west) different LSM_PBL configurations performed better. The PX_ACM LSM_PBL configuration was selected because it was consistently near the top performing configuration in the southeastern United States across variables and locations and was never the worst-performing configuration. However, there are numerous limitations in the MM5 with the LSM and PBL treatment being some of the most important. The MM5 PX_ACM frequently predicts very low PBL heights that can appear as "holes" in the spatial distribution of PBL heights that do not appear physically realistic and may affect air quality modeling. Although the MM5 PX_ACM configuration model performance in the southeastern United States mostly met performance benchmarks, the performance was much worse in the western United States. Additionally, there is a stochastic component of real world meteorology that is not captured by MM5. For example, for some air pollution episodes stagnation is an important attribute that MM5 fails to simulate well as it tries to organize the flow fields. However, the MM5 model represents approximately 20 years of development by various researchers.

4.5.2. SMOKE

In early testing, a number of undocumented features of the SMOKE 1.5b version necessitated re-runs of the emissions processing software to overcome errors and/or ambiguities in source documentation and QA reporting. It is unclear whether similar conditions will be encountered with the SMOKE 2.0 release. As a full software release, rather than a "beta" version, SMOKE 2.0 is expected to be more robust and more fully-documented than the SMOKE 1.5b release. However, with any newly-released software system, there is the potential for errors and/or ambiguities to affect the emissions modeling schedule. Should problems arise or issues be encountered which would require additional SMOKE runs or potential SMOKE modifications or alternate modeling methods, the NCDAQ will immediately notify stakeholders and make recommendations for resolving the issues. Upon receipt of technical direction from the stakeholders, appropriate corrective action will be taken.

Features are continuing to be developed in the SMOKE emissions model. As it is not as mature as some other emission models (e.g., EMS, EPS, etc.), SMOKE does not include as many features. The NCDAQ will keep abreast of SMOKE development activities to identify new features that will assist in the emissions modeling.

4.5.3. CMAQ

Like all air quality models, a major limitation of CMAQ is the input for emissions, meteorological, and IC/BC data. Key science limitations in the model itself include the nitrate formation chemistry. Testing found the CMAQ nitrate performance suspect with winter overestimations and summer underestimations. Other science limitations in the current version of CMAQ include inadequate treatment of sea salt and the assumption that all secondary particulate matter is in the fine mode. Lack of any two-way grid nesting limits the ability of the model to properly resolve point source plumes or urban photochemistry. Other limitations of CMAQ include its computational requirements, such as the need for excessive disk space.

4.6. Model Input Requirements

Each of the modeling system components has significant database requirements. These data needs fall into two categories: those required for model setup and operation, and those required for model evaluation testing. The main input data base requirements for the meteorological, emissions, and air quality models are identified in the following section.

4.6.1. MM5

The databases required for setting up, exercising, and evaluating the MM5 model for the 2002 season consist of various fixed and variable inputs.

- Topography: High resolution (e.g., 30 sec to 5 min) topographic information derived from the Geophysical Data Center global datasets from the NCAR terrain databases are available for prescribing terrain elevations throughout the 36-km and 12-km grid domain.

- Vegetation Type and Land Use: Vegetation type and land use information on the 36-km grid may be developed using the PSU/NCAR 10 min. (~18.5 km) databases while for the 12-km grids, the USGS data are available.

- Atmospheric Data: Initial and boundary conditions to the MM5 may be developed from operationally analyzed fields derived from the NCEP ETA (40 km resolution) following the procedures outlined by Stauffer and Seaman (1990). These 3-hr synoptic-scale initialization data include the horizontal wind components (u and v), temperature, and relative humidity at the standard pressure levels, plus sea-level pressure and ground temperature. Here, ground temperature represents surface temperature over land and sea-surface temperature over water.

- Water Temperature: Water temperatures required on both 36-km and 12-km grids can be derived from the ETA skin temperature variable. These temperatures are bi-linearly interpolated to each model domain and, where necessary, filtered to smooth out irregularities.

- Clouds and Precipitation: While the non-hydrostatic MM5 treats cloud formation and precipitation directly through explicit, resolved-scale, and parameterized sub-grid scale processes, the model does not require precipitation or cloud input. The potential for precipitation and cloud formation enters through the thermodynamic and cloud processes formulations in the model. The only precipitation-related input required is the initial mixing ratio field that is developed from the National Weather Service (NWS) and NMC datasets previously discussed.

- Multi-Scale FDDA: The standard "multi-scale" data assimilation strategy to be used on the 36-km and 12-km grids will objectively analyze three-dimensional fields produced every 3 hours from the NWS rawinsonde wind, temperature, and mixing ratio data, and similar analyses are generated every three hours from the available NWS surface data.

4.6.2. SMOKE

The databases required to set up and operate SMOKE are as follows:

- Area source emissions in IDA format
- Off-road mobile source emissions in IDA format
- Stationary point source emissions in IDA format
- Utility emissions
    - Continuous Emissions Monitoring (CEM) emissions, day specific for actual 2002
    - 5-year average CEM emissions, day specific for typical 2002
    - Based on Integrated Planning Model (IPM) modeling for future year

- Wildfire emissions
    - Day specific for actual 2002
    - Multi-year average for typical year 2002 and future year
- On-road motor vehicle activity data
- MOBILE6.2 input parameters

Also required for annual modeling are data files specific for:

- Temporal allocation
- Spatial allocation
- Speciation

4.6.3. CMAQ

The CMAQ CTM requires the following inputs:

- Three-dimensional hourly meteorological fields that will be generated by the CMAQ MCIP2.3 processing of the BAMS MM5 output
- Three-dimensional hourly emissions generated by SMOKE
- Initial conditions and boundary conditions
- Topographic information
- Land use categories
- Photolysis rates generated by the CMAQ JPROC processor

5.0 Grid Specifications and Modeling Domains

This chapter summarizes the model domain definitions including the model domain, resolution, map projections and nesting schemes for high resolution sub-domains.

5.1. Horizontal Modeling Domain

A coarse grid continental United States domain with a 36-km horizontal grid resolution will be used as the outer grid domain for MM5 modeling. The CMAQ domain is nested within the MM5 36-km domain. Figure 5.1-1 shows the MM5 horizontal domain as the outer most, blue grid with the CMAQ 36-km domain nested in the MM5 domain. To achieve finer spatial resolution in the VISTAS states, the NCDAQ will also use a one-way nested high resolution grid with a 12-km grid resolution. Figure 5.1-2 shows the 36-km CMAQ continental grid and the high resolution, nested 12-km grid in the VISTAS states. Figure 5.1-3 shows in more detail the 12-km grid for the VISTAS region.

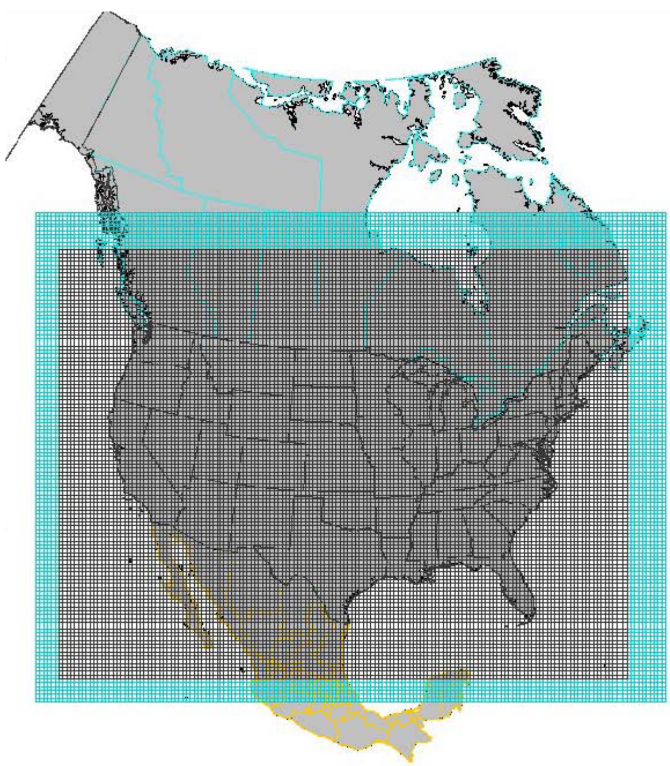

Figure 5.1-1: The MM5 horizontal domain is the outer most, blue grid, with the CMAQ 36-km domain nested in the MM5 domain.

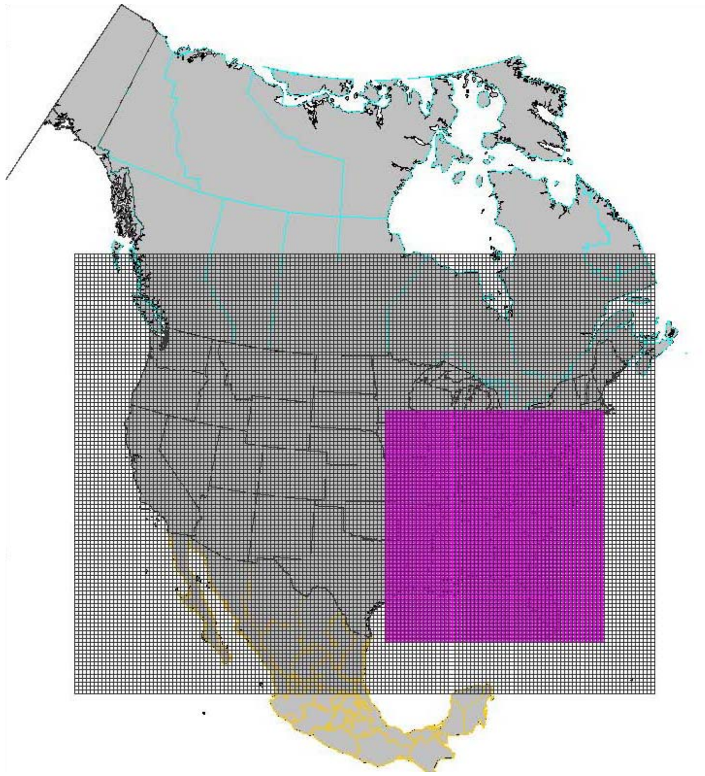

Figure 5.1-2: The 36-km CMAQ continental grid and the high resolution, nested 12-km grid over the VISTAS states.

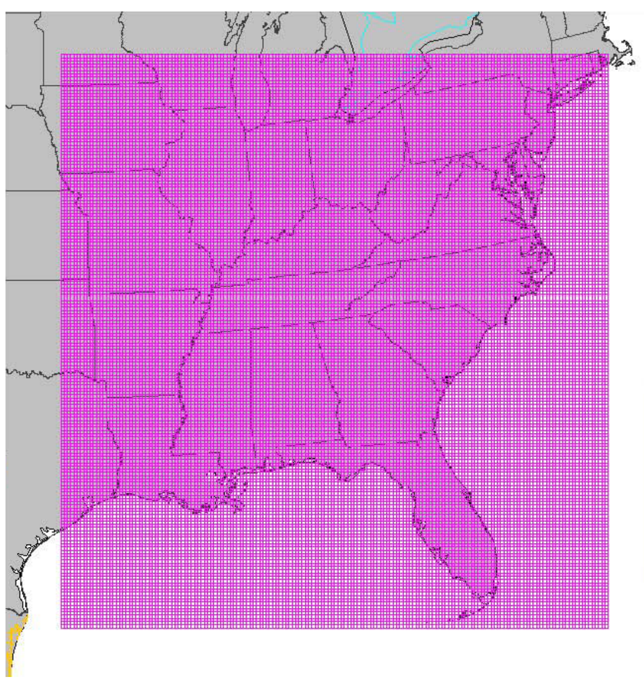

Figure 5.1-3: A more detailed view of the 12-km grid over the VISTAS region.

Both MM5 and CMAQ employ the RPO unified grid definition for the 36-km continental domain. The RPO unified grid consists of a Lambert-Conformal map projection using the map projections parameters listed in Table 5.1-1.

Table 5.1-1: RPO Unified Grid Definition.

PARAMETER	VALUE
projection	Lambert-conformal
1st true latitude (alpha)	33 degrees
2nd true latitude (beta)	45 degrees
x center	- 97 degrees
y center	40 degrees

The MM5 36-km grid includes 164 cells in the east-west dimension by 128 cells in the north-south dimension. The CMAQ 36-km grid includes 148 cells in the east-west dimension and 112 cells in the north-south dimension. Since the MM5 coarse grid is also nested in the Eta grid, there is a possibility of boundary effects near the MM5 boundary that occur as the Eta meteorological variables are being simulated by MM5 and must come into dynamic balance with MM5's algorithms. Thus, a larger MM5 domain was selected to provide a buffer of eight to nine grid cells around each boundary of the CMAQ 36-km domain. This is designed to eliminate any errors in the meteorology from boundary effects in the MM5 simulation at the interface of the MM5 and Eta grids. The buffer region used here exceeds the USEPA suggestion of at least five grid cell buffer at each boundary.

Table 5.1-2 lists the number of rows and columns and the definition of the X and Y origin (i.e., the southwest corner) for the 36-km and 12-km grids for both MM5 and CMAQ. Note that the CMAQ grid is rotated 90 degrees relative to the MM5 grid, so rows and columns are reversed. In Table 5.1-2 "Dot" refers to the grid mesh defined at the vertices of the grid cells while "cross" refers to the grid mesh defined by the grid cell centers. Thus, the dimension of the dot mesh is equal to the cross mesh plus one. Finally, note that the grid definition for the CMAQ MCIP and CMAQ Chemical Transport Model (CCTM) are identical.

Table 5.1-2: Grid Definitions for MM5 and CMAQ.

MODEL	COLUMNS DOT (CROSS)	ROWS DOT (CROSS)	XORIGIN	YORIGIN
MM5 36km	129 (128)	165 (164)	-2952000	-2304000
CMAQ 36km	149 (148)	113 (112)	-2736000	-2088000
MM5 12km	190 (189)	181 (180)	7200	-1656000
CMAQ 12km	169 (168)	178 (177)	108000	-1620000

5.2. Vertical Modeling Domain

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employed a terrain following coordinate system defined by pressure, using 34 layers that extend from the surface to the 100 mb. Table 5.2-1 lists the layer definitions for both MM5 and for CMAQ. A layer averaging scheme is adopted for CMAQ to reduce the computational cost of the CMAQ simulations. The effects of layer averaging were evaluated in conjunction with the VISTAS modeling effort and were found to have a relatively minor effect on the model performance metrics when both the 34-layer and a 19-layer CMAQ models were compared to ambient monitoring data.

Table 5.2-1: Vertical Layer Definition for MM5 Simulations (Left Most Columns), and Approach for Reducing CMAQ Layers by Collapsing Multiple MM5 Layers (Right Columns)

MM5					CMAQ 19L				
Layer	Sigma	Pres. (mb)	Height (m)	Depth (m)	Layer	Sigma	Pres .(mb)	Height (m)	Depth (m)
34	**0.000**	**100**	**14662**	**1841**	**19**	**0.000**	**100**	**14662**	**6536**
33	0.050	145	12822	1466		0.050	145		
32	0.100	190	11356	1228		0.100	190		
31	0.150	235	10127	1062		0.150	235		
30	0.200	280	9066	939		0.200	280		
29	**0.250**	**325**	**8127**	**843**	**18**	**0.250**	**325**	**8127**	**2966**
28	0.300	370	7284	767		0.300	370		
27	0.350	415	6517	704		0.350	415		
26	0.400	460	5812	652		0.400	460		
25	**0.450**	**505**	**5160**	**607**	**17**	**0.450**	**505**	**5160**	**1712**
24	0.500	550	4553	569		0.500	550		
23	0.550	595	3984	536		0.550	595		
22	**0.600**	**640**	**3448**	**506**	**16**	**0.600**	**640**	**3448**	**986**
21	0.650	685	2942	480		0.650	685		
20	**0.700**	**730**	**2462**	**367**	**15**	**0.700**	**730**	**2462**	**633**
19	0.740	766	2095	266		0.740	766		
18	**0.770**	**793**	**1828**	**259**	**14**	**0.770**	**793**	**1828**	**428**
17	0.800	820	1569	169		0.800	820		
16	**0.820**	**838**	**1400**	**166**	**13**	**0.820**	**838**	**1400**	**329**
15	0.840	856	1235	163		0.840	856		
14	**0.860**	**874**	**1071**	**160**	**12**	**0.860**	**874**	**1071**	**160**
13	0.880	892	911	158	**11**	**0.880**	**892**	**911**	**158**
12	**0.900**	**910**	**753**	**78**	**10**	**0.900**	**910**	**753**	**155**
11	0.910	919	675	77		0.910	919		
10	**0.920**	**928**	**598**	**77**	**9**	**0.920**	**928**	**598**	**153**
9	0.930	937	521	76		0.930	937		
8	**0.940**	**946**	**445**	**76**	**8**	**0.940**	**946**	**445**	**76**
7	**0.950**	**955**	**369**	**75**	**7**	**0.950**	**955**	**369**	**75**
6	**0.960**	**964**	**294**	**74**	**6**	**0.960**	**964**	**294**	**74**
5	**0.970**	**973**	**220**	**74**	**5**	**0.970**	**973**	**220**	**74**
4	**0.980**	**982**	**146**	**37**	**4**	**0.980**	**982**	**146**	**37**
3	**0.985**	**986.5**	**109**	**37**	**3**	**0.985**	**986.5**	**109**	**37**
2	**0.990**	**991**	**73**	**36**	**2**	**0.990**	**991**	**73**	**36**
1	**0.995**	**995.5**	**36**	**36**	**1**	**0.995**	**995.5**	**36**	**36**
0	**1.000**	**1000**	**0**	**0**	**0**	**1.000**	**1000**	**0**	**0**

6.0 Development of Emissions Inventories

There are five different emission inventory source classifications; stationary point sources area sources, off-road mobile sources, on-road mobile sources, and biogenic sources. Stationary point sources are those sources that emit greater than a specified tonnage per year and the data is provided at the facility level. Stationary area sources are those sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (i.e., dry cleaners, service stations, etc.) Off-road mobile sources are equipment that can move but do not use the roadways, i.e., lawn mowers, construction equipment, railroad locomotives, aircrafts, etc. On-road mobile sources are automobiles, trucks, and motorcycles that use the roadway system. Biogenic sources are emissions from natural sources, such as trees, crops, grasses and natural decay of plants.

Emission estimates for stationary point and area sources, as well as for off-road mobile sources are calculated and formatted for processing through the SMOKE emissions processing system, which formats the data into air quality model ready files. On-road mobile source emissions are estimated within the SMOKE system, which uses the USEPA's MOBILE6.2 model, with modeling meteorology and various mobile inputs. The biogenic emissions are also estimated within the SMOKE system, using the USEPA's BEIS model, with modeling meteorology.

In addition to the various source classifications, there are also various types of emission inventories. The first is the actual base year inventory. This inventory is the base year emissions that correspond to the meteorological data, for this modeling effort is 2002. These emissions are used for evaluating the air quality model performance.

The second type of inventory is the typical base year inventory. This inventory is similar to the actual base year, however for sources that may have significant changes from year to year a more typical emission value is used. In this modeling effort, typical emissions were developed for the electric generating units and the wildland fire emissions. The air quality modeling results using these emissions are used in calculating the relative reduction factors used in the attainment demonstration test.

The future year base inventory is an inventory developed for some future year for which attainment of the $PM_{2.5}$ standard is needed. For this modeling project, the future year inventory will be 2009, the last complete year for which the standard must be attained. It is the future year base inventory that control strategies and sensitivities are applied to determine what controls, to which source classifications, must be made in order to attain and maintain the $PM_{2.5}$ standard.

In the sections that follow, the inventories used for each source classifications are discussed.

6.1. Point Source Emissions

The point source emissions will be separated into electric generating units (EGU) and non-EGU categories. The reason for splitting the point source inventory is that the EGU sources account for the majority of the point source NO_x emissions and hour specific data is available for these sources through the USEPA's acid rain database. Using this more refined data will help improve the air quality modeling performance. Annual emissions will be used for the non-EGU sources.

All point sources will be spatially allocated in the domain based on the stationary source geographic coordinates. If a point source is missing its latitude/longitude coordinates, the source will be placed in the center of its respective county.

6.1.1. Electric Generating Units

Actual Base Year Inventory

For EGU sources with the USEPA reported 2002 CEM data or with 2002 hourly emissions provided by stakeholders, actual hourly data will be used. For the sources where the USEPA CEM data are utilized, NO_x, SO_2, and heat input-based hour-specific profiles were developed and applied to NO_x, SO_2, and all other emissions, respectively. The annual emission values that have been provided will be maintained, but will be distributed using hourly to annual profiles. For sources where hour-specific data was provided by stakeholders, this data will be substituted for the USEPA CEM-based emissions and distributions.

To temporally allocate the remaining EGU point sources, the NO_x, SO_2, and heat input data will be collected from the 2002 CEM datasets, and used to develop unit-level temporal distributions. The hourly, day of week, and monthly specific temporal profiles will be used in conjunction with the emissions inventory supplied emissions data to calculate hourly EGU emissions by unit.

Typical Base Year Inventory

Since the NO_x emissions from EGU sources are a significant part of the emissions inventory, a typical base year emissions inventory was developed for these sources to avoid anomalies in emissions due to variability in meteorology, economic and outage factors in 2002. This approach is consistent with the USEPA's modeling guidance.

To develop a typical year 2002 emissions inventory for EGU sources, for each unit the average CEM heat input for 2000 through 2004 was divided by the 2002 actual heat input to generate a unit specific normalizing factor. This normalizing factor was then multiplied by the 2002 actual emissions. The heat inputs for the period 2000 through 2004 were used since the modeling current design values use monitoring data from this same 5-year period.

If a unit was shutdown for an entire year during the 2000 through 2004 period, the average of the years the unit was operational was used. If a unit was shutdown in 2002, but not permanently shutdown, the emissions and heat inputs 2001 (or 2000) were used in the normalizing calculations.

Future Base Year Inventory

As part of the VISTAS modeling, VISTAS and the Midwest Regional Planning Organization (MRPO) contracted with ICF Resources, L.L.C., to generate future year emission inventory for the electric generating sector of the contiguous United States using the IPM. IPM is a dynamic linear optimization model that can be used to examine air pollution control policies for various pollutants throughout the contiguous United States for the entire electric power system. The dynamic nature of IPM enables the projection of the behavior of the power system over a specified future period. The optimization logic determines the least-cost means of meeting electric generation and capacity requirements while complying with specified constraints including air pollution regulations, transmission bottlenecks, and plant-specific operational constraints. The versatility of IPM allows users to specify which constraints to exercise and populate IPM with their own datasets.

Since the modeling is based on the USEPA's prior analyses for which detailed public documentation is available, a summary of only the incremental changes that were proposed by VISTAS and MRPO as part of this analysis are presented here.

The VISTAS analysis is based on the USEPA modeling applications using IPM (V.2.1.6). As per the analytical needs of VISTAS and MRPO, the following changes were made to the underlying assumptions in the USEPA Base Case (V2.1.6):

i) The underlying database in the VISTAS analysis is the USEPA's National Electric Energy Data System Database, with changes based upon the comments and technical directions from VISTAS and MRPO's stakeholders. The changes focused on existing installations of NO_x, SO_2 and particulate matter controls, NO_x emission rates, SO_2 emission limits, capacity of existing units, heat rate and unit identifications of selected units in the VISTAS and MRPO regions.

ii) The analysis covers the period between 2007 and 2030. To make the model size and run time tractable, IPM is run for a number of selected years within the study horizon known as run years. Each run year represents several calendar years in the study horizon, and all calendar years within the study horizon are mapped to their representative run years. Although results are only reported for the run years, IPM takes into account all years in the study horizon while developing the projections.

iii) The Duke Power and Progress Energy control technology investment strategies for complying with North Carolina's Clean Smokestacks Rule were explicitly hardwired in the analysis.

iv) The USEPA's Clean Air Interstate Rule (CAIR) rule implemented as part of this analysis is broadly consistent with the USEPA 40 CFR Parts 51 et. al., Supplemental Proposal for the Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone, proposed on June 10, 2004. Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, Wisconsin are the states affected by the CAIR SO_2 and the CAIR annual NO_x policies starting 2010. Connecticut is affected by an ozone season NO_x policy. The CAIR plants affected by the annual NO_x policy are capped at 1.6 million tons starting 2010 and 1.33 million tons starting 2015. The power plants affected by the CAIR SO_2 policy have to surrender two Title IV SO_2 allowances for every ton of SO_2 emitted starting 2010 and three Title IV SO_2 allowances for every ton of SO_2 emitted starting 2015.

6.1.2. Non-Electric Generating Units

2002 Base Year Inventory

For the non-EGU sources, the same inventory will be used for both the actual and typical base year emissions inventories. The non-EGU category will use annual emissions, which will be temporally allocated to month, day, and hour using source category code (SCC) based allocation factors. These factors will be based on the cross-reference and profile data supplied with the SMOKE 2.0 version.

The non-EGU sources annual emissions will be the 2002 VISTAS inventory based on the 2002 Consolidated Emissions Reporting Rule (CERR) submitted data for all states in the modeling domain unless a state or RPO provides updated data.

Future Year Base Inventory

The general approach for assembling future year data is to use recently updated growth and control data consistent with the USEPA's CAIR analyses, supplement these data with available stakeholder input, and provide the results for stakeholder review to ensure credibility. To assemble growth/control data needed for the final 2009 inventories, the VISTAS contractor will perform the following activities:

- Use the final 2002 VISTAS inventory as the starting point for the future base year inventory.
- Obtain, review, and apply the most current growth factors developed by the USEPA, based on forecasts from an updated Regional Economic Models, Inc. model (version 5.5) and the latest *Annual Energy Outlook* published by the Department of Energy.
- Obtain, review, and apply any State-specific or sector-specific growth factors submitted by stakeholders.
- Obtain information regarding sources that have shut down after 2002 and work with the states to determine if these sources should be removed from the future year inventory.
- Obtain, review, and apply control assumptions that are expected to be in place by 2009.

Controls Applied to the Non-EGU Inventory

1-hour Ozone SIP

Information about control programs for the 1-hour ozone nonattainment areas came from the report by E.H. Pechan and Associates entitled *VOC and NO_x Control Measures Adopted by States and Nonattainment Areas for 1999 NEI Base Case Emissions Projection Calculations*. The report identified and compiled a listing of the VOC and NO_x control measure programs expected to be implemented after 1999, as well as an estimate of their influence on projected emissions. Five nonattainment areas in the VISTAS region were included: Atlanta, Birmingham, metro Washington DC (including several counties in Virginia), Louisville, and northern Kentucky.

Emission reductions requirements from NO_x Reasonably Available Control Technology (RACT) in 1-hour Ozone SIP areas were implemented prior to 1999. These reductions should already be accounted for in the VISTAS 2002 inventory since the 2002 inventory was based on 2002 actual emissions submitted by the States.

NO_x SIP Call

For non-EGU sources, Phase I of the NO_x SIP call applies to large industrial boilers and turbines, and cement kilns. States in the VISTAS region affected by the NO_x SIP call have developed rules for the control of NO_x emissions that have been approved by the USEPA. The VISTAS contractor has reviewed the available state rules and guidance documents to determine the affected sources and ozone season allowances.

For the sources within North Carolina, the NCDAQ has decided to use the 2007 emission allowances for the 2009 future year inventory. The allowances are given in terms of tons per ozone season (the five month period from May to September). To calculate annual emissions, the capped allowances were multiplied by a factor of 12/5.

The Phase II rule applies to large internal combustion engines, which are primarily used in pipeline transmission service at compressor stations. The NCDAQ has established emissions caps for three facilities affected by the Phase II NO_x SIP call rule and will apply these caps to the future year inventory.

For the other states in the VISTAS region, affected units were identified using the same methodology as was used by the USEPA in the proposed Phase II rule (i.e., a large internal combustion engine is one that emitted, on average, more than 1 ton per day during 2002). The final rule reflects a control level of 82 percent for natural gas-fired internal combustion engines and 90 percent for diesel or dual fuel categories. Therefore, these control levels were applied to the identified sources.

Maximum Achievable Control Technology Regulations

The USEPA anticipates reductions in particulate matter and SO_2 as a result of the Industrial Boiler/Process Heater Maximum Achievable Control Technology (MACT) standard. The methods used to account for these reductions are the same as those used for the Interstate Air Quality Transport Rule. Since the attainment demonstration is utilizing one atmosphere modeling, the reductions for these pollutants were accounted for.

MACT requirements were also applied, as documented in the USEPA report entitled *Control Packet Development and Data Sources,* dated July 14, 2004. The point source MACTs and associated emission reductions were designed from Federal Register notices and discussions with the USEPA's Emission Standards Division staff. Emission reductions will be applied only for MACT standards with an initial compliance date of 2002 or greater, since effects from MACT with earlier compliance dates should already be accounted for in the 2002 base year inventory.

The future year base inventory does not include the NO_x co-benefit effects of the Gas Turbines or stationary Reciprocating Internal Combustion Engines MACT regulations, which the USEPA estimates to be small compared to the overall inventory.

Petroleum Refinery Initiative

Three refineries in the VISTAS region are affected by two October 2003 Clean Air Act settlements under the USEPA Petroleum Refinery Initiative. The refineries are: (1) the Chevron refinery in Pascagoula, Mississippi; (2) the Ergon refinery in Vicksburg, Mississippi; and (3) the Ergon refinery in Newell, West Virginia. Although these sources are not within North Carolina or South Carolina, the expected emission reductions will be accounted for in the 2009 modeling.

NO_x RACT in 8-hour Ozone SIP

The NCDAQ will make every effort to include NO_x RACT controls for 8-hour ozone nonattainment areas in the VISTAS region. However, since cost is a factor of consideration in a RACT determination, it may not be known at the time of the final modeling which sources will be subject to actual controls.

Clean Air Interstate Rule

As stated in the preamble to the CAIR rule, the rule would not require or assume additional emission reductions from non-EGU boilers and turbines.

6.2. Stationary Area Source Emissions

Stationary area sources include sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (i.e., combustion of fuels for heating, structure fires, service stations, etc.). Emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such as fuel usage, number of household or population. Thus, a variety of activity level data is collected, including, United States Census economic data, forestry and agriculture agency data, and other data sources. Stationary area source emissions are estimated on the county level.

Actual Base Year Inventory

A portion of the area source 2002 base year inventory for North Carolina was developed by the NCDAQ and provided to the VISTAS contractor. The remaining portion of the area source inventory was calculated by the VISTAS contractor. The sources estimated by the contractor included emissions from animal husbandry, wildland fires, and particulate matter from paved and unpaved roads. For the other states within the modeling domain, the state supplied data or the CERR data was used.

Area source categories estimated by the NCDAQ were identified from a list in the USEPA guidance document EPA-450/4-91-016, *Procedures for the Preparation of Emission Inventories of Carbon Monoxide and Precursors of Ozone*, and from the Emission Inventory Improvement Program (EIIP) technical reports.

In general, emission factor estimation approaches were used to calculate area source emissions. Emission factors may be grouped as per capita emission factors; commodity consumption-related emission factors; and level-of-activity based emission factors. The emission factors were obtained from the *Procedures for the Preparation of Emission Inventories of Carbon Monoxide and Precursors of Ozone*, from the EIIP technical reports, or the USEPA's *AP-42, Compilation of Air Pollutant Emission Factors, Fifth Edition*.

The emissions from area sources were estimated by multiplying an emission factor by the appropriate indicator of collective activity for each source category within the inventory area. An indicator is any parameter associated with the activity level of a source that can be correlated with the air pollutant emissions from that source, such as fuel usage, number of households, or population. The values of these indicators are gathered from various sources (government reports, census, trade groups, employment data, direct surveys, etc.) as appropriate.

For the animal husbandry and fertilizer application emissions, the Carnegie Mellon University ammonia model was used. For paved and unpaved roads particulate matter emissions, emissions developed by the USEPA as part of their 2002 National Emissions Inventory development effort was used.

Windblown dust and sea salt emissions were not included in the inventory. These source categories are insignificant sources of particulate matter in North Carolina and therefore, do not significantly impact the $PM_{2.5}$ nonattainment issues and would not affect the $PM_{2.5}$ attainment modeling demonstration.

For wildland fires, i.e., wildfires and prescribed burns, monthly estimates of fire emissions, which include burn acreage and biomass loading information will be used. Depending on the completeness and quality of the data, attempts will be made to calculate spatial and temporal distributions of the fire emissions, rather than relying on standard distribution profiles. Data will be obtained through consultation with stakeholders that participate in the VISTAS Fire Special Interest Work Group. The fire data will be split into two groups, small fires estimated on a county level and treated as an area source; and large fires that will be treated as a point source.

Typical Base Year Inventory

The actual base year inventory will serve as the typical base year inventory for all area source categories except for wildland fires. For this source category, development of a typical year fire inventory provided the capability of using a comparable dataset for both the base year and future years. Thus, fire emissions would remain the same for air quality modeling in both the base and any future years. The VISTAS Fire Special Interest Work Group was consulted and decided to use State level ratios of acres over a longer term record (three or more years) developed for each fire type relative to 2002. The 2002 acreage was then scaled up or down based on these ratios to develop a typical year inventory.

Future Year Base Inventory

The VISTAS contractor generated the future base year emissions inventory used in the attainment demonstration modeling. The general approach used to calculate the future base year emissions for stationary area sources was as follows:

- Use the final 2002 VISTAS base year inventory as the starting point for the future base year inventory.
- Obtain any State specific growth factors and/or future controls from the States to use in developing the projections.
- Back calculate uncontrolled emissions for the 2002 base year inventory based on existing controls reported for the 2002 base year inventory.
- Controls (including control efficiency, rule effectiveness and rule penetration) provided by the States or originally developed for use in estimating projected emissions for the USEPA's Heavy Duty Diesel rulemaking emission projections and used in the CAIR projections were then used to calculate controlled emissions. State submitted controls had precedence over the USEPA developed controls.
- Growth factors supplied from the States or the USEPA's CAIR emission projections were then applied to project the controlled emissions to the appropriate year. In some cases, the USEPA's Economic Growth and Analysis System Version 5 growth factors were used if no growth factor was available from either the States or the CAIR growth factor files.

6.3. Non-Road Mobile Source Emissions

Non-road mobile sources are equipment that can move but do not use the roadways, such as construction equipment, aircraft, railroad locomotives, lawn and garden equipment, etc. For the non-road mobile source inventory, the list of sources to inventory came from the USEPA's NONROAD2005 model and the USEPA guidance document, *Procedures for Emission Inventory Preparation Volume IV: Mobile Sources*. For the majority of the non-road mobile sources, the emissions can be estimated using the USEPA's NONROAD model. For the three source categories not included in the NONROAD model, i.e., aircraft engines, railroad locomotives and commercial marine, more traditional methods of estimating the emissions were used.

2002 Base Year Inventory

For the non-road mobile sources, the same inventory will be used for both the actual and typical base year emissions inventories. All non-road mobile source emissions, except for aircraft engines, commercial marine vessels and railroad locomotives, were estimated using the USEPA NONROAD2005 model. This model predicts the emissions for non-road equipment based upon the year inputted into the model.

For railroad locomotive emissions, emission factors were supplied by the *Procedures for Emission Inventory Preparation Volume IV: Mobile Sources* document, which were then multiplied by a variety of different activity levels (i.e., gallons of fuel per county for railroad locomotive engines). Refinements could be made using information from *Development of*

Railroad Emission Inventory Methodologies (SR2004-06-02) from the Southeastern States Air Resource Managers, Inc.

Aircraft emissions at airports were calculated by VISTAS contractors using landing and take off data from Federal data sources. These will be reviewed and refined as appropriate for the Charlotte, Greensboro, and Raleigh-Durham airports. Emissions are calculated using the Federal Aviation Administration's (FAA's) Emissions and Dispersion Modeling System version 4.2, when there is sufficient detail to employ it.

Commercial marine emissions are estimated by procedures described in *Commercial Marine Activity for Deep Sea Ports in the United States (EPA420-R-99-020)*.

Future Base Year Inventory

For the source categories estimated using the USEPA NONROAD model, the model was used to create a future base year inventory. The NONROAD model takes into consideration rules that are in effect that could impact the emissions from these source categories. For the four largest airports in North Carolina, the FAA's Terminal Area Forecast will be used to project growth in aircraft emissions.

For the commercial marine, railroad locomotives and the remaining airport emissions, the VISTAS contractor will project the future base year emissions using the following guidelines:

- Use the final 2002 VISTAS inventory as the starting point for the future base year inventory.
- Detailed inventory data (both before and after controls) for 1996 and 2010 will be obtained from the USEPA's Clean Air Interstate Rule Technical Support Document. Straight-line interpolations between 1996 and 2010 will be used to create a combined growth and control factor. This is done at the State-County-SCC-Pollutant level of detail.
- Obtain, review and apply any State-specific growth factors submitted.
- Apply adjustments to account for additional emission reductions do the low sulfur non-road diesel fuels.

6.4. On-Road Mobile Source Emissions

Highway mobile sources are considered those vehicles that travel on the roadways and comprise over 30 percent of the NO_x emissions in North Carolina, and 42 percent of the NO_x emissions in South Carolina. Emissions from motor vehicles occur throughout the day while the vehicle is in motion, at idle, parked, and during refueling. Each of these emissions sources needs to be estimated in order to properly reflect the total emissions from this source category. In its simplest terms emissions from highway mobile sources are calculated by multiplying an activity level, in this case daily vehicle miles traveled (VMT) as provided by the North Carolina Department of Transportation (NCDOT), by an emission factor.

The USEPA developed the MOBILE model to estimate emission factors based on information on the way vehicles are driven in a particular area. The newest version of the MOBILE model, MOBILE6.2, will be used to develop the on-road mobile source emissions estimates for carbon monoxide (CO), NO_x, particulate matter, and VOC emissions. Key inputs for the MOBILE model include information on the age of vehicles on the roads, the average speed of those vehicles, what types of road those vehicles are traveling on, and any control programs (e.g., emissions inspection programs). Inputs are combined with gridded, day-specific temperature data to calculate the gridded, temporalized emission estimates. Of note, whereas the on-network emissions estimates are spatially allocated based on link location and subsequently summed to the grid cell level, the off-network emissions estimates are spatially allocated based on a combination of the Federal Highway Administration version 2.0 highway networks and population. For the North Carolina 36/12-km modeling, no link-based data will be used. The MOBILE6 emissions factors are based on day-specific temperatures predicted by the meteorological model.

6.4.1. Speed Assumptions

Emissions from motor vehicles vary with the manner in which the vehicle is operated. Vehicles traveling at 65 miles per hour (mph) emit a very different mix of pollutants than the car that is idling at a stoplight. The NCDAQ will collect hourly speeds per functional class for this modeling effort. Information from Travel Demand Models will be used where available.

6.4.2. Vehicle Age Distribution

The North Carolina vehicle age distribution comes from the NCDOT annual registration data. Both statewide and area specific registration data is provided. The only areas with "area specific" registration data include the Charlotte/Gastonia, Raleigh/Durham and Greensboro/ Winston-Salem areas. The latest available age distribution at the time of the modeling will be used.

6.4.3. Vehicle Mix Assumptions

The North Carolina statewide vehicle mix will be developed by the NCDAQ using the latest available, at the time of the modeling, Highway Performance Maintenance System count data. The raw data is converted into MOBILE6.2 format following the method outlined in the August 2004 guidance document *EPA420-R-04-013, Technical Guidance on the Use of MOBILE6.2 for Emissions Inventory Preparation*. For the Hickory and Triad nonattainment areas, local vehicle count data will be used to generate the vehicle mix for all road types except for urban and rural interstates. Local data is not available for the interstates; therefore, the State-wide mix data will be used.

Version 2 of the SMOKE model uses the MOBILE5 eight vehicle classification format for the vehicle mix. Therefore, the current vehicle mix format used by the NCDAQ had to be converted from the sixteen MOBILE6 vehicle classification format to correlate to the MOBILE5 eight vehicle classification system. This was done using the guidance provided by the USEPA.

6.4.4. Temperature Assumptions

MOBILE6 in the SMOKE emissions model uses the gridded (modeled) meteorology data to calculate temperature. Spatial and temporal temperature averaging will be implemented to minimize the SMOKE (mobile) run times.

6.4.5. Vehicle Inspection and Maintenance Program Assumptions

In the early 1990's, North Carolina adopted emissions inspection requirements for vehicles in nine urban counties. This program tests emissions at idle for 1975 and newer gasoline powered light and heavy duty vehicles. The program is a basic, decentralized tailpipe test for Hydrocarbons and CO only.

In 2002, North Carolina implemented a new vehicle emissions inspection program referred to as onboard diagnostics (OBDII). This program covers all light-duty gasoline powered vehicles that are model year 1996 and newer. The program was implemented in the original nine tailpipe test counties and expanded to a total of forty-eight counties by January 1, 2006. In addition, the idle test will be phased-out in 2006 in the original nine counties. In order to accurately reflect these OBDII tests, two separate programs must be incorporated into the 2002 input files. The implementation dates of each program are also included in the input files.

6.4.6. RVP Assumptions

Reid Vapor Pressure (RVP) reflects a gasoline's volatility. North Carolina has adopted the Phase II RVP of 7.8 psi during June-September as a control measure for the following counties: Davidson, Durham, Forsyth, Gaston, Guilford, Mecklenburg, Wake, Granville, and Davie. Lower RVP leads to lower VOC emissions from gasoline handling and lowers vapor losses from motor vehicles. The remaining areas have a RVP of 9.0 psi during June-September. For remaining months, RVPs are as follows:

- October RVP = 13.5 psi statewide
- November RVP = 13.5 psi statewide
- December RVP = 15 psi statewide
- January RVP = 15 psi statewide
- February RVP = 13.5 psi statewide
- March RVP = 13.5 psi statewide
- April RVP = 13.5 psi statewide
- May RVP = 9.0 psi statewide

6.4.7. VMT Assumptions

Mobile source emissions are calculated by multiplying emission factors by daily VMT. In this modeling exercise, the NCDAQ will use VMT from Travel Demand Models where available. For all other areas the VMT data will be provided by the NCDOT.

6.5. Biogenic Source Emissions

A revised version of a commonly used biogenic emissions model, the Biogenic Emissions Inventory System, has recently been developed and tested by the USEPA over two separate modeling domains/episodes. This version of the model (BEIS-3, v0.9) contains several changes over BEIS-2, including the following:

- Vegetation input data -- are now based on a 1-km Biogenic Emissions Landuse Database (BELD3) vegetation data base,
- Emission factors – many updates including some recent North American Research Strategy for Tropospheric Ozone (NARSTO) modifications,
- Environmental algorithm -- includes a sunlit/shaded leaf solar radiation model.

A series of sensitivity modeling simulations has been completed and concluded that the more recent BEIS-3 methodology will impact base case model ozone predictions in most parts of the United States. The preliminary tests have also shown that the newer biogenic emissions do not appear to have a large effect on: 1) the control signal response, 2) relative reduction factors resulting from a projected emissions change, or 3) overall regional model performance in the eastern United States.

For this particular application of BEIS-3, version 0.9 as currently incorporated in the SMOKE processor will be used. This means that: 1) soil nitric oxide (NO) emissions shall be prepared without the input of specific soil moisture and precipitation data and 2) methanol emissions will not be modeled explicitly. Otherwise, the modeling should be identical to a BEIS-3 (v1.0) application.

The BELD-3 landuse data on a Lambert conformal grid at 1-km resolution have already been developed, are available, and will be used to estimate biogenic emissions in this study. The BEIS model also requires as input hourly, gridded temperature and solar radiation data to estimate biogenic emissions, and these data will be derived from the MM5 predictions.

6.6. Development of Modeling Inventories

The SMOKE emissions model will be used to create the air quality model ready files. The chemical speciation method used is the CB4 mechanism. The gridding surrogates are based off the 2000 census data and are the most up to date available. The temporal profiles used to disaggregate the annual emissions to the appropriate month, day and hour are the latest available profiles provided with the SMOKE model with the exception of the EGU profiles, which will be developed based on CEM data.

For each model-ready emissions inventory, separate air quality model-ready files will be created for the EGU point sources, non-EGU point sources, area sources, dust, low-level fires, elevated fires, non-road mobile sources, on-road mobile sources, and biogenic emissions.

7.0 Quality Assurance Plan

This section discusses the QA procedures that will be used in the SIP modeling. The QA procedures listed here describe the combined efforts to be employed by VISTAS and the NCDAQ. The VISTAS contractors will perform QA on modeling inputs and outputs for the modeling region as a whole. The NCDAQ will perform QA on their respective emission inventories, as well as look at near state data for reasonableness. Additionally, the NCDAQ will review the modeling outputs for reasonableness.

7.1. Quality Assurance Objectives

In December 2002, the USEPA published extensive guidance on developing a Quality Assurance Project Plan (QAPP) for modeling studies (EPA, 2002). The objective of a QAPP is to ensure that a modeling study is scientifically sound, robust, and defensible. The new USEPA guidance suggests that a QAPP should include the following elements:

- A systematic planning process including identification of assessments and related performance criteria
- Peer reviewed theory and equations
- A carefully designed life-cycle development process that minimizes errors
- Clear documentation of assumptions, theory, and parameterization that is detailed enough so others can fully understand the model output
- Input data and parameters that are accurate and appropriate for the problem
- Output data that can be used to help inform decision-making
- Documentation of any changes from the original quality assurance plan

Moreover, the USEPA guidance specifies that different levels of QAPP may be required depending on the intended application of the model, with a modeling study designed for regulatory purposes requiring the highest level of quality assurance.

The QAPP also provides a valuable resource for project management. It can be used to document data sources and assumptions used in the modeling study, and it can be used to guide project personnel through the data processing and model application process to ensure that choices are consistent with the project objectives.

The guidance document also addresses model development, coding and selection of models, and model performance requirements. VISTAS/NCDAQ modeling are using an existing USEPA sponsored model hence our QAPP will focus primarily on documenting data sources and QA of data processing performed by the model team. The QA objectives for specific aspects of the project are discussed below, and these will be incorporated into a QAPP that conforms to the USEPA guidance document for modeling studies.

7.2. Emissions Model Inputs and Outputs

Emissions QA and Quality Control (QC) are the most critical steps in performing air quality modeling studies. Emissions processing can be time consuming and involves complex manipulation of many different types of large datasets. If errors are made and rigorous QA measures are not in place, these errors may remain undetected, resulting in delays and wasted time and resources.

7.2.1. VISTAS QA Effort

As part of the VISTAS QA effort, an "Emissions Gatekeeper" function will be implemented. The role of this Gatekeeper is to perform quality assurance activities on the following emissions inventory data:

- Emissions inventory data obtained from the VISTAS emissions inventory contractors

- The emission inventory to be used for modeling outside of the states in the VISTAS region.

Specifically, the Emissions Gatekeeper will review the content and format of the provided emission inventories, ensuring an appropriate appraisal of the emissions data and estimates for the VISTAS States. Other tasks will include any additional translation from mass emissions files into the emissions modeling input file structure necessary for modeling. The VISTAS Study Team will supplement these activities with QA checks on the intermediate and model output files using internal and public domain visualization and diagnostic packages.

This multistep emissions QA/QC approach includes the initial emissions QA/QC by the Emissions Gatekeeper described above, as well as QA/QC by the Emissions Modeler during the processing of emissions, and then additional QA/QC by the air quality modeler of the processed model ready emission files. This multistep process, with three separate groups involved in the QA/QC of the emissions, is much more likely to catch any errors prior to the air quality model simulations.

7.2.2. Emissions Modeling QA/QC

Modeling QA involves performing data quality checks, assuring simulation accuracy, and recognizing and identifying problems as they happen; it is the process of looking for glaring faults in the model input and output data (I/O) and determining whether the input data are producing the desired results. Scrutiny of the I/O using standard statistical analyses can reveal problems in the data and/or the model setup. Using a standard approach for analyzing emissions model I/O establishes reference points to use when scrutinizing the data. Seeking these indicators of correct model performance allows QA personnel to determine the accuracy of the simulations and whether faults in the data or model configuration exist.

QA documentation will include records of model configuration, details about data files, simulation records, and final report generation. After finishing each QA step, the modeler will record the result and his/her initials on a QA checklist.

Data formats will be confirmed using the SMOKE manual to check text files and using PAVE to check binary netCDF files, such as the meteorology inputs. Sanity checks look for glaring errors in the file contents and ensure that the data make sense in the context of how they will be used and relative to similar or reference datasets.

Lead modelers will oversee the entire modeling process, perform the majority of the SMOKE modeling, and receive and archive input and output data. Secondary modelers will perform some of the SMOKE modeling, organize the SMOKE QA reports into emissions summaries for data QA and reporting, and will generate custom QA summaries and reports for troubleshooting any problems encountered during the modeling process.

Outside reviewers will be solicited from outside the emissions modeling team on a volunteer basis to conduct periodic reviews/audits of the data and modeling process. Outside reviewers will consist of peers, co-workers not working directly on the inventory in question, state inventory contacts and stakeholders.

7.2.3. SMOKE Log Files

Each of the programs that make up SMOKE produces a log at run time. Stored in a single directory for each unique simulation, the logs contain information about the configuration of SMOKE, the names and locations of the input and output files used in the simulation, and any warnings, notes, or errors (collectively called "flags") that occurred during model execution. Generated as text files, the logs are named according to the program that created them and the emissions source modeled by the simulation, and the names include identifiers that distinguish the simulation from all others. The logs are usually the first source of information consulted in determining whether a simulation completed as expected or for troubleshooting suspected problems.

7.2.4. SMOKE QA Reports

Two types of QA reports are generated by SMOKE. One set is created by the program *Smkmerge* and the other by the program *Smkreport*. While both programs allow users to configure the content of the reports, *Smkreport* is a more powerful reporting program that was designed specifically as a QA tool. Controlled by configuration files, *Smkreport* can create text reports at every step in the emissions generation process. In addition to creating reports from information drawn from the intermediate SMOKE data matrices (e.g., the temporal matrix), *Smkreport* can summarize the amount of emissions assigned to different temporal, spatial, and chemical profiles; normalize emissions by population; and report the amount of emissions allocated to each vertical layer per model-hour. *Smkreport* also allows the targeted reporting of emissions at specific sources, plants, grid cells, or subdomains.

The program *Smkmerge* creates either state- or county-level reports at each of the major steps in the emissions generation process (spatial allocation, temporal allocation, chemical allocation or speciation, and merging). Although *Smkmerge* cannot create as many different report types as *Smkreport*, *Smkmerge* does have the ability to report biogenic emissions totals, whereas *Smkreport* can create reports only for anthropogenic emissions sources.

7.2.5. Visualization Tools

Visualization is an important part of the QA/QC procedure. Viewing bar charts and pie charts of the data verifies that more populous urban counties have greater emissions then the rural counties. Additionally, the PAVE visualization tool is used to graphically view the data to make sure that the data appears reasonable both spatially and temporally.

Visualization tools will be used to assist in the QA process for the emissions data both before and after being processed through the SMOKE emissions model. The air quality data will also employ visualization tools to view the modeling results to ensure that the modeling results look reasonable.

7.2.6. Document Tracking

In order to keep track of the details of modeling, certain notes and files will be maintained. Notes will be kept of files produced on desktop computers as to origin and purpose. These notes may be maintained in a logbook or by using the file properties summary tag available for files in the Windows operating system. Files in the workstation will be similarly tracked. It may be useful to maintain a log within directories for this purpose.

7.3. Meteorological Model Outputs

As part of the VISTAS QA effort, a "Meteorological Gatekeeper" will be tasked with providing an independent review and quality assurance of the meteorological modeling and related datasets developed by the VISTAS meteorological modeling contractor (BAMS) and used subsequently by the emissions and air quality modeling teams. This Gatekeeper QA review ensures that any potential problems with the datasets (should they exist) are identified and corrected in a timely manner. In the case of meteorology, the Gatekeeper's independent QA analysis of the MM5 meteorological datasets serves to provide direct assistance to the emissions and air quality modeling team as it undertakes to ratify the SMOKE model outputs and to diagnose CMAQ model performance and sensitivity analyses.

In addition to having personal responsibility for the quality and chain of custody of the meteorological datasets supplied by other VISTAS contractors, the Meteorological Gatekeeper will be responsible for ensuring and maintaining the integrity of the data files uploaded to the project website. This website, hosted by UCR (University California – Riverside), serves as the repository of data for the ENVIRON/UCR/Alpine modeling centers and for the VISTAS Technical Analysis Workgroup participants. In performing the Gatekeeper quality assurance activity, one of the first steps is to conduct an independent operational evaluation on the MM5 model results at 36-km and 12-km grid scale. This evaluation covers surface and aloft wind direction, temperature, mixing ratio, precipitation, and PBL depths on a continental scale (36-km) and subregional scale (12-km) basis.

The Gatekeeper will also perform supplemental, ad hoc analysis of pertinent MM5 fields (e.g., PBL depths) where that might be useful to the emissions and air quality modeling teams. Another task of the Gatekeeper will be to exercise MCIP version 2.3 to read the MM5 outputs from BAMS and produce binary input files for the CCTM to provide the complete set of parameters necessary in the emissions processing and air quality modeling.

In summary, the quality assurance plan for the meteorological data will include the following elements:

- Upon receiving the MM5 and MCIP 2.3 output files from BAMS, the NCDAQ will verify the integrity of the file transfer (i.e., no missing and/or corrupted files).

- Since the CMAQ modeling domain is a subset of the MM5 domain, the NCDAQ will verify that the modeling domain and vertical layer structures in the MCIP files are identical to the CMAQ modeling domain.
- Several days of the MM5 output will be selected and the meteorological modeling team will reprocess the MM5 files with MCIP v2.3 using the predetermined MCIP options. The MCIP files will then be compared with those provided by BAMS to verify that identical results from the MCIP processing were obtained.
- Horizontal and vertical plots of temperature, pressure, precipitation, modeled flow patterns, PBL heights, etc. will be created to assess whether the MCIP output fields are reasonable.
- The VISTAS 2002 MM5 simulation will be evaluated using the same surface observations, subdomains and procedures as used to evaluate the Western Regional Air Partnership 2002 MM5 simulation as an independent QA and evaluation of the database.
- Plots constructed by the VISTAS Gatekeeper will be made available on the VISTAS website for viewing and download (http://pah.cert.ucr.edu/vistas/vistas2/index.shtml).

7.4. Air Quality Model Inputs and Outputs

Key aspects of QA for the CMAQ input and output data include the following:

- Verification that correct configuration and science options are used in compiling and running each model of the CMAQ modeling system, where these include the MCIP, JPROC, ICON, BCON and the CCTM.
- Verification that correct input datasets are used when running each model.
- Evaluation of CCTM results to verify that model output is reasonable and consistent with general expectations.
- Processing of ambient monitoring data for use in the model performance evaluation.
- Evaluation of the CCTM results against concurrent observations.
- Backup and archiving of critical model input data.

The most critical element in the QA plan for CMAQ simulations is the QA/QC of the meteorological and emissions input files. The major QA issue specifically associated with the air quality model simulations is verification that the correct science options were specified in the model itself and that the correct input files were used when running the model. For the CMAQ model, a system of naming conventions was employed which uses environment variables in the compile and run scripts that guarantee that correct inputs and science options are used. A redundant naming system is also used so that the name of key science options or inputs is included in the name of CMAQ executable program, in the name of the CMAQ output files, and in the name of the directory in which the files are located. This is accomplished by using the environment variables in the scripts to specify the names and locations of key input files. For example, if a model simulation is performed using the CB4 mechanism, all compile and run scripts contain the variable definition "$MECH = CB4," and this variable is hard coded into the script for the executable name, the output file name, and the output directory name. This procedure produces long file/directory names but it effectively prevents mistakes or makes mistakes readily apparent if they do occur.

A second key QA procedure is to never "recycle" run scripts (i.e., the original runs scripts and directory structure that were used in performing a model simulation). For example, if a simulation is performed with the SAPRC mechanism, instead of editing the original scripts to specify "$MECH = SAPRC," a parallel directory structure with a new set of scripts to perform the SAPRC simulations will be created. This provides a permanent archive of the scripts that were used in performing model simulations. In addition, output from the model simulation will be directed to a log file that provides a record of input file names, warning messages, etc., that will be archived.

Post-processing QA of the CMAQ output files similar to that described for the emissions processing will be performed. Animated graphics interchange format (GIF) files using PAVE will be generated to search for unexpected patterns in the CMAQ output files. In the case of model sensitivity studies, the animated GIFs will be prepared as difference plots for the sensitivity case minus the base case. Often, errors in the emissions inputs can be discovered by viewing the animated GIFs. Finally, 24-hour average plots for each day of the CMAQ simulations will be produced. This provides a summary that can be useful for more quickly comparing various model simulations.

8.0 Model Performance Evaluation

The USEPA's April 2007 guidance document *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of the Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze* suggests that model performance be evaluated based on two components:

- How well the model is able to replicate observed concentrations of $PM_{2.5}$ components, ozone and/or precursors (surface and aloft), and
- How accurately the model characterizes the sensitivity of changes in ozone and/or $PM_{2.5}$ to changes in emissions.

Each component suggests a different type of evaluation procedure, with the first being "operational evaluation," and the second being "diagnostic evaluation." Since the attainment test is a relative test, it is not as necessary to exactly duplicate ozone concentrations. As a result, there is now more emphasis placed on the diagnostic model evaluation.

This section outlines the method used to evaluate model performance. Working with the knowledge that many states involved with the VISTAS regional haze work would want to apply some of the work to their individual SIPs for 8-hour ozone and $PM_{2.5}$, plans were put in place to perform exhaustive analysis of all atmospheric constituents, including ozone. The NCDAQ intends to build off the modeling efforts with VISTAS; therefore, the model performance evaluation will be an extension of VISTAS efforts.

8.1. Model Evaluation Tools (Operational Evaluation)

8.1.1. Statistical Performance Metrics

In compliance with the aforementioned USEPA guidance (EPA, 2007), VISTAS will compile a suite of metrics for use in evaluating model performance. The standard set of statistical performance measures suggested by the USEPA for evaluating $PM_{2.5}$ models includes: normalized bias, normalized gross (unsigned) error, fractional bias, fractional gross error, and fractional bias in standard deviations. Several other measures will be included in the final report to fulfill the requirements in the 8-hour ozone guidance (addition of average peak prediction accuracy), and to better accommodate other modeling groups with their comparison of modeling efforts. A list of metrics for calculation on a routine basis using the UCR analysis package is listed in Table 8.1-1. The metrics calculated in conjunction with VISTAS will include the examination of various atmospheric constituents, including the major components of $PM_{2.5}$.

Typically, the statistical metrics are calculated at each monitoring site across the full computational domain for all simulation days. During the VISTAS CMAQ evaluation, the gas-phase and aerosol statistical measures shown in Table 8.1-1 will be computed for the full 36-km and 12-km domains, as well as for the individual RPOs and on other subdomains as appropriate. Temporally, the statistical measures will be computed for the appropriate averaging times: 1 hr for ozone, and gas-phase precursors such as NO, nitrogen dioxide (NO_2), CO, SO_2, 8-hour for ozone, and 24-hour for sulfate, nitrate, $PM_{2.5}$, and other aerosol species. These results will then be averaged over annual, monthly, and seasonal periods for display, further analysis, and reporting. Should it become necessary as part of model performance diagnosis, the statistics will be aggregated in other ways, e.g., (a) day vs. night, (b) weekday vs. weekend, (c) precipitation vs. non-precipitation days, (d) month of the year, and (e) the 20% haziest/cleanest days, in order to help elucidate model performance problems. For the purposes of the Hickory/Triad $PM_{2.5}$ SIP, only the statistics for $PM_{2.5}$ and its component species will be reported. The statistics for the pollutants and precursors will be reviewed internally for reasonableness.

Table 8.1-1: Statistical Metrics

Statistical Measure	Shorthand Notation	Mathematical Expression	Notes
Accuracy of Paired Peak	A_p	$\frac{P - O_{peak}}{O_{peak}}$	
Coefficient of Determination	r^2	$\frac{\left[\sum_{i=1}^{N}\left(P_i - \overline{P}\right)\left(O_i - \overline{O}\right)\right]^2}{\sum_{i=1}^{N}(P_i - \overline{P})^2 \sum_{i=1}^{N}(O_i - \overline{O})^2}$	P_i= prediction at time and location i; O_i = observation at time and location i; $\overline{P}$ = arithmetic average of P_i, i = 1, 2, . . ., N; $\overline{O}$ = arithmetic average of O_i, i = 1, 2, . . ., N;
Normalized Mean Error	NME	$\frac{\sum_{i=1}^{N}\left\|P_i - O_i\right\|}{\sum_{i=1}^{N}O_i}$	Reported as %
Root Mean Square Error	RMSE	$\left[\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)^2\right]^{\frac{1}{2}}$	Reported as %
Fractional Gross Error	F_E	$\frac{2}{N}\sum_{i=1}^{N}\left\|\frac{P_i - O_i}{P_i + O_i}\right\|$	Reported as %
Mean Absolute Gross Error	MAGE	$\frac{1}{N}\sum_{i=1}^{N}\left\|P_i - O_i\right\|$	
Mean Normalized Gross Error	MNGE	$\frac{1}{N}\sum_{i=1}^{N}\frac{\left\|P_i - O_i\right\|}{O_i}$	Reported as %
Mean Biased	MB	$\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)$	Reported as concentration
Mean Normalized Bias	MNB	$\frac{1}{N}\sum_{i=1}^{N}\frac{(P_i - O_i)}{O_i}$	Reported as %
Mean Fractionalized Bias (Fractional Bias)	MFB	$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$	Reported as %

Table 8.1-1: Statistical Metrics (Continued)

Statistical Measure	Shorthand Notation	Mathematical Expression	Notes
Normalized Mean Bias	NMB	$\frac{\sum_{i=1}^{N}(P_i - O_i)}{\sum_{i=1}^{N} O_i}$	Reported as %
Bias Factor	BF	$\frac{1}{N}\sum_{i=1}^{N}\left(\frac{P_i}{O_i}\right)$	Reported as BF:1 or 1:BF or in fractional notation (BF/1 or 1/BF)

8.1.2. Graphical Representations

The core operational air quality model evaluation will utilize numerous graphical displays to facilitate quantitative and qualitative comparisons between CMAQ predictions and measurements. Together with the statistical metrics listed in Table 8.1-1, the graphical procedures are intended to help: (a) identify obviously flawed model simulations, (b) guide the implementation of any performance improvements in the 2002 model input files in a logical, defensible manner, and (c) to help elucidate the similarities and differences between the alternative CMAQ simulations. These graphical tools are intended to depict the model's ability to predict the observed gaseous species, such as ozone, and fine particulate species concentrations. The core graphical displays to be considered for use in model performance evaluation include the following:

- Spatial mean concentration time series plots
- Time series plots at monitoring locations
- Ground-level gas-phase and particulate concentration maps (i.e., tile plots)
- Concentration scatter plots stratified by station, by time, and by network
- Soccer and bugle plots
- Histogram plots of the statistical metrics, stratified by day, by pollutant, by subregion (e.g., 12-km vs. 36-km, by RPO), and by monitoring network
- Quantile - Quantile (Q-Q) plots
- Animations of predicted hourly pollutant concentrations

These graphical displays will be generated, where appropriate, for the full annual cycle as well as for monthly and seasonal periods.

8.2. Model Performance Testing (Diagnostic Evaluation)

Rarely does a modeling team find that the first simulation satisfactorily meets all (or even most) model performance expectations. Based on experience, initial simulations that "look very good" usually do so as the result of compensating errors. The norm is to engage in a logical, documented process of model performance improvement wherein a variety of diagnostic probing tools and sensitivity testing methods are used to identify, analyze, and then attempt to remove the causes of inadequate model performance. This is invariably the most technically-challenging and time consuming phase of a modeling study. The annual CMAQ model base case simulations are expected to present some performance challenges that may necessitate focused diagnostic and sensitivity testing in order for them to be resolved. It is hoped that these diagnostic and/or sensitivity tests can be adequately carried out within the resources and schedule. Where practical, diagnostic or sensitivity analyses, if needed, could be performed on selected episodes within the annual cycle, thereby avoiding the time-consuming task of running CMAQ for the full 2002 period. Below, the types of diagnostic and sensitivity testing methods that might be employed in diagnosing inadequate model performance and devising appropriate methods for improving the model response are identified.

8.2.1. Traditional Sensitivity Testing

Model sensitivity experiments are useful in three distinct phases, or "levels", of an air quality modeling study and all will be used as appropriate. These levels are:

- **Level I**: Model algorithm evaluation and configuration testing
- **Level II**: Model performance testing, uncertainty analysis and compensatory error diagnosis
- **Level III:** Investigation of model output response (e.g., ozone, aerosol, deposition) to changes in precursors as part of emissions control scenario analyses.

The Level I and Level II cover the aspect of operational evaluation, while Level III covers diagnostic evaluation.

The Level I sensitivity tests with CMAQ have already been completed in the initial VISTAS configuration and diagnostic analyses. However, given that open community nature of CMAQ and the frequent science updates to the model and supporting databases, it is possible that some additional configuration sensitivity testing will be necessary.

Potential Level II sensitivity analyses might be helpful in accomplishing the following tasks:

- To reveal internal inconsistencies in the model
- To provide a basis for compensatory error analysis
- To reveal the parameters (or inputs) that dominate (or do not dominate) the model's operation
- To reveal propagation of errors through the model
- To provide guidance for model refinement and data collection programs

The merits of performing Level II sensitivity testing will depend upon whether performance problems are encountered. In addition, the number of tests possible, should performance difficulties arise, will be limited by the available schedule and resources. From past experience with CMAQ and other models, it is possible to identify examples of sensitivity runs that could be useful in model performance improvement exercises with the annual 2002 CMAQ simulation. These include:

- Modified biogenic emissions estimates
- Modified on-road motor vehicle emissions
- Modified air quality model vertical grid structure
- Modified boundary conditions
- Modified fire emissions
- Modified EGU emissions
- Modified ammonia emission estimates
- Modified aerosol/Nitric Pentoxide/Nitric acid (HNO_3) chemistry
- Modified ammonia and HNO_3 deposition velocities

Note that in a few cases [e.g., vertical grid structure, ammonium (NH_4) emissions estimates], some sensitivity experimentation has already been carried out by VISTAS. To the extent that this information can help guide the future diagnostics analyses, this earlier work will be used.

Level III sensitivity analyses have two main purposes. First, they facilitate the emissions control scenario identification and evaluation processes. Currently, four complimentary sensitivity "tools" can be used in regional photochemical models depending upon the platform being used. These methods include: (a) traditional or "brute force" testing, (b) Decoupled Direct Method, (c) Ozone Source Apportionment Technology and Particulate Matter Source Apportionment Technology, and (d) Process Analysis. Each method has its strong points and they will be employed where needed. The second purpose of Level III sensitivity analyses is to help quantify the estimated reliability of the air quality model in simulating the atmosphere's response to significant emissions changes.

Examples of Level III monthly or annual sensitivity runs for Phase II might include:

- Ozone, sulfate, nitrate, ammonium and other aerosol sensitivities to SO_2 emissions
- Ozone, sulfate, nitrate, ammonium and other aerosol sensitivities to elevated point source NO_x emissions
- Ozone, sulfate, nitrate, ammonium and other aerosol sensitivities to ground level NO_x emissions
- Sulfate, nitrate, ammonium and other aerosol sensitivities to ammonia

The need to perform sensitivity experimentation (Levels I, II, or III) will depend on the outcome of operational performance evaluations. If such a need arises, the ability to actually carry out selected sensitivity and/or diagnostic experiments will hinge on the availability resources and sufficient time to carry out the analyses. Clearly, selection of the specific analysis method will depend upon the nature of the technical question(s) being addressed at the time.

8.3. Air Quality and Ozone Column Data

Data from ambient monitoring networks for both gas and aerosol species are used in the model performance evaluation. Table 8.3-1 summarizes ambient monitoring networks used to collect data for Air Quality model performance evaluation. Data have been compiled for all networks listed except the Photochemical Assessment Monitoring Stations (PAMS) and particulate matter Super-sites.

Additional data used in the air quality modeling include the Total Ozone Mapping Spectrometer (TOMS). TOMS data provides ozone column data, is available for 24-hour average, and is obtained from http://toms.gsfc.nasa.gov/eptoms/ep.html. The TOMS data is used in the CMAQ radiation model to calculate photolysis rates.

Table 8.3-1: Overview of Ambient Data Monitoring Networks.

Monitoring Network	Chemical Species Measured	Sampling Period	Data Availability/Source
The Interagency Monitoring of Protected Visual Environments (**IMPROVE**)	Speciated $PM_{2.5}$ and PM_{10} (see species mappings)	1 in 3 days; 24 hr average	http://vista.cira.colostate.edu/improve/Data/IMPROVE/improve_data.htm
Clean Air Status and Trends Network (**CASTNET**)	Speciated $PM_{2.5}$, Ozone (see species mappings)	Approximately 1-week average	http://www.epa.gov/castnet/data.html
National Atmospheric Deposition Program (**NADP**)	Wet deposition (hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium)), Mercury	1-week average	http://nadp.sws.uiuc.edu/
Air Quality System (**AQS**) Aka Aerometric Information Retrieval System (**AIRS**)	CO, NO_2, O_3, SO_2, $PM_{2.5}$, PM_{10}, Pb	Typically hourly average	http://www.epa.gov/air/data/
Speciation Trends Network (STN)	Speciated PM	24-hour average	http://www.epa.gov/ttn/amtic/amticpm.html
Southeastern Aerosol Research and Characterization (**SEARCH**)	24-hr $PM_{2.5}$ (FRM Mass, OC, BC, SO_4, NO_3, NH_4, Elem.); 24-hr PM coarse (SO_4, NO_3, NH_4, elements); Hourly $PM_{2.5}$ (Mass, SO_4, NO_3, NH_4, EC, TC); and Hourly gases (O_3, NO, NO_2, NO_y, HNO_3, SO_2, CO)	Hourly or 24hour average, depending on parameter.	Electric Power Research Institute (EPRI), Southern Company, and other companies. http://www.atmospheric-research.com
USEPA Particulate Matter Supersites	Speciated $PM_{2.5}$		http://www.epa.gov/ttn/amtic/supersites.html
Photochemical Assessment Monitoring Stations (**PAMS**)	Varies for each of 4 station types.		http://www.epa.gov/ttn/amtic/pamsmain.html
National Park Service Gaseous Pollutant Monitoring Network	Acid deposition (Dry; SO_4, NO_3, HNO_3, NH_4, SO_2), O_3, meteorological data	Hourly	http://www2.nature.nps.gov/ard/gas/netdata1.htm

9.0 Control Strategy

It is important to remember that photochemical models are tools; they do not make decisions. The results from photochemical models are one of several pieces of information that decision-makers must consider when adopting control strategies. To ensure that the modeling analyses provide information that meets the needs of the decision makers, it is imperative that the air quality modelers and decision makers agree upon the type and amount of information that is needed to meet the study objectives. This section outlines the process behind developing and evaluating emission control strategies to be employed for the $PM_{2.5}$ attainment demonstration.

9.1. Control Strategy Design

9.1.1. Emission Sensitivity Test

To begin the process of control strategy design a series of simulations using across-the-board reductions of direct $PM_{2.5}$ emissions and $PM_{2.5}$ precursors can be run. The purpose of these simulations is to evaluate the relative effectiveness of various pollutant reductions to help tailor effective control strategy measures.

Errors in emission estimates can lead to errors in control decisions. Important sources in future year inventories can be simulated at the lower and upper bounds of their estimated accuracy. In doing this, the NCDAQ can find out if changes, within the known accuracy of the emission estimates, can lead to different decisions for control strategies. Once the future year inventories are assembled, the sources with the highest uncertainty can be identified. These sources could include biogenic emissions, motor vehicle exhaust, and gasoline evaporation. VOC speciation profiles can also be included in these sensitivity tests.

9.1.2. Isopleth Construction

From the emissions sensitivity tests, isopleths relating uniform reductions of $PM_{2.5}$ precursor emissions to $PM_{2.5}$ formation can be constructed. These isopleths can give some insight into emission reduction goals, but are not designed to evaluate specific control strategies. They do not simulate real controls that change temporal and spatial distributions as well as the organic mix of species. With these limitations in mind, the isopleths can help design the control measures that may reduce levels close to ambient standards. If resources are available, a series of simulations covering a range of actual control measures will be run. These simulations can be used to design appropriate and defensible control strategies. In addition, isopleths of population exposure can be prepared and used to assess proposed control measures in an integrated manner.

9.1.3. Ranking Control Strategies

Control strategies should be implemented in an ordered fashion that reduces both $PM_{2.5}$ concentrations and population exposure. Emission controls that affect multiple pollutants should be sorted separately from single pollutant controls. Estimates of control levels that are expected in future years should be made. An attempt to reduce population exposure to a minimum each year while reducing $PM_{2.5}$, can be made by looking at all potentially available controls.

9.2. Control Strategy Evaluation

Selection of candidate control strategies will take into consideration the results of the combination of analyses described in the previous sections. Once candidate control strategies are identified, the strategies may be simulated. If needed, an analysis will be performed to investigate the predicted impact of each strategy on air quality and population exposure. The results of these analyses will be summarized both in tabular and graphical form to allow systematic comparison and contrast of all strategies.

To assist decision makers in fully understanding the impact of proposed control strategies, the following products may be prepared as a part of the control strategy evaluation:

1. Total $PM_{2.5}$ Spatial Plots
2. Difference Plots
3. Population Exposure Tables and Histograms
4. Change in predicted future design values

Each of these products will compare future year base simulations with one or more control simulations. An attempt should be made to minimize population exposure as controls are introduced. To assist in this effort, population exposure and $PM_{2.5}$ statistics can be organized by future year and control strategy. Upon completion of this evaluation, a final control strategy will be selected for detailed evaluation.

9.3. Identification of Control Strategy Scenarios

A designated subcommittee will select the control strategy scenarios to be modeled for demonstrating attainment. The control strategy selection process will follow the current the USEPA guidance, and will incorporate our present understanding of $PM_{2.5}$ formation on an urban and regional scale.

Mandated controls will be modeled first (inspection and maintenance programs, NO_x SIP Call, North Carolina's Clean Smokestacks Act legislation, federal engine standards, federal fuel standards, etc.). If attainment of the annual $PM_{2.5}$ NAAQS is not shown, additional alternative control strategies identified by the preceding steps, will be modeled until attainment is reached.

A "frozen" future year dataset will be available for use in testing alternative control strategies. This will consist of a set of model input and output files for each episode. Anyone with access to the model (e.g., power companies and universities) can use these files as long as they do not change future base case emission inventories, meteorology, growth factors, or mandated controls. Alternative controls can be modeled in addition to controls strategies modeled by the states.

10.0 Demonstration of Attainment

This section summarizes the procedures that will be used to demonstrate attainment of the annual $PM_{2.5}$ NAAQS. An attainment demonstration consists of (a) analyses which estimate whether selected emissions reductions will result in ambient concentrations that meet the NAAQS, and (b) an identified set of measures that will result in the required emissions reductions. Determining necessary emission reductions may be done by relying exclusively on results obtained with air quality models. These include the outcomes of the modeled attainment test plus a screening test to estimate whether a proposed emission reduction suffices to meet the NAAQS.

10.1. $PM_{2.5}$ Model Attainment Test

The $PM_{2.5}$ model attainment test is similar to the ozone model attainment test, in that both test use the model estimate in a relative sense using relative response factors (RRFs). A RRF is calculated for each constituent of $PM_{2.5}$ and is then used to calculate the projected $PM_{2.5}$ concentration for the future modeling year. Since the attainment test for $PM_{2.5}$ utilizes both total $PM_{2.5}$ and the individual component species, the test is referred to the Speciated Model Attainment Test (SMAT). In its entirety, SMAT consists of four basic steps.

First, the observed quarterly mean $PM_{2.5}$ and quarterly mean composition for each monitor is calculated. This is achieved by multiplying the monitored quarterly mean concentration of $PM_{2.5}$ from FRM monitors by the monitored fractional composition of $PM_{2.5}$ species for each quarter (e.g., (20% sulfate) x (15.0 $\mu g/m^3$ PM2.5 mass) = 3.0 $\mu g/m^3$ sulfate mass).

The monitored quarterly mean concentration of $PM_{2.5}$ from FRM monitors are the 5 year baseline design values (DVB) that are the result of averaging the 3 current design values (DVC) that straddle the modeling base year. The fractional composition of $PM_{2.5}$ species is derived from STN monitoring site data that has been processed by the "sulfate, adjusted nitrate, derived water, inferred carbonaceous material balance approach", or SANDWICH method, so STN and FRM masses are equivalent. The mean composition derived from the SANWICH method includes the percent of $PM_{2.5}$ that can be attributed to SO_4, NO_3, OC, EC, other primary inorganic particulates (or crustal materials), NH_4, and particle bound water (PBW).

The second step is to use model results to derive component specific RRF for each monitor for each quarter.

$$(RRF)_{ij} = ([C_{j,\,projected}]/[C_{j,\,current}])_i \qquad \textit{Equation 10.1-1}$$

Where:

$C_{j,\,current}$ is the quarterly mean concentration predicted at or near the monitoring site with emissions characteristic of the period used to calculate the baseline design value for annual $PM_{2.5}$.

$C_{j,\,projected}$ is the future year quarterly mean concentration predicted at or near the monitoring site.

For the third step, the component specific RRFs are applied to the observed air quality concentrations to projected quarterly species estimate. For each quarter, the current quarterly mean component concentration (step 1) are multiplied by the component-specific RRF obtained in step 2. This leads to an estimated future quarterly mean concentration for each component.

The fourth step sums the quarterly components to get a quarterly mean PM2.5 value. These quarterly mean values are then averaged to produce a future year annual average PM2.5 estimate, or future design value (DVF), for each FRM monitoring site. This final value is then compared to the NAAQS (15.0 $\mu g/m^3$) to determine if attainment is reached. An example calculation for site "X" is presented in Example 10.1 to further demonstrate the procedure for the $PM_{2.5}$ nonattainment test.

Example 10.1:

Step 1: Site X has the following observed quarterly mean $PM_{2.5}$ mass for the four quarters in the 2000-2004 period:

Table 10.1 –1: Observed Quarterly PM2.5 Concentrations for Site X

Quarter	2000	2001	2002	2003	2004
1	16.14	15.30	13.25	12.94	13.10
2	16.58	16.61	14.32	16.08	14.92
3	18.90	18.83	21.12	19.34	19.60
4	18.89	13.16	12.73	11.81	12.39

This data yields the following 3-year DVCs, and 5-year DVB:

Table 10.1-2: 3year DVC and 5 year DVB for Site X

Quarter	2000-2002 3-YR DVC	2001-2003 3-YR DVC	2002-2004 3-YR DVC	2000-2004 5-YR DVB
1	14.90	13.83	13.10	13.94
2	15.84	15.67	15.11	15.54
3	19.62	19.76	20.02	19.80
4	14.93	12.57	12.31	13.27

Based on a collocated STN site, the quarterly speciation profile for site X is:

Table 10.1-3: Quarterly Component Fraction at Site X

Quarter	Fraction Crustal	Fraction EC	Fraction OC	Fraction SO4	Fraction NO3	Fraction NH4	Fraction H2O
1	2.43%	5.96%	46.88%	24.94%	4.79%	8.37%	6.63%
2	4.13%	3.69%	36.73%	34.88%	0.07%	10.33%	10.16%
3	2.86%	2.52%	33.08%	39.29%	0.05%	11.30%	10.90%
4	2.04%	4.82%	48.63%	24.12%	4.17%	8.83%	7.38%

Multiplying the 5-year quarterly DVB by the quarterly speciation profile yields the following quarterly mean composition:

Table 10.1-4: Quarterly Mean Composition for Site X

Quarter	FRM Mass	Blank Mass	Non-Blank Mass	Crustal	EC	OC	SO4	NO3	NH4	PBW
1	13.94	0.50	13.44	0.33	0.80	6.30	3.35	0.64	1.12	0.89
2	15.54	0.50	15.04	0.62	0.56	5.52	5.25	0.01	1.55	1.53
3	19.80	0.50	19.30	0.55	0.49	6.38	7.58	0.01	2.18	2.10
4	13.27	0.50	12.77	0.26	0.62	6.21	3.08	0.53	1.13	0.94

Step 2: Modeling produced the following RRFs for Crustal, EC, OC, SO_4, and NO_3 component of PM2.5 near site X:

Table 10.1-5: RRFs for Site X

Quarter	Crustal	EC	OC	SO4	NO3
1	0.9987	0.7752	0.8814	0.8856	0.9417
2	1.1504	0.7894	0.9516	0.7614	0.7045
3	1.2178	0.8145	0.9629	0.6326	0.6050
4	1.0373	0.7436	0.8966	0.8096	0.8672

Step 3: The quarterly mean RRFs from table 10.1-5 are multiplied by the weighted quarterly average species concentrations from table 10.1-4 to derive future year concentrations. The future year ammonium concentrations are calculated from the sulfate, nitrate, and (current year) degree of neutralization (DON) values. Assuming that the DON is unchanged from the current year, the ammonium is calculated using the following formula:

$NH4_{future} = DON * SO4_{future} + 0.29*NO3_{future}$ *Equation 10.1-2*

In the example above, assuming the base year DON is:

Table 10.1-6: DON for Each Quarter for Site X

Quarter	DON
1	0.280
2	0.296
3	0.287
4	0.316

then the Quarter 1 $Ammonium_{Future} = 0.280 * 3.35 + 0.29 * 0.64 = 1.007$ µg/m3, etc.

The $NH4_{future}$, $SO4_{future,}$ and $NO3_{future}$ concentrations can then be used to develop a polynomial equation to predict future year particle bound water concentration. This step yields estimated future quarterly component concentrations of:

Table 10.1-7: Future Quarterly Component Concentrations for Site X

Quarter	Crustal	EC	OC	SO4	NO3	NH4	PBW
1	0.326	0.621	5.553	2.969	0.606	1.007	0.792
2	0.714	0.438	5.256	3.994	0.008	1.183	1.161
3	0.673	0.397	6.148	4.797	0.006	1.379	1.335
4	0.271	0.458	5.567	2.493	0.462	0.921	0.764

Step 4: These quarterly components are then added to get a quarterly mean PM2.5 value.

Table 10.1-8: Future Quarterly Component Concentrations and Quarterly Mean PM2.5 Concentrations (SUM) for Site X

Quarter	Crustal	EC	OC	SO4	NO3	NH4	PBW	SUM
1	0.326	0.621	5.553	2.969	0.606	1.007	0.792	12.083
2	0.714	0.438	5.256	3.994	0.008	1.183	1.161	13.593
3	0.673	0.397	6.148	4.797	0.006	1.379	1.335	16.399
4	0.271	0.458	5.567	2.493	0.462	0.921	0.764	14.172

These quarterly sums are then average to produce a future year annual average PM2.5 estimate, or DVF, of 13.08 $\mu g/m^3$ for monitoring site X. This DVF at site X is less than 15 $\mu g/m^3$; therefore, the site passes the attainment test.

10.2. Screening Test

Per the USEPA Guidance, the states will perform an analysis of unmonitored areas to determine if attainment of the annual $PM_{2.5}$ standard is expected in these areas. The USEPA is working on developing the Model Attainment Test Software (MATS) to perform the unmonitored area analysis, or screening test. This tool will allow for spatial interpolation of baseline monitoring data, which will provide modeling current design values for an entire area and not just at monitoring sites. This field is then paired with the modeling results in MATS to produce DVFs for an entire geographic area. This final gradient adjusted spatial field can then be examined for any unmonitored areas that area predicted not to meet the $PM_{2.5}$ NAAQS. The NCDAQ will implement this tool, should it be available in time to contribute to a timely SIP submittal. Should a peer reviewed MATS release be delayed, and is unavailable at the time of SIP submittal NCDAQ will examine the modeling data and current monitoring network to determine if any additional violations are suggested and is the logical course of action that should be taken.

10.3. Corroborative Analysis

After the completion of the attainment test, the USEPA $PM_{2.5}$ modeling guidance suggests additional measures should be taken to further support or refutes the attainment test results. This corroboratory evidence is referred to as supplemental analysis when used to further support an attainment demonstration. A weight of evidence determination can be used to conclude that attainment is likely, especially when the predicted future design values are between 14.5 and 15.5 $\mu g/m^3$. Analysis can include a wide variety of tests and analyses, including the application and results of air quality models, observed air quality trends and estimated emissions trends, and the outcome of observational models.

Should the area, clearly demonstrate attainment (DVF $< 14.5\ \mu g/m^3$), then basic supplemental analysis will be performed to further support the test's findings. If either the attainment or screening tests are greater than 15.5 $\mu g/m^3$, it is doubtful that the more qualitative arguments made in a weight of evidence determination can be sufficiently convincing to conclude that the NAAQS for $PM_{2.5}$ will be attained.

For DVFs between 14.5 and 15.5 µg/m^3, a weight of evidence determination will be preformed to supplement the conclusion that the area is expected to attain the NAAQS. The end product of a weight of evidence determination is a document which describes analyses performed, data used, key assumptions and outcomes of each analysis, and why the State believes that the evidence, viewed as a whole, supports a conclusion that the area will attain the annual NAAQS for $PM_{2.5}$.

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Attachment A: Acronyms Used

$\mu g/m_3$	Microgram per meter cubed
µm	Micrometer
ACM	Asymmetric Convective Mixing
AERO3/ISORROPIA	Aerosol Chemistry Scheme for CMAQ
AIRS	Aerometric Information Retrieval System
AQI	Air Quality Index
AQS	Air Quality System
BAMS	Barons Advanced Meteorological, LLC
BCON	Boundary Condition Processor
BCs	Boundary Conditions
BEIS3	Biogenic Emission Inventory System, version 3
BELD3	Biogenic Emissions Landuse Database
CAA	Clean Air Act
CAD	Cold Air Damming
CAIR	Clean Air Interstate Rule
CAMx	Comprehensive Air Quality Model with Extensions
CASNET	Clean Air Status and Trends Network
CB4	Carbon Bond Version 4
CB4-2002	Carbon Bond Version 4 - 2002 update
CCTM	CMAQ Chemical Transport Model
CEM	Continuous Emissions Monitoring
CERR	Consolidated Emissions Reporting Rule
CMAQ	Community Multiscale Air Quality
CMAS	Community Modeling and Analysis
CO	Carbon monoxide
CPC	Climate Prediction Center
CTM	Chemical Transport Model
D_a	Aerodynamic Diameter
DON	Degree of Neutralization
DV	Design Value
DVC	Current Design Value
DVB	Baseline Design Value
DVF	Future Design Value
EGU	Electric Generating Unit
EIIP	Emissions Inventory Improvement Program
EMS	Emissions Modeling System
EPS	Emissions Preprocessing System
ETA	NCEP meteorological model named for the vertical coordinate system used in the model.
FAA	Federal Aviation Administration
FDDA	Four Dimensional Data Assimilation
FRM	Federal Reference Method
GIF	Graphics Interchange Format
HKY	Hickory
HNO_3	Nitric Acid
I/O	input/output

ICON	Initial Condition Processor
ICs	Initial Conditions
IDA	Inventory Data Analyzer
IMPROVE	Integrated Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
ISORROPIA	Inorganic Aerosol Thermodynamics/Partitioning: Model that calculates the composition and phase state of an ammonia-sulfate-nitrate-chloride-sodium-water inorganic aerosol in thermodynamic equilibrium with gas phase precursors.
JPROC	Photolysis Rate Processor
km	kilometer
LEX	Lexington air quality monitoring site
LSM	Land Surface Model
m	meter
MACT	Maximum Achievable Control Technology
MATS	USEPA's Model Attainment Test Software
mb	millibar, Measure of atmospheric pressure
MCIP	Meteorological-Chemistry Interface Processor
MCIP2.3	Meteorological-Chemistry Interface Processor (ver. 2.3)
MM5	Mesoscale Meteorological Model, 5 refers to the version number
MNDHL	Mendenhall air quality monitoring site
MOBILE6.2	USEPA vehicle emission factor model, which is a software tool for predicting gram per mile emissions of hydrocarbons, carbon monoxide, oxides of nitrogen, carbon dioxide, particulate matter, and toxics from cars, trucks, and motorcycles under various conditions.
mph	miles per hour
MPP	Massively Parallel Processors
MRPO	Midwest Regional Planning Organization
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standard
NADP	National Atmospheric Deposition Program
NCAR	National Center for Atmospheric Research
NCDAQ	North Carolina Division of Air Quality
NCDOT	North Carolina Department of Transportation
NCEP	National Center for Environmental Predictions
NEI	National Emissions Inventory
NH_4	Ammonium
NMC	National Meteorological Center
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NO_x	Oxides of Nitrogen

NO_x SIP Call	Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone. Rule designed to mitigate significant transport of NO_x, one of the precursors of ozone.
NO_y	Total Available Nitrogen
NWS	National Weather Service
O_2	Atmospheric Oxygen
O_3	Ozone
OH	Hydroxyl radical
OBDII	Onboard diagnostics
PBW	Particle Bound Water
PAMS	Photochemical Assessment Monitoring Stations
PAVE	Package for Analysis and Visualization of Environmental data
PBL	Planetary Boundary Layer
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter with a diameter less than 2.5 μm
PSU	Pennsylvania State University
PSU/NCAR	Pennsylvania State University/National Center for Atmospheric Research
PX	Pleim-Xiu
PX_ACM LSM_PBL	MM5 configuration of Pleim-Xiu Land Surface Model, Asymmetric Convective Mixing PBL model
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
Q-Q plots	Quantile-Quantile plots
RACT	Reasonably Available Control Technology
RADM	Regional Acid Deposition Model
RAMS	Regional Atmospheric Modeling System
REMSAD	Regional Modeling System for Aerosols and Deposition
RPO	Regional Planning Organization
RRF	Relative Response Factor
RVP	Reid Vapor Pressure
SANDWICH	**S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous material balance approac**h**
SAPRC99	Photochemical Mechanism in CMAQ
SCC	Source Classification Code
SEARCH	Southeastern Aerosol Research and Characterization
SIP	State Implementation Plan
SMAT	Speciated Model Attainment Test
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur Dioxide
SOA	Secondary Organic Aerosol
SORGAM	Secondary Organic Aerosol Model
STN	Speciation Trends Network
TEOM	Tapered Element Oscillating Microbalance

TOMS	Total Ozone Mapping Spectrometer
u, v, w	Three Dimensional Wind Components in spherical coordinates : u = E/W; v = N/S; w = vertical
UAMIV	Urban Airshed Model - Version 4
UAM-V	Urban Airshed Model - Version 5
UCAR	University Corporation for Atmospheric Research
UCR	University of California at Riverside and Davis
USEPA	United States Environmental Protection Agency
USGS	United States Geological Service
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VMT	Vehicle Miles Traveled

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Draft Report

Modeling Protocol

For

Association for Southeastern Integrated Planning (ASIP)

Emissions and Air Quality Modeling to Address 8-Hour Ozone and $PM_{2.5}$ Nonattainment in the Southeastern United States

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1.0 INTRODUCTION

This report constitutes the first draft of the Air Quality Modeling Protocol for the Association for Southeastern Integrated Planning (ASIP) to address the regional component of emissions and air quality modeling of 8-hour ozone and $PM_{2.5}$ nonattainment in the Southeastern United States. The ASIP emissions and air quality modeling activities are being carried out by the contractor team of ENVIRON International Corporation and Alpine Geophysics, LLC. Southeastern States may use the regional emissions and air quality modeling from ASIP and also may conduct more refined ozone and $PM_{2.5}$ modeling of their own nonattainment areas. Previously, the ASIP team has prepared a Quality Assurance Project Plan (QAPP) that details the extensive quality assurance (QA) and quality control (QC) activities being performed as part of ASIP (Morris and Stella, 2005).

1.1 SESARM Organization

Southeastern States Air Resource Managers, Inc., commonly known as SESARM, is a Georgia corporation organized and operated under the provisions of the Official Code of Georgia Annotated, Title 14, Chapter 3, also known as the Georgia Nonprofit Corporation Code. SESARM qualifies as a charitable, tax-exempt, nonprofit corporation as provided in the United States Code, Title 26, Subtitle A, Chapter 1, Subchapter F, Part 1, Section 501(c)(3). SESARM does not engage in for-profit activities nor does it use federal funds to influence legislation. SESARM was incorporated February 24, 1997. Its tax-exempt status was most recently re-confirmed in correspondence from the United States Internal Revenue Service dated December 12, 2001.

SESARM directly represents the eight southeastern state air pollution control agencies located within Region 4 of the United States Environmental Protection Agency (EPA). The member states are Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. The Board of Directors of SESARM consists of the air pollution control agency director from each state air pollution control agency.

SESARM's Articles of Incorporation describe its purposes as being to enhance communication and thus promote more effective air pollution management in the Southeast, improve the effectiveness of its members in meeting national and regional air pollution goals, conduct and facilitate research and training necessary to meet its purposes, evaluate air quality issues, recommend actions to resolve air quality problems, and develop steps to accomplish air quality improvements.

When EPA promulgated regional haze regulations on July 1, 1999, it established requirements that states and tribes submit implementation plans to demonstrate reasonable progress towards the ultimate visibility goals of the rule. The first demonstration of reasonable progress is to be made for the year 2018 in state implementation plans due December 2007. EPA also offered an optional approach that groups of states might collaborate in regional analyses of the haze problem. This option showed promise in allowing more cost-effective analyses and the southeastern states opted to follow this option. Southeastern States Air Resource Managers Inc.

(SESARM) accepted responsibility for regional planning organization work tasks on behalf it its member agencies pursuant to this option.

The member agencies of SESARM determined that it was appropriate to expand the collaborative effort for the regional haze program beyond their member boundaries and invited Virginia and West Virginia to join the group. A memorandum of agreement was arranged among the agencies and executed on August 22, 2001. The effort was named the Visibility Improvement State and Tribal Association of the Southeast (VISTAS). Since that time, the agencies have worked together to organize their efforts, develop work task lists and schedules, procure professional services, and support administrative operations. Bylaws were developed and agreed upon by the participating members. An organizational structure was created including an oversight committee, an operations committee, and various work groups. This early planning has served the project well and much progress has been made.

1.2 ASIP Project Background

On December 17, 2004, EPA made fine particle ($PM_{2.5}$) nonattainment determinations for at least one area in seven of the states participating in the VISTAS regional haze project. They are Alabama, Georgia, North Carolina, Kentucky, Tennessee, Virginia, and West Virginia. In addition, South Carolina has one three-county area that was designated as unclassifiable in the same action. EPA's Clean Air Interstate Rule (CAIR) modeling indicated that certain nonattainment areas may still be in nonattainment after full implementation of CAIR. These areas include Jefferson County, Alabama and Clayton and Fulton Counties in Georgia.

The $PM_{2.5}$ compliance date is April 2010 unless a state demonstrates that more time is necessary in which case up to five additional years may be granted. The nonattainment designations triggered the requirement for development of state implementation plans (SIPs) that will be due in April 2008. The draft guidance from EPA indicates that a significant requirement of $PM_{2.5}$ SIPs will be attainment demonstrations using, at least in part, modeling analyses to define effective emissions control strategies and confirm that attainment can be achieved after implementation of the strategies. 2009 is the modeling year for the $PM_{2.5}$ attainment demonstration and also is an interim analysis year for the VISTAS regional haze demonstration.

In April of 2004, EPA determined areas that were not meeting the 8-hour ozone standard. States having one or more 8-hour ozone nonattainment areas in the Southeast are Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. EPA will require attainment of the 8-hour ozone standard in basic nonattainment areas by June 15, 2009 and in moderate nonattainment areas by June 15, 2010. This will require states with basic 8-hour ozone nonattainment areas to model 2008 as the SIP modeling demonstration year while moderate nonattainment areas will require 2009 as the modeling year. Given that North Carolina and Virginia have two year SIP approval processes, there is an immediate need to complete an analysis of ozone attainment using air quality modeling.

The states participating in the VISTAS project (the SESARM EPA Region 4 states plus Virginia and West Virginia from Region 3) have concluded that a collaborative process will be the most efficient approach for the collective states to develop information upon which to base the $PM_{2.5}$ and 8-hour ozone attainment demonstrations. The local air regulatory agencies for Jefferson County, AL, Jefferson County, KY, Mecklenburg County, NC, Forsythe County, NC, Knox County, TN, and Shelby County, TN have also become signatory parties to this collaborative effort. SESARM will coordinate among participating agencies and oversee the performance of the inventory and modeling tasks in parallel with the VISTAS regional haze project tasks.

The name of this collaborative effort is the Association for Southeastern Integrated Planning (ASIP). SESARM was awarded a grant from EPA on February 8, 2005 to conduct what was originally called the fine particle SIP development support project but is now known as ASIP.

1.3 Purpose of the ASIP Modeling Protocol

The ASIP Modeling Protocol sets forth the procedures, data sources and modeling approach to be used in performing the ASIP 8-hour ozone and $PM_{2.5}$ modeling for the Southeastern United States that will be the basis of the regional modeling component for the Southeastern States 8-hour ozone and $PM_{2.5}$ State Implementation Plans (SIPs) due June 2007 and April 2008 respectively. The procedures will be reviewed by States, Federal Agencies, Stakeholders and others so that a full and complete understanding of the modeling approach will be understood by all. States, Agencies and Stakeholders and invited to comment on the procedures outlined in the Modeling Protocol and will warranted the procedures will be refined to address comments.

1.4 Problem Definition

Figures 1-1 and 1-2 display the 8-hour ozone and $PM_{2.5}$ nonattainment areas designed by EPA in April and December 2004, respectively. Of the 10 States in the VISTAS region, 8 include counties that have been designed as nonattainment of the 8-hour ozone standard (Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia). Similarly, seven of the VISTAS states have counties that are designated as nonattainment for $PM_{2.5}$ (Alabama, Georgia, North Carolina, Kentucky, Tennessee, Virginia, and West Virginia). Of the 10 VISTAS states only Florida and Mississippi do not have any 8-hour ozone and $PM_{2.5}$ nonattainment areas, South Carolina includes 8-hour ozone nonattainment counties (near Charlotte) but no $PM_{2.5}$ nonattainment areas.

The states need to submit the 8-hour ozone State Implementation Plans (SIPs) to EPA by June 2007; the $PM_{2.5}$ SIPs are due by April 2008. Some of the states involved in the ASIP ozone/PM modeling have two-year legislative review processes. Thus, the definition of the SIP control plans is needed in early 2006. Consequently, the ASIP regional ozone and PM modeling has an aggressive schedule.

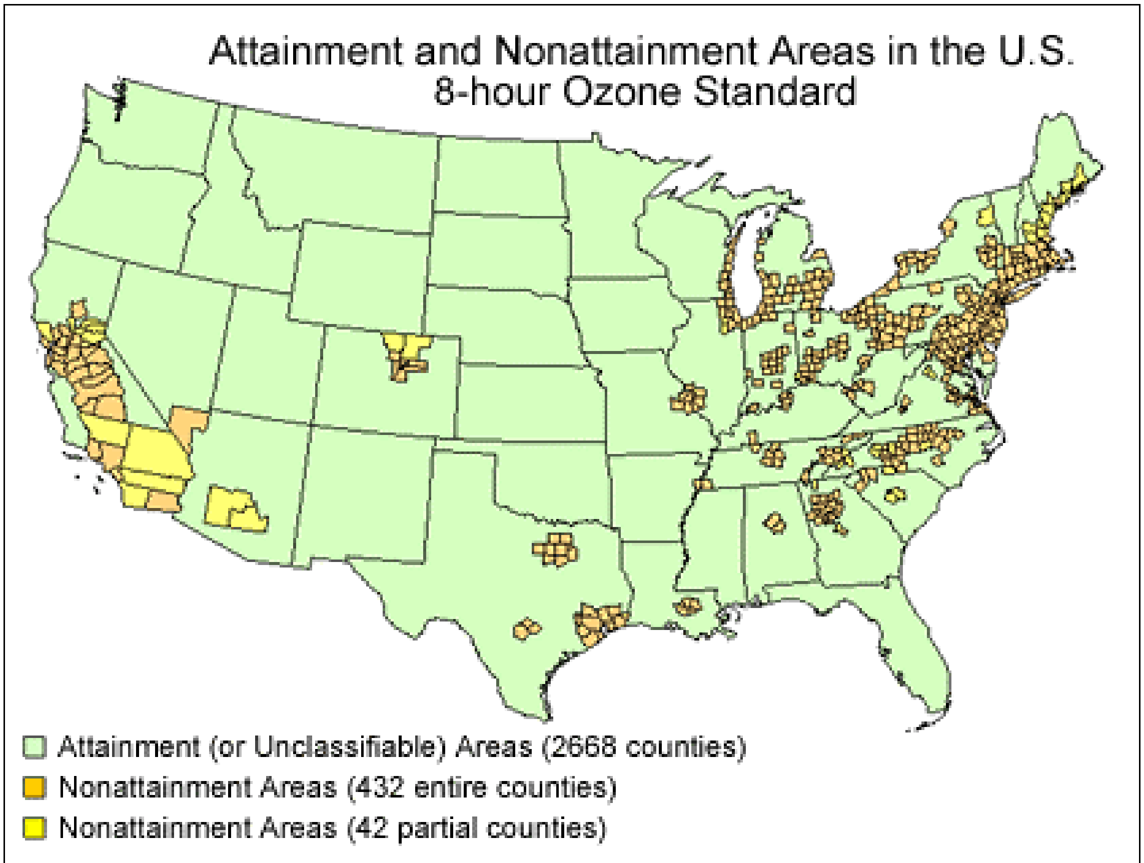

Figure 1-1. 8-hour ozone nonattainment counties in the US designated by EPA in April 2004.

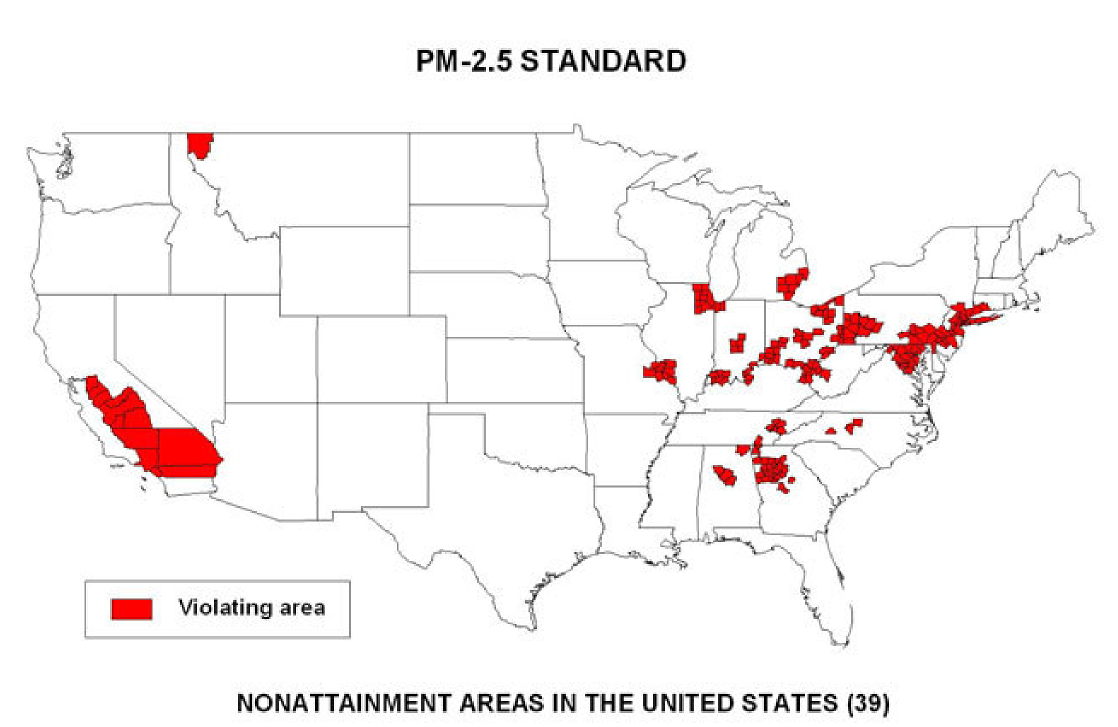

Figure 1-2. $PM_{2.5}$ nonattainment counties designed by EPA in December 2004.

1.5 Background

The Association for Southeastern Integrated Planning (ASIP) Emissions and Air Quality Modeling Team is operating regional scale, three-dimensional air quality models for ozone and fine particulate matter ($PM_{2.5}$) that simulate the emissions, chemical transformations, and transport of gaseous and particulate matter (PM) species in the eastern United States. A key element of this work includes the integration of emissions inventories and models with regional transport models. The general services provided by the ASIP Emissions and Air Quality Modeling Team include, but are not limited to:

- Emissions processing and modeling;
- Air quality modeling simulations;
- Analysis, display, and reporting of modeling results; and
- Storage/quality assurance of the modeling input and output files.

The ASIP regional emissions and air quality modeling is leveraging the modeling databases developed by VISTAS to provide the technical basis for the regional haze SIPs due in December 2007. Regional haze is caused by primary and secondary fine particles and is simulated using "one-atmosphere" regional photochemical grid models. Such models also simulate regional ozone and fine PM so can also be used to address the ASIP 8-hour ozone and $PM_{2.5}$ issues. VISTAS initiated their regional haze modeling in 2003 using a two-phase approach.

1.5.1 VISTAS Two-Phased Approach

The VISTAS Emissions and Air Quality Modeling activities are being performed in two Phases. Phase I, which occurred primarily during the 2003 calendar year, consisted of emissions and regional haze modeling for three episodes to identify the optimal model configuration(s) for simulating regional haze, ozone and fine PM in the southeastern US. Phase II, initiated in 2004, consists of operating the emissions and air quality models for the 2002 calendar year to develop the regional haze modeling databases needed to address the requirements of the Section 308 RHR SIPs and TIPs. The ASIP regional ozone and $PM_{2.5}$ modeling is building off the VISTAS Phase II 2002 36/12 km annual modeling activities.

1.5.1.1 VISTAS Phase I

The objective of VISTAS Phase I was to determine the optimal modeling configuration for use in the subsequent Phase II visibility assessment. Accordingly, Phase I entailed a comprehensive literature review of recent relevant visibility studies using various photochemical/aerosol modeling platforms in order to assess and identify model configurations, data bases, and model testing methodologies that were appropriate for use in conducting the VISTAS Phase I emissions and PM modeling assessment. Key elements of Phase I included:

- Review all relevant air quality model simulations that have been completed related to regional haze and $PM_{2.5}$ modeling and document the relevant sensitivity analyses, model configuration testing, and performance evaluations that have been performed (ENVIRON, 2003b);

- Review the current science in regional emissions modeling (e.g., EPS, EMS and SMOKE) and PM air quality modeling (e.g., CMAQ, CMAQ-MADRID, CMAQ-AIM, REMSAD, UAM-V/PM, CAMx4 and PMCAMx) to determine the most appropriate model(s) for use by VISTAS (ENVIRON, 2003b);

- Review available ambient data for evaluating one-atmosphere PM/ozone models (ENVIRON, 2003c);

- Develop and implement a plan or Modeling Protocol for testing and evaluating alternative science configurations of the recommended Phase I model(s) and document the results (ENVIRON, 2003a); and

- Prepare a Task 6 Modeling Protocol prescribing the model set-up, data base development, performance testing, and control strategy evaluation procedures to be implemented in VISTAS Phase II (ENVIRON, 2004a).

VISTAS formed three standing workgroups to plan and direct the project. These included: (a) the Technical Analysis (emissions and modeling) Workgroup; (b) the Data (monitoring) Workgroup; and (c) the Planning Workgroup. Under Phase I, the VISTAS Technical Analysis Workgroup (TAWG) managed the comprehensive model configuration testing program aimed, as noted above, at evaluating the capabilities of current state-of-science regional emissions, prognostic meteorological and PM/visibility models. The resultant modeling system (models and databases) identified and tested in Phase I were intended to be applied in Phase II following the procedures set forth in the Phase II Modeling Protocol (ENVIRON, 2004a).

For the meteorological component of the Phase I modeling, SESARM contracted with Baron Advanced Meteorological Systems (BAMS) to apply the PSU/NCAR Mesoscale Model (MM5) in multiple configurations and to evaluate its performance against surface and aloft meteorological observations (Olerud, 2003a-d). The emissions modeling component of VISTAS Phase I was carried out by the research team of ENVIRON/Alpine/UCR with staff at Alpine Geophysics taking the lead role in setting up, testing, and applying the emissions modeling system. The air quality modeling component was performed by the team at the ENVIRON/Alpine/UCR modeling centers. A dominant theme during Phase I was the exchange of modeling codes, databases, and evaluation software between the three modeling centers as the air quality modeling was carried out.

1.5.1.2 VISTAS Phase II

The VISTAS Phase II modeling is performing annual PM/regional haze simulations for the 2002 calendar year. Detailed performance testing has been completed. The modeling system has been demonstrated using several inventory versions for the base year (2002) and future years (2009 and 2018). These results are posted to the VISTAS modeling website managed by University of California at Riverside (http://pah.cert.ucr.edu/vistas/vistas2/). Beginning in winter 2005-2006, the modeling system will be exercised with a variety of emissions control scenarios enabling VISTAS to assess the effects of future year emission control strategies on visibility and other air quality issues. The modeling system will also allow VISTAS to track reasonable progress toward regional haze goals. More specifically, the VISTAS Phase II program will focus on the use of the CMAQ modeling system for calendar year 2002 over the same 36/12 km horizontal grid system used in Phase I. A potentially large number of annual (and episodic) model simulations has been or will be performed; the list below reflects current plans:

- **2002 Annual Run.** The initial annual model simulations and performance evaluations using the 2002 inventory for VISTAS and non-VISTAS states, Canada and Mexico. Multiple iterations of the 2002 annual simulation have been required to confirm the appropriateness of the model science configuration(s) recommended by the Phase I work, to evaluate updates to the model and model inputs (especially emissions inventory versions) and to refine model performance.

- **2002 Annual Run with "Typical Year" EGU/Fire Inventory.** An annual 2002 simulation representing the 2000-2004 baseline period for EGU and fire emissions and using 2002 revised inventory for all other source sectors. The primary objective of this inventory is to provide the base line modeled air quality condition against which future year modeling runs will be compared to develop relative reduction factors for each pollutant species.

- **2018 Future Year Annual Runs.** 2018 future year emission inventory simulations using the 2002 calendar year meteorological conditions involving a base case inventory of typical EGU and fire emissions. Initially a 2018 On-the-Books (OTB) base case scenario, which consisted of all promulgated regional controls measures as of the beginning of 2005, and a 2018 On-the-Way (OTW) scenario that consisted of OTB plus regional SOx and NOx controls expected to be part of the Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR) were modeled. After the final CAIR was released in June 2005, the 2018 OTB scenario was dropped. The Integrated Planning Model (IPM) was used to project future EGU emissions; all other inventories were forecasted to 2018 using growth and control factors documented by MACTEC (2005).

- **2009 Intermediate Future Year Annual Runs.** Simulations for the 2009 future-year were performed to provide estimates of visibility improvements at Class I areas for an intermediate future year.

- **Future Year Emission Control Strategies.** Prescription of the future year emissions control strategies to be performed in 2006 will be defined after the foregoing simulations and analyses have been completed. Currently, a 2018 CAIR plus BART control strategy is being developed.

Closely integrated with the annual meteorological, emissions and air quality modeling will be ongoing project management, technical review, and quality assurance activities performed under the guidance of the VISTAS Contracting Officer and the TAWG. The modeling team members will participate with VISTAS management in regular monthly conference calls, as well as ad hoc topical conference calls as needed, and will attend periodic meetings with the TAWG members throughout Phase II.

Complementing the data acquisition, modeling input development activities, and project management activities, four other Phase II activities will be performed, consistent with the VISTAS Quality Assurance Project Plan (QAPP) (ENVIRON, Alpine and UCR, 2004).

1.6 ASIP Modeling Approach

The ASIP regional ozone and PM modeling builds off of the VISTAS Phase II 2002 annual modeling and uses many of the same QA/QC procedures.

1.6.1 Data Gatekeepers

The ASIP and VISTAS emissions and air quality modeling team receive emissions, meteorological and air quality data from other contractors or other sources. As a first line of QA, we have defined a Gatekeeper function to assure the data have been received correctly, the quality of the data has been evaluated, and that the data received have been documented. The same Gatekeeper QA approach will be used in the ASIP ozone and $PM_{2.5}$ modeling. Separate air quality, meteorological and emissions Gatekeepers have been identified whose roles are defined below. In addition, a Data Management Gatekeeper has been defined who will post data, reports and results to the project website and archive all key data generated in the project.

- **Air Quality Data Gatekeeper**. As necessary, obtain air quality data as appropriate for model input development and model performance evaluation and assure that the quality of all air quality data obtained is consistent with the approved QAPP. Provide documentation of evaluation and generate IC/BC inputs for CMAQ for all modeling runs.

- **Meteorological Gatekeeper**. As necessary, obtain meteorological data, as MM5 or MCIP files, as appropriate for annual 2002 modeling runs and other episode periods and perform data quality checks as approved in the QAPP, together with appropriate documentation of model performance evaluation activities.

- **Emissions Gatekeeper.** Obtain emissions inventory data necessary to support annual 2002 and future year modeling and recommend sources of emissions data to be used for Canada and Mexico. Assure quality of all emissions data received is consistent with the approved QAPP, and develop all emissions modeling files to support modeling runs for 2002 and future years. Develop the chemical speciation files and temporal and spatial allocation files necessary to convert annual inventories into hourly and daily emissions modeling files, as appropriate. Develop all emissions modeling files for non-VISTAS states to support modeling runs for future year base case and emissions strategies.

- **Data Management Gatekeeper**: Maintain the ASIP results and other documents as requested by the ASIP group to support all 8-hour ozone and $PM_{2.5}$ modeling tasks. This includes, for example, the storage of model inputs and outputs for annual runs and the transfer (via USB/firewire portable disk or alternative media) of electronic files to ASIP states, EPA, other contractors, and stakeholders.

1.6.2 Emissions QA/QC

Emissions Quality Assurance (QA) and Quality Control (QC) are the single most critical steps in performing air quality modeling studies. Because emissions processing is tedious, time consuming and involves complex manipulation of many different types of large data sets, errors are frequently made in emissions processing and, if rigorous QA measures are not in place, these errors may remain undetected. In ASIP we will continue with the multistep emissions QA/QC approach applied in the VISTAS Phase I and II modeling. This includes the initial emissions QA/QC by the Emissions Gatekeeper described above, as well as QA/QC by the Emissions Modeler during the processing of emissions and then additional QA/QC by the Air Quality Modeler of the processed model ready emission files. This multistep process with three separate groups involved in the QA/QC of the emissions is intended to detect and correct errors prior to the air quality model simulations.

Emissions QA/QC performed as part of the emissions modeling includes:

EMS and EPA Input Screening Error Checking Algorithms: Although the SMOKE emissions model will be used for emissions processing, some of the more advanced EMS input error checking algorithms will be used to screen the data and identify potential emission input errors. Additionally, EPA has issued revised stack QA and augmentation procedures memorandum that will be used to identify and augment any outlying stacks.

SMOKE Error Messages: SMOKE provides various cautionary or warning messages during the emissions processing. We will redirect the SMOKE output to log files and review the log files for serious error messages. An archive of the log files will be maintained so that the error messages can be reviewed at a later date if necessary.

SMOKE Emissions Summaries: We will use QA functions built into the SMOKE processing system to provide summaries of processed emissions as daily totals according to species, source category and county and state boundaries. These summaries will then be compared with summary data prepared for the pre-processed emissions, e.g., state and county totals for emissions from the augmented emissions data.

Once the CMAQ-ready emission inputs have been prepared, we will perform additional emissions QA/QC as follows:

Spatial Summary: We will sum the emissions for all layers and for all 24 hours that is used to prepare a PAVE plot showing the daily total emissions spatial distribution. For a 20 day simulation this produces approximately 20 days x 20 species x 5 emissions categories = 2,000 plots. In our base case simulations these plots will be presented as tons per day. The objective of this step is to identify errors in spatial distribution of emissions.

Vertical Profile: For point sources the emissions total for each layer will be summed and plotted to show the vertical distribution of emissions. These plots show the emissions on the x-axis for each model layer on the y-axis. The objective of this step is to identify possible errors in vertical distribution of emissions.

Short Term Temporal Summary: The total domain emissions for each hour will be accumulated and time series plots prepared that display the diurnal variation in total hourly emissions. The objective of this step is to identify errors in temporal profiles.

Long Term Temporal Summary: The total domain emissions for each day will be accumulated and displayed as time series plots that show the daily total emissions across the domain as a function of time. The objective of this step is to identify particular days for which emissions appear to be inconsistent with other days for no reason (e.g., not a weekend) and compare against the general trend.

Control Strategy Spatial Displays: Spatial summary plots of the daily total emissions differences between a control strategy and base case emissions scenarios will be generated. These plots can be used to immediately identify a problem in a control strategy. For example, if a state's SO_2 control strategy is being analyzed and there are changes in emissions for other pollutants or for SO_2 outside of the state under study problems in emissions processing can be identified prior to the air quality model simulation.

1.6.3 Meteorology QA/QC

The meteorological modeling contractor (BAMS) had primary responsibility in the QA/QC of the MM5 meteorological fields. ASIP will rely on the QA/QC conducted by the VISTAS emissions and air quality modeling team as part of Phase II modeling to assure that the data has transferred correctly, to obtain an assessment of the quality of the data and to assist in the interpretation of the air quality modeling results.

The VISTAS Phase II Meteorological Gatekeeper performed the following activities that serve to QA/QC the meteorological fields used in the ASIP modeling:

- Analyzed the MM5 data to assure it had been transferred correctly.
- Evaluated the MM5 using METSTAT and the surface meteorological network.
- Evaluated upper-air MM5 meteorological estimates by comparing them to upper-air observations and satellite images.
- Compared the VISTAS 2002 MM5 simulation with the one generated by WRAP.
- Generated the CMAQ-ready meteorological inputs using the MCIP2.2 processor.

The CMAQ meteorological input files were updated to MCIP version 3.0 in late 2005.

1.6.4 Air Quality Modeling QA/QC

- Key aspects of QA/QC for the ASIP CMAQ modeling input and output data include the following:
- Verification that correct configuration and science options are used in compiling and running each model in the CMAQ modeling system, where these include the MCIP, JPROC, ICON, BCOM and the CCTM.
- Verification that correct input data sets are used when running each model.
- Evaluation of CMAQ results to verify that model output is reasonable and consistent with general expectations.
- Backup and archiving of critical model input data.

The most critical element for ASIP CMAQ simulations is the QA/QC of the emissions input files, which is discussed above. The major QA issue specifically associated with the air quality model simulations is verification that the correct science options were specified in the model itself and that the correct input files were used when running the model. For the CMAQ model we employ a system of naming conventions using environment variables in the compile and run scripts that guarantee that correct inputs and science options are used. We also employ a redundant naming system so that the names of key science options or inputs are included in the name of the CMAQ executable program, in the name of the CMAQ output files, and in the name of the directory in which the files are located. This is accomplished by using the environment variables in the scripts to specify the names and locations of key input files.

A second key QA procedure is to never "recycle" run scripts, i.e., we always preserve the original runs scripts and directory structure that were used in performing a model simulation.

We will also perform a post-processing QA of the CMAQ output files similar to that described for the emissions processing. We will generate animated gif files using PAVE that can be viewed to search for unexpected patterns in the CMAQ output files. In the case of model sensitivity studies, the animated gifs will be prepared as difference plots for the sensitivity case minus the base case. Often, errors in the emissions inputs can be discovered by viewing the animated GIFs. Finally, we will produce 24 hour average plots for each day of the CMAQ simulations. This provides a summary that can be useful for quickly comparing various model simulations.

1.6.5 Overview of Data Flow and Quality Assurance Process

Figure 1-3 displays an overview of the data flow and quality assurance process in the ASIP Emissions and Air Quality Modeling study. The ASIP Modeling Team receives different types of data from various contractors and other sources that have performed their own Quality Assurance (QA) and Quality Control (QC). Whenever data are received by the Modeling Team, it is first subjected to a QA check by a Gatekeeper who assesses the accuracy and quality of the data and prepares a summary presentation on the QA check. Figure 1-3a lists the Gatekeepers in the Modeling Team for emissions, boundary conditions, meteorological, ozone column (TOMS) and air quality data. If the Gatekeeper identifies any problems with the data, the provider of the data is contacted and asked to correct the data. Once the Gatekeeper has conducted a QA check of the data it is passed on to the modeler who performs their QA of the data. The data are then used in the modeling and resultant output (e.g., model-ready emissions or meteorological files) are then subjected to another round of QA to assure the integrity of the data is retained.

Once the model-ready inputs have been developed and subjected to QA/QC, the CMAQ model is applied using Base Case emissions and the modeling results subjected to a model performance evaluation. The model performance evaluation (MPE) represents an extensive QA effort and is the most time consuming component of the study. EPA has developed draft guidance for evaluating regional PM and haze models that includes performance goals (EPA, 2001). In addition, the Modeling team has adapted EPA MPE approaches and goals for 1-hour (EPA, 1991) and 8-hour (EPA, 1999; 2005b) ozone modeling. The MPE/QA process is being performed under VISTAS since VISTAS and ASIP share the same modeling platform database and approach. The MPE/QA approach is using as many different tools and analysis as possible in order to fully understand the accuracy and reliability of the model simulation. As seen in Figure 1-3b, the MPE process in VISTAS/ASIP is a multistep process using several different techniques:

UCR Analysis Tools: The University of California at Riverside (UCR) Analysis Tools were used extensively in VISTAS and are run on a Linux platform separately for each network. Graphics are automatically generated using gnuplot and the software generates the following:

- Tabular statistical measures;
- Time Series Plots; and
- Scatter Plots by allsite_allday, allday_onesite and allsite_oneday.

MAPS Analysis Tools: Alpine Geophysics (Alpine) has a MAPS Analysis Tool that also runs under Linux and is based on Fortran and NCAR Graphics. It was originally developed for evaluating ozone models and has been extended to treat PM species as well. In addition to calculating similar statistics, scatter plots and time series plots as the UCR Analysis Tools, it also can generate spatially averaged time series plots of concentrations, bias and error, performs analysis of peak concentrations and includes a Flying Data Grabber (FDB) for comparing modeling results with aircraft data.

ENVIRON Analysis Tools: ENVIRON has developed specialized evaluation tools to analyze ozone and PM model performance for urban-scale modeling and comparison against EPA model performance goals.

GA DNR Analysis Plots: Dr. James Boylan of the Georgia Department of Natural Resources has extended the concept in EPA's draft PM fine particulate and regional haze modeling guidance that model performance for species that make up a major contribution to visibility impairment be subjected to more stringent goals than species that are minor contributors by developing concentration-dependent performance goals and "Bugle Plots" to display them.

The evaluation of the VISTAS/ASIP 2002 CMAQ Base Case simulation used each of the analysis tools listed above demonstrating their descriptive and complimentary nature.

The issue of model performance goals for PM species is an area of ongoing research and debate. For ozone modeling, EPA has established performance goals for 1-hour ozone normalized mean bias and gross error of ≤±15% and ≤35%, respectively (EPA, 1991). EPA's draft fine particulate modeling guidance notes that performance goals for ozone should be viewed as upper bounds of model performance, which PM models may not be able to always achieve and we should demand better model performance for PM components that make up a larger fraction of the PM mass than those that are minor contributors (EPA, 2001). Measuring PM species is not as precise as ozone monitoring. In fact, the differences in measurement techniques for some species likely exceed the more stringent performance goals, such as those for ozone. For example, recent comparisons of the PM species measurements using the IMPROVE and STN measurement technologies found differences of approximately ±20% (SO_4) to ±50% (EC) (Solomon et al., 2004).

In the VISTAS/ASIP 2002 CMAQ Base Case modeling, we have adopted three levels of model performance goals for bias and gross error as listed in Table 1-1 that are used to help evaluate model performance. Note that we are not suggesting that these performance goals be generally adopted or that they are the most appropriate goals to use. Rather, we are just using them to frame and put the PM model performance into context and to facilitate model performance intercomparison across episodes, species, models and sensitivity tests.

As noted in EPA's draft PM modeling guidance, less abundant PM species should have less stringent performance goals. Accordingly, we are also using performance goals that are a continuous function of average observed concentrations proposed by Dr. James Boylan at the Georgia Department of Natural Resources that have the following features:

- Asymptotically approaching proposed performance goals or criteria when the mean of the observed concentrations are greater than 2.5 ug/m^3.

- Approaching 200% error and ±200% bias when the mean of the observed concentrations are extremely small.

Dr. Boylan uses bias/error goals and criteria of ±30%/50% and ±60%/75% and plots bias and error as a function of average observed concentrations. As the mean observed concentration approaches zero the bias performance goal and criteria flare out to ±200% creating a horn shape, hence the name "Bugle Plots".

Table 1-1. Model performance goals to help interpret modeling results.

Fractional Bias	Fractional Error	Comment
≤±15%	≤35%	Ozone model performance goal for which PM model performance would be considered good.
≤±30%	≤50%	A level of model performance that we would hope each PM species could meet

≤±60%	≤75%	At or above this level of performance indicates fundamental problems with the modeling system.

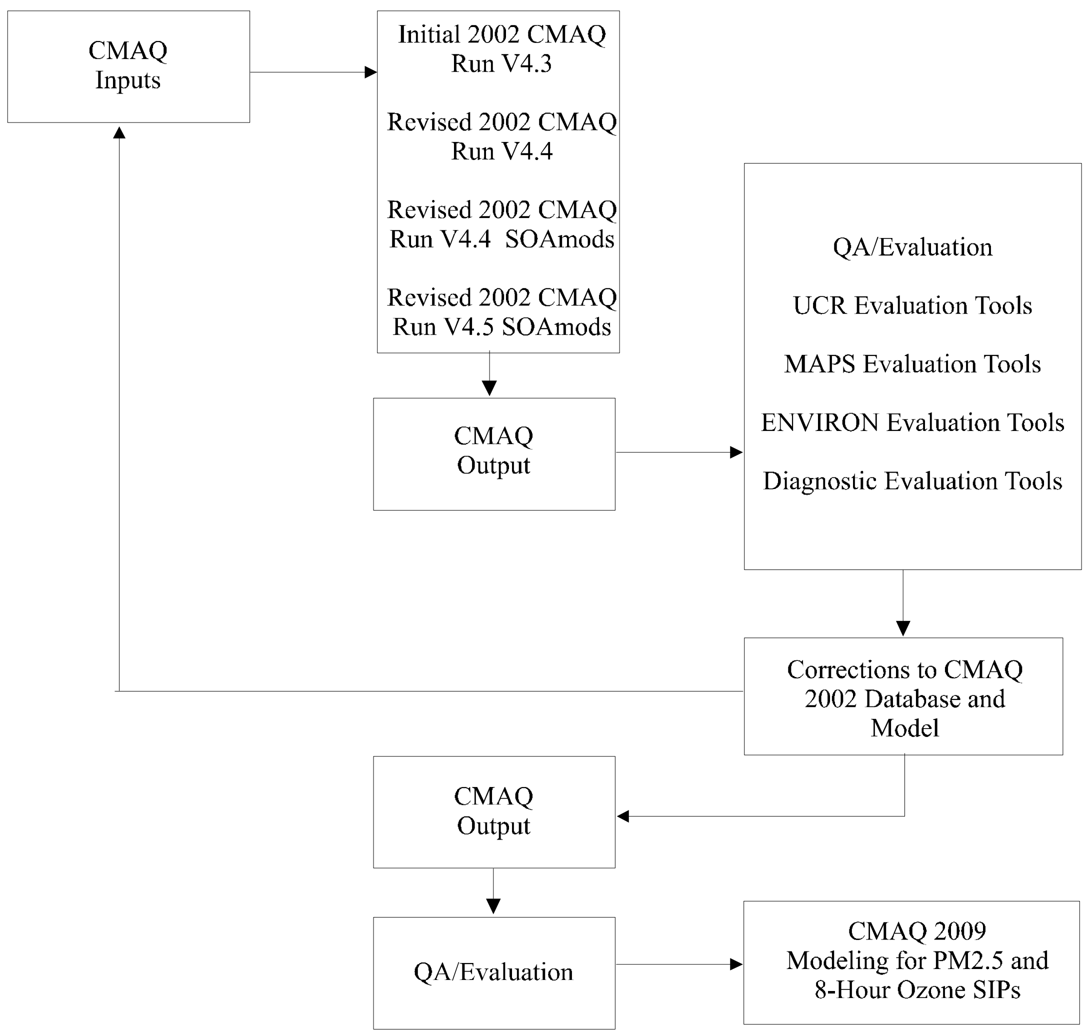

Figure 1-3a. Data flow and quality assurance steps in the ASIP Emissions and Air Quality Modeling.

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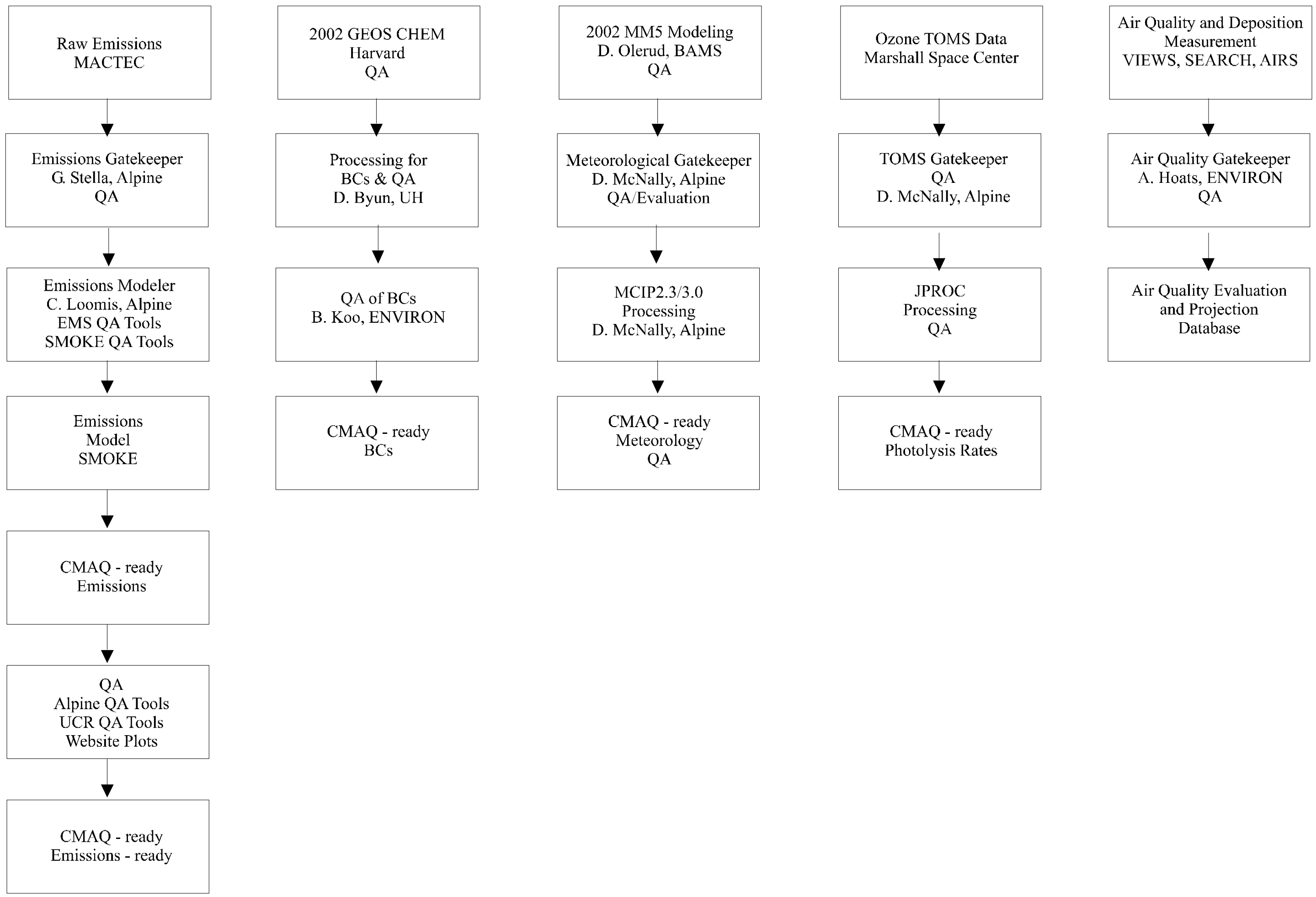

Figure 1-3b. Concluded. Data flow and quality assurance steps in the ASIP Emissions and Air Quality Modeling.

1.7 Project Management

1.7.1 Project Organization

The ASIP ozone and PM modeling project is conducted by ENVIRON International Corporation (ENVIRON) and Alpine Geophysics, LLC (Alpine), with input from SESARM and the ASIP States. Organizational commitment is an essential element for developing and implementing a successful research project. Ralph Morris of ENVIRON would be the ASIP Emissions and Air Quality Modeling Project Manager (PM). The ASIP Modeling Team has two Co-Principal Investigators that coordinate activities at each of the modeling centers, Ralph Morris of ENVIRON and Gregory Stella of Alpine. The PM and two Co-PIs are kept apprised of all project activities, from identifying the need to develop sound experimental and project designs to delivering reports. Commitments to research and project activities, such as those described in this QAPP are made only after the activities are thoroughly reviewed and approved by the PM and Co-PIs and SESARM and the ASIP States. Figure 1-4 presents the organizational chart that shows the lines of responsibility and information flow for activities under this project. Table 1-2 lists the project responsibilities for participants in the ASIP Emissions and Air Quality Modeling study, with more details on their roles provided next.

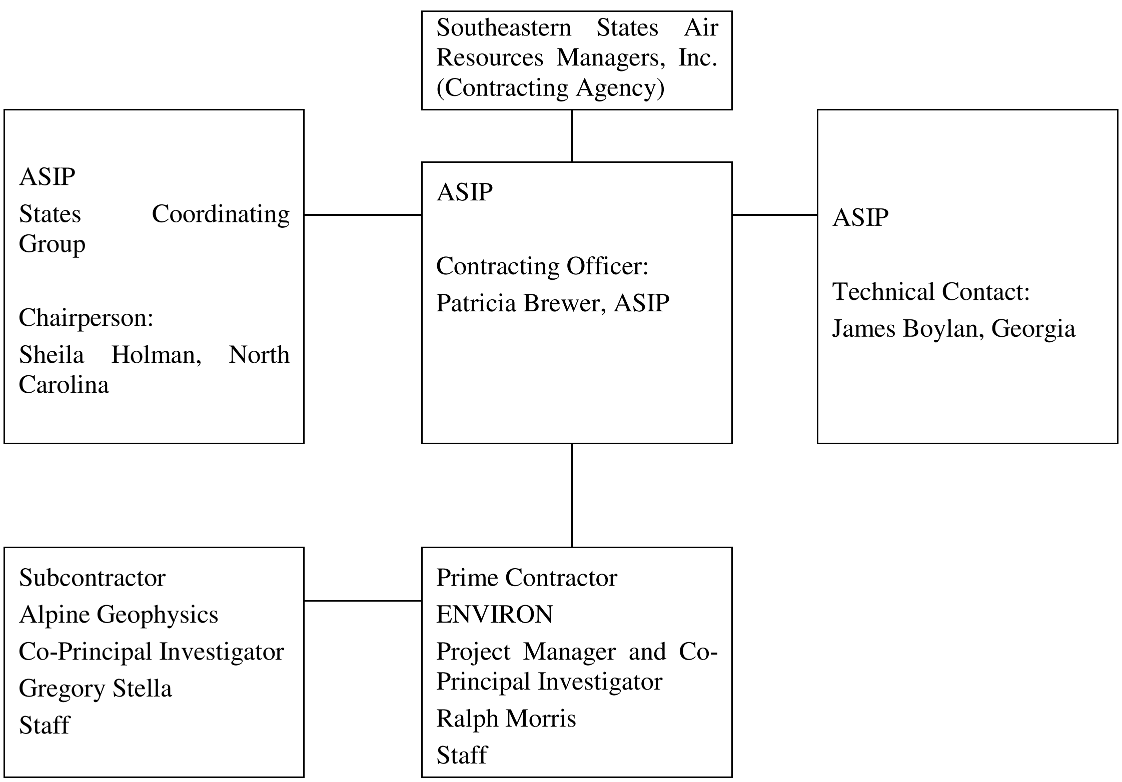

Figure 1-4. ASIP Emissions and Air Quality Modeling Project Organizational Chart.

Table 1-2. ASIP Emissions and Air Quality Modeling project participants and contacts.

Person & Role	Affiliation/Address	Contact Information
Patricia Brewer (Contracting Officer)	ASIP Technical Coordinator 2090 US Highway 70 Swannanoa, NC 28778	(828) 296-4500 (Fax) (828) 299-7043 pat.brewer@ncmail.net
James Boylan (Technical Contact for Emissions & AQ Modeling)	Georgia DNR Air Protection Branch 4244 International Pkwy, Ste 120 Atlanta, GA 30354-3906	(404) 362-4851 (Fax) (404) 363-7100 James_Boylan@mail.dnr.state.ga.us
Michael Abraczinskas (Technical Contact for MM5 Modeling)	North Carolina DENR 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 715-3743 Michael.Abraczinskas@ncmail.net
Ralph Morris (Project Manager and Co-Principal Investigator)	ENVIRON 101 Rowland Way Novato, CA 94945	(415) 899-0708 (Fax) (415) 899-0707 rmorris@environcorp.com
Gregory Stella (Co-Principal Investigator)	Alpine Geophysics, LLC 387 Pollard Mine Road Burnsville, NC 28714	(828) 675-9045 (Fax) (828) 675-5801 gms@alpinegeophysics.com
Key ENVIRON Participants		
Bonyoung Koo	ENVIRON 101 Rowland Way Novato, CA 94945	(415) 899-0727 bkoo@environcorp.com
Abby Hoats	ENVIRON	(415) 899-0735 ahoats@environcorp.com
Steven Lau	ENVIRON	(415) 899-0739 slau@environcorp.com
Key Alpine Geophysics Participants		
Dennis McNally	Alpine Geophysics, LLC 7341 Poppy Way Arvada, CO 80007	(303) 421-2211 (Fax) (303) 421-9553 dem@alpinegeophysics.com
Cyndi Loomis	Alpine Geophysics, LLC 7341 Poppy Way Arvada, CO 80007	(303) 421-2211 (Fax) (303) 421-9553 cfl@alpinegeophysics.com
T. W. Tesche	Alpine Geophysics, LLC 3479 Reeves Drive Ft. Wright, KY 41017	(859) 341-7502 twt@iac.net

1.8 ASIP Project Manager and Co-Principal Investigator

Mr. Ralph Morris of ENVIRON is the Project Manager (PM) and Co-Principal Investigator (Co-PI) for the Association for Southeastern Integrated Planning (ASIP) Emissions and Air Quality Modeling Team. He provides overall direction to the project and establishes a policy relationship with the sponsor, ensuring that all issues of importance to the ASIP group are addressed. The PM is responsible for the overall conduct of the project, experimental design, reporting of the results, and interacting with the client, consultants, and project staff. The specific responsibilities of the PM include, but are not necessarily limited to, the following:

- Directs and coordinates the activities of the project team and computer facilities to conduct the test program
- Ensures that this QAPP and the Modeling Protocol are followed during the course of the project
- Guides the overall approach for performing modeling evaluations
- Keeps current on project status and delivers progress reports
- Conducts initial modeling or analysis of experiments to determine if inconsistencies or unexpected results suggest possible experimental or measurement problems
- Evaluates overall data quality, characterization results, and overall system performance with regard to meeting project objectives
- Reviews and delivers modeling and assessment reports
- Interacts with external scientific reviewers, collaborators and other external groups in their area of expertise in the development of study priorities, reporting of results, and obtaining external input
- Oversees the project team in responding to any issues raised in assessment reports and initiates corrective actions as necessary
- Serve as ENVIRON's primary point of contact for contract issues
- Establishes a project budget and monitors the effort to ensure that budget is not exceeded
- Establishes a Subcontract with Alpine Geophysics, LLC to perform the work, and adhere to the terms and conditions of that contract
- Assists in the performance of the modeling program in accordance with its contract and the Work Plan
- Provides information to assist the ASIP group in achieving its goals as stated in its Work Plan and Strategic Plan
- Develops individual test protocols and reports as directed
- Analyzes modeling data and provides assessment reports
- Supports the Principal Investigator and ASIP in responding to any issues raised in assessment reports

1.8.1 ENVIRON and Alpine Geophysics Co-Principal Investigators

The two Co-Principal Investigators of Ralph Morris and Gregory Stella perform the following functions:

- Direct and coordinate the day-to-day project activities of the project team and computer facilities to conduct the test program

- Ensure that this QAPP and Modeling Protocol are followed during the course of the project
- Manage the activities in each of the two modeling centers
- Direct personnel working on this project
- Guide the approach for performing modeling evaluations following the direction of the Project Manager
- Keep current on project status and deliver information to Project Manager for progress reports
- Conduct initial modeling or analysis of experiments to determine if inconsistencies or unexpected results suggest possible experimental or measurement problems
- Evaluate overall data quality, characterization results, and overall system performance with regard to meeting project objectives
- Review and deliver data and sections for integration into modeling and assessment reports
- With the Project Manager, interact with external scientific reviewers, collaborators and other external groups in their area of expertise in the development of study priorities, reporting of results, and obtaining external input
- Oversee the project team in each modeling center responding to any issues raised in assessment reports and initiate corrective actions as necessary with the Project Manager
- Monitor the effort to ensure that budget is not exceeded
- Assist in the performance of the modeling program in accordance with its contract and the Work Plan
- Develop individual test protocols and report as directed
- Analyze modeling data and provide assessment reports

1.8.2 ASIP Contracting Officer

The ASIP Contracting Officer (Patricia Brewer) serves as the primary contact between the Emissions and Air Quality Modeling Team and ASIP and performs the following functions:

- Provides day-to-day oversight of the ASIP Emissions and Air Quality Modeling Team activities
- Works with the Project Manager, Co-Principal Investigators, SESARM, ASIP States, collaborators, Stakeholders, etc. to define scope of work and to assure that the interests and concerns of all of the ASIP participants are appropriately represented as project priorities are developed or modified due to external input
- Assists in organizing and conducting meetings, conference calls, and workshops where this and related projects are discussed
- Reviews work products

1.8.3 ASIP Technical Contact

The ASIP Technical Contact (James Boylan) for the Emissions and Air Quality Modeling Team works with the ASIP Contacting Officer in the day-to-day oversight and management of the modeling analysis:

- Provides day-to-day oversight of ASIP Emissions and Air Quality Modeling Team activities
- Works with the ASIP Contracting Officer, Project Manager, and Co-Principal Investigators to assure that the study is being carried out in a technically correct fashion following the QAPP and Modeling Protocol
- Prepares and gives presentations to VISTAS groups on the activities of the Modeling team.
- Reviews work products.

1.8.4 ASIP States

The primary purpose of the ASIP Emissions and Air Quality Modeling work is to develop the regional modeling component for 8-hour ozone and $PM_{2.5}$ State Implementation Plans (SIPs) being developed by several southeastern U.S. states that are due June 2007 and April 2008, respectively. Most of the ten VISTAS states also participate in ASIP. Alabama, Georgia, North Carolina, Kentucky, Tennessee, Virginia, and West Virginia have $PM_{2.5}$ non-attainment areas and Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia have 8-hour ozone non-attainment areas. The ASIP states will oversee the regional emissions inventory development and ozone and fine particulate modeling that will be required for the State Implementation Plans (SIP's). Emissions Inventory efforts include the development of 2002 base case emissions inventories and future year forecasts to be utilized in the ASIP modeling efforts. Modeling efforts will include identification, evaluation, and application of air quality modeling tools to quantify the effects of emission management options upon air quality in 8-hour ozone and $PM_{2.5}$ nonattainment areas in the southeastern United States. Specific activities of the ASIP States include:

- Oversee the activities of the ASIP Emissions and Air Quality Modeling Team through the Contracting Officer, conference calls, and periodic in-person meetings and workshops
- Provides the Contracting Officer, technical Contact, Project Manager and Co-Principal Investigators input on the research plans and their ability to meet the needs of the various stakeholders relevant to the overall objectives of the project
- Provides input as needed to assure that the project has effective and appropriate peer review
- Makes the Project Manager and Co-Principal Investigators aware of other projects that may be of relevance to this project
- Reviews the Modeling Protocol and QAPP and conducts critical project reviews

1.9 Communications Plan

The ASIP Emissions and Air Quality Modeling Team members, other ASIP Contractors and ASIP representatives are linked by e-mail correspondence, and also use this as a means to communicate and exchange data, either as e-mail attachments, website or by network-accessible files. A considerable amount of information is exchanged by e-mail within this project. The ASIP Modeling Team will use the same four listservs as used by VISTAS to distribute information to different groups as indicated in Table 1-3.

Table 1-3. VISTAS listservs that will be used to distribute information by the ASIP Emissions and Air Quality Modeling Team and other ASIP participants.

Listserv	Purpose
Vistas-all@cert.ucr.edu	Contacts all participants including Modeling Team, VISTAS TAWG and Stakeholders
Vistas-modeling@cert.ucr.edu	Contacts Modeling team and VISTAS TAWG Modeling Contacts
Vistas-emissions@cert.ucr.edu	Contacts emissions staff in the Modeling team and emissions people in the VISTAS TAWG
Vistas-met@cert.ucr.edu	Contacts meteorology staff in the Modeling team and meteorology people in the VISTAS TAWG

The Modeling Team members and ASIP States and Contracting Officer hold periodic conference calls and meetings to report results, discuss project status, and modify work plans as necessary. Unscheduled meetings or conference calls are also held concerning specific issues as the needs arise. In addition, periodic project meetings and conference calls are held. In these meetings detailed technical information is exchanged, project status is discussed, and project direction is assessed.

Written progress reports on the ASIP Emissions and Air Quality Modeling Team activities are submitted to the ASIP Contracting Officer on a monthly basis. These reports summarize project progress, results to date, problems encountered and necessary action items, and plans for the upcoming reporting period.

2.0 MODEL SELECTION

This chapter introduces the regional meteorological, emissions and air quality models to be used in the 8-hour ozone and $PM_{2.5}$ regional modeling for ASIP. The specific science configurations for each modeling system are identified and discussed briefly, where necessary. The configurations of each modeling system have been selected as the culmination of the regional modeling performed as part of the closely related VISTAS regional haze modeling efforts.

2.1 Recommended Models

Based on the findings in the VISTAS Phase I and II modeling activities, ASIP selected the following models for use in modeling 8-hour ozone and particulate matter (PM) of size of 2.5 microns or less ($PM_{2.5}$):

- **MM5:** The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5) is a nonhydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate, and regional haze regulatory modeling studies.

- **SMOKE**: The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad, area, point, fire and biogenic emission sources for photochemical grid models.

- **CMAQ:** EPA's Models-3/Community Multiscale Air Quality (CMAQ) modeling system is a 'One-Atmosphere' photochemical grid model capable of addressing ozone, particulate matter (PM), visibility and acid deposition at regional scale for periods up to one year.

Application of the MM5 for the 2002 annual period and the ASIP 36/12 km domains was performed by BAMS under contract to SESARM as part of the VISTAS Phase II activities. Details of the model application and evaluation procedures being carried out by BAMS may be found at http://www.baronams.com/projects/VISTAS/. For completeness, in this chapter we describe the three regional modeling systems and their intended use in the ASIP 2002 annual modeling.

2.2 MM5 Mesoscale Prognostic Model

Over the past decade, researchers at the Pennsylvania State University (PSU) and the National Center for Atmospheric Research (PSU/NCAR) have collaborated in the refinement and extension of the PSU Mesoscale Meteorological Model leading to the current version of the system, MM5 (Ver 3.6, MPP). Originally developed in the 1970s at PSU and first documented by Anthes and Warner (1978), the MM5 modeling system maintains its status as a state-of-the-science model through enhancements provided by a broad user community (e.g., Chen and

Dudhia, 2001; Stauffer and Seaman, 1990, 1991; Xiu and Pleim, 2000). The MM5 modeling system is routinely employed in forecasting projects as well as refined investigations of severe weather. Utilization of MM5 within air quality applications is also a common practice. In recent years, the MM5 modeling system has been successfully applied in continental scale annual simulations for the years 1996 (Olerud et al., 2000), 2001 (McNally and Tesche, 2003), and 2002 (Johnson, 2003). Due to its ongoing scientific development worldwide, extensive historical applications, broad user community support, public availability, and established performance record compared with other applications-oriented prognostic models, ASIP/VISTAS selected the MM5 as the preferred meteorological model. This section provides an overview of the MM5 and its data input requirements.

2.2.1 MM5 Overview

The non-hydrostatic MM5 model (Dudhia, 1993; Grell et al., 1994) is a three-dimensional, limited-area, primitive equation, prognostic model that has been used widely in regional air quality model applications (Seaman, 2000). The basic model has been under continuous development, improvement, testing and open peer-review for more than 20 years (Anthes and Warner, 1978; Anthes et al., 1987) and has been used world-wide by hundreds of scientists for a variety of mesoscale studies, including cyclogenesis, polar lows, cold-air damming, coastal fronts, severe thunderstorms, tropical storms, subtropical easterly jets, mesoscale convective complexes, desert mixed layers, urban-scale modeling, air quality studies, frontal weather, lake-effect snows, sea-breezes, orographically induced flows, and operational mesoscale forecasting.

MM5 is based on the prognostic equations for three-dimensional wind components (u, v, and w), temperature (T), water vapor mixing ratio (q_v), and the perturbation pressure (p'). Use of a constant reference-state pressure increases the accuracy of the calculations in the vicinity of steep terrain. The model uses an efficient semi-implicit temporal integration scheme and has a nested-grid capability that can use up to ten different domains of arbitrary horizontal and vertical resolution. The interfaces of the nested grids can be either one-way or two-way interactive. The model is also capable of using a hydrostatic option, if desired, for coarse-grid applications.

MM5 uses a terrain-following non-dimensionalized pressure, or "sigma", vertical coordinate similar to that used in many operational and research models. In the non-hydrostatic MM5 (Dudhia, 1993), the sigma levels are defined according to the initial hydrostatically-balanced reference state so that the sigma levels are also time-invariant. The gridded meteorological fields produced by MM5 are directly compatible with the input requirements of 'one atmosphere' air-quality models using this coordinate (e.g., CMAQ). MM5 fields can be easily used in other regional air quality models with different coordinate systems (e.g., CAMx) by performing a vertical interpolation, followed by a mass-conservation re-adjustment.

Distinct planetary boundary layer (PBL) parameterizations are available for air-quality applications, both of which represent sub-grid-scale turbulent fluxes of heat, moisture and momentum. These parameterizations employ various surface energy budget equations to estimate ground temperature (T_g), based on the insolation, atmospheric path length, water vapor, cloud cover and longwave radiation. The surface physical properties of albedo, roughness length, moisture availability, emissivity and thermal inertia are defined as functions of land-use for numerous categories via a look-up table. One scheme uses a first-order eddy diffusivity formulation for stable and neutral environments and a modified first-order scheme for unstable regimes. The other uses a prognostic equation for the second-order turbulent kinetic energy, while diagnosing the other key boundary layer terms.

Initial and lateral boundary conditions are specified from mesoscale three-dimensional analyses performed at 12-hour intervals on the outermost grid mesh selected by the user. Additional surface fields are analyzed at three-hour intervals. A Cressman-based technique is used to analyze standard surface and radiosonde observations, using the National Meteorological Center's (NMC) spectral analysis as a first guess. The lateral boundary data are introduced into MM5 using a relaxation technique applied in the outermost five rows and columns of the most coarse grid domain.

A major feature of the MM5 is its use of state-of-science methods for Four Dimensional Data Assimilation (FDDA). The theory underlying this approach and details on how it has been applied in a variety of applications throughout the country are described in depth elsewhere (Stauffer and Seaman, 1990, 1991; Seaman et al., 1992, 1997).

Results of detailed performance evaluations of the MM5 modeling system in regulatory air quality application studies have been widely reported in the literature (e.g., Emery et al., 1999; Tesche et al., 2000, 2003) and many have involved comparisons with other prognostic models such as RAMS and SAIMM. The MM5 enjoys a far richer application history in regulatory modeling studies compared with RAMS or other models. Furthermore, in evaluations of these models in over 60 recent regional scale air quality application studies since 1995, we have generally found that MM5 model tends to produce somewhat better photochemical model inputs than alternative models. For these and other reasons set forth in the MM5 modeling protocol developed by BAMS (Olerud and Sims, 2003), MM5 was selected as the meteorological modeling system for the ASIP/VISTAS study.

2.2.2 MM5 Configuration for ASIP and VISTAS Phase II Modeling

Based on the extensive sensitivity testing carried out by Olerud and Sims (2003) as part of VISTAS, the MM5 (Ver 3.6, MMP) configuration to be used by BAMS modelers in the VISTAS Phase II modeling that will also be used by ASIP will consist of the following (see Table 2-3 for more details):

> Nested 36/12 km grids, with 34 vertical layers;
> Two way nesting, no feedback;
> Initialization and boundary conditions from Eta analysis fields;
> Pleim-Xiu (P-X) soil model;
> Asymmetric Convective Mixing (ACM) PBL model;
> Kain-Fritsch 2 cumulus parameterization;
> Mixed phase (Reisner 1) cloud microphysics;
> Raptid Radiative Transfer Model (RRTM) radiation;
> Snow effect turned on;
> ETA model sea surface temperature;
> 24-category USGS vegetation data sets;

> Thermal roughness by the Garratt method; and
> Standard FDDA analysis nudging on 36 km and 12 km grid nests.

2.3 SMOKE Emissions Modeling System

2.3.1 SMOKE Overview

The Sparse Matrix Operator Kernel Emissions (SMOKE) Emissions Processing System Prototype was originally developed at MCNC (Coats, 1995; Houyoux and Vukovich, 1999). As with most 'emissions models', SMOKE is principally an *emission processing system* and not a true *emissions modeling system* in which emissions estimates are simulated from 'first principles'. This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting emissions inventory data into the formatted emission files required by an air quality simulation model. For mobile sources, SMOKE actually simulates emissions rates based on input mobile-source activity data, emission factors and in some cases, outputs from transportation travel-demand models.

SMOKE was originally designed to allow emissions data processing methods to utilize emergent high-performance-computing (HPC) as applied to sparse-matrix algorithms. Indeed, SMOKE is the fastest emissions processing tool currently available to the air quality modeling community. The sparse matrix approach utilized throughout SMOKE permits both rapid and flexible processing of emissions data. The processing is rapid because SMOKE utilizes a series of matrix calculations instead of less efficient algorithms used in previous systems. The processing is flexible because the processing steps of temporal projection, controls, chemical speciation, temporal allocation, and spatial allocation have been separated into independent operations wherever possible. The results from these steps are merged together at a final stage of processing.

SMOKE supports area, mobile, fire and point source emission processing and also includes biogenic emissions modeling through a rewrite of the Biogenic Emission Inventory System, Version 3 (BEIS3) (see, http://www.epa.gov/ttn/chief/software.html#pcbeis). SMOKE has been available since 1996, and it has been used for emissions processing in a number of regional air quality modeling applications. In 1998 and 1999, SMOKE was redesigned and improved with the support of the U.S. Environmental Protection Agency (EPA), for use with EPA's Models-3/CMAQ (http://www.epa.gov/asmdnerl/models3). The primary purposes of the SMOKE redesign were support of: (a) emissions processing with user-selected chemical mechanisms and (b) emissions processing for reactivity assessments.

SMOKE contains a number of major features that make it an attractive component of the VISTAS modeling system (Seppanen, 2003). The model supports a variety of input formats from other emissions processing systems and models including the Inventory Data Analyzer (IDA), Emissions Modeling System—2003 (EMS-2003), and the Emissions Preprocessor System 2.x (EPS2.x). It supports both gridded and county total land use scheme for biogenic emissions modeling. Although not necessary in ASIP, SMOKE can accommodate emissions files from up to 10 countries and any pollutant can be processed by the system.

Recent *computational improvements* to SMOKE include: (a) enhanced disk space requirements compared with other emissions processing software, (b) run-time memory allocation, eliminating any need to recompile the programs for different inventories, grids, or chemical mechanisms, and (c) updated I/O API libraries. A number of *science features* have been incorporated into the version 2.0 of SMOKE including: (a) any chemical mechanism can be used to partition pollutants to model species, as long as the appropriate input data are supplied, (b) integration with the MOBILE6.2 on-road mobile source emissions model including link based processing, (c) support of plume-in-grid (PiG) processing, (d) integration of the BEIS3 emissions factors in SMOKE.

Notable features of SMOKE from an *applications* standpoint include: (a) improved control strategy input formats and designs, (b) control strategies can include changes in the reactivity of emitted pollutants, a useful capability, for example, when a solvent is changed in an industrial process, (c) no third party software is required to run SMOKE, although some input file preparation may require other software, (d) fewer SMOKE programs than the SMOKE prototype because programs were combined where possible to be used for multiple source categories, (e) integration with Models-3 file formats and settings, (f) improved data file formats, (g) support of various air quality model emissions input formats (e.g., CMAQ, MAQSIP, UAM-IV, UAM-V, REMSAD and CAMx), (h) enhanced quality assurance pre- and post-processing, (h) fully integrated with Models-3, which will provide the SMOKE Tool for SMOKE input file preparation, (i) enhanced treatment of growth and control factors, (j) improved emissions reporting and QA capabilities, and (k) improved temporal allocation.

Continuing model development activities with SMOKE now occur out of the University of North Carolina (UNC) Carolina Environmental Program (CEP). SMOKE beta Version 1.5b was released 17 March 2003 and this is the version employed in the VISTAS Phase I modeling. Several patches to the model were provided during the summer of 2003, and SMOKE Version 2.0 was released on 30 Sept '03. In 2004 SMOKE Version 2.1 was released that contained further improvements and enhancements. The VISTAS/ASIP modeling adopted SMOKE Version. 2.1 at that time. In September 2005 SMOKE Version 2.2 was released by the Community Modeling and Analysis (CMAS) center's Model Clearinghouse at http://www.cmascenter.org/modelclear.shtml. At that time ASIP/VISTAS had expended considerable effort in setting up and performing emissions modeling using SMOKE Version 2.1. Additionally, the upgrades identified in Version 2.2 were options that ASIP/VISTAS had circumvented using existing file code and formats and switching to this latest version was felt could jeopardize the modeling schedule. Consequently, ASIP elected to continue emissions modeling using SMOKE Version 2.1. The SMOKE user's guide is available online at the main SMOKE website, http://www.cep.unc.edu/empd/products/smoke.

2.3.2 SMOKE Configuration for ASIP Modeling

As an emissions processing system, SMOKE has far fewer 'science configuration' options compared with the MM5 and CMAQ models. For a thorough characterization of the methods that will be used to exercise the SMOKE system for the annual 2002 emissions processing, see Section 5.2, "Development of Emissions Model Inputs and Resultant Inventories". Table 2-4 summarizes the version of the SMOKE system to be used and the sources of data to be employed in constructing the required modeling inventories.

2.4 CMAQ Modeling System

2.4.1 CMAQ Overview

For more than a decade, EPA has been developing the Models-3 Community Multiscale Air Quality (CMAQ) modeling system with the overarching aim of producing a 'One-Atmosphere' air quality modeling system capable of addressing ozone, particulate matter (PM), visibility and acid deposition within a common platform (Dennis, et al., 1996; Byun et al., 1998a; Byun and Ching, 1999, Pleim et al., 2003). The original justification for the Models-3 development emerged from the challenges posed by the 1990 Clean Air Act Amendments and EPA's desire to develop an advanced modeling framework for 'holistic' environmental modeling utilizing state-of-science representations of atmospheric processes in a high performance computing environment (Ching, et al., 1998). EPA completed the initial stage of development with Models-3 and released the Community Multi-Scale Air Quality model (CMAQ) in mid-1999 as the initial operating science model under the Models-3 framework (Byun et al., 1998b). Since the initial CMAQ release in 1999, there have typically been annual[GMS1]

CMAQ consists of a core Chemical Transport Model (CTM) and several pre-processors including the Meteorological-Chemistry Interface Processor (MCIP), initial and boundary conditions processors (ICON and BCON) and a photolysis rates processor (JPROC). EPA is continuing to improve and develop new modules for the CMAQ model and typically provides a new release each year. In the past EPA has also provides patches for CMAQ as errors are discovered and corrected. EPA has funded the Community Modeling and Analysis Systems (CMAS) center to support the coordination, update and distribution of the Models-3 system.

A number of features in CMAQ's theoretical formulation and technical implementation make the model well-suited for annual PM and 8-hour ozone modeling. In CMAQ, the modal approach has been adapted to dynamically represent the PM size distribution using three log-normal modes (2 fine and 1 coarse). Transfer of mass between the aerosol and gas phases is assumed to be in equilibrium and all secondary aerosol (sulfate, nitrate, SOA) is assumed to be in the fine modes. The thermodynamics of inorganic aerosol composition are treated using the ISORROPIA module. Aerosol composition is coupled to mass transfer between the aerosol and gas phases. For aqueous phase chemistry, the RADM model is currently employed. This scheme includes oxidation of SO_2 to sulfate by ozone, hydrogen peroxide, oxygen catalyzed by metals and radicals. The impact of clouds on the PM size distribution is treated empirically. For wet deposition processes, CMAQ uses the RADM/RPM approach. Particle dry deposition is included as well. CMAQ contains three options for treating secondary organic aerosol (SOA), latest being the Secondary Organic Aerosol Model (SORGAM) that was updated in August 2003 to be an reversible semi-volatile scheme whereby VOCs can be converted to condensable gases that can then form SOA and then evaporate back into condensable gases depending on atmospheric conditions. Gas-phase chemistry can be treated by the CB4, RADM or SAPRC chemical mechanisms.

Pleim et al., (2003) describe the features implemented in CMAQ Version 4.3 (released August 2003). Many of these features are mentioned above; others pertain to details in the model's chemistry, transport, computer implementation, and model operation. In September 2004 CMAQ Version 4.4 was released that included updates and enhancements (Pleim, 2004). CMAQ Versions 4.3 and 4.4 were used for much of the VISTAS Phase I and II testing and model performance evaluation. In October 2005 CMAQ Version 4.5 was released (Pleim, 2005) which has been adopted for the ASIP and VISTAS modeling.

The VISTAS model evaluation indicated fairly good performance for sulfate, winter overestimation bias and summer underestimation bias for nitrate and reasonably good performance for Elemental Carbon (EC), albeit with lots of scatter and low correlation. However, Organic Carbon (OC) was underestimated with the summer OC underestimation bias being quite severe. As OC is typically the second most important PM component contribution to visibility impairment and is the most or second most important component contributing to $PM_{2.5}$ violations in the southeastern US, VISTAS and ASIP were concerned with the large OC underestimation tendency. After an intense focused analysis of the issue, VISTAS identified processes important to the formation of Secondary Organic Aerosols (SOA) that were not included in the CMAQ SOA module that may be important to OC in the Southeastern US (Morris et al., 2005). Consequently, VISTAS enhanced the CMAQ SOA module by adding several new processes. This enhancement, called SOAmods described below, was implemented in CMAQ Version 4.4 and exhibited much improved OC model performance over the standard CMAQ SOA treatment (Morris et al., 2005b).

In October 2005, the new Version 4.5 of CMAQ was released (Pleim, 2005). CMAQ Version 4.5 included several enhancements and corrections, including a correction to the CMAQ mass conservation scheme. Given the importance of mass conservation in air quality modeling, ASIP and VISTAS have adopted an enhanced version of CMAQ Version 4.5 for their modeling and transferred the SOAmods enhancement to it.

2.4.3 CMAQ Version 4.5

CMAQ Version 4.5 has several corrections, updates and enhancements over earlier versions of the model:

1) Aerosols
   - Added sea salt (fine equilibrium; non-interactive coarse mode) -- aero4
   - Updated aerosol dry deposition algorithm
   - Updated mechanism include files to remove any aerosol species with zero concentrations for aero4
   - Updated ISORROPIA to v1.5 (25 Oct 2003) and fixed some discontinuities
   - Added diagnostic variables to calculate PM2.5 concentrations
   - Corrected bug in mode merging to reduce mode crossover
   - Modified SO4 used in ISORROPIA call
   - Corrected inconsistency in MINL2SG (aerodepv)
   - Corrected the EMSULF (H2SO4 emissions) unit conversion bug

2) Chemistry
   - Added CB4/chlorine chemistry and associated EBI solver
   - Added CB4/air toxics and SAPRC99/air toxics chemistry and associated EBI solvers
   - Added degradation algorithm to the generalized solvers
   - Corrected treatment of convergence failures in EBI solvers

- No longer support the RADM2 mechanism

3) P-in-G
   - Improved calculation of plume centerline
   - Fixed bug in the aerosol species array subscripting
   - Corrected error in non-reactive species NH3 fluxes and dry deposition

4) PBL modeling
   - Updated to use PURB (% urban) for setting minimum Kz

5) Clouds
   - Added new sub-grid cloud mixing algorithm/module (based on ACM)
   - Added new cloud diagnostic variables
   - Corrected the interpolation times for resolved clouds (to time-step midpoint) and for subgrid clouds (to half hour)

6) Advection
   - Added new mass continuity scheme

7) Other
   - Added dynamic vertical layer allocation
   - Added primary carbon source apportionment capability
   - Added sulfate tracking capability

Thus, even though VISTAS Phase I and II modeling testing and evaluation and initial ASIP runs were performed using CMAQ Versions 4.3 and 4.4 and considerable effort has been committed to these earlier versions of CMAQ, the CMAQ Version 4.5 model updates were significant enough that VISTAS and ASIP decided to switch over to the new version (Ver 4.5) of CMAQ.

In the VISTAS testing and evaluation of the CMAQ V4.3 and V4.4, the model performance for Organic Carbon (OC) was characterized by a systematic under-prediction bias that was particularly severe in the summer. As OC is one of the two most important PM components for $PM_{2.5}$ exceedances and visibility degradation in the Southeastern US (SO4 being the other), VISTAS/ASIP were concerned with this underestimation tendency. Thus, VISTAS performed research in this area and identified several missing processes related to Secondary Organic Aerosol (SOA) formation in the CMAQ model. In particular, CMAQ failed to account for SOA from several biogenic emission sources such as sesquiterpenes and isoprene. Consequently, VISTAS enhanced the CMAQ SOA module to treat these missing processes that resulted in improved OC performance (Morris et al., 2006). This SOAmods enhancement is discussed next.

2.4.4 SOAmods Enhancement

The formulation of the CMAQ SOA module is described in Binkowski and Roselle (2003). SOA is formed primarily from aromatic VOCs and biogenic terpenes. The biogenic

SOA precursors were modeled with the Biogenic Emissions Information System – Version 3 (BEIS3) model (Pierce et al., 2002). BEIS3 generates three biogenic VOC species: isoprene (ISOP), monoterpenes (TERP) and other biogenic VOC (OVOC). For this study, the Carbon Bond IV photochemical mechanism was used (Gery et al., 1987) that represents VOC compounds based on their carbon bond structure. The BEIS3 ISOP, TERP and OVOC species are speciated into the CB4 species for photochemical modeling in CMAQ and CAMx as follows (molar speciation):

- ISOP = ISOP (isoprene is an explicit species)
- ALD2 = 1.5 x TERP
- OLE = 0.5 x TERP
- PAR = 6.0 x TERP
- NR = 0.5 x OVOC
- OLE = 0.5 x OVOC
- PAR = 8.5 x OVOC
- TERPB = TERP

Here, ALD2, OLE, PAR and NR are the CB4 chemical mechanism representations of the biogenic VOC emissions as high molecular weight aldehydes, olefinic carbon bond, paraffin carbon bond and non-reactive functional groups. In CMAQ, the TERPB species is specified in the emissions inputs, along with its CB4 representation of ALD2, OLE and PAR, but does not participate in the photochemical mechanism and is only used in the SOA formation module. The TERPB species forms a SGTOT species based on oxidation parameters extracted from the photochemical module. SGTOT consists of the combined gaseous condensable gas (CG) plus particle SOA that are assumed to be in equilibrium. CMAQ transports the SGTOT species and splits it to a CG gaseous and particle SOA for output.

The CMAQ TERB SOA formation rate is based on a fit to smog chamber data collected at the California Institute of Technology for several biogenic monoterpene species (Binkowski and Roselle, 2003). A review of recent literature of biogenic SOA measurements identified several processes that may be important to biogenic SOA formation that are not treated by the BEIS3 biogenic emissions and the CMAQ SOA module:

Polymerization: Recent measurements indicate that some SOA species may polymerize, resulting in species that are no longer volatile and cannot evaporate back to a CG. In this case, the equilibrium assumption between the CG and SOA will understate the amount of particle SOA present in the atmosphere (Kalberer et al., 2004; Jang et al., 2002).

Sesquiterpenes: Sesquiterpenes are not accounted for in the BEIS3/CMAQ SOA modeling system (Guenther et al., 2000; Vizuete et al., 2004).

Isoprene: More recent evidence suggests that isoprene can also form particle SOA compounds that are not accounted for in CMAQ (Claeys et al., 2004; Matsunaga et al., 2003; 2005).

Acid Catalyzation: Recent literature also suggests that some SOA formation may have acid catalyzed reactions (Claeys et al., 2004; Jang et al., 2005).

Heterogeneous Reactions: Recent evidence suggests that some SOA formation may occur during heterogeneous aqueous-phase chemical reactions (Yu et al., 2005).

A prototype module was added to CMAQ that accounted for the first three processes listed above. The last two processes were not included in this work because there are not enough quantitative experimental data yet to establish a parameterization. Modules were added to the CMAQ SOA module under the following constraints:

- The existing CMAQ SOA module for monoterpenes would remain unchanged;
- The same CMAQ model inputs would be used; and
- The basic CMAQ model formulation would remain unchanged, modules would be added to account for polymerization and SOA from sesquiterpenes and isoprene.

Figure 2-1 displays how the prototype representation of new processes to represent SOA polymerization and SOA formation from sesquiterpenes and isoprene were added to the CMAQ SOA module using the existing CMAQ structure and inputs. The new components of the SOA module are indicated in bold italic, whereas the existing CMAQ SOA components (Binkowski and Roselle, 2002) use a regular font. There are several parameters that must be defined in the new elements of the enhanced SOA module: emission factors (EF), canopy escape efficiencies for gases (EEG) and aerosols (EEA) and SOA yields (Y). Based on an analysis of recent measurements, primarily from a recent biogenic emissions field study in Duke Forest, North Carolina (Stroud et al., 2005; Matsunaga et al., 2005), a range of values for the factors in Figure 2-1 were developed as shown in Table 2-1. For the initial prototype of the enhanced SOA module, we selected the mid-point of the range values for the factors from the measurements (Table 2-1). No attempt was made to optimize the parameters in Table 2-1 for OC/TCM model performance.

The emission factors, EF1 and EF2, relate the monoterpene emissions estimated by BEIS3 to emissions of monoterpenes, EF1 (e.g., α-pinene), and sesquiterpenes (EF2). Table 2-1 displays the range of EF1 and EF2 factors based on recent field study data (Stroud et al., 2005). Using the midpoint of the range results in emission factors of 0.7 for EF1 and 0.4 for EF2. EF1 is assigned a value of 0.7 based on field observations that indicate that the BEIS3 terpene emission factors are likely overestimated due to a tendency of earlier measurements approaches to artificially increase the emissions due to disturbance when leaves were enclosed in the measurement system. As an initial approach for including sesquiterpene emissions, we have assigned EF2 a value of 0.4 based on the ratio of the observed sesquiterpene emission from the Duke Forest field study (Stroud et al, 2005) to the BEIS3 monoterpene emission estimate. The net result is that BEIS3 TERP emissions are increased by 10% and split 64% as monoterpenes and 36% as sesquiterpenes. The CG yields from the sesquiterpenes are assumed to partly condense into a non-volatile SOA particle that is modeled in CMAQ using the new secondary organic carbon species (SOC2) species and only some of the gas and aerosol species associated with sesquiterpenes are assumed to escape from the canopy using the mid-range of the Escape Efficiencies (EE) estimated by Stroud et al. (2005). The fraction of BEIS3 TERP emissions that are assumed to be monoterpenes (i.e., 64% of the emissions) are treated with the standard CMAQ two-product SOA module (Binkowski and Roselle, 2003) assuming equilibrium between the CG and SOA with the SOA output in the standard AORGB species (Binkowski and Roselle, 2003).

The isoprene SOA formation pathway forms a CG using the mid-point yield rate based on the range of recent measurements (Stroud et al., 2005) and a CG/SOA partitioning rate based on the mid-point of measurements from Matsunaga et al. (2003, 2005) (Table 2-1). The isoprene SOA is assumed to be volatile and is modeled as a new secondary organic carbon species in CMAQ SOAmods (SOC3). Finally, all SOA species, with the exception of the already non-volatile SOC1 (polymerized SOA) and SOC2 (sesquiterpene product) species, are assumed to partially polymerize into non-volatile particles that are stored in the SOC1 species. The polymerization rate is based on the results of Kalberer et al (2004) who found that 50% of the SOA polymerized in 20 hours.

Several levels of Quality Assurance and Quality Control of the enhanced SOAmods module in the CMAQ model were conducted as follows.

QA/QC of SOAmods Coding: The SOAmods implementation was conducted at ENVIRON. Staff at the University of California at Riverside performed independent QA/QC of the SOAmods code implementation and independent testing and evaluation.

QA of SOAmods Formulation: The new processes being added to the CMAQ SOA module was discussed with researchers at EPA's Office of Research and Development (ORD). Although they have not completed all the laboratory tests, the inclusion of SOA from sesquiterpene and isoprene has been observed and are supported.

Peer Review of SOAmods: The formulation of the SOAmods enhancement to the CMAQ SOA module was documented and comments were received by several parties. The results were also written up and submitted to *Atmospheric Environment* where it was subjected to peer review and is awaiting publication (Morris et al., 2006).

Model Performance Evaluation of SOAmods: The final level of QA of the SOAmods was comparisons of CMAQ V4.4 model performance with and without including the SOAmods enhancement. Table 2-2 displays fractional bias error for Organic Carbon (OC) IMPROVE and STN monitoring sites in the VISTAS, MRPO, MANE-VU and CENRAP states using the standard CMAQ Version 4.4 (V4.4) and then CMAQ V4.4 with the SOAmods enhancement. Whereas the standard CMAQ V4.4 underestimates OC across IMPROVE sites of from –76% (MRPO) to –102% (VISTAS), with the SOAmods enhancement the fractional biases centered on zero and ranges from –14% to +8%. Similar results are seen for OC fractional bias across the more urban STN sites where the CMAQ V4.4 exhibits an underestimation bias of –67% to –105%, when using SOAmods the under-prediction bias is –27% to –44%. Note that the continued underestimation of OC across the urban STN sites is likely due to missing primary OC emissions and uncertainties in the STN OC measurements.

With the release of CMAQ Versions 4.5 in October 2005, the SOAmods enhancement was added to the AERO3 aerosol module in CMAQ Version 4.5 that was compared against the standard CMAQ Versions 4.5 and SOAmods was found to produce similar improvements in OC model performance as seen with CMAQ Versions 4.4. ASIP and VISTAS are now proceeding with their regional haze and 8-hour ozone/$PM_{2.5}$ modeling using the CMAQ Versions 4.5 SOAmods.

2.4.5 CMAQ Configuration for ASIP Modeling

The configuration of CMAQ used in the ASIP modeling is based on the extensive testing and evaluation of several versions and configurations of CMAQ performance as part of Phase I and II of the VISTAS modeling (Morris et al., 2004a,b; Morris et al., 2005a). As part of VISTAS, the science team has tested and evaluated CMAQ versions 4.3, 4.4beta, 4.4 and 4.5. When the CMAQ treatment of SOA was found to be incomplete, it was enhanced with the SOAmods update, first in CMAQ Version 4.4 and then in CMAQ Version 4.5. In this section we identify the main science options we recommend for 8-hour ozone and $PM_{2.5}$ modeling with CMAQ. In particular, we propose to run CMAQ Version 4.5 with the SOAmods enhancement and the configuration as shown in Table 2-5. The model would be set up and exercised on the same nested 36/12 km grid domain used in VISTAS, employing one-way grid nesting. That is, boundary conditions for the 12 km grid simulation are extracted from the 36 km run using the CMAQ BCON processor. A total of 19 vertical layers would be implemented, extending up to a region top of 100 mb (approximately 15 km AGL).

The PPM horizontal advection solver will be used along with the spatially varying (Smagorinsky) horizontal diffusion approach and K-theory for vertical diffusion. The new Yamertino vertical transport scheme of CMAQ Version 4.5 will be used to correct the mass conservation problems in past versions of the model. MM5 meteorological output based on the Pleim-Xiu Land-Surface Model (LSM) and the ACM planetary boundary layer (PBL) scheme will be used (see Table 2-3) and the recently updated CMAQ Meteorological-Chemistry Interface Processor (MCIP3.0) would process the MM5 data using the "pass through" option. The CB4 gas-phase, RADM aqueous-phase, and AERO4/ISORROPIA aerosol chemistry schemes are recommended for use in the CMAQ 2002 modeling. Treatment of reversible secondary organic aerosols would be simulated by the SORGAM implementation in CMAQ with the SOAmods enhancement described above.

2.5 Model Limitations

All mathematical models possess inherent limitations owing to the necessary simplifications and approximations made in formulating the governing equations, implementing them for numerical solution on fast computers, and in supplying them with input data sets and parameters that are themselves approximations of the full state of the atmosphere and emissions processes. Below, we list the more important limitations of the various modeling systems to be employed in ASIP and VISTAS modeling.

2.5.1 MM5

Four different configurations of the MM5 Land Soil Model (LSM) and Planetary Boundary Layer (PBL) were evaluated as part of the 2002 meteorological modeling. Depending on the meteorological variable (e.g., winds, temperature, moisture) and location (e.g., mountains, coastal, east, west) different LSM_PBL configurations performed better. The Pleim-Xiu Asymmetric Convective Mixing PX_ACM LSM_PBL configuration was selected because it consistency was near the top performing configuration in the VISTAS region across variables and locations and was never the worst performing configuration. However, there are numerous limitations in the MM5 with the LSM and PBL treatment being some of the most important. The MM5 PX_ACM frequently predicts very low PBL heights that can appear as "holes" in the spatial distribution of PBL heights that don't appear physically realistic and may affect air quality modeling. Although the MM5 PX_ACM configuration model performance in the VISTAS region mostly met performance benchmarks, the performance was much worst in the western U.S. In addition, there is a stochastic component of real world meteorology that is not captured by MM5. For example, for some ozone episodes stagnation is an important attribute that MM5 fails to simulate well as it tries to organize the flow fields. The MM5 model represents approximately 20 years of development by various researchers and is showing its age. The many limitations in MM5 have spawned the development of a new meteorological model, the Weather Research Forecast (WRF) model. However, the WRF model will not be used or tested in the VISTAS/ASIP modeling.

2.5.2 SMOKE

In the VISTAS Phase I study a number of undocumented features of the SMOKE 1.5b version necessitated re-runs of the emissions processing software to overcome errors and/or ambiguities in source documentation and QA reporting. Although there were fewer problems with the SMOKE Version 2.0 and 2.1 releases, problems were encountered that were not well documented that necessitated reruns of the model. In October 2005 Version 2.2 of SMOKE was released. However, for reasons discussed earlier, ASIP elected to keep using Version 2.1 and not transition to the new SMOKE Version 2.2. VISTAS has fully set up and evaluated SMOKE Version 2.1, including identification of problems in the modeling that have been corrected. Switching to the new Version 2.2 could not only cause a serious set back in the ASIP modeling schedule, it may result in picking up additional new undocumented errors in the new modeling system that could require rerunning scenarios. Should problems arise or issues be encountered which would require additional SMOKE runs or potential SMOKE modifications or alternate modeling methods, we will immediately notify ASIP and make recommendations for resolving the issues. Upon receipt of technical direction from ASIP, appropriate corrective action will be taken.

Features are continuing to be developed in the SMOKE emissions model. As it is not as mature as some other emission models (e.g., EMS, EPS, etc.) it does not include as many features. We will keep abreast of SMOKE development activities to identify new features that will assist in the ASIP emissions modeling.

2.5.3 CMAQ

Like all air quality models, a major limitation of CMAQ is the emissions, meteorological and IC/BC inputs. Key science limitations in the model itself include the nitrate formation and Secondary Organic Aerosol (SOA) chemistry. The VISTAS testing found the CMAQ nitrate performance suspect with winter overestimations and summer underestimations. Improvements in the ammonia emissions inventory and model formulation have improved this performance attribute, especially the winter overestimation bias. Deficiencies in the CMAQ SOA module have been partly corrected with the SOAmods enhancement. However, the current SOAmods formulation is based on very little data and more refined SOA enhancements are needed. Lack of any two-way grid nesting limits the ability of the model to properly resolve point source plumes or urban photochemistry a without a prohibitive number of grid cells. Another limitation of CMAQ is the computational requirements, including the need of excessive disk space.

2.6 Model Input Requirements

Each of the ASIP/VISTAS modeling system components has significant data base requirements. These data needs fall into two categories: those required for model setup and operation, and those required for model evaluation testing. Below, we identify the main input data base requirements for the meteorological, emissions, and air quality models.

2.6.1 MM5

The databases required to set up, exercise, and evaluate the MM5 model for the annual 2002 episode consist of various fixed and variable inputs.

- Topography: High resolution (e.g., 30 sec to 5 min) topographic information derived from the Geophysical Data Center global data sets from the National Center for Atmospheric Research (NCAR) terrain databases are available for prescribing terrain elevations throughout the 36 km and 12 km grid domain.

- Vegetation Type and Land Use: Vegetation type and land use information on the 36 km grid may be developed using the NCAR/PSU 10 min. (~18.5 km) databases while for the 12 km grids, the United States Geological Survey (USGS) data are available.

- Atmospheric Data: Initial and boundary conditions to the MM5 may be developed from operationally analyzed fields derived from the National Center for Environmental Predictions (NCEP) ETA (40 km resolution) following the procedures outlined by Stauffer and Seaman (1990). These 3-hr synoptic-scale initialization data the horizontal wind components (u and v), temperature (T), and relative humidity (RH) at the standard pressure levels, plus sea-level pressure (SLP) and ground temperature (T_g). Here, T_g represents surface temperature over land and sea-surface temperature over water.

- Water Temperature: Water temperatures required on both 36 km and 12 km grids can be derived from the ETA skin temperature variable. These temperatures are bi-linearly interpolated to each model domain and, where necessary, filtered to smooth out irregularities.

- Clouds and Precipitation: While the non-hydrostatic MM5 treats cloud formation and precipitation directly through explicit resolved-scale and parameterized sub-grid scale processes, the model does not require precipitation or cloud input. The potential for precipitation and cloud formation enters through the thermodynamic and cloud processes formulations in the model. The only precipitation-related input required is the initial mixing ratio field that is developed from the NWS and NMC data sets previously discussed.

- Multi-Scale FDDA: The standard "multi-scale" data assimilation strategy to be used on the 36 km and 12 km grids will objectively analyzed three-dimensional fields produced every 3-hr from the NWS rawinsonde wind, temperature, and mixing ratio data, and similar analyses generated every three hours from the available NWS surface data.

2.6.2 SMOKE

The databases required to set up and operate SMOKE for the ASIP 2002 annual simulation are as follows:

- Area Source emissions in IDA format
- Fugitive Dust Source emissions in IDA format
- Nonroad source emissions in IDA format
- Non-EGU Stationary Point Source emissions in IDA format
- EGU Stationary Point Source emissions in IDA format
- CEM-Based EGU Emissions, hour specific for 2002
- Prescribed, Agricultural, and Wildfire Emissions, day specific for 2002
- Onroad Motor Vehicle VMT and activity data
- MOBILE6.2 input parameters

Also required for annual modeling are data files specific for:

- Temporal allocation
- Spatial allocation
- Speciation

Chapter 5 discusses the data input requirements and data sources in detail.

2.6.3 CMAQ

As described in more detail in Chapter 5, the CMAQ Chemical Transport Model (CTM) requires the following inputs:

- Three-dimensional hourly meteorological fields that will be generated by the CMAQ MCIP3.0 processing of the BAMS MM5 output;
- Three-dimensional hourly emissions generated by SMOKE;
- Initial conditions and boundary conditions (IC/BC);
- Topographic information;
- Land use categories; and
- Photolysis rates generated by the CMAQ JPROC processor.

Table 2-1. Parameters use in enhanced SOA module (see Figure 2-1).

Parameter	Mid-Point	Range
EF1	0.7	0.4 ~ 1.0
EF2	0.4	0.2 ~ 0.6
EEG1	0.325	0.2 ~ 0.45
EEA1	0.2	0.05 ~ 0.35
Y2	0.875	0.75 ~ 1.0
Y1	0.11	0.06 ~ 0.16
P1	0.45	0.15 ~ 0.75

EF1 = emission factor of monoterpenes to the TERP emissions estimated by BEIS3
EF2 = emission factor of sesquiterpenes relative to the TERP emissions estimated by BEIS3
EEG1 = escape efficiency of gas phase precursor of sesquiterpenes from canopy
EEA1 = escape efficiency of SOA from sesquiterpenes from canopy
Y1 = SOA yield of oxidated isoprenes
Y2 = SOA yield of sesquiterpenes

Table 2-2. Comparison of fractional bias performance metric for Organic Carbon (OC) using the standard CMAQ Version 4.4 (V4.4) and CMAQ V4.4 with the SOAmods enhancement.

July 2002 Fractional Bias	IMPROVE OC		STN OC	
	V4.4	SOAmods	V4.4	SOAmods
Southeastern U.S.	-102%	-2%	-105%	-32%
Midwestern U.S.	-76%	+12%	-67%	-24%
Northeast U.S.	-82%	-14%	-95%	-44%
Central U.S.	-98%	+8%	-81%	-27%

Table 2-3. MM5 Meteorological Model Configuration for ASIP		
Science Options	**Configuration**	**Details/Comments**
Model Code	MM5 Version 3.6 (MPP)	Grell et al., 1994
Horizontal Grid Mesh	36/12 km	
36 km grid	164 x 128 cells	
12 km grid	180 x 189 cells	
Vertical Grid Mesh	34 layers	Vertically varying; sigma pressure coord.
Grid Interaction	No Feedback	IFEED=0
Initialization	Eta first guess fields/LittleR	
Boundary Conditions	Eta first guess fields/LittleR	
Microphysics	Reisner I Mixed Ice	Look up table
Cumulus Scheme	Kain-Fritsch 2	On 36/12 Grids
Planetary Boundary Layer	ACM PBL	
Radiation	RRTM	
Vegetation Data	USGS	24 Category Scheme
Land Surface Model	P-X Land Surface Model (LSM)	
Shallow Convection	None	
Sea Surface Temperature	Eta Skin	Spatially varying
Thermal Roughness	Garratt	
Snow Cover Effects	None	
4D Data Assimilation	Analysis Nudging on 36/12	
Integration Time Step	90 seconds	
Simulation Periods	Annual 2002	Other episodic periods to be defined
Platform	Linux Cluster	Done at BAMS

Table 2-4. SMOKE Emissions Model Configuration for ASIP

Emissions Component	Configuration	Details/Comments
Emissions Model	SMOKE Version 2.1	Oct '04 release
Horizontal Grid Mesh	36/12 km	
36 km grid	148 x 112 cells	RPO Unified Grid
12 km grid	168 x 177 cells	VISTAS/ASIP eastern US 12 km grid
Area Source Emissions	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
On-Road Mobile Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Point Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states and stakeholders
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Off-Road Mobile Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Biogenic Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Temporal Adjustments	Seasonal, day, hour	Based on latest collected information and CEM-based profiles
Chemical Speciation	Revised CB4 Chemical Speciation	Expected EPA release in Jan '04
Gridding	Revised EPA Spatial Surrogates Used	Gridding of surrogates from http://www.epa.gov/ttn/chief/emch/spatial/
Growth and Controls	VISTAS Special Interest Team Generated Data	Base Cases defined by VISTAS Planning Workgroup
Quality Assurance	QA Tools in SMOKE 2.1	Independent QA with AG's Established Protocol
Simulation Periods	Annual 2002	Other episodic periods to be defined
Platform	Dual Athelon 2600 \+	Local 1.8 terabyte Ultra 320 RAID 5 system processing and storage

Table 2-5. CMAQ Air Quality Model Configuration for ASIP		
Science Options	**Configuration**	**Details/Comments**
Model Code	CMAQ Version 4.5 with SOAmods	Pleim et al., (2005)
Horizontal Grid Mesh	36/12 km	36 km covering cont. U.S; 12 km covering eastern US
36 km grid	148 x 112 cells	RPO National Grid
12 km grid	168 x 177 cells	VISTAS/ASIP 12 km grid
Vertical Grid Mesh	19 Layers	First 17 layers sync'd w/ MM5
Grid Interaction	One-way nesting	
Initial Conditions	~15 days full spin-up	Separately run 4 quarters of 2002
Boundary Conditions	2002 3-hourly GEOS-CHEM annual run	Day-specific 3-hour BCs from Global Climate Model
Emissions		
Baseline Emissions Processing	SMOKE (Ver 2.1)	MM5 Meteorology input to SMOKE, CMAQ
Dust Transport Fraction	Applied in emissions before SMOKE	Tom Pace updates
NH3 Inventory Adjustment	Applied in emissions before SMOKE	
Sub-grid-scale Plumes	No Plume-in-Grid (PinG)	
Chemistry		
Gas Phase Chemistry	CBM-IV	
Aerosol Chemistry	AE4/ISORROPIA	Includes active Sea Salt
Secondary Organic Aerosols	Secondary Organic Aerosol Model (SORGAM)	Schell et al., (2001)
Aerosol Mass Conservation Patch	Yes	Georgia Institute of Technology Update
Cloud Chemistry	RADM-type aqueous chemistry	Includes subgrid cloud processes
N2O5 Reaction Probability	0.01 – 0.001	
Meteorological Processor	MCIP Version 3.0	Includes dry deposition for Sea Salt and percent urban minimum Kz (PURB)
Horizontal Transport		
Eddy Diffusivity Scheme	K-theory with Kh grid size dependence	Multiscale Smagorinsky (1963) approach
Vertical Transport		
Advection Scheme	Yamertino	V4.5 Mass Conservation (Yamertino)
Eddy Diffusivity Scheme	K-theory	
Diffusivity Lower Limit	Kzmin = 0.1 to 2.0	PURB option in Ver 4.5
Planetary Boundary Layer	No Patch	
Deposition Scheme	M3dry	Directly linked to Pleim-Xiu Land Surface Model

Table 2-5. CMAQ Air Quality Model Configuration for ASIP		
Science Options	**Configuration**	**Details/Comments**
		parameters
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) solver	Hertel et al (1993) EBI solver ~ 2x faster than MEBI
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	
Simulation Periods	Annual 2002	With~15 day spin-up in December 2001
Integration Time Step	Determined by met conditions	15 minute coupling time step
Platform	Athlon MP 2600+	MPI using 6 processors per quarter

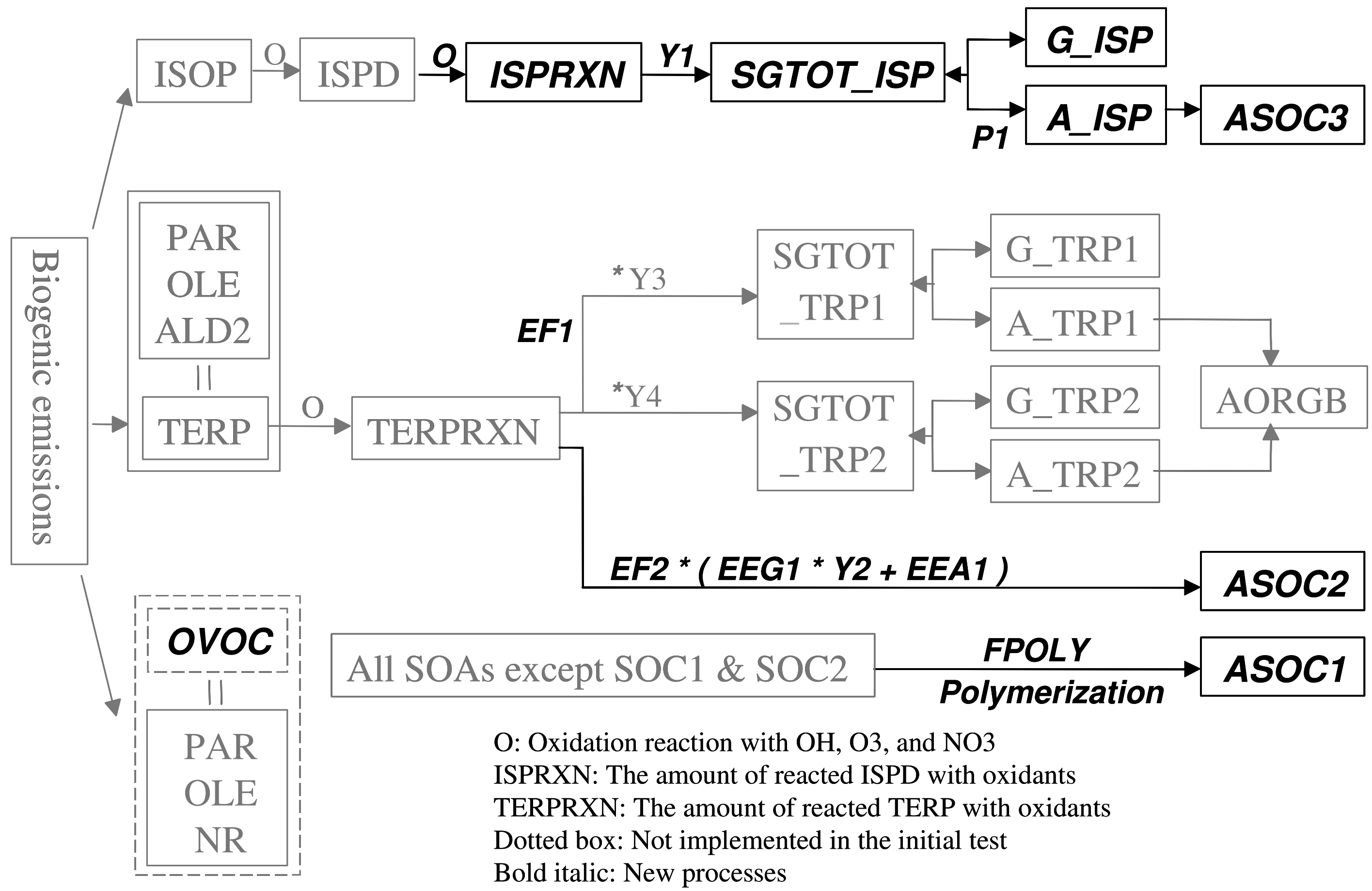

Figure 2-1. Schematic describing the addition of new SOAmods processes (bold italic) within the existing CMAQ SOA module (regular font) to treat polymerization and SOA from sesquiterpenes and isoprene (see Table 2-1 for parameters).

3.0 EPISODE SELECTION

This chapter provides a brief overview of the process followed by the ASIP in determining the most appropriate period(s) for $PM_{2.5}$ and 8-hour ozone modeling to be used in the Southeastern States $PM_{2.5}$ and 8-hour ozone attainment demonstrations for their State Implementation Plans (SIPs). As discussed in more detail below, one criteria in selecting modeling periods for attainment demonstration modeling is the selection of modeling periods for which databases already exist, if appropriate. This was a major criteria for the ASIP 8-hour ozone and $PM_{2.5}$ modeling that relied heavily on the VISTAS modeling databases. Thus, the ASIP episode selection was based on the analysis by the VISTAS Technical Analysis Work Group (TAWG) selection of the 2002 annual period for regional haze modeling. ASIP reviewed the 2002 annual period and also found it suitable for $PM_{2.5}$ and 8-hour ozone modeling. While ASIP and the VISTAS TAWG plan to prepare a formal report documenting these activities, this work was not available at the time of this writing. However, much of the technical work underpinning the ASIP/VISTAS episode selection process has been published and peer-reviewed over the later stages of the VISTAS work efforts and it is this body of information that we have distilled in preparing the brief episode selection summary that follows.

3.1 Overview of EPA Guidance

EPA's current draft guidance on $PM_{2.5}$/Regional Haze modeling (EPA, 2001) and final guidance for 8-hour ozone modeling (EPA, 2005) identifies specific goals to consider when selecting one or more episodes for use in demonstrating attainment of the $PM_{2.5}$ and 8-hour ozone NAAQS. There is much in common with selecting episodes for annual and episodic $PM_{2.5}$ and 8-hour ozone attainment demonstrations, as well as regional haze, EPA's guidance addresses all three in a consistent fashion in their guidance documents (EPA, 2001; 2005). As an update to the draft $PM_{2.5}$ and regional haze modeling guidance, EPA has published an updated summary of $PM_{2.5}$ and Regional Haze Modeling Guidance (Timin, 2002) that serves, in some respects, as in interim placeholder until the final guidance is issued as part of the PM2.5/regional haze NAAQS implementation process that is expected during 2006.

EPA recommends that episode selection derive from three principal criteria:

- A variety of meteorological conditions that lead to exeedances of the $PM_{2.5}$ and 8-hour ozone NAAQS should be covered;
- To the extent possible, the modeling data base should include days for which extensive data bases (i.e. beyond routine aerometric and emissions monitoring) are available; and
- Sufficient days should be available such that relative reduction factors (RRFs) can be based on several days ($\geq$ 15 days, with at least 5 days being essentially mandatory).

For regional haze and annual $PM_{2.5}$ modeling, the guidance goes further by suggesting that the preferred approach is to model a full, *representative* year (EPA, 2001, pg. 188). EPA also lists several 'other considerations' to bear in mind when choosing potential PM/regional haze and 8-hour ozone modeling episodes including: (a) choose periods which have already been modeled; (b) choose periods which are drawn from the years upon which the current design values are based; (c) include weekend days among those chosen; and (d) choose modeling periods that meet as many episode selection criteria as possible in the maximum number of nonattainment areas as possible.

ASIP and VISTAS adopted a logical, stepwise approach in implementing the EPA guidance in order to identify the most preferable, representative year for $PM_{2.5}$, regional haze and 8-hour modeling. These steps are summarized briefly in this chapter.

3.2 Episode Selection Methodology

The episode selection methodology entailed coordinated investigations by ASIP and VISTAS contractors and members of the VISTAS Technical Analysis Workgroup (TAWG). To begin, Olerud (2003b) identified important meteorological characteristics and data sets in the Southeastern U. S. directly relevant to the evaluation of candidate annual modeling episodes. A separate detailed aerometric analysis and pattern recognition study was carried out by ICF (Douglas et al., 2003) to characterize the extent to which days from January-March 2002 and January-March 2003 represent the type of meteorological conditions that are most frequently associated with high and low values of a haze index and $PM_{2.5}$ concentrations. Using the standard Classification and Regression Tree (CART) analysis software, these researchers characterized each of the days within these two three-month periods relative to haze and $PM_{2.5}$ observations as well as other relevant meteorological factors. This work was based on previous episode characterization work carried out in support of the SEARCH and MARAMA research projects (Douglas et al., 2003). The analysis was also supported by climate summaries provided by the North Carolina Division of Air Quality (NCDAQ).

In parallel with the CART episode characterization analyses, collaborative investigations by ASIP and VISTAS TAWG participants (e.g., NCDAQ, Georgia DNR, FL DEP) intensively studied the availability of $PM_{2.5}$ ozone, meteorological, and emissions data and representativeness of alternative Baseline modeling periods from a regulatory standpoint (Boylan et al., Brewer et al., 2003). Daily average speciated $PM_{2.5}$ monitoring data in the Southeastern US were review intensively, by site and by monitoring network (e.g., IMPROVE, SEARCH, STN, FRM). 8-hour ozone data for the nonattainment areas were also analyzed. In addition to analyzing data representativeness, consideration was given to the timeliness with which new data could be obtained for the ASIP and VISTAS modeling. Also, data availability from parallel meteorological and emissions database acquisition efforts was considered both for the Southeastern US states as well as for other states and countries in the 36 km domain.

To assess the representativeness of the five year baseline 2000-2004 period that is used in the 8-hour ozone, PM2.5 and regional haze projections (see Chapter 8), temperature and precipitation records were examined over the 108 yr period of record and additional high-resolution meteorological analyses were considered (e.g., CART analyses for SEARCH and MARAMA sites). For each PM2.5 monitoring site in the VISTAS domain, and for each component of PM 2.5, monthly means and deviations (from the monthly mean) were calculated for the months within the 2002-2003 period of record. Daily, monthly, and annual trends of PM 2.5 concentrations across the three year period were subsequently analyzed (Boylan et al., 2003). Equally as important, the methodologies and decisions underpinning the episode selection processes carried out by other RPOs were also considered (several had already chosen CY-2002 as the modeling year).

3.3 Selection of CY 2002 For ASIP and VISTAS

After a lengthy process of integrated studies, the episode selection process culminated in the selection of calendar year (CY) 2002 (1 January through 31 December) as the most current, representative, and pragmatic choice for VISTAS regional haze and ASIP 8-hour ozone and $PM_{2.5}$ modeling. All of the EPA criteria for 8-hour ozone, $PM_{2.5}$ and PM/regional haze episode selection were directly considered in this process together with many other pragmatic considerations (e.g., timing of new emissions or aerometric data deliveries by EPA or the states to the modeling teams).

4.0 MODELING DOMAINS AND DATA AVAILABILITY

This chapter summarizes the model domain definitions including the model domain, resolution, map projections and nesting schemes for high resolution sub-domains.

4.1 Horizontal Modeling Domain

The ASIP horizontal domains for each of the models will be identical to those used in the VISTAS Phase I and II modeling. As in VISTAS, as well as the CENRAP and WRAP RPOs, a coarse grid continental United States (US) domain with a 36 km horizontal grid resolution will be used (the Inter-RPO domain). The CMAQ domain is nested in the MM5 domain. The selection of the MM5 domain is described in the VISTAS MM5 modeling protocol (Olerud, 2003). Figure 4-1 shows the MM5 horizontal domain as the outer most, blue grid. Also shown in Figure 4-1 is the CMAQ 36 km domain nested in the MM5 domain. To achieve finer spatial resolution in the Southeastern US States are also using a one-way nested high resolution grid with a 12 km grid resolution. Figure 4-2 shows the 36 km CMAQ continental grid and the high resolution, nested 12-km grid in the VISTAS states. Figure 4-3 shows in more detail the 12 km grid for the Southeaster US region that is the focus of ASIP and VISTAS.

Both MM5 and CMAQ employ the Regional Planning Organization (RPO) unified grid definition for the 36 km continental domain. The RPO unified grid consists of a Lambert-Conformal map projection using the map projections parameters listed in Table 4-1.

Table 4-1. RPO Unified Grid Definition.

PARAMETER	VALUE
projection	Lambert-conformal
alpha	33 degrees
beta	45 degrees
x center	97 degrees
y center	40 degrees

The MM5 36 km grid includes 164 cells in the east-west dimension and by 128 cells in the north-south dimension. The CMAQ 36 km grid includes 148 cells in the east-west dimension and 112 cells in the north-south dimension. Because the MM5 model is also nested in the Eta model, there is a possibility of boundary effects near the MM5 boundary that occur as the Eta meteorological variables are being simulated by MM5 and must come into dynamic balance with MM5's algorithms. Thus, a larger MM5 domain was selected to provide a buffer of 8 to 9 grid cells around each boundary of the CMAQ 36 km domain. This is designed to eliminate any errors in the meteorology from boundary effects in the MM5 simulation at the interface of the MM5 and Eta models. The buffer region used here exceeds the EPA suggestion of at least 5 grid cell buffer at each boundary.

Table 4-2 lists the number of rows and columns and the definition of the X and Y origin (i.e., the southwest corner) for the 36 km and 12 km grids for both MM5 and CMAQ. Note that the CMAQ grid is rotated 90 degrees relative to the MM5 grid, so rows and columns are reversed. In Table 4-2 "Dot" refers to the grid mesh defined at the vertices of the grid cells while "cross" refers to the grid mesh defined by the grid cell centers. Thus, the dimension of the dot mesh is equal to the cross mesh plus one. Finally, we note that the grid definition for the CMAQ Meteorology Chemistry Interface Processor (MCIP) and CMAQ Chemical Transport Model (CCTM) are identical.

Table 4-2. Grid Definitions For MM5 and CMAQ.

MODEL	COLUMNS DOT(CROSS)	ROWS DOT(CROSS)	XORIGIN	YORIGIN
MM5 36km	129 (128)	165 (164)	-2952000	-2304000
CMAQ 36km	149 (148)	113 (112)	-2736000	-2088000
MM5 12km	190 (189)	181 (180)	7200	-1656000
CMAQ 12km	169 (168)	178 (177)	108000	-1620000

4.2 Vertical Modeling Domain

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employed a terrain following coordinate system defined by pressure, using 34 layers that extend from the surface to the 100 mb. Table 4-3 lists the layer definitions for both MM5 and for CMAQ. A layer averaging scheme is adopted for CMAQ to reduce the computational cost of the CMAQ simulations. The effects of layer averaging were evaluated in the VISTAS Phase I modeling effort and found to have a relatively minor effect on the model performance metrics when both the 34 layer and a 19 layer CMAQ models were compared to ambient monitoring data.

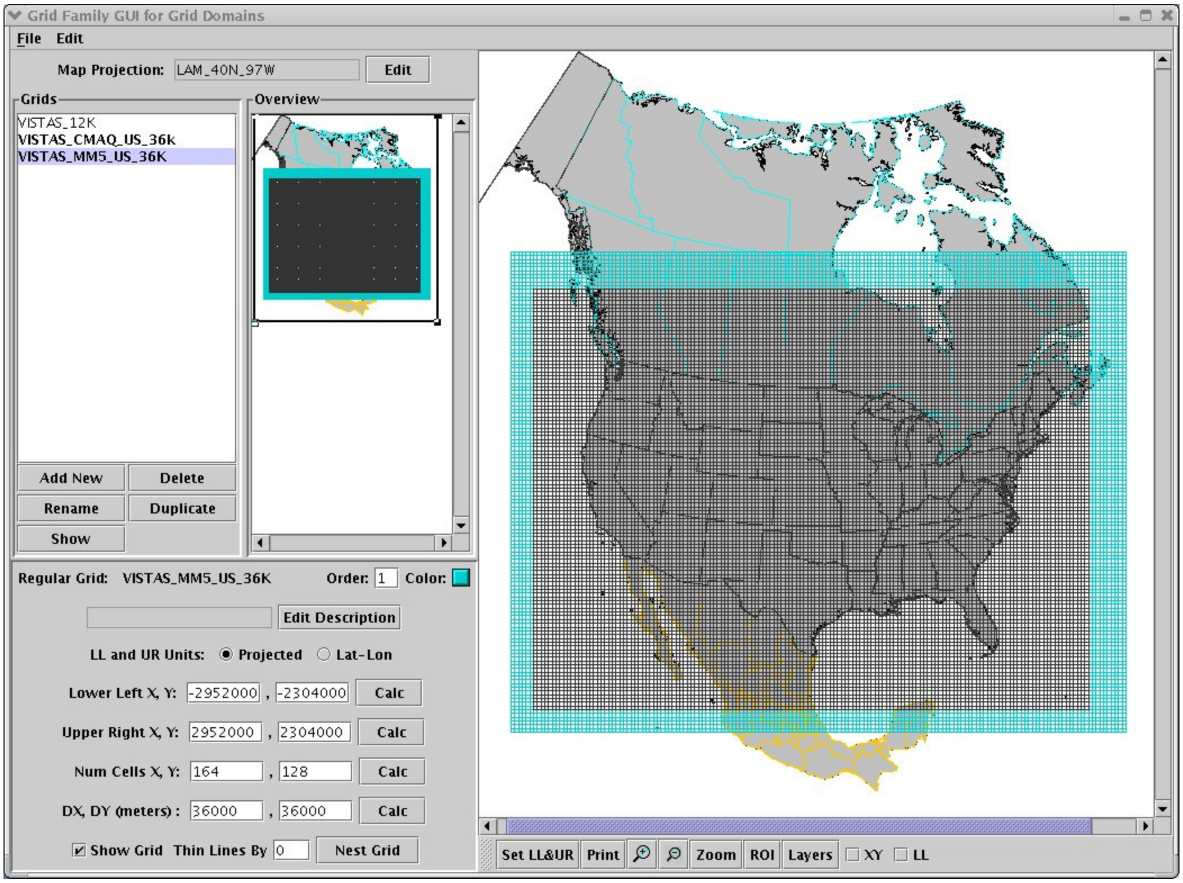

Figure 4-1. Nesting of 36-km CMAQ Grid in the MM5 36-km Grid.

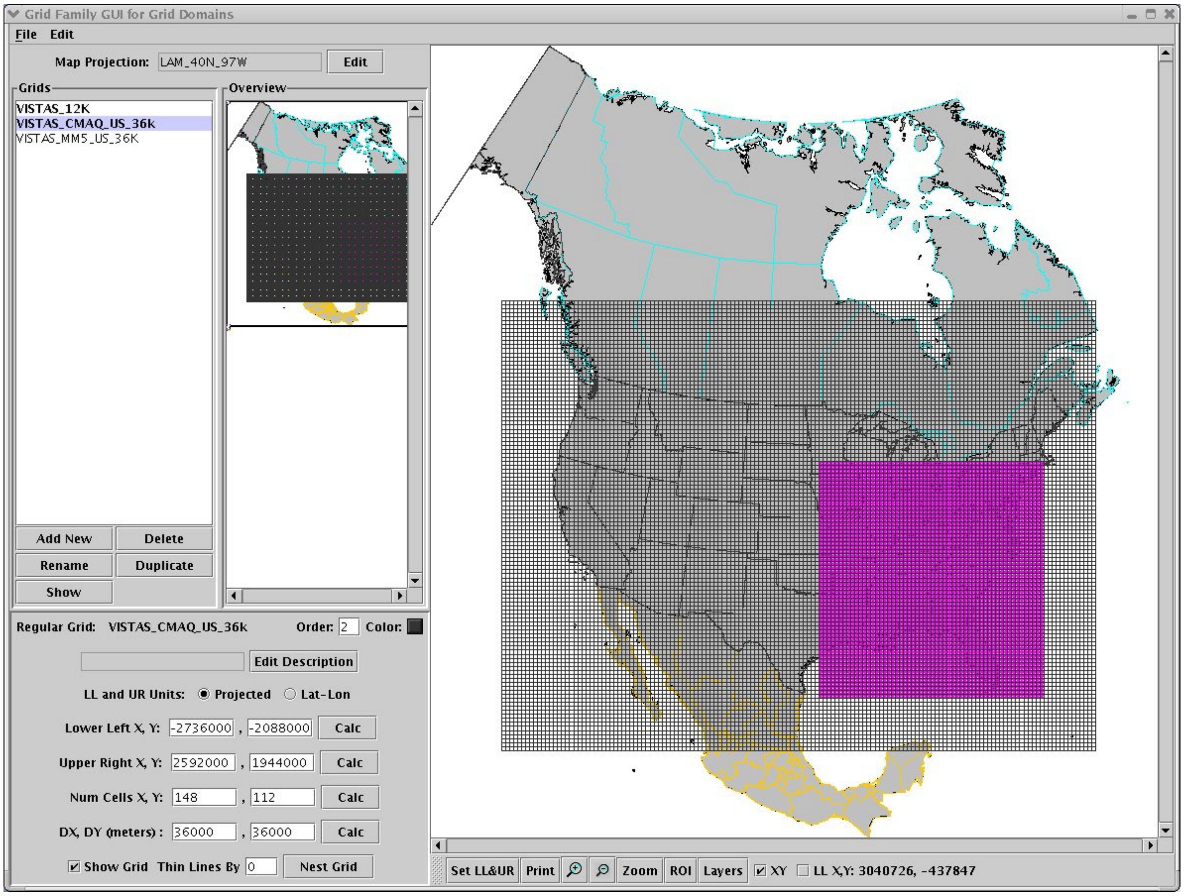

Figure 4-2. Nesting of 12-km Grid in the CMAQ 36-km Grid.

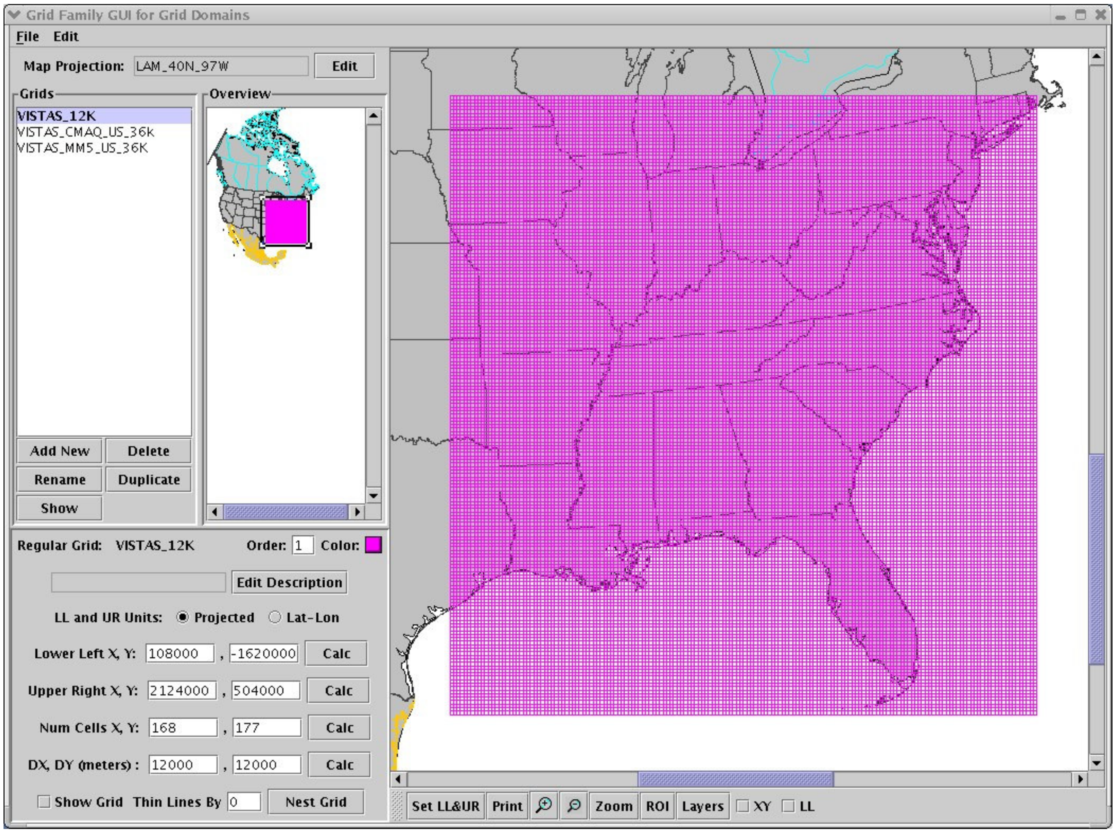

Figure 4-3. Domain Definition for High Resolution 12-km Grid.

Table 4-3. Vertical Layer Definition For MM5 Simulations (Left Most Columns), And Approach For Reducing CMAQ Layers By Collapsing Multiple MM5 Layers (Right Columns).

MM5					CMAQ 19L				
Layer	Sigma	Pres(mb)	Height(m	Depth(m)	Layer	Sigma	Pres(mb)	Height(m)	Depth(m)
34	**0.000**	**100**	**14662**	**1841**	**19**	**0.000**	**100**	**14662**	**6536**
33	0.050	145	12822	1466		0.050	145		
32	0.100	190	11356	1228		0.100	190		
31	0.150	235	10127	1062		0.150	235		
30	0.200	280	9066	939		0.200	280		
29	**0.250**	**325**	**8127**	**843**	**18**	**0.250**	**325**	**8127**	**2966**
28	0.300	370	7284	767		0.300	370		
27	0.350	415	6517	704		0.350	415		
26	0.400	460	5812	652		0.400	460		
25	**0.450**	**505**	**5160**	**607**	**17**	**0.450**	**505**	**5160**	**1712**
24	0.500	550	4553	569		0.500	550		
23	0.550	595	3984	536		0.550	595		
22	**0.600**	**640**	**3448**	**506**	**16**	**0.600**	**640**	**3448**	**986**
21	0.650	685	2942	480		0.650	685		
20	**0.700**	**730**	**2462**	**367**	**15**	**0.700**	**730**	**2462**	**633**
19	0.740	766	2095	266		0.740	766		
18	**0.770**	**793**	**1828**	**259**	**14**	**0.770**	**793**	**1828**	**428**
17	0.800	820	1569	169		0.800	820		
16	**0.820**	**838**	**1400**	**166**	**13**	**0.820**	**838**	**1400**	**329**
15	0.840	856	1235	163		0.840	856		
14	**0.860**	**874**	**1071**	**160**	**12**	**0.860**	**874**	**1071**	**160**
13	0.880	892	911	158	**11**	**0.880**	**892**	**911**	**158**
12	**0.900**	**910**	**753**	**78**	**10**	**0.900**	**910**	**753**	**155**
11	0.910	919	675	77		0.910	919		
10	**0.920**	**928**	**598**	**77**	**9**	**0.920**	**928**	**598**	**153**
9	0.930	937	521	76		0.930	937		
8	**0.940**	**946**	**445**	**76**	**8**	**0.940**	**946**	**445**	**76**
7	**0.950**	**955**	**369**	**75**	**7**	**0.950**	**955**	**369**	**75**
6	**0.960**	**964**	**294**	**74**	**6**	**0.960**	**964**	**294**	**74**
5	**0.970**	**973**	**220**	**74**	**5**	**0.970**	**973**	**220**	**74**
4	**0.980**	**982**	**146**	**37**	**4**	**0.980**	**982**	**146**	**37**
3	**0.985**	**986.5**	**109**	**37**	**3**	**0.985**	**986.5**	**109**	**37**
2	**0.990**	**991**	**73**	**36**	**2**	**0.990**	**991**	**73**	**36**
1	**0.995**	**995.5**	**36**	**36**	**1**	**0.995**	**995.5**	**36**	**36**
0	**1.000**	**1000 0 0**		**0**	**0**	**1.000**	**1000 0 0**		

4.3 Data Availability

The CMAQ modeling system requires emissions, meteorological, initial and boundary condition (IC/BC) and ozone column data for defining the inputs to operate the CMAQ Chemical Transport Model and air quality data with which to evaluate the CMAQ CTM concentrations and deposition estimates.

4.3.1 Emissions Data

The base year emissions inventory for Phase II of the VISTAS modeling will be the basis for the ASIP modeling. These data are founded on 2002 Consolidated Emission Reporting Rule (CERR) inventories submitted to VISTAS by participating state or local agencies and compiled by VISTAS emission inventory contractors in NEI Input Format (NIF) 3.0. These emissions were reviewed by VISTAS stakeholders and considered complete in January of 2004, with minor modifications submitted since that time. Non-VISTAS state emissions will be based on inventories obtained by the Study Team from the other RPOs or EPA and determined to be representative of the 2002 episode year. Mexican and Canadian emissions will be based on the latest available inventories obtainable by the Study Team in formats lending themselves to emissions modeling. For purposes of air quality model validation, actual 2002 calendar year emissions for EGU and fire activity will be used. For strategy and future year emission runs, “typical year” emissions for these categories will be processed for 2002 and the future years.

A final revised 2002 VISTAS state emission inventory is expected in February 2006 and will be used in the final model performance demonstration and configuration expected to begin in spring 2006. Non-VISTAS state emissions are expected to be based on RPO updated base year emissions augmented with additional data provided by RPO, State, and international sources. As in the initial revised modeling, actual 2002 calendar year emissions will be modeled for EGU and fires for base case model performance evaluation, while “typical year” emissions for these categories for 2002 and the future years will be processed during the strategy runs.

All emissions will be converted to Inventory Data Analyzer (IDA) formatted versions and the data will be processed for air quality modeling using Version 2.1 of the Sparse Matrix Operating Kernel Emissions (SMOKE) model. Included in these runs will be the temporal and speciation profiles and cross-reference data provided with the version 2.1 release of the model augmented with any recommended and approved emission profile data provided by the emissions inventory contractor, obtained from EPA, or prepared by the Study Team prior to initial emissions modeling. Spatial allocation of the emissions will be based on profiles and spatial allocation factors developed for the National RPO grid. Additional description of emissions processing is described in Chapter 5 and emissions QA is described in Chapter 6.

4.3.2 Air Quality

Data from ambient monitoring networks for both gas and aerosol species are used in the model performance evaluation. Ambient monitoring data are described in detail in the report: “Review and Assessment of Available Ambient Air Quality Data to Support Modeling and Modeling Performance Evaluation for the Three VISTAS Phase I Episodes” (ENVIRON, UCR and Alpine 2003) so are not repeated here. Table 4-4 summarizes ambient monitoring networks. Data have been compiled for all networks except the PAMS and PM Supersites.

Of particular note for the ASIP 8-hour ozone and $PM_{2.5}$ attainment demonstration modeling are the locations of the key ozone monitors and key FRM monitors where ozone and PM has been determined to be in nonattainment. Also important are the STN speciated PM monitor that is associated with each FRM PM monitor. ASIP is currently formulating its strategy on how the $PM_{2.5}$ attainment demonstration will be performed using associated FRM and STN PM monitoring sites.

Table 4-4. Overview of Ambient Data Monitoring Networks.

Monitoring Network	Chemical Species Measured	Sampling Period	Data Availability/Source
The Interagency Monitoring of Protected Visual Environments (**IMPROVE**)	Speciated PM25 and PM10 (see species mappings)	1 in 3 days; 24 hr average	http://vista.cira.colostate.edu/improve/Data/IMPROVE/improve_data.htm
Clean Air Status and Trends Network (**CASTNET**)	Speciated PM25, Ozone (see species mappings)	Approximately 1-week average	http://www.epa.gov/castnet/data.html
National Atmospheric Deposition Program (**NADP**)	Wet deposition (hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium)), Mercury	1-week average	http://nadp.sws.uiuc.edu/
Air Quality System (**AQS**) Aka Aerometric Information Retrieval System (**AIRS**)	CO, NO2, O3, SO2, PM25, PM10, Pb	Typically hourly average	http://www.epa.gov/air/data/
$PM_{2.5}$ Federal Reference Method (**FRM**)	Total $PM_{2.5}$ Mass	1 in 3 days; 24-hour averages	
Speciation Trends Network (**STN**)	Speciated PM	24-hour average	http://www.epa.gov/ttn/amtic/amticpm.html
Southeastern Aerosol Research and Characterization (**SEARCH**)	24-hr PM25 (FRM Mass, OC, BC, SO4, NO3, NH4, Elem.); 24-hr PM coarse (SO4, NO3, NH4, elements); Hourly PM2.5 (Mass, SO4, NO3, NH4, EC, TC); and Hourly gases (O3, NO, NO2, NOy, HNO3, SO2, CO)	Hourly or 24-hour average, depending on parameter.	Electric Power Research Institute (EPRI), Southern Company, and other companies. http://www.atmospheric-research.com
EPA Particulate Matter Supersites	Speciated PM25		http://www.epa.gov/ttn/amtic/supersites.html
Photochemical Assessment Monitoring Stations (**PAMS**)	Varies for each of 4 station types.		http://www.epa.gov/ttn/amtic/pamsmain.html
National Park Service Gaseous Pollutant Monitoring Network	Acid deposition (Dry; SO4, NO3, HNO3, NH4, SO2), O3, meteorological data	Hourly	http://www2.nature.nps.gov/ard/gas/netdata1.htm

4.3.3 Ozone Column Data

Additional data used in the air quality modeling include the Total Ozone Mapping Spectrometer (TOMS). TOMS data is available for 24-hour average and is obtained from http://toms.gsfc.nasa.gov/eptoms/ep.html. The day-specific TOMS data is used in the CMAQ radiation model (JPROC) to calculate photolysis rates. The TOMS data were missing or bad for several periods in 2002: August 2-12; June 10; and November 18-19. Thus, the TOMS data for August 1, 2002 was used for August 2-7 and TOMS data for August 13 was used for August 8-12. Similarly, TOMS data for June 9 was used for June 10 and data for August 17 was used for August 18-19.

4.3.4 Meteorological Data

Meteorological data are being generated using the MM5 prognostic meteorological model by Baron Advanced Meteorological Systems (BAMS). BAMS is operating the MM5 at 5-day increments for 2002 on the 36 km and 12 km grid with a 14 day spin up period for the end of December 2001. Details on the VISTAS Phase II 2002 MM5 modeling can be found at the BAMS VISTAS website: http://www.baronams.com/projects/VISTAS/.

4.3.5 Initial and Boundary Conditions Data

The CMAQ default Initial Concentrations (ICs) will be used along with a ~15 day spin up period to eliminate any significant influence of the ICs.

The CMAQ Boundary Conditions (BCs) for the Inter-RPO 36 km grid and the ASIP simulations will be based on day-specific 3-hourly averages from a 2002 GEOS-CHEM global simulation model output. Boundary conditions for the 12 km grid will be based on CMAQ results from the 36 km rid processed with the CMAQ BCON boundary condition processor.

5.0 MODEL INPUT PREPARATION PROCEDURES

In this section we describe the procedures to be used to develop the CMAQ model inputs for the ASIP 2002 annual 36/12 km model simulations to address 8-hour ozone and $PM_{2.5}$ nonattainment in the Southeastern US States. The development of the CMAQ meteorological and emissions inputs are discussed first followed by the science options to be used by CMAQ. The procedures for developing the initial and boundary conditions and photolysis rates inputs are then discussed along with the model application procedures. With the exception of using a 2009 future-year and performing daily mobile source emissions modeling, the procedures used in the ASIP CMAQ 36/12 km modeling are identical to those used in VISTAS (ENVIRON, 2004; Morris et al., 2004a,b).

5.1 Meteorological Inputs to Emissions and Air Quality Models

The emissions and air quality models require certain meteorological input data including wind fields, estimates of turbulent eddy dispersion, humidity, temperature, clouds, and actinic flux. Spatially gridded and hourly varying meteorological data are needed to estimate biogenic, mobile source emissions, and plume-rise for large, elevated point sources. Meteorological data are needed to drive chemical transport models for solving atmospheric diffusion and chemistry equations for model species. Because observed data are not available for the full gridded model domain, numerical meteorological models are used to provide these inputs.

The National Center for Atmospheric Research (NCAR)/Pennsylvania State University (PSU) Fifth-Generation Mesoscale Model (MM5) (v3.6) is being used by the VISTAS meteorological modeling contactor, Baron Advanced Meteorological Systems (BAMS) (Olerud, 2004a-d) to simulate meteorology at a 36-km resolution for calendar year 2002 over the entire continental United States and including portions of Canada, Mexico, and the Atlantic and Pacific Oceans. MM5 is also being applied over the southeastern U.S. using a 12 km resolution grid. The MM5 is a three-dimensional prognostic meteorological model that is used not only for meteorology studies but also for air quality studies. Some of the physics used in the simulation include one-way nesting; nonhydrostatic dynamics; four-dimensional data assimilation of wind, temperature, and mixing ratio; explicit treatment of moisture; cumulus cloud parameterization; vertical mixing of momentum in the mixed layer; PBL process parameterization; atmospheric radiation; sea ice treatment; and snow cover (see Chapter 2 for more details).

After the MM5 simulation is completed, the MM5 output files are transferred to the emissions and air quality modeling team and analyzed by the Meteorological Gatekeeper. The Meteorological Gatekeeper performs two main roles; (1) to provide an independent evaluation of the 2002 MM5 simulation that also serves to determine whether the MM5 data have been transferred correctly from the VISTAS meteorological modeling contractor and (2) to process the 2002 MM5 output using Version 2.2 of the Models-3 CMAQ Meteorological-Chemical Interface Processor (MCIP) to generate meteorological fields that will be used for emissions processing and air quality simulation.

5.1.1 MCIP Reformatting Methodology

The Models-3 Community Multiscale Air Quality (CMAQ) modeling system is designed to simulate multiscale (urban and regional) and multi-pollutant (oxidants, acid deposition, and particles) air quality problems. But before running the CMAQ Chemical Transport Model (CCTM), the MM5 generated meteorological data must be pre-processed and converted to Models-3 consistent data structures. MCIP Version 3.0 will be used to preprocess the MM5 meteorological output. The "pass through" option in MCIP will be used in the modeling. One of MCIP's functions is to translate meteorological parameters from the output of the Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Modeling System Generation 5 (MM5) to the Models-3 input/output applications program interface (I/O API format) which is required for operation of Models-3 CMAQ processors. Some other necessary parameters not available from the meteorological model are estimated with appropriate diagnostic algorithms in the program. The key functions of MCIP include:

1. Reading in meteorological model output files
2. Extraction of meteorological data for CTM window domain
3. Interpolation of coarse meteorological model output for finer grid
4. Collapsing of meteorological profile data if coarser vertical resolution data is requested
5. Computation or passing through surface and PBL parameters
6. Diagnosing of cloud parameters
7. Computation of species-specific dry deposition velocities
8. Generation of coordinate dependent meteorological data for the generalized coordinate CCTM simulation
9. Output meteorological data in Models-3 I/O API format

The MCIP processor transforms the data into I/O API format while also calculating several new data fields (e.g. low, middle, and high cloud fractions) that are not readily available in the raw MM5 output. It also interpolates temperature and wind speed to observation height (1.5m and 10m, respectively). The MCIP processor culls a minimum of six cells about the domain periphery to minimize edge effects in the MM5 simulation. MCIP can be used to further reduce the rows or columns in the MM5 data so that the domain definition for the MCIP output files precisely matches the domain used in the air quality modeling. MCIP also allows MM5 layers to be "collapsed" (i.e., some layers can be aggregated). When feasible it is desirable to use the same layer structure in the air quality model as in the MM5 to prevent errors associated with aggregating layer data and to maintain consistency between data produced by the meteorological model and those used by the chemistry-transport model. However, due to computational costs associated with using large number of vertical layers, vertical layer collapsing is typically used to reduce the total number of layers used by the CCTM. In the ASIP and VISTAS modeling we will collapse from 34 layers in MM5 output into 19 layers for the CMAQ air quality simulations. The first 8 layers of CMAQ, up to approximately 450 m AGL, will match the MM5 vertical layer structure exactly. The MM5 layers are then "doubled up" in CMAQ, up to a height of approximately 3,500 m AGL. The region top for CMAQ is the same as used by MM5, 100mb (approximately 15 km AGL). The 36 km analysis domain contains 148 columns, 112 rows, and 19 layers. The 12 km analysis domain covers 168 columns, 177 rows, and 19 layers. More details on the CMAQ modeling domain definitions are provided in Chapter 4 with the vertical layer structure of MM5 and MCIP/CMAQ shown at Table 4-3.

5.1.2 Products of the Meteorological Input Development Process

The meteorological input development process produces three two-dimensional and four three-dimensional daily meteorological and geophysical output data in the Models-3 I/O API format. These CCTM-ready meteorological input files are used in both emissions processing and the CCTM simulations. The met fields are 36 km and 12 km horizontal resolution on a Lambert Conformal Projection (LCP) coordinate system with 19 vertical sigma layers extending from the surface to the 100 mb pressure level. The data files include three-dimensional gridded fields of u- and v-wind components, vertical velocity, temperatures, Jacobian, Jacobian weighted air density, total air density, water vapor, cloud water content, rain water content, ice and snow mixing ratio, layer heights, and vertical exchange coefficients. Two-dimensional gridded fields of latitude and longitude, squared map-scaled factor, surface temperatures and pressures, 1.5 and 10 meter temperature, planetary boundary heights, rainfall, total cloud fraction, snow cover, deposition velocities, u* and w*, surface roughness length, as well as dominant land use category are also developed.

Table 5-1 shows the configuration to be used in MCIP Version 3.0 for processing the 2002 MM5 output to produce CCTM-ready meteorology input files.

Table 5-1. MCIP V3.0 Configuration used In the ASIP Modeling.

Module or option	Values or setting	Additional Information
PBL value computation option	1	Use PBL value from input meteorology
Radiation fields	1	Use radiation fields from input meteorology
Dry deposition option	2	Use Models-3 (Pleim) dry deposition routine
Use PURB Kz_min Option	True	Calculate Kz_min as a function of percent urban land use
Sea Salt Deposition	True	Output dry deposition parameters for Na and Cl
Output interval	60	Unit is in minutes
Vertical layer structure	19 layers	See Chapter 4

5.2 Development of Emissions Model Inputs and Resultant Inventories

The base year emissions inventory for ASIP modeling are founded on 2002 Consolidated Emission Reporting Rule (CERR) inventories submitted to VISTAS by participating state or local agencies and compiled by VISTAS emission inventory contractors in NEI Input Format (NIF) 3.0. These emissions were reviewed by VISTAS stakeholders and considered complete in January of 2004, with minor modifications submitted since that time.

Non-VISTAS state emissions are based on inventories obtained by the Study Team and determined to be representative of the 2002 episode year. Base year 2002 emission inventories for non-mobile source categories were obtained from each RPO in the U.S. domain. These data were supplemented with EPA based VMT and MOBILE6 input files necessary to develop onroad mobile source emissions domain-side. Additionally, an inventory of point source resolved agricultural fire emissions were provided by the western state RPO (WRAP) and utilized in the modeling.

Mexican and Canadian emissions are based on the latest available inventories obtainable by the Study Team in formats lending themselves to emissions modeling. At this time, these inventories are the same as in Phase I.

For purposes of air quality model validation, actual 2002 calendar year emissions for EGU and fire activity will be used, while during strategy and future year emission runs, "typical year" emissions for these categories will be processed.

A final revised 2002 VISTAS state emission inventory is expected in February 2006 and will be used in the final model performance demonstration and configuration expected to begin in spring 2006. Non-VISTAS state emissions are expected to be based on RPO updated base year emissions augmented with additional data provided by RPO, State, and international sources. As in the initial revised modeling, actual 2002 calendar year emissions will be modeled for EGU and fires for base case model performance evaluation, while "typical year" emissions for these categories for 2002 and the future years will be processed during the strategy runs.

These emissions will then be converted to Inventory Data Analyzer (IDA) formatted versions and the data will be processed for air quality modeling using Version 2.1 of the Sparse Matrix Operating Kernel Emissions (SMOKE) model. Included in these runs will be the temporal, spatial, and speciation profiles and cross-reference data currently provided with the 2.1 release of the model augmented with any recommended and approved emission profile data provided by the emissions inventory contractor or obtained from EPA prior to initial emissions modeling. The processing will be adjusted for each run to account for the specific air quality model (AQM) input required by CMAQ.

5.2.1 Emissions Modeling Methodology

Emissions inventory development for photochemical modeling must address several source categories including: (a) stationary point sources, (b) area sources, (c) on-road mobile sources, (d) non-road mobile sources, and (e) biogenic sources. For this analysis, these estimates must be developed to support the episode that is being modeled (i.e., the historical base year when the episode actually occurred; 2002).

Development of an emissions inventory customized for the ASIP region requires a merging of: (a) the most recent *pertinent* regional inventory and (b) available high-resolution, locale-specific emissions estimated by local, state, and regional agencies in the VISTAS region. Local air regulatory and transportation planning agencies are generally the best sources of domain specific activity and control factors to use in developing the base year emissions. Often, these local emissions data sets come from a variety of sources, frequently in different formats.

The study team will acquire emissions estimate data from Emissions Inventory Contractor, in the NIF 3.0 format for purposes of generating the emission inventory base year files necessary for the ASIP contract. These data will be augmented with highway mobile source data submitted to the ASIP emission inventory contractors from the VISTAS participating States.

Contacts with ASIP's emission inventory contractors and the U.S. EPA will be established and formal requests made for inventory corrections, updates and ancillary data pertinent to the modeling of emissions in their jurisdictions. Where feasible and consistent with project resources and schedule, these updated data sets will be acquired and will be used to create day-specific modeling inventories specific to the ASIP domain for the base year episodes to be modeled.

5.2.2 Set-up of SMOKE Over the ASIP Domain

SMOKE will be configured to generate point, area, nonroad, highway, and biogenic source emissions. In addition, certain subcategories, such as fires and EGUs will be maintained in separate source category files in order to allow maximum flexibility in producing alternate strategies. Settings for each of the source categories are discussed in relevant sections below. With the exception of biogenic and highway mobile source emissions that are generated using the, BEIS and MOBILE6 modules in SMOKE, respectively, pre-computed annual emissions will be processed using the month, day, and hour specific temporal profiles of the SMOKE model.

To produce an emissions inventory to support annual modeling, representative time periods will be selected and modeled. Area, nonroad, and point sources will be modeled as a block of Thursday, Friday, Saturday, Sunday, Monday one per month (total of 60 days modeled). For 36-km modeling, onroad motor vehicles will be represented by an entire single week for each month. This selection criteria allows for the representation of day-of-the-week variability in the on-road motor vehicles, and models a representation of the meteorological variability in each month. For 12-km runs, onroad motor vehicles will be run for every day of the year. Holidays will be modeled as Sundays. A list of modeled holidays is provided in Table 5-2. The biogenic emissions will be modeled on a day specific basis (365 days).

Table 5-2. SMOKE Modeled Holidays.

Date	Julian Day	Holiday Description
January 1, 2002	2002001	New Year's Day
March 29, 2002	2002089	Good Friday
May 27, 2002	2002147	Memorial Day
July 4, 2002	2002185	July 4th
September 2, 2002	2002245	Labor Day
November 28, 2002	2002332	Thanksgiving Thurs
November 29, 2002	2002333	Thanksgiving Fri
December 24, 2002	2002358	Christmas Eve
December 25, 2002	2002359	Christmas Day

Population will be used as a gridding default for all source categories when the assigned surrogate would cause SMOKE to drop emissions. This can be a case when the county-level emission inventories are prepared using surrogates other than those available for modeling purposes.

The domain for the Phase II episode will be identical to the Phase I domain, which is based on the EPA's 36-km national CMAQ domain, illustrated in Figure 5-1 below (details on the modeling domains are provided in Chapter 4).

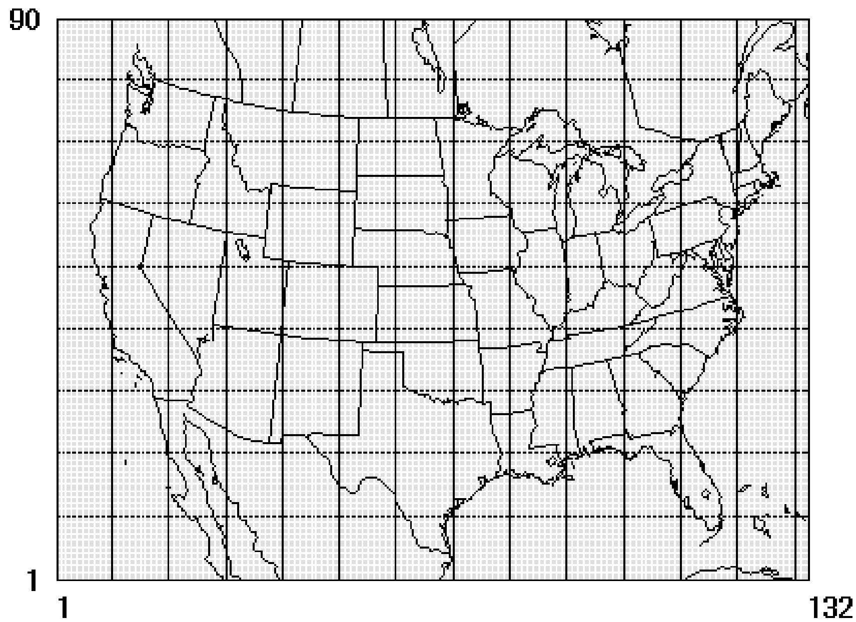

Figure 5-1. EPA 36-km National CMAQ Domain.

The parameters for the SMOKE runs are as follows:

Episodes: 2002 Calendar Base Year. Optional tasks for episodic modeling of up to 60 days that will likely be from 2003.

Future Years: To be determined.

Output Time Zone: Greenwich Mean Time (zone 0)

Projection: Lambert Conformal with Alpha=33, Beta=45, Gamma=-97, and center at (-97,40).

Domain:

- 36 Kilometer Grid: Origin at (-2736, -2088) kilometers with 148 rows by 112 columns and 36-km square grid cells.
- 12 Kilometer Grid: Origin at (108, -1620) kilometers with 168 rows by 177 columns and 12-km square grid cells.

Layer Structure: The CMAQ layer structure will be 19 layers, with specific layer positions defined in the meteorology files (see Chapter 4).

CMAQ Model Species: The CMAQ initial configuration will be for the CB-IV chemical mechanism with PM. The model species in the emission input files will be: CO, NO, NO2, ALD2, ETH, FORM, ISOP, NR, OLE, PAR, TERPB, TOL, XYL, NH3, SO2, SULF, PEC, PMFINE, PNO3, POA, PSO4, and PMC.

Meteorology Data: Daily (25-hour). SMOKE requires the following five types of MCIP outputs: (1) Grid cross 2-d, (2) Grid cross 3-d, (3) Met cross 2-d, (4) Met cross 3-d, and (5), Met dot 3-d. These files need to match the grid projection and overlap with the emissions modeling region but can be larger in the horizontal directions than the modeling region shown in Figure 1. Therefore, the data files for the 36 Kilometer grid domain will be at least 90 columns by 132 rows

Elevated Sources: All sources will be treated by SMOKE as potentially elevated. No plume-in-grid sources will be modeled. Wildfire emissions will be handled as point sources.

Producing 365 day-specific input files for all source categories places a burden on available computing facilities, data management systems, and would adversely affect the ASIP schedule. Selecting representative model days for some or all of the source categories reduces the processing and file handling requirements to a more manageable level and in most cases does not compromise the accuracy of the emissions files.

Other current or recent projects undertaken by EPA, WRAP and MRPO have used a selection approach for all of the source categories (except biogenics) that use a representative weekday/Saturday/Sunday either for each month or each season to model all of the emissions files. In an attempt to better represent the level of temporal and spatial detail available for each source category, we have developed a more detailed strategy.

Biogenic emissions will be modeled for each episode day, using the daily meteorology. Point sources, including CEM-based and fire emissions will be modeled for each episode day to take advantage of the available day-specific emissions and meteorology. Area sources, including nonroad mobile and dust emissions do not utilize meteorological data, and are temporally allocated by monthly, daily and hourly profiles. Reviewing these profiles indicate that maximum temporal definition can be achieved by selecting representative Thursday, Friday, Saturday, Sunday, and Monday profiles for each month.

Motor vehicle emissions are influenced by meteorological variability, but the processing requirements for daily motor vehicle emissions were determined to be prohibitive under the current schedule. Rather than utilizing averaged meteorological data or pre-calculated motor vehicle emissions, for the 36-km domain, a single week per month was selected for modeling. This week was selected from mid-month, to try to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would require atypical processing. As noted above, in the 12-km domain runs, daily modeling will be conducted. The area source modeling dates were also selected from these ranges to simplify data handling procedures.

<u>2002 36-km modeling of Onroad Mobile Sources Represented by the Following Weeks</u>:

January 13-19
February 10-16
March 10-16
April14-20
May 12-18
June 9-15
July 14-20
August 11-17
September 15-21
October 13-19
November 10-16
December 15-21

<u>2002 12-km onroad Mobile Source Modeling was Performed for Every Day</u>

5.2.3 Development of Point Source Emissions

Stack parameters are often more important to the reliability of the air quality modeling results than the emissions rates themselves. Stack parameter data are frequently incorrect, especially in some of the current regional modeling inventories and careful QA is required to assure that the point source emissions are properly located both horizontally and vertically on the modeling grid. To screen for simple, but potentially serious inventory errors such as these, the study team has modified procedures originally developed by EPA to quality assure, augment, and where necessary, revise, stack parameters to examine the accuracy of the point source emissions, as well as standardize procedures to identify and correct stack data errors. These procedures will be implemented in the NIF to IDA conversion step of the inventory development. Additionally, SMOKE has a number of built-in QA procedures designed to catch missing or out-of-range stack parameters. These procedures will also be invoked in the processing of the point source data.

For the ASIP initial baseline modeling, we will be separating the point source emissions into EGU and non-EGU categories. The non-EGU category will not be using any day or hour-specific emissions. All non-EGU point source emissions will be temporally allocated to month, day, and hours using annual emissions and source category code (SCC) based allocation factors. These factors will be based on the cross-reference and profile data supplied with the SMOKE 2.1 version and will be supplemented with relevant data provided to the study team by ASIP or its contractors.

For EGU sources with EPA reported CEM data or with hourly emissions provided by stakeholders, actual hourly data will be used to temporally allocate emissions. For those sources where EPA CEM data are utilized, NOx, SO2, and heat input-based hour-specific profiles were developed and applied to NOx, SO2, and all other emissions, respectively. This ensured that the annual emission values provided by the emissions inventory contractor were maintained, but distributed using hourly to annual profiles. For sources providing hour-specific data and where they were approved by the State in which they operated, those data were substituted for EPA CEM-based distributions.

To temporally allocate the remaining EGU point sources, the NOx, SO2, and heat input data were collected from the 2002 Continuous Emissions Monitoring (CEM) datasets, and used to develop unit-level temporal distributions. The hour, day of week, and monthly specific temporal profiles will be used in conjunction with the emissions inventory supplied emissions data to calculate hourly EGU emissions by unit.

All point sources will be spatially allocated in the domain based on the stationary source geographic coordinates. If a point source is missing its latitude/longitude coordinates, the source will be placed in the center of its respective county.

5.2.4 Development of Area and Non-Road Source Emissions

All area and non-road source emissions will be temporally allocated to month, day, and hours using annual emissions and source category code (SCC) based allocation factors. These factors will be based on the cross-reference and profile data supplied with SMOKE Version 2.1 and will be supplemented with relevant data provided to the study team by ASIP or its contractors. Area and non-road sources will be spatially allocated in the domain based on SCC-based spatial allocation factor files. If an area or non-road source SCC does not have an existing cross-reference profile assigned to it, the county-level emissions will be allocated by population density in the respective county.

A crustal PM transport factor will be applied to fugitive dust emission sources that have been identified in U.S. EPA modeling to have only a portion of its mass transportable from the source of the emission generation. The EPA's studies indicate that 60 to 90 percent of PM emissions from fugitive dust sources do not reach an elevated level necessary to be transported or modeled in an episodic simulation. For this reason, we will apply county-specific fugitive dust emissions transport factors to these sources in the modeling files to adjust PM emissions accordingly. These factors can be located at http://www.epa.gov/ttn/chief/emch/invent/statusfugdustemissions_082203.pdf.

5.2.5 Development of On-Road Mobile Source Emissions

The MOBILE6 module of SMOKE will be used to develop the base year on-road mobile source emissions estimates for CO, NOx, PM, and VOC emissions. The MOBILE6 parameters, vehicle fleet descriptions, and VMT estimates will be combined with gridded, episode-specific temperature data to calculate the gridded, temporalized emission estimates. Of note, whereas the on-network emissions estimates are spatially allocated based on link location and subsequently summed to the grid cell level, the off-network emissions estimates are spatially allocated based on a combination of the FHWA Version 2.0 highway networks and population. For the ASIP 36/12 km modeling, no link based data will be used. The MOBILE6 emissions factors are based on episode-specific temperatures predicted by the meteorological model. Further, the MOBILE6 emissions factors model accounts for the following:

- Hourly and daily minimum/maximum temperatures;
- Facility speeds;
- Locale-specific inspection/maintenance (I/M) control programs, if any;
- Adjustments for running losses;
- Splitting of evaporative and exhaust emissions into separate source categories;
- VMT, fleet turnover, and changes in fuel composition and Reid vapor pressure (RVP).

The primary input to MOBILE6 is the MOBILE shell file. The MOBILE shell contains the various options (e.g. type of inspection and maintenance program in effect, type of oxygenated fuel program in effect, alternative vehicle mix profiles, RVP of in-use fuel, operating mode) that direct the calculation of the MOBILE6 emissions factors.

5.2.6 Development of Biogenic Source Emissions

A revised version of a commonly used biogenic emissions model, the Biogenic Emissions Inventory System (BEIS), has recently been developed and tested by EPA over two separate modeling domains/episodes. This version of the model (BEIS-3, v0.9) contains several changes over BEIS-2, including the following:

- Vegetation input data -- are now based on a 1-km Biogenic Emissions Landuse Database (BELD3) vegetation data base,
- Emission factors – many updates including some recent NARSTO modifications,
- Environmental algorithm -- includes a sunlit/shaded leaf solar radiation model.

A series of sensitivity modeling simulations has been completed and concluded that the more recent BEIS-3 methodology will impact base case model ozone predictions in most parts of the U.S. The preliminary tests have also shown that the newer biogenic emissions **do not** appear to have a large effect on: 1) the control signal response, 2) relative reduction factors resulting from a projected emissions change, or 3) overall regional model performance in the eastern U.S.

For this particular application of BEIS-3, Version 0.9 as currently incorporated in the SMOKE processor will be used. This means that: 1) soil NO emissions shall be prepared without the input of specific soil moisture and precipitation data and 2) MEOH emissions will not be modeled explicitly. Otherwise, the modeling should be identical to a BEIS-3 (v1.0) application.

The BELD-3 landuse data on a Lambert conformal grid at 1-km resolution have already been developed, are available, and will be used to estimate biogenic emissions in this study. The BEIS model also requires as input hourly, gridded temperature and solar radiation data to estimate biogenic emissions, and these data will be derived from the MM5 predictions.

5.2.7 Wildfires, Agricultural, and Prescribed Burns, Wind Blown Dust and Sea Salt Source Emissions

Wildfires, Agricultural, and Prescribed Burns

Wildfire, agricultural, and prescribed burn emissions will be handled separately from the standard area source input files. The study team expects to receive monthly estimates of fire emissions from the emissions inventory contractor, which include burn acreage and biomass loading information for the VISTAS states. Depending on the completeness and quality of the data received, attempts will be made to calculate spatial and temporal distributions of the fire emissions, rather than relying on standard distribution profiles. Also, the study team will attempt to calculate vertical distribution of the fire emissions, based on fire size and biomass involvement. The SMOKE 2.1 can model fire plume rise if provided with the following variables:

PTOP – Top of the fire plume profile (meters above ground level)
PBOT – Bottom of the fire plume profile (meters above ground level)
Lay1 – The percent of the emissions entrained in the first modeling layer

The WRAP Fire Emissions Joint Forum Emissions Inventory Report (FEJF, 2002) has documented an approach to calculating these plume descriptors. In this method, the fires are assigned to one of 5 size categories, based on the total burn acreage, and the biomass fuel loading. These categories are then used to calculate representative hourly plume profiles. These profiles are then used by SMOKE 2.1 to distribute the vertical emissions for the fires. To successfully model fires as elevated point sources, the data provided by the emissions inventory contractor will need to include both the day or days on which the fire occurs, and a spatial identifier of the fire location. At a minimum, a latitude and longitude of the fire location can be used, while a polygon coverage would be preferable.

In addition, wildfire and prescribed burn data, including emissions estimates and plume rise distributions, will be obtained from other RPOs and used to supplement the inventory for the non-VISTAS states.

Windblown Dust

PM_{10} and $PM_{2.5}$ emissions from wind erosion of natural geogenic sources (SCCs 2730100000 [total] and 2730100001 [dust devils]) will be excluded from the resulting modeling files using a 100 percent reduction in the control packets.

Sea Salt

CMAQ currently treats sea salt as an inert PM species. That is, the sea salt is not allowed to chemically interact with other species, such as producing particulate sodium nitrate. There are plans to update CMAQ to have chemically active sea salt, but it is unclear whether such an update will occur during the ASIP modeling. Accordingly, the initial modeling will be conducted without any sea salt emissions. If CMAQ is updated to treat chemically active Sea Salt, or if CAMx is run using its full-science options, then Sea Salt emissions will be generated using appropriate procedures (e.g., as was done in VISTAS Phase I).

5.2.8 Speciation and Reformatting of Emissions

SMOKE will be run to speciate the emissions estimates according to the requirements of the Carbon Bond Mechanism version four (CBM-IV, CB-IV or CB4). The SMOKE model will also reformat the emissions estimates for use in CMAQ modeling. For each model-ready emissions inventory, SMOKE will produce at a minimum five (5) separate air quality model-ready files: low-level point source, area source, elevated point source, mobile source, and biogenics. Other source categories, such as EGU and fire emissions may also be handled as separate air quality model-ready files.

5.2.9 Development of Modeling Inventories

The emissions inventories modeled for the VISTAS ASIP can be grouped into four distinct types: (1) 2002 actual annual emission inventories, (2) 2002 typical annual emission inventories; (3) 2009 base case emission inventories; and (4) 2009 control strategy emission inventories. In all cases, the Study Team expects to receive the emissions inventory data for the ASIP states from the emissions inventory contractor, add non-ASIP states and Canadian and Mexican data acquired from alternate EPA and/or RPO sources, and produce the CMAQ ready emissions files.

5.2.9.1 2002 Annual Inventories

2002 36/12 km actual and typical annual inventories will be developed under ASIP for CMAQ modeling. These inventories will be identical to the 2002 36/12 km actual and typical inventories developed under VISTAS, only the 2002 12 km ASIP inventories used everyday on-road mobile source emissions modeling.

5.2.9.2 2009 Annual Future Year Inventories

2009 36/12 km annual emission inventories will be develop for an On-the-Books (OTB) base case emissions scenario and, as needed, control strategy emission scenarios. The 2009 On-the-Books base case will include growth and controls that have been promulgated, such as the following regional rules:

- NOx SIP Call
- Tier 2/Low Sulfur
- Heavy Duty Diesel
- Non-Road Engine
- Clean Air Interstate Rule (CAIR)

Not included in the 2009 OTB base case emissions scenario are Regional Haze controls including Best Available Retrofit Technology (BART) controls and any additional controls needed to attain the 8-hour ozone and $PM_{2.5}$ standards. Control strategies to be modeled will be determined during the course of the study.

5.2.10 Products of the Emissions Inventory Development Process

In addition to the CMAQ-ready input files generated for each hour of the days modeled in the ASIP annual run, a number of quality assurance (QA) files may be prepared and used to check for gross errors in the emissions inputs. Importing the model-ready emissions into PAVE and looking at both the spatial and temporal distribution of the emission provides insight into the quality and accuracy of the emissions inputs.

- Visualizing the model-ready emissions with the scale of the plots set to a very low value, we can determine whether there are areas omitted from the raw inventory or if emissions sources are erroneously located in water cells.
- Spot-check the holiday emissions files to confirm that they are temporally allocated like Sundays.
- Producing pie charts emission summaries that highlight the contribution of each emissions source component (e.g. nonroad mobile).
- Normalizing the emissions by population for each state will illustrate where the inventories may be deficient and provide a reality check of the inventories.
- Spot check vertical allocation of point sources using PAVE.

We will use state inventory summaries prepared prior to the emissions processing to compare against SMOKE output report totals generated after each major step of the emissions generation process.

To check the chemical speciation of the emissions to CB-IV terms and the vertical allocation of the emissions, we will compare reports generated with SMOKE reports to target these specific areas of the processing. For speciation, we will compare the inventory import state totals versus the same state totals with the speciation matrix applied.

For checking the vertical allocation of the emissions, we will create reports by source, hour, and layer for randomly selected states in the domain. We will create these reports for a representative weekday in each of the episodes for each of these selected states.

The quantitative QA analyses often reveal significant deficiencies in the input data or the model setup. It may become necessary to tailor these procedures to track down the source of each major problem. As such, we can only outline the basic quantitative QA steps that we will perform in an attempt to reveal the underlying problems with the inventories or processing. Following are some of the reports that may be generated to review the processed emissions:

- State and county totals from inventory for each source category
- State and county totals after spatial allocation for each source category
- State and county totals by day after temporal allocation for each source category for representative days

- State and county totals by model species after chemical speciation for each source category
- State and county model-ready totals (after spatial allocation, temporal allocation, and chemical speciation) for each source category and for all source categories combined
- Totals by source category code (SCC) from the inventory for area, mobile, and point sources
- Totals by state and SCC from the inventory for area, mobile, and point sources
- Totals by county and SCC from the inventory for area, mobile, and point sources
- Totals by SCC and spatial surrogates code for area and mobile sources
- Totals by speciation profile code for area, mobile, and point sources
- Totals by speciation profile code and SCC for area, mobile, and point sources
- Totals by monthly temporal profile code for area, mobile, and point sources
- Totals by monthly temporal profile code and SCC for area, mobile, and point sources
- Totals by weekly temporal profile code for area, mobile, and point sources
- Totals by weekly temporal profile code and SCC for area, mobile, and point sources
- Totals by diurnal temporal profile code for area, mobile, and point sources
- Totals by diurnal temporal profile code and SCC for area, mobile, and point sources
- PAVE plots of gridded inventory pollutants for all pollutants for area, mobile, and point sources

5.3 Model Configuration and Modeling Approach

5.3.1 CMAQ Science Configuration

This section described the model configuration and science options to be used in the ASIP modeling effort. The recommendations are based on testing and model evaluations of several models or model configurations carried out in the VISTAS study, as well as related studies including WRAP, CENRAP, BRAVO, CAIR and other studies. Table 5-3 summarizes the proposed configuration for CMAQ. The latest version of CMAQ is currently Version 4.5 that was released October 2005. CMAQ Version 4.5 includes several enhancements and corrections over precious versions of the model, including corrections to the mass conservation algorithms and active treatment of Sea Salt. VISTAS has updated CMAQ Version 4.5 with the

SOAmods secondary organic aerosol (SOA) module enhancements (see Section 1). ASIP has adopted CMAQ Version 4.5 with SOAmods as its primary model for demonstrating attainment of the 8-hour ozone and $PM_{2.5}$ standards.

In the CMAQ base configuration we will run both the 36 km and 12 km grids using one-way grid nesting where the boundary conditions for the 12 km grid simulation are extracted from the 36 km run using the CMAQ BCON processor. The base configuration of CMAQ will use 19 vertical layers up to a region top of 100 mb (approximately 15 km AGL).

The PPM advection solver would be used along with the spatially varying (Smagorinsky) horizontal diffusion approach. K-theory will be used for vertical diffusion. The minimum eddy diffusion constant (Kz_min) will be based on the new CMAQ Version 4.5 PURB option that depends on the percent of urban land use in the grid cell with Kz_min ranging from 0.1 m^2/s to 2.0 m^2/s when the grid cell is 100% urban.

The MCIP3.0 will be used to process the MM5 data using the "pass through" option and outputting parameters to treat Sea Salt dry deposition and the PURB Kz_min option.

The AERO4/ISORROPIA aerosol chemistry scheme will be used for inorganic aerosol thermodynamics. During the VISTAS testing of the CMAQ Version 4.3 and Version 4.4 models it was noted that the AERO3/ISORROPIA aerosol modules failed to conserve sulfur and nitrogen mass, an examination of the AERO4/ISORROPIA module revealed that this is also likely true for the new version in CMAW Version 4.5. A mass conservation patch developed by the Georgia Institute of Technology (GIT) was added to the model that renormalized the total sulfur, reactive nitrogen and reduced nitrogen species after the call to the aerosol modules to conserve sulfur and nitrogen mass in the model. Sensitivity simulations with and without the mass conservation patch showed it has a very small effect and does not affect model performance, however mass conservation is a fundamental characteristic of the real-world atmosphere so ASIP and VISTAS have retained the mass conservation patch for the CMAQ aerosol modules in the modeling. Note that the GIT mass conservation patch is different that the corrections to the CMAQ mass conservation in CMAQ Version 4.5, the GIT mass conservation patch corrects for sulfur and nitrogen mass loss or gained within the CMAQ aerosol modules, whereas the CMAQ Version 4.5 mass conservation update corrects mass conservation problems in earlier versions of CMAQ in the advection algorithms. The SORGAM scheme, which includes a reversible thermal equilibrium, will be used for secondary organic aerosols. The CB4 gas-phase mechanism will be used in the ASIP and VISTAS modeling.

Table 5-3. ASIP Model Configuration for the CMAQ Chemical Transport Model.

Model Option	CMAQ
Model Version	Version 4.5 (October 2005)
Horizontal Resolution	36/12 km
No. Vertical Layers	NZ = 19
Horizontal Advection	PPM
Vertical Advection	PPM
Horizontal Diffusion	Spatially Varying
Vertical Diffusion (Kz)	K_V (Eddy Diffusion)
Minimum Kz	PURB 0.1 to 2.0 m^2/s
MM5 Configuration	Pleim-Xiu/ACM

Model Option	CMAQ
MM5 Processing	MCIP3.0 Pass Through
Gas-Phase Chemistry	CB4
Gas-Phase Chemistry Solver	EBI/Hertel
Secondary Organic Aerosol	SORGAM w/ SOAmods
Aqueous-Phase Chemistry	RADM
Aerosol Chemistry	AE4/ISORROPIA
Dry Deposition	Pleim-Xiu
Plume-in-Grid	Off
Initial Concentrations	CMAQ Default w/ ~15 day spin-up
Boundary Conditions	3-Hourly 2002 GEOS-CHEM
Emissions	2002 VISTAS States 2002 RPO Inventories

5.3.2 Spin-Up Initialization

For the 2002 annual CMAQ modeling, the model will be exercised separately for four quarters. The 2002 MM5 modeling started on December 17, 2001 at 12Z. Thus, allowing for 12 hours of spin up of the MM5 model, CMAQ will be initialized at 00Z on December 18, 2001. This results in a 13 day spin up period for CMAQ and the first quarter run segment of 2002. For the other quarter run segments of 2002, CMAQ will be initialized with a 15 day spin up period.

5.3.3 Boundary Conditions

Boundary Condition (BC) concentrations along the lateral edges of the 36 km Inter-RPO modeling domain were based on a 2002 simulation of the GEOS-CHEM global chemistry model (Jacob, Park and Logan, 2005). The 2002 GEOS-CHEM output were processed to the CMAQ 36 km domain boundary cells and vertical layer structure (Byun, 2004). The resultant BCs were 3-hourly day-specific based on the 2002 GEOS-CHEM simulation.

5.3.4 Photolysis Rates

Several chemical reactions in the atmosphere are initiated by the photodissociation of various trace gases. To accurately represent the complex chemical transformations in the atmosphere, accurate estimates of these photodissociation rates must be made. The Models-3 CMAQ system includes the JPROC processor, which calculates a table of clear-sky photolysis rates (or J-values) for a specific date. JPROC uses default values for total aerosol loading and provides the option to use default column O3 data or to use TOMS data for total column O3.

JPROC produces a "look-up" table provides the photolysis rates as a function of latitude, altitude, and time (in terms of the number of hours of deviation from local noon, or hour angle). In the current CMAQ implementation, the J-values are calculated for six latitudinal bands (10º, 20º, 30º, 40º, 50º, and 60º N), seven altitudes (0 km, 1 km, 2 km, 3 km, 4 km, 5 km, and 10 km), and hourly values up to ±8 hours of deviation from local noon. During model calculations, photolysis rates for each model grid cell are estimated by first interpolating the clear-sky photolysis rates from the look-up table using the grid cell latitude, altitude, and hour angle, followed by applying a cloud correction factor.

The photolysis rates input file must be prepared as separate look-up tables for each simulation day. The modeling team has already prepared scripts to automate the production of photolysis rate files for each day of the annual simulation. Photolysis files are ASCII files, and these will be visually checked for selected days to verify that photolysis are within the expected ranges.

During the VISTAS modeling errors were found in the TOMS data for a few short periods that affected the CMAQ photolysis rates input. The days with the bad or missing TOMS ozone column data were identified (June 10, August 2-12; and November 18-19) and the following approach was used to fill the bad data:

- June 9 data were used for June 10;
- August 1 data were used for August 2-7;
- August 13 data were used for August 8-12; and
- November 17 data were used for November 18-19.

6.0 QUALITY ASSURANCE PLAN

In this section we discuss the quality assurance procedures that will be used in the ASIP modeling. More details are provided in the ASIP Quality Assurance Project Plan (QAPP; Morris and Stella, 2005).

6.1 Quality Assurance Objectives

In December 2002, the USEPA publish extensive guidance on developing a Quality Assurance Project Plan (QAPP) for modeling studies (EPA, 2002). The objective of a QAPP is to ensure that a modeling study is scientifically sound, robust, and defensible. The new EPA guidance suggests that a QAPP should include the following elements:

- a systematic planning process including identification of assessments and related performance criteria;
- peer reviewed theory and equations;
- a carefully designed life-cycle development process that minimizes errors;
- clear documentation of assumptions, theory, and parameterization that is detailed enough so others can fully understand the model output;
- input data and parameters that are accurate and appropriate for the problem;
- output data that can be used to help inform decision making;
- documentation of any changes from the original quality assurance plan;

Moreover, the EPA guidance specifies that different levels of QAPP may be required depending on the intended application of the model, with a modeling study designed for regulatory purposes requiring the highest level of quality assurance.

The QAPP also provides a valuable resource for project management. It can be used to document data sources and assumptions used in the modeling study, and it can be used to guide project personnel through the data processing and model application process to ensure that choices are consistent with the project objectives.

The modeling team has already developed QA documents and procedures in the VISTAS effort (Morris, Tonnesen and Tesche, 2003) and ASIP modeling (Morris and Stella, 2005).

6.2 Emissions Model Inputs and Outputs

Emissions Quality Assurance (QA) and Quality Control (QC) are the single most critical step in performing air quality modeling studies. Because emissions processing is tedious, time consuming and involves complex manipulation of many different types of large data sets, errors are frequently made in emissions processing and, if rigorous QA measures are not in place, these errors may remain undetected.

As part of the VISTAS and ASIP QA effort, an "Emissions Gatekeeper" function was implemented to QA the emission inventories. The role of this Gatekeeper is to perform quality assurance activities on the following emission inventory (EI) data:

(1) EI data obtained from the VISTAS and ASIP emissions inventory contractors; and
(2) The emission inventory to be used for modeling outside of the States in the Southeastern US region.

Specifically, the Emissions Gatekeeper will review the content and format of the provided emission inventories ensuring an appropriate appraisal of the emissions data and estimates for the Southeastern US States. Other tasks will include any additional translation from mass emissions files into the emissions modeling input file structure necessary for modeling. The Study Team will supplement these activities with QA checks on the intermediate and model output files using internal and public domain visualization and diagnostic packages.

For ASIP, we propose to continue with multistep emissions the QA/QC approach applied in the VISTAS modeling. This includes the initial emissions QA/QC by the Emissions Gatekeeper described above, as well as QA/QC by the Emissions Modeler during the processing of emissions and then additional QA/QC by the air quality modeler of the processed model ready emission files. This multistep process with three separate groups involved in the QA/QC of the emissions is much more likely to catch any errors prior to the air quality model simulations.

6.2.1 Emissions Modeling QA/QC

EMS and EPA Input Screening Error Checking Algorithms: Although the SMOKE emissions model will be used for emissions processing, some of the more advanced EMS input error checking algorithms will be used to screen the data and identify potential emission input errors. Additionally, EPA has issued a revised stack QA and augmentation procedures memorandum that will be used to identify and augment any outlying stacks.

SMOKE error messages: SMOKE provides various cautionary or warning messages during the emissions processing. We will redirect the SMOKE output to log files and review the log files for serious error messages. An archive of the log files will be maintained so that the error messages can be reviewed at a later date if necessary.

SMOKE emissions summaries: We will use QA functions built into the SMOKE processing system to provide summaries of processed emissions as daily totals according to species, source category and county and state boundaries. These summaries will then be compared with summary data prepared for the pre-processed emissions, e.g., state and county totals for emissions from the augmented emissions data.

6.2.2 QA of the Model-Ready Emissions Impacts

The goal of the post-processed emissions summary QA is to detect possible errors in the final, model-ready binary emissions files by preparing summary plots that characterize spatial and temporal patterns in the emissions data. This step is designed to catch errors that may be missed in the internal SMOKE QA procedures. We will use a QA/QC post-processing program that read the CMAQ-ready I/O API emissions file formats for each of the major source categories (mobile, area, point, biogenic, fire) and produce the following plots.

Spatial Summary: We will sum the emissions for all layers and for all 24 hours that is used to prepare a PAVE plot showing the daily total emissions spatial distribution. For a 20 day simulation this produces approximately 20 days x 20 species x 5 emissions categories = 2,000 plots. In our base case simulations these plots will be presented as tons per day. The objective of this step is to identify errors in spatial distribution of emissions.

Vertical Profile: For point sources the emissions total for each layer will be summed and plotted to show the vertical distribution of emissions. These plots show the emissions on the x-axis for each model layer on the y-axis. The objective of this step is to identify possible errors in vertical distribution of emissions.

Short Term Temporal Summary: The total domain emissions for each hour will be accumulated and time series plots prepared that display the diurnal variation in total hourly emissions. The objective of this step is to identify errors in temporal profiles.

Long Term Temporal Summary: The total domain emissions for each day will be accumulated and displayed as time series plots that show the daily total emissions across the domain as a function of time. The objective of this step is to identify particular days for which emissions appear to be inconsistent with other days for no reason (e.g., not a weekend) and compare against the general trend.

Control Strategy Spatial Displays: Spatial summary plots of the daily total emissions differences between a control strategy and base case emissions scenarios will be generated. These plots can be used to immediately identify a problem in a control strategy. For example, if a VISTAS states SO_2 control strategy is being analyzed and there are changes in emissions for other pollutants or for SO_2 outside of the VISTAS states problems in emissions processing can be identified prior to the air quality model simulation.

6.3 Meteorological Model Outputs

As part of the VISTAS effort, a “Meteorological Gatekeeper” function was implemented. As ASIP is using the exactly same 2002 36/12 km meteorological fields as VISTAS, the VISTAS meteorological QA/QC procedures are also applicable to ASIP. The task of the VISTAS Gatekeeper was to provide an independent review and quality assurance of the meteorological modeling and related data sets developed by the VISTAS meteorological modeling contractor (BAMS) and used subsequently by the emissions and air quality modeling teams. This Gatekeeper QA review serves two specific purposes: (a) to ensure that any potential problems with the data sets (should they exist) are identified and corrected in a timely manner, and (b) to provide the study team with information to support ongoing CMAQ model performance testing and sensitivity analyses. In the case of meteorology, the Gatekeeper's independent QA analysis of the MM5 meteorological data sets serves to provide direct assistance to the emissions and air quality modeling team as it undertakes to ratify the SMOKE model outputs and to diagnose CMAQ model performance and sensitivity analyses.

The Meteorological Gatekeeper also has personal responsibility for the quality and chain of custody of the meteorological data sets. In performing the Gatekeeper quality assurance activity, one of the first steps is to conduct an independent operational evaluation on the MM5 model results at 36 km and 12 km grid scale. This evaluation covers surface and aloft wind direction, temperature, mixing ratio, precipitation, and planetary boundary layer (PBL) depths on a continental scale (36 km) and subregional scale (12 km) basis. The specific techniques to be used are described in the MM5 model performance protocol prepared for EPA for annual modeling (McNally and Tesche, 2002). The Gatekeeper will also perform supplemental, ad hoc analysis of pertinent MM5 fields (e.g., PBL depths) where that might be useful to the emissions and air quality modeling teams. Another task of the Gatekeeper will be to exercise the Meteorological Chemistry Interface Processor (MCIP) Version 2.2 is to read the MM5 outputs from BAMS and produce binary input files for the CMAQ Chemical Transport Model (CCTM) to provide the complete set of parameters necessary in the emissions processing and air quality modeling.

In summary, the quality assurance plan for the meteorological data will include the following elements:

- Upon receiving the MM5 and MCIP 2.2 output files from BAMS, we will verify the integrity of the file transfer (e.g., no missing and/or corrupted files);
- Since the CMAQ modeling domain is a subset of the MM5 domain, we will verify that the modeling domain and vertical layer structures in the MCIP files are identical to the CMAQ modeling domain;
- We will select several days of the MM5 output and reprocess the MM5 files with MCIP v2.2 using the predetermined MCIP options. We will then compare the MCIP files with those provided by BAMS to verify that we obtain identical results from the MCIP processing.
- We will create horizontal and vertical plots of temperature, pressure, precipitation, modeled flow patterns, PBL heights, etc. to assess whether the MCIP output fields are reasonable;
- The VISTAS 2002 MM5 simulation will be evaluated using the same surface observations, subdomains and procedures as used to evaluate the WRAP 2002 MM5 simulation as an independent QA and evaluation of the database.

- We will make the plots available on the VISTAS website for viewing and download.

- We will re-process the MM5 output using MCIP3.0 so that ASIP and VISTAS can use the latest (Version 4.5) version of the CMAQ model that includes active treatment of Sea Salt emissions.

6.4 Air Quality Model Inputs and Outputs

Key aspects of QA for the CMAQ input and output data include the following:

- Verification that correct configuration and science options are used in compiling and running each model of the in the CMAQ modeling system, where these include the MCIP, JPROC, ICON, BCON and the CCTM.
- Verification that correct input data sets are used when running each model.
- Evaluation of CCTM results to verify that model output is reasonable and consistent with general expectations.
- Processing of ambient monitoring data for use in the model performance evaluation.
- Evaluation of the CCTM results against concurrent observations.
- Backup and archiving of critical model input data.

The most critical element in the QA plan for CMAQ simulations is the QA/QC of the meteorological and emissions input files. The major QA issue specifically associated with the air quality model simulations is verification that the correct science options were specified in the model itself and that the correct input files were used when running the model. For the CMAQ model we employ a system of naming conventions using environment variables in the compile and run scripts that guarantee that correct inputs and science options are used. We also employ a redundant naming system so that the name of key science options or inputs are included in the name of CMAQ executable program, in the name of the CMAQ output files, and in the name of the directory in which the files are located. This is accomplished by using the environment variables in the scripts to specify the names and locations of key input files. For example, if a model simulation is performed using the CB4 mechanism, all compile and run scripts contain the variable definition "$MECH = CB4", and this variable is hard coded into the script for the executable name, the output file name, and the output directory name. This procedure produces long file/directory names but it effectively prevents mistakes or makes mistakes readily apparent if they do occur.

A second key QA procedure is to never "recycle" run scripts, i.e., we always preserve the original runs scripts and directory structure that were used in performing a model simulation. For example, if we perform simulation with the SAPRC mechanism, instead of editing the original scripts to specify "$MECH = SAPRC" we will create a parallel directory structure with a new set of scripts to perform the SAPRC simulations. This provides a permanent archive of the scripts that were used in performing model simulations. In addition, output from the model simulation will be directed to a log file that provides a record of input file names, warning messages etc that will be archived.

We will also perform a post-processing QA of the CMAQ output files similar to that described for the emissions processing. We will generate animated gif files using PAVE that can be viewed to search for unexpected patterns in the CMAQ output files. In the case of model sensitivity studies, the animated gifs will be prepared as difference plots for the sensitivity case minus the base case. Often, errors in the emissions inputs can be discovered by viewing the animated GIFs. Finally, we will produce 24 hour average plots for each day of the CMAQ simulations. This provides a summary that can be useful for more quickly comparing various model simulations.

7.0 MODEL PERFORMANCE EVALUATION

7.1 OVERVIEW

A critical component of every air quality modeling study is the model performance evaluation where the modeled estimates for the current year base case are compared against observed values to access the model's accuracy and provide an indication of its reliability. As noted previously, the ASIP modeling database, models and modeling approach are intricately linked to the VISTAS modeling. Chapter 11 presents a summary of the current Scope of Work (SOW) for the ASIP Emissions and Air Quality Modeling activities. This ASIP SOW delineates the tasks, approach and schedule for carrying out the various technical activities described in greater detail in this Modeling Protocol. Although the ASIP SOW does not explicitly include the model performance evaluation (MPE) component of the modeling that is being carried out under VISTAS, the MPE is a critically important component of a modeling study so the approaches to be used in the model evaluation of the ASIP/VISTAS databases are described in this section of the ASIP Modeling Protocol.

Consistent with the spirit of a Modeling Protocol for regulatory decision-making, this section lays out the 'roadmap' for achieving an adequately tested modeling system for regulatory usage. But, obviously, this does not mean that every analysis identified in this chapter will be carried out or is indeed even possible given the ASIP and VISTAS schedule and resources, the existing aerometric data bases, and present technology constraints. The roadmap guides the way to the desired destination – in this case, an evaluated, operational PM/regional haze/ozone modeling system – but does not commit the driver to exploring every side street and back country road along the way. Indeed, one expectation of the ASIP and VISTAS is a close working relationship with the modeling team to ensure that the available resources and schedule are applied most efficiently in reaching the aforementioned goal.

This chapter describes a range of model testing methodologies *potentially* available to the Emissions and Air Quality Modeling study team in its efforts to adequately evaluate the performance of the CMAQ air quality modeling system for the 2002 annual period. The final 2002 actual base case modeling will likely be conducted in early 2006. Preliminary 2002 base case simulations and abbreviated model performance evaluation has uncovered several performance issues that have been attempted to be addressed through improvements in model inputs, formulation or both. In this Section we set forth a broad range of methods and techniques that *may* be brought to bear in examining CMAQ model performance. We identify the core operational evaluation procedures, recommended in EPA (2001) $PM_{2.5}$ and regional haze modeling guidance that has been and will continue to be performed as part of the VISTAS modeling efforts. We also describe a broad range of additional performance testing methods that may be worth considering, if deemed needed and resources and time are available.

Clearly, not all of the supplemental evaluative techniques identified in this chapter will ultimately be performed by VISTAS/ASIP. There are three main reasons for this:

- The VISTAS/ASIP SOWs places clear limits on the resources available to perform model evaluation analyses. Accordingly, some evaluation steps, while desirable, simply may not be possible given current funding levels;

- The VISTAS/ASIP SOW places stringent schedule demands on the model evaluation. A number of the model performance evaluation methods introduced in this chapter (e.g. Weight of Evidence analyses, diagnostic testing with individual measurement networks, PM indicator species and ratios analyses could very likely require more time to carry out given their quasi-research nature. Since VISTAS/ASIP is not a model research and development effort, but rather an operational evaluation of existing modeling systems for regulatory decision-making, some interesting, but time consuming analyses simply may not be possible given the present schedule; and

- To conform to the EPA PM guidance documents requirements for PM model testing, it may not be necessary to conduct many of the diagnostic and Weight of Evidence tests identified in this protocol. Indeed, an adequate evaluation of the VISTAS/ASIP modeling system may be possible through straightforward application of the core operational performance evaluation procedures identified in EPA's 2001 draft $PM_{2.5}$ and regional haze and final 2005 8-hour ozone guidance.

At a minimum, the evaluation of the CMAQ modeling system for the annual 2002 simulation will be consistent with EPA's draft guidance on PM model testing and final 8-hour ozone modeling guidance. EPA's guidance essentially calls for an operational evaluation of the model focusing on a specific set of gas phase and aerosol chemical species and a suite of statistical metrics for quantifying model response over the annual cycle. The emphasis is on assessing: (a) How accurately the model predicts observed concentrations? and, (b) How accurately does the model predict responses of predicted air quality to changes in inputs? States are encouraged to utilize the evaluation procedures set forth in the earlier 1991 guidance document (EPA, 1991) for gas phase species and the newer (2001 and 2005) guidance for PM and ozone species. Thus, in carrying out the initial operational evaluation and the subsequent final evaluation, we will implement the suggested EPA performance testing methodologies for the key gas phase and aerosol species. Since these methods are explicitly presented in EPA's guidance documents, there is no need to repeat them here.

We conclude by again emphasizing that most important goal of the CMAQ evaluation is to determine whether the aggregate modeling system (model codes plus input data sets and observational data for testing) offers sufficiently reliable and accurate results that public decision-makers may have reasonable confidence in using the model to help choose between alternative emission control strategies designed to regional haze reduction scenarios. If the CMAQ model evaluation, as outlined in this chapter, provides sufficient evidence that the modeling system is operating reliably and in conformance with measurements and scientific expectations, then specific justifications explaining why the model is acceptable for developing 8-hour ozone, $PM_{2.5}$ and regional haze strategies. Conversely, should the evaluation determine that the modeling system suffers from important flaws or errors that undermine its reliability or use, these findings will also be documented, together with recommendations regarding the use of alternate methods, steps to improve the model and/or data base, or other approaches that can be used in the analysis.

7.2 Context for the Model Performance Evaluation

We begin the discussion of the CMAQ 2002 modeling evaluation methodology by reviewing how the model output is used to project future year 8-hour ozone and $PM_{2.5}$ levels.

When designing a model performance evaluation, it is important to understand how the modeling results will ultimately be used. EPA has published two versions of draft guidance for fine particulate and regional haze modeling (EPA, 2000; 2001), utilizing a Fine Particulate Guidance Workgroup to provide technical input in the development of both documents[1]. More recently, EPA has provided an informal update on the PM/regional haze modeling guidance (Timin, 2002) and conducted a PM model evaluation workshop (see, for example, Timin, 2004; Boylan, 2004) shedding additional light on what the final $PM_{2.5}$ and regional haze guidance document might contain. After issuing several draft guidance documents for 8-hour ozone modeling (EPA, 1999, 2005a, EPA issued the final 8-hour ozone modeling guidance in 2005 (EPA, 2005b). These modeling guidance documents, along with the 1-hour ozone guidance (EPA, 1991) provide a framework for the VISTAS/ASIP model performance evaluation approach.

A key concept in EPA's guidance for addressing 8-hour ozone and $PM_{2.5}$ issues and regional haze is that the modeling results should be used in a relative sense to scale or roll back the observed 8-hour ozone and individual particulate matter (PM) species concentrations. The modeled derived ratios of future-year to current-year scaling factors used to project future-year 8-hour ozone and PM species components are called relative reduction factors (RRFs). As 8-hour ozone concentrations are made up as an average of 1-hour ozone concentrations and there is a wealth of model performance evaluation for 1-hour ozone, then the model performance for 1-hour ozone is important also. Since the model is used to project future year $PM_{2.5}$ species components rather than total $PM_{2.5}$ mass, then the model performance for each of the components that make up $PM_{2.5}$ is actually more important than for total $PM_{2.5}$ mass which the standard was written for. These components are:

- Sulfate (SO4);
- Nitrate (NO3);
- Ammonium (NH4);
- Organic Carbon (OC);
- Elemental Carbon (EC); and
- Other Inorganic fine Particulate (IP or Soil).

The VISTAS/ASIP model testing will concentrate on an operational evaluation of those model predictions that are most necessary for estimating $PM_{2.5}$ (i.e., NH_4, SO_4, NO_3, OC, EC and IP) and 8-hour ozone (i.e., 1-hour and 8-hour ozone) concentrations. Where feasible and supported by sufficient measurement data, we will also evaluate the modeling system for its ability to accurately estimate coarse mass (CM) PM and other gas-phase precursor, product and indicator species. The correct simulation of gas-phase oxidant species is needed for PM since correct, unbiased simulation of gas-phase photochemistry is a necessary element of reliable secondary PM predictions. This evaluation will be carried out across the full Southeastern US domain for the entire year and also on

[1] Members of the VISTAS modeling team participated on this work group over the two-year span of its activities.

subdomains (e.g., ozone and $PM_{2.5}$ nonattainment areas) and month-by-month to daily basis to help build confidence that the modeling system is operating correctly. With this context in mind, we next turn to the philosophy of the model evaluation process.

7.3 Multi-Layered Model Testing Process

EPA's "Draft Guidance for Demonstrating Attainment of Air Quality Goals for $PM_{2.5}$ and Regional Haze" (EPA, 2001) and final guidance for 8-hour ozone modeling (EPA, 2005b) affirms the recommendations of numerous modeling scientists over the past decade (see, for example, Dennis et al., 1990; Tesche et al., 1990, 1994; Seigneur et al., 1998, 2000; Russell and Dennis, 2000; Arnold et al., 2003; Boylan et al., 2003; Tonnesen, 2003) that a comprehensive, multi-layered approach to model performance testing should be performed, consisting of the four components: operational, diagnostic, mechanistic (or scientific) and probabilistic. As applied to $PM_{2.5}$ and 8-hour ozone modeling, this multi-layered framework may be viewed conceptually as follows:

> **Operational Evaluation**: Tests the ability of the model to estimate PM concentrations, the components at PM_{10} and $PM_{2.5}$ (i.e., sulfate, nitrate, ammonium, organic carbon, elemental carbon and other $PM_{2.5}$) and 1-hour and 8-hour ozone concentrations. This evaluation examines whether the measurements are properly represented by the model predictions but does not necessarily ensure that the model is getting "the right answer for the right reason";

> **Diagnostic Evaluation:** For fine PM, this step tests the ability of the model to predict PM chemical composition including PM precursors (e.g., SOx, NOx, and NH_3) and associated oxidants (e.g., ozone and nitric acid); PM size distribution; temporal variation; spatial variation; mass fluxes; and components of light extinction (i.e., scattering and absorption). For 8-hour ozone the diagnostic evaluation tests the models ability to predict the temporal and spatial variations in ozone, ozone precursor species (e.g., VOC, NOx and CO) and key indicator species that provide indication of key photochemical regimes (e.g., NOx/ozone, HNO3/H2O2, NOy, etc.);

> **Mechanistic Evaluation:** Tests the ability of the model to predict the response of PM and ozone to changes in variables such as emissions and meteorology; and

> **Probabilistic Evaluation:** Takes into account the uncertainties associated with the model predictions and observations of PM and ozone.

Within the constraints of the VISTAS/ASIP schedule and resources, the VISTAS/ASIP model evaluation effort will attempt to include elements of each of these components. The operational evaluation will obviously receive the greatest attention since this is the primarily thrust of EPA's 2001 $PM_{2.5}$ and 2005 8-hour ozone guidance. However, we will consider, where feasible and appropriate, diagnostic and mechanistic tests (e.g., use of probing tools, indicator species and ratios, aloft model evaluations, urban vs. rural performance analyses), traditional sensitivity simulations to explore uncertainty, and comparison of the VISTAS/ASIP CMAQ performance with those from other groups (e.g., MANE-VU, MRPO, CENRAP) some of which the use alternative science platforms (e.g., CAMx). The scope of these additional diagnostic and mechanistic tests will be shaped by the resources available and the timing of when such analyses are commissioned relative to the VISTAS/ASIP schedule and resources.

Before discussing the types of testing procedures available for the above evaluation components, we first identify the surface and aloft data sets that are available to support these comparisons.

7.4 Development of Consistent Evaluation Data Sets

7.4.1 Surface Measurements

The ground-level model evaluation database will be developed using several routine and research-grade databases. The first is the routine gas-phase concentration measurements for ozone, NO, NO_2 and CO archived in EPA's Aerometric Information Retrieval System (AIRS/AQS) database. Other sources of information come from the various PM monitoring networks in the U.S. These include the: (a) Interagency Monitoring of Protected Visual Environments (IMPROVE), (b) Clean Air Status and Trends Network (CASTNet), (c) Southeastern Aerosol Research and Characterization (SEARCH), (d) EPA $PM_{2.5}$ and PM_{10} Mass Networks (EPA-FRM), (e) EPA Speciation Trends Network (STN); (f) National Acid Deposition Network (NADP) and (g) EPA Supersites (EPA-SPEC) networks. Typically, these networks provide ozone, other gas phase precursors and product species, PM mass and species, and visibility measurements. Noteworthy for the VISTAS/ASIP evaluation is the 24-hour average and continuous speciated $PM_{2.5}$ and continuous gas-phase concentration measurements available from the SEARCH network for 2002 modeling period. For 2003, additional continuous PM speciated data will be available from the FOCUS network and in the Midwest U.S. ammonia measurements are available. However, since these data were not collected during the 2002 modeling year, their use in the evaluation will be more qualitative and diagnostic.

As an example, the IMPROVE network gives daily (24-hour) average mass concentrations every 3 days for SO_4, NO_3, organic carbon (OC), elemental carbon (EC), soil (IP) and total, $PM_{2.5}$ and PM_{10} mass from which CM can be derived. Some IMPROVE sites also have gas-phase species measurements (e.g., ozone and Great Smokey and Shenandoah National Parks). These data are available at approximately 38 sites in the VISTAS/ASIP 12 km domain. In addition, hourly values of light extinction and deciview are available at several of these sites. The SEARCH network provides 24-hour as well as continuous (hourly) speciated measurements of $PM_{2.5}$ components and other specifics from 8 stations, depending on the time period (Hansen et al., 2003). Of key importance for the ASIP modeling is the ozone and PM performance of the CMAQ model at the, respectively, AIRS/AQS and FRM, and nearby STN, sites that are measuring violations of the 8-hour ozone and $PM_{2.5}$ NAAQS. We will use data from these and the other observational databases listed in Table 7-1, for CMAQ model performance testing.

Ozone measurements are highly accurate and precise, but can be highly influenced by local conditions, such as local NOx sources that can suppress the observed ozone concentrations and make them less representative of the surrounding community. An important consideration in evaluating models for PM is that different PM monitoring networks may use different measurement approaches that "measure" different amounts of the same species that are also different from the modeled species. For example, the IMPROVE network only speciates $PM_{2.5}$ so any sulfate or nitrate in the coarse mode ($PM_{2.5-10}$) is included in the Coarse Mass (CM) species "measurement" (where CM = PM_{10} – $PM_{2.5}$ mass). Because the different monitoring networks may use different measurement technology that results in different "measured" values for the same PM component, the CMAQ model will be evaluated separately for each monitoring network. Ozone is made up of a single species so the mapping of the measured to modeled species is easily accomplished. However, there is sometimes ambiguity in the mapping of modeled PM species to measurements. For example, PM measurements only measure the carbon component of OC, whereas in the model the entire Organic Mass Carbon (OMC) is simulated that includes carbon as well as other elements attached to the carbon (e.g., hydrogen and oxygen). Thus, a factor is assumed to adjust the measured OC to OMC. In the past a 1.4 OMC/OC factor has been used based on urban scale measurements of fresh OC emissions and this is the factor used in the current IMPROVE reconstructed mass equation (Malm, 2000). However, this OMC/OC factor is likely too low, especially for aged OC compounds, and OMC/OC ratios of 1.4 to 2.2 have been observed (Turpin and Lim, 2001) with the current average OMC/OC ratio value of 1.8 being recommended.

The VISTAS Phase I air quality data assessment report (ENVIRON, 2003c) provides more details on the ambient monitoring data available for the VISTAS/ASIP model performance evaluation modeling.

7.4.2 Aloft Measurements

In recent years, the use of instrument aircraft in support of regulatory monitoring and research programs has become much more commonplace. Indeed, in the upper Midwest, the Lake Michigan Air Directors Consortium (LADCo) has been centrally involved in aircraft programs to support model development and applications studies for seventeen (17) years, beginning with pioneering flights in 1987. Supplementing the long-term sampling performed by LADCo in the Midwest, there have been other occasional intensive airborne sampling campaigns throughout the eastern U.S. (e.g., the 1999 SOS field program which provided aloft data for our evaluation of CMAQ for the July '99 episode), that have produced very useful information for air quality model performance testing. Fortunately, during CY-2002, there were at least two mature airborne field programs underway in the eastern U.S. One was centered over the Midwest, the other on the mid-Atlantic coast. A brief characterization of these potentially valuable CMAQ model evaluation data sets is given here. Note that the advanced modeling evaluation using non-routine data sets like aircraft data are not currently planned under the VISTAS/ASIP work efforts. However, their inclusion in the evaluation would provide valuable information on the model accuracy and reliability.

During 2002, the Wisconsin Department of Natural Resources (WDNR) and the Midwest RPO (MRPO) (who funded the Jacko aircraft) collaborated on the support of airborne sampling using two aircraft that, along with ground-based measurements, provided a 3-dimensional representation of air pollution concentrations across the upper Midwest with some flight paths extending south to include the Mammoth Cave, KY and Dolly Sods, WV Class I areas in the VISTAS domain. The goal of the WDNR/MRPO flights was to collect aloft air quality and meteorological data to support model evaluation and data analyses. The aircraft flights were aimed at: (1) characterizing high fine particle and ozone episodes, (2) characterizing air quality over the

Class I areas in the upper Midwest (Isle Royale National Park and Seney National Wildlife Refuge in northern Michigan) on both clean and hazy days, and (3) characterizing urban areas in the Midwest.

As indicated in Table 7-2, airborne sampling was performed over a broad region of the Midwest (including portions of the VISTAS states) from 1 June to 22 November. Lasting 3-5 hours, the WDNR and Jacko aircraft sampled a variety of aerometric parameters (depending upon the flight and aircraft) including wind speed, wind direction temperature, dew point, relative humidity, pressure, O_3, NO, NO_2, NO_x, NO_y, speciated VOCs, carbonyls, HNO_3, NH_3, Hg, SO_4, OC, EC, $PM_{2.5}$, and light scattering (Neph). Still photographs documenting visibility were also collected. Presently, the full WDNR/MRPO aircraft database, from the first flights in 1987 to the recent sampling in 2003 is being aggregated into a master data base archive.

At the University of Maryland, researchers have been using ground-based monitors, radiosondes, profilers, and instrumented aircraft to make observations each year since 1992. Parameters measured included meteorology; selected trace gases; fine particulate chemistry, microphysics and optical properties across broad regions of the middle Atlantic coast. During 2002, the University Research Foundation's Aztec-F aircraft instrument suite included O_3, NO, CO, SO_2 samplers, as well as a NO_2 closed-path tunable diode laser system, and a differential GPS-based meteorology (T, RH) and horizontal wind (*u* and *v* horizontal components) data system. Aztec-F flights were made from 23 May to 3 October, typically lasting 3 hours.

7.5 Model Evaluation Tools

This section introduces the various statistical measures, graphical tools, and related analytical procedures that have proven useful over the years in evaluating grid-based chemical transport models. Many of the methodologies mentioned below have been utilized in the VISTAS Phase I preliminary evaluation and have been refined during the course of the VISTAS and other (e.g., WRAP, MRG, CENRAP) studies. While we plan on calculating a rich variety of statistical performance metrics, only a very limited subset of these measures will actually be relied upon to form judgments concerning model acceptability and in the final reporting.

7.5.1 Statistical Performance Metrics

EPA's 1991 and 2005 ozone and draft 2001 PM and regional haze guidance documents suggests a suite of metrics for use in evaluating model performance. EPA's 1-hour ozone guidance lists three statistical measures with performance goals that a model should achieve before being used to demonstrate ozone attainment in a SIP:

- Mean Normalized Bias (MNB) $\leq \pm 15\%$
- Mean Normalized Gross Error (MNGE) $\leq 35\%$
- Unpaired Peak Accuracy (UPA) $\leq \pm 20\%$

The 1-hour ozone MNB and MNGE performance measures are typically calculated using an observed hourly ozone cutoff threshold of 60 ppb (40 ppb is also used sometimes). These performance measures have also been used for 8-hour ozone model performance evaluation. The newer 8-hour ozone (EPA, 2005b) and draft PM2.5/regional haze (EPA, 2001) modeling guidance focuses more on a holistic model evaluation approach that assesses not only how well the model matches the observation but also whether the model is correctly simulating the processes that produces the elevated ozone and PM concentrations, including a comparison against a conceptual model. In fact some performance measures and goals in earlier versions of the 8-hour ozone guidance (e.g., most daily maximum 8-hour ozone concentrations near the monitor matching to within ±20%; EPA, 1999) were not included in the final version (EPA, 2005b).

Table 7-3 lists a standard set of statistical performance measures that will be used to evaluate fine particulate and ozone models. These performance measures will be calculated using several model performance evaluation software tools for ozone and PM species concentrations, including:

UCR Analysis Tool operates on a Linux platform, performs species and temporal matching of the predictions and observations and generates statistical performance measures, scatter plots and time series plots for user specified subdomains and across all sites and all days, for each site and all days and for each day across all sites.

Alpine Geophysics MAPS Software also operates on a Linux platform generating statistical measures, scatter plots, time series plots and spatial comparisons of predictions and observations. MAPS also spatial averaged performance summaries (e.g., time series of bias and error) that are useful for synthesizing model performance.

PAVE by MCNC is used on a Linux platform to generate spatial maps (tile plots) of model predictions with super imposed observations as colored symbols.

ENVIRON Performance Software calculates performance statistics and exports them along with the predictions and observations to be used with macros operating standard Windows software such as Excel and SURFER to generate graphical displays of model performance that can be customized by the user where the data are also available for further analysis if desired.

The VISTAS/ASIP ozone and PM evaluation of the 2002 36/12 km CMAQ base case simulation will strive to use each of these evaluation packages to some extent to elucidate model performance. Although procedures for assessing ozone model performance are well established since ozone SIPs using photochemical grid modeling in the attainment demonstration have been developed for over a decade (e.g., dating back to the 1994 SIPs; see Morris, 1995). Procedures for evaluating PM models, however, are much less established and research is ongoing. Morris and co-workers (2005) summarize some of the newer PM model evaluation techniques for assessing regional haze models as part of VISTAS, enhancements to these techniques with a focus on urban PM performance will be needed for the ASIP PM2.5 evaluation.

Typically, the statistical metrics are calculated at each monitoring site across the full computational domain for all simulation days. In the VISTAS/ASIP CMAQ evaluation, we will stratify the performance statistics across relevant space and time scales. As part of the operational evaluation, the gas-phase and aerosol statistical measures shown in Table 7-3 will be computed for the full 36 km and 12 km domains, as well as for the individual RPOs (VISTAS, WRAP, CENRAP, MRPO and MANE-VU) and on other subdomains as appropriate (e.g., 8-hour ozone and $PM_{2.5}$ nonattainment areas). Temporally, we will compute the statistical measures for the appropriate averaging times: 1-hour and 8-hour for ozone and hourly for other gas-phase precursors such as NO, NO_2, CO, SO_2; usually 24-hour for sulfate, nitrate, EC, OC, PM and other aerosol species, although some SEARCH sites have continuous PM species and the CASTNet monitoring network measures weekly PM species; and weekly for wet deposition of sulfate, nitrate and ammonium from the NADP network. Where appropriate these results will then be averaged over annual, monthly, and seasonal periods for display, further analysis, and reporting. Should it become necessary as part of model performance diagnosis, we will consider aggregating the statistics in other ways, e.g., (a) day vs. night, (b) weekday vs. weekend, (c) precipitation vs. non-precipitation days, (d) month of the year, and (e) exceedance events, in order to help elucidate model performance problems. The amount of these supplemental time/space analyses would depend on available resources. In subregional performance testing, the focus would likely be on the nonattainment areas, Class I areas and sites where enhanced monitoring (EPA STN and FRM locations, the hourly/daily SEARCH sites) within the VISTAS 12 km domain (Hansen et al., 2003) is available.

As part of the operational evaluation, the metrics defined in Table 7-3 will be calculated for each gas phase species and each fine particulate species in the extinction equation as well as separately for SO_4, NO_3 and ammonium (NH_4) on both the 36 km and 12 km domains. In any diagnostic evaluations that are performed, we will examine the model's ability to estimate the gaseous species listed above from EPA's guidance (EPA, 1991; 2001; 2005). However, in reality ambient gaseous species in 2002 are principally available for ozone, NO_2, SO_2, and CO.

7.5.2 Graphical Representations

The VISTAS/ASIP operational air quality model evaluation will utilize numerous graphical displays to facilitate quantitative and qualitative comparisons between CMAQ predictions and measurements, many of which were used in the VISTAS Phase I Final Report (ENVIRON, 2004) and summarized by Morris and co-workers (2005). Together with the statistical metrics listed in Table 7-3, the graphical procedures are intended to help: (a) identify obviously flawed model simulations, (b) guide the implementation of performance improvements in the 2002 model input files in a logical, defensible manner, and (c) to help elucidate the similarities and differences between the alternative CMAQ simulations. These graphical tools are intended to depict the model's ability to predict the observed fine particulate and gaseous species concentrations.

The VISTAS Phase I modeling helped to refine the suite of graphical tools most effectively in assessing model performance and the differences between the baseline CMAQ runs and sensitivity experiments. The core graphical displays to be considered for use in Phase II include the following:

- Spatial mean concentration time series plots;
- Time series plots at monitoring locations;
- Ground-level gas-phase and particulate concentration maps (i.e., tile plots);
- Concentration scatterplots stratified by station, by time, and by network;
- Bias and error stratified by concentration;

> Bias and error stratified by time;
> Histogram plots of the statistical metrics, stratified by day, by pollutant, by subregion (e.g., 12 km vs. 36 km, by RPO), and by monitoring network; and
> Quantile-Quantile (Q-Q) plots.

These graphical displays will be generated, were appropriate for the full annual cycle as well as for monthly and seasonal periods. The displays will be generated with a consistent suite of products including the UCR analysis tools, Alpine MAPS software and ENVIRON evaluation software.

7.5.3 MAPS/Flying Data Grabber Routines

This section describes the procedures we would implement for the aloft gas phase and PM model evaluation with CMAQ using aircraft data should resources be available to make such a comparison. This aloft performance evaluation would employ aircraft data sets from various sampling programs carried out over the Midwest and eastern U.S. during 2002. Details on how these data are used to evaluate CMAQ performance aloft together with findings from our aloft model evaluations with the 10-21 July 1999 episode are described in the VISTAS Phase I Final Report (ENVIRON, 2004).

The principal challenge in using the aircraft data for meteorological and photochemical model evaluations relates to the 'incommensurability' of Lagrangian aircraft observations with Eulerian (i.e., fixed location) volume-averaged model estimates (see, for example, Hanna, 1994). Aircraft data are essentially continuous, high frequency Lagrangian samples having response times on the order of 30 seconds or less. In contrast, CMAQ model estimates represent hourly-averaged values. Thus, the aircraft data must be averaged in some manner to yield quantities that are at least qualitatively comparable to the air quality fields estimated by CMAQ in the grid volume(s) through which the aircraft passes. The objective is to develop hourly-average time series of measurements and model estimates that are as nearly comparable as possible.

The procedures proposed for processing the aloft meteorological and air quality observations and CMAQ model predictions have been described in several science reports prepared in connection with the Lake Michigan Ozone Study (Tesche and McNally, 1993a-d, 2001) and more recently the Houston-Galveston 1-hr ozone SIP modeling that utilized the TexAQS 2000 data base (Tesche and Jeffries, 2002). These methods, formalized within AG's Flying Data Grabber (FDG*)* model, were employed in Phase I for the 13-21 July 1999 episode. The methods used are substantial extensions of the techniques pioneered a decade ago by Schere and Wayland (1989) for the Regional Oxidant Model (ROM2.0) evaluation against the NEROS database and by Barchet and Dennis (1990) for the RADM/ADOM evaluation (Dennis et al., 1990).

For a typical aircraft (or helicopter flight), the Flying Data Grabber first identifies the specific time interval during which the aircraft was located in a given CMAQ model grid cell along the flight path. The observations are then integrated to produce mean, standard deviation, bias and error estimates for the variable measured within each grid cell of the flight path. This averaging process produces an observed, averaged time series for the above statistical quantities along the flight path. Note, that these time intervals are characteristically much smaller than the one-hour model averaging time. Flight path statistics, together with the mean modeled and observed horizontal winds along the flight paths are also produced by the FDG. The maximum and minimum values during each time segment within a grid cell are also recorded.

The FDG methodology further assumes that the air quality model estimates vary approximately linearly during each hour. It is then straightforward to construct an estimated time series of the modeled values that corresponds to the above-described observed time series derived from the aircraft data. The measurements and model estimates, now on roughly comparable time and space scales, are subsequently processed with the MAPS statistical/graphical software tools described in the Phase I Task 4a report (ENVIRON, 2003d). The statistics of principal interest are the mean values of the observed and modeled concentrations together with estimates of bias and imprecision (i.e., gross error). A variety of graphical representations are also produced to facilitate evaluation an intercomparison.

7.5.4 Use of Multiple Evaluation Packages

In VISTAS Phase I model evaluation (ENVIRON, 2004) relied principally on the UCR evaluation package that was originally developed for WRAP and then enhanced by VISTAS. This package produce scatter plots by site, day or all sites and days, time series plots and statistical measures In the VISTAS/ASIP model evaluation we will attempt to augment the UCR Analysis Tool evaluation software with other software evaluation packages as discussed previously.

7.5.5 Probing Tools and Allied Methods

The VISTAS/ASIP CMAQ model evaluation will employ routine operational evaluation methods and standard statistical metrics (Table 7-4) and graphical displays to support the assessment of whether the model is shown to perform with sufficient accuracy and reliably for its intended purpose. Ideally, this operational evaluation will confirm that the modeling system is performing consistent with its scientific formulation, technical implementation, and at a level that is at least as reliable as other current state-of-science methods. Should unforeseen model performance problems arise in the initial or refined year 2002 model simulations, it may be necessary to draw into the evaluation supplemental diagnostic tools to aid in model testing. These diagnostic techniques are loosely referred to as “probing tools”. The actual need for their use, if any, can only be determined once the initial 2002 CMAQ operational evaluation is completed. Should such diagnostic methods actually be needed, their usage would require additional resources not currently allocated under VISTAS/ASIP. Below, we identify the types of probing tools that could be brought to bear under should their use become necessary.

Current ‘One-Atmosphere” models such as CMAQ and CAMx have been outfitted with a number of “probing tools” that have proven to be very useful in testing and improving model performance and in evaluating emissions control strategies. Among the probing tools available in one or both models are: (a) ozone source apportionment technology (OSAT) algorithms, (b) PM Source Apportionment Technology (PSAT) and Tagged Species Source Apportionment (TSSA) PM source apportionment techniques; (c) process analysis (PA), and (d) the direct decoupled method (DDM) for sensitivity analysis.

Source Apportionment Techniques: CAMx contains a suite of "source attribution" methods for ozone and PM that use reactive tracers that operate in parallel to the host model. The Ozone Source Apportionment Technology (OSAT) tracks ozone formation from user defined source regions and categories based on how the group's ozone precursors contributed to ozone formation. Thus, OSAT decides whether ozone formation is NOx or VOC limited in each grid cell at each time step, and bases ozone attributions on the relative amounts of the limiting precursor from different sources that are present in that grid cell at that time step. These incremental ozone attributions are integrated throughout the model run. The method is generally applicable and has been widely used to aid model diagnosis in the performance testing phase, to guide control strategy development and for ozone culpability assessments (e.g., NOx SIP Call and CAIR). The PM Source Apportionment Technology (PSAT) also uses reactive tracers to rack PM species formation back to user defined source regions and categories based on the primary precursor to the PM species (e.g., sulfate is traced back to SO2 emissions, nitrate is traced back to NOx emissions, etc.). A Tagged Species Source Apportionment (TSSA) approach has also been implemented in CMAQ and tested for sulfate and nitrate (Tonneson, 2004, personal communication). However, TSSA contained unexplained PM source apportionment that has been attributable to mass conservation errors in CMAQ that has been fixed in the latest (Version 4.5, October 2005) of CMAQ (Pleim, 2005).

Decoupled Direct Method (DDM): Various forms of the Decoupled Direct Method (DDM) have been installed in CMAQ and CAMx, based on the original work of Dunker and co-workers (Dunker, 1981; 1984; Dunker et al., 2002) and researchers at Georgia Institute of Technology (GIT). In general, the DDM method: (a) calculates first order sensitivities dC/dP where C is a concentration output and P an input parameter[2], (b) promotes accuracy by using consistent numerical methods and the same time steps for concentrations and sensitivities, (c) optimizes the code for efficiency, but not at expense of accuracy, and (d) calculates sensitivities with respect to parameters representing pollutant sources – emissions, BCs and ICs. Finally, the DDM provides a flexible and powerful user interface for defining various sensitivities including:

- Emissions resolved by geographic area.
- Emissions resolved by source category.
- BCs optionally resolved by boundary edge (N, S, E, W, Top).
- All sensitivities available relative to sources of individual species (NO, PAR, etc.) or species group (VOC, NOx or ALL).
- Simultaneously calculate sensitivities to many initial condition, boundary condition and emissions parameters.

In recent comparisons between CAMx DDM sensitivities and brute-force sensitivities (calculated from +/- 20% perturbations) Dunker et al., (2002a,b) reported that sensitivities of ozone with respect to area source NOx and VOC emissions were calculated and results indicated that the agreement between DDM and brute force sensitivities is excellent. DDM implementation into CMAQ is reported by Kumar (2003).

2 Recent research by Prof. Russell and coworkers at GIT has led to the extension of the CMAQ DDM method to include second order sensitivity coefficients (see, Hakami et al., 2003).

Process Analysis (PA): Photochemical air quality model simulations are usually evaluated primarily in terms of their ability to simulate observed O_3 data. There is an increasing awareness that chemical mechanisms and air quality models must also be evaluated in terms of their ability to simulate the fundamental chemical processes that control O_3 formation and the sensitivity of O_3 to emissions reductions (Arnold et al., 1998). Process analysis is a method for explaining model simulations by adding algorithms to the AQM to store the integrated rates of species changes due to individual chemical reactions and other sink and source processes (Jeffries and Tonnesen, 1994; Tonnesen, 1995). By integrating these rates over time and outputting them at hourly intervals, process analysis provides diagnostic outputs that can be used to explain a model simulation in terms of the budgets of free radicals, production and loss of odd oxygen and O_3, and conversion of NOx to inert forms, as well as the effects of transport and other sink and source terms. Of particular importance to the VISTAS modeling, process analysis can also improve model diagnosis and performance evaluation efforts by identifying processes that are 'out of balance' (Tesche and Jeffries, 2002), by identifying situations for which the model formulation and/or implementation should not be expected to apply and by suggesting how ambient data can be used to evaluate model accuracy for key terms in the chemical processing of VOC and NOx (e.g., Imre et al., 1998). Process Analysis (PA) is implemented in both CMAQ and CAMx and each model supports three complementary aspects of the method: (a) the integrated process rate (IPR), (b) integrated reaction rate (IRR) and (c) chemical process analysis (CPA). Several versions of process analysis (PA) have been implemented in air quality models (AQMs) including both trajectory models (Tonnesen, 1990, 1995) and grid models (Jang et al., 1995, Tonnesen and Dennis, 2000; Arnold et al., 1998; and Wang, 1997). The fundamental approach in all versions of PA is similar: The AQM is modified to calculate the integral over time of the individual sink and source processes and each chemical reaction. These integrated sink/source process rates (IPR) and integrated reaction rates (IRR) can then be stored to a file and analyzed using a post-processor, or some processing can be performed internally in the model and a more limited set of process diagnostic information is output directly by the AQM. Chemical process analysis (CPA) is an improvement on the IRR method whereby some of the processing of IRR information is internalized within the AQM to output chemically meaningful parameters directly (e.g., budget terms for O_3, NOx and odd oxygen).

Process analysis measures for aerosol chemistry have not been analyzed as much as for ozone chemistry. Although the ozone chemistry process analysis is directly related to secondary sulfate and nitrate formation, there is additional process analysis information available in the aerosol modules that are not extracted in either CMAQ or CAMx. In particular, information on sulfate formation and oxidants from the aqueous-phase module and on the sulfate/nitrate equilibrium from the aerosol thermodynamics module would be a useful addition to the current process analysis output.

Because application of all three of these probing tools--source apportionment, DDM, and Process Analysis—are computational intensive and require a fair amount of analysis time to reap the benefits of using the methods, they do not lend themselves directly to annual simulations. However, each method has potential for use in addressing key episodic periods or geographical locations in the VISTAS/ASIP domain where performance in the 2002 simulation may present a problem or where particular attention needs to be focused on emissions controls (a specific nonattainment area for example). In such focused applications, one or more of these probing tools may indeed serve a purpose and will be considered where appropriate.

7.6 Model Evaluation Procedures

EPA draft PM modeling guidance (EPA, 2001, pg. 227) suggests that the performance evaluation focus on two aspects (similar suggestions are contained in the 8-hour ozone modeling guidance, EPA, 2005b):

> How well is the model able to replicate observed concentrations of components of $PM_{2.5}$, total observed mass of $PM_{2.5}$? and
> How accurately does the model characterize the sensitivity of changes in component concentrations to changes in emissions?

Recognizing that the former is much easier to accomplish than the latter, EPA goes on to declare that testing of a model's reliability in estimating the actual effects of emissions changes is the more important. Over the past 20 years, a substantial body of information and analytical techniques has been developed to address the first aspect. Unfortunately, even today there are little rigorous methods available for quantifying the accuracy and precision of a model's predictions of ozone, PM or visibility changes as the result of emissions changes. In this section we explain how the VISTAS/ASIP testing will address the first aspect of the performance evaluation, i.e., how does the model compare against observed data. In section 7.9 we consider the second performance consideration.

7.6.1 Assessment of Ground-Level Gas-Phase and Aerosol Species

Given that $PM_{2.5}$ mass is the sum of the individual components of fine particulate matter and the $PM_{2.5}$ attainment demonstration test involves the separate projection of each PM component, the model should be evaluated separately for each of the key fine particulate matter components that make up $PM_{2.5}$ mass. Current EPA draft PM modeling guidance suggests that the model should also be evaluated for several key gas-phase species that are important for fine particulate modeling. For *particulate species* this includes SO_4 and/or S, NH_4, NO_3, mass associated with SO_4, mass associated with NO_3, elemental carbon (EC), organic carbon (OC), IP, mass of individual constituents of IP, and coarse matter (CM). The *gaseous species* include ozone (O_3), HNO_3, NO_2, PAN, NH_3, NOy, SO_2, CO, and H_2O_2.

For ozone modeling, EPA guidance (EPA, 2001; 2005b) recommends evaluating the model for ozone as well as ozone precursor (e.g., VOC, NOx and CO) as well as key indicator species (e.g., NOy, NOz, HNO3, H2O2, etc.). As noted previously, the 1-hour ozone modeling guidance includes model performance goals, whereas more recent 8-hour ozone (EPA, 2005b) and $PM_{2.5}$ (EPA, 2001) guidance stresses more confirmatory and corroborative techniques and processed based evaluation to assure that the model is getting the right answer for the right reason, in addition to demonstrating that the model exhibits skill in predicting the observed 8-hour ozone and $PM_{2.5}$ concentrations.

At some of the IMPROVE sites there are also direct measurements of hourly extinction using transmissometer or nephelometer instruments that will provide another measure of performance for fine particulate Thus, it would be scientifically interesting to evaluate the model estimated extinction with the hourly measured values at these sites.

As part of the CMAQ operational evaluation, model outputs will be compared statistically and graphically to observational data obtained from the AIRS/AQS, IMPROVE, SEARCH, CASTNet, EPA-FRM, EPA-STN, and other monitoring networks. These monitoring data will be obtained from AIRS, VIEWS, and other appropriate organizations. These comparisons will likely include:

- Daily monthly, seasonal and annual averages for SO_2, SO_4, NO_3, EC, OC, $PM_{2.5}$, and PM_{10}, taking care to exclude periods of sampling interference in the observational data. We will look for systematic biases between the model results and IMPROVE observations, and if biases are found, identify possible sources of error in the model inputs.

- Hourly, high resolution PM species and gaseous species concentrations at sites where available (e.g., SEARCH, AIRS and EPA-Supersites).

- At sites with contrasting aerosol mass loadings, analysis of the temporal behavior of the major scattering and absorbing aerosol constituents along with the visibility trends, to establish correlations.

- For ozone, comparisons against observed hourly and 8-hour ozone concentrations in nonattainment areas.

The types of analysis that could be performed as part of the VISTAS/ASIP CMAQ diagnostic model evaluations that could be considered are:

- Evaluate seasonal trends in observations of organic and inorganic aerosol precursors and their effects on PM composition and visibility, and evaluate the ability of the model to capture these seasonal trends.

- Evaluate how well the model simulates various physicochemical processes by: (a) examining observed and modeled correlations between various species pairs, and (b) comparing model-predicted ratios of various species (individual or families) with observations to evaluate gas/particle partitioning (e.g., nitrate/total nitrate, SO_4/SO_x).

- Investigate the performance of the model at selected observational sites characterized by different chemical regimes that may be encountered either spatially or during different seasons to help identify any inadequacies in the model and to provide a better understanding of conditions under which model inferences may be weak.

- Create scatter plots of modeled vs. observed data and hourly and 24-hour averages by site and subregion to help identify any site-specific biases.

> Create time series plots of predicted and observed concentrations stratified by key variables as appropriate.

> Evaluate for total sulfur ($SO_2 + SO_4$), nitrate ($HNO_3 + NO_3$) and ammonia ($NH_3 + NH_4$).

> Compare observed versus modeled mass fractions of PM constituents at various sites that are characterized by their proximity or remoteness relative to sources, or by specific meteorological conditions (e.g., frontal passage, stagnation, precipitation); these will enable identification of trends in the model of over- or under-prediction of specific PM constituents under these conditions.

> Calculate the measured and predicted relative abundance of key PM components and compare with EPA guideline recommendations and emergent alternative science recommendations (e.g., removing the soil component from the calculations, use of alternative relative importance equations [i.e., Boylan, 2004]).

> Evaluate for ozone precursors and key indicator species and ratios (e.g., HNO3/H2O2) as well as product species.

The suite of statistical metrics and graphical tools identified in the previous section for the core operational evaluation efforts that would likely also be used to diagnose performance problems with the CMAQ simulations should they exist and to highlight differences between model runs. Experience in ozone/PM modeling is the best basis upon which to identify obviously flawed simulation results. Efforts to improve the CMAQ model's base case performance will be made, where necessary, warranted (i.e., to reduce the discrepancies between model estimates and observations), and consistent with the project resources and schedule; however, these model performance improvements efforts must be based on sound scientific principles. "Curve-fitting" exercises will be avoided.

7.6.2 Assessment of Aloft Gas-Phase and Aerosol Species

A substantial number of aircraft flights were conducted during 2002 over the Midwest and Eastern U.S. Should VISTAS elect to fund the optional aloft model performance evaluation, we will endeavor to obtain this information and use it in a scientific performance evaluation of aloft gas-phase and aerosol species (see section 7.3.2).

7.7 Performance Goals and Benchmarks

Establishment of performance goals and benchmarks for regulatory modeling is a necessary but difficult activity. Here, performance goals refer to targets that we believe a good performing model should achieve, where as performance benchmarks are based on historical model performance measures for the best performing simulations. Performance goals are necessary in order to provide consistency in model applications and expectations across the country and to provide standardization in how much weight may be accorded modeling study results in the decision-making process. It is a problematic activity, though, because many areas present unique challenges (e.g., Houston, San

Joaquin Valley, Los Angeles) and no one set of performance goals is likely to fit all needs. Equally concerning is the very real danger that modeling studies will be truncated when the 'statistics look right' before full assessment of the model's reliability is made. This has the potential from breeding built-in compensating errors (Reynolds et al., 1996) as modelers strive to get good statistics as opposed to searching for the explanations for poor performance and then rectifying them. A NARSTO review of more than two-dozen urban-scale ozone SIP applications found this tendency to be all too prevalent in the regulatory modeling of the 1990s. (Roth et al, 1997). In fact more recent

Nearly 15 years ago, research sponsored by the California Air Resources Board (Tesche et al., 1990) led to the agency's adoption of three performance goals for 1-hour ozone modeling in the state:

- > Unpaired (in time and space) peak prediction accuracy (≤ ± 20%);
- > Mean normalized bias in hourly averaged concentrations (≤ ± 15%); and
- > Mean normalized gross error in hourly concentrations (≤ 35%).

These performance goals for 1-hour ozone concentrations were adapted from previous surveys of several dozen urban-scale photochemical grid modeling studies (principally in California) focusing on ozone episodes of 1 to at most 3 days in duration. A surprising number of these studies did not include biogenic VOC emissions in the inventory under the then prevailing belief that biogenics were a negligibly small source category compared to automobile emissions. Most of the studies (Tesche, 1985, 1988; Tesche et al., 1985; 1990) comprising the data base from which the California ozone performance goals were derived entailed hourly ozone concentrations well above background levels 60 ppb. As a result, it was common practice to use a "cutoff values" ranging between 40 ppb to 60ppb to eliminate prediction-observations pairs that would cause these bias and error residual statistics to become extraordinarily large when measured concentrations were low.) Accordingly, normalized statistics such as bias and error proved to be suitable in most applications since the observed concentrations were generally high. These three California ozone model performance goals were adopted by EPA (1991) as part of the nationwide photochemical modeling guidelines and have been heavily used since.

EPA's 1999 draft 8-hour ozone modeling guidance adopted the 1-hour performance goals and added additional performance goals related to 8-hour ozone model performance. For example, the draft 8-hour ozone guidance lists a performance goal to match the observed daily maximum 8-hour ozone concentrations near the monitor to within ±20%.

However, when these evaluation metrics and goals were later applied to evaluate PM species, difficulties arose because performance statistics that divide by low concentration observations become much less useful. Indeed, some observed PM species approach zero (e.g., NO_3) which results in the MNB and MNGE performance metrics approaching infinity. In time, this has led to the introduction of the fractional and normalized mean bias and error metrics (see Table 7-4) in addition to the mean normalized bias and gross error (MNB and MNGE) metrics and related performance expectations based on these alternative measures.

While the 1-hour ozone metrics and goals still have value in interpreting ozone and some gas-phase species performance, it has been necessary to develop new performance metrics and goals for fine particulates. EPA's PM guidance document (EPA, 2001) guidance document identifies particulate matter components of interest to include: SO_4 and/or S, NH_4, NO_3, mass associated with SO_4, mass associated with NO_3, EC, OC, IP, and mass of individual constituents of inorganic primary particulate matter (i.e., IP). Gaseous pollutants of interest include ozone, HNO_3, NO_2, PAN, NH_3, NO_y, SO_2, CO, and H_2O_2. In addition, EPA guidance identifies several potentially useful statistical measures including: (a) accuracy of spatially averaged concentrations near a monitor, (b) fractional bias in means and standard deviations of predictions and observations, (c) normalized bias, (d) normalized gross error, (e) unpaired comparisons between predicted and observed peak concentrations.

As with ozone in the 1980s, actual experience with PM models has led to the development of the current performance expectations for these models. For example, PM_{10} SIP model performance goals for mean normalized gross error of < 30% for southern California (SCAQMD, 1997; 2003) and < 50% for Phoenix (ENVIRON, 1998) have been used. As correctly pointed out by Seigneur and co-workers (2003), the current ability of regional PM models to predicting regional PM and visibility is an area of research with improvements needed for characterizing meteorology and emissions as well as PM models themselves. To this list we would add the need for improvements in model evaluation methodologies as well.

When EPA's draft guidance was developed nearly four (4) years ago, an interim set of fine particulate modeling performance goals were suggested for aggregated mean normalized gross error and mean normalized bias as follows (EPA, 2001):

Pollutant	Gross Error	Normalized Bias
$PM_{2.5}$	~30-50%	~±10%
Sulfate	~30-50%	~±20-30%
Nitrate	~20-70%	~±15-50%
EC	~15-60%	NA
OC	~40-50%	~±38%

Because regional-scale fine particulate and regional haze modeling is an evolving science, and considerable practical application and performance testing has transpired in the intervening years since these goals were postulated, we consider them general guidelines. As part of the VISTAS preliminary model performance evaluation efforts along with the model evaluation studies conducted by WRAP (Tonnesen et al., 2004; CENRAP (Morris et al., 2005), MRPO (Baker, 2005), and other studies has developed model performance goals and criteria for PM species. These goals and a summary of model evaluation display techniques are summarized by Morris and co-workers (2005) and consist of the following:

Fractional Bias	Fractional Error	Comment
≤±15%	≤35%	Ozone model performance goal for which PM model performance would be considered good.
≤±30%	≤50%	A level of model performance that we would hope each PM species could meet
≤±60%	≤75%	At or above this level of performance indicates fundamental problems with the modeling system.

We regard the above goals and criteria not as a pass/fail test, but rather as a basis of intercomparing model performance across studies, sensitivity tests and models.

7-8. Diagnostic and Sensitivity Testing

Rarely does a modeling team find that the first simulation satisfactorily meets all (or even most) model performance expectations. Indeed, our experience has been that initial simulations that 'look very good', usually do so as the result of compensating errors. The norm is to engage in a logical, documented process of model performance improvement wherein a variety of diagnostic probing tools and sensitivity testing methods are used to identify, analyze, and then attempt to remove the causes of inadequate model performance. This is invariably the most technically challenging and time consuming phase of a modeling study. We anticipate that the annual CMAQ model base case simulations will present some performance challenges that may necessitate focused diagnostic and sensitivity testing in order for them to be resolved. Hopefully, these diagnostic and/or sensitivity tests can be adequately carried out within the resources and schedule of Tasks 4a/4b. If not, then it may be necessary to draw upon the Optional Task 14 (Enhanced Model Performance Evaluation) and/or Optional Task 15 (Contingency) resources to conduct the necessary work. Where practical, diagnostic or sensitivity analyses, if needed, could be performed on selected episodes within the annual cycle, thereby avoiding the time-consuming task of running CMAQ for the fully 2002 period. Below we identify the types of diagnostic and sensitivity testing methods that might be employed in diagnosing inadequate model performance and devising appropriate methods for improving the model response.

7.8.1 Traditional Sensitivity Testing

Model sensitivity experiments are useful in three distinct phases or 'levels' of an air quality modeling study and all will be used as appropriate in the VISTAS Phase II modeling with CMAQ. These levels are:

> **Level I**. Model algorithm evaluation and configuration testing;
> **Level II**. Model performance testing, uncertainty analysis and compensatory error diagnosis, and
> **Level III.** Investigation of model output response (e.g., ozone, aerosol, deposition) to changes in precursors as part of emissions control scenario analyses.

Most of the Level I sensitivity tests with CMAQ have already been completed in the Phase I configuration and diagnostic analyses. However, given that open community nature of CMAQ and the frequent science updates to the model and supporting data abases, it is possible that some additional configuration sensitivity testing will be necessary in the early months of Phase II Potential Level I sensitivity runs would be carried out at one or more of the Team's three modeling centers. Potential Level II sensitivity analyses might be helpful in accomplishing the following tasks:

> To reveal internal inconsistencies in the model;
> To provide a basis for compensatory error analysis;

- > To reveal the parameters (or inputs) that dominate (or do not dominate) the model's operation;
- > To reveal propagation of errors through the model; and
- > To provide guidance for model refinement and data collection programs.

At this time, it is not possible to identify one or more Level II sensitivity runs that might be needed to establish a reliable annual 2002 CMAQ base case. The merits of performing Level II sensitivity testing will depend upon whether performance problems are encountered in Tasks 4a/4b. Also, the number of tests possible, should performance difficulties arise, will be limited by the available schedule and Phase II resources under Optional Task 14 (Extended Model Performance Evaluation). Thus, at this juncture, one cannot be overly prescriptive on the number and emphasis of sensitivity runs that may ultimately be desirable in Phase II. However, from past experience with CMAQ and other models, experience it is possible to identify examples of sensitivity runs could be useful in model performance improvement exercises with the annual 2002 CMAQ simulation. These include:

- > Modified biogenic emissions estimates;
- > Modified on-road motor vehicle emissions;
- > Modified air quality model vertical grid structure;
- > Modified boundary conditions;
- > Modified fire emissions;
- > Modified EGU emissions;
- > Modified ammonia emission estimates.
- > Modified aerosol/N_2O_5/HNO_3 chemistry; and
- > Modified NH_3 and HNO_3 deposition velocities.

Note that in a few cases (e.g., vertical grid structure, NH_4 emissions estimates), some sensitivity experimentation has already been carried out in Phase I with the Jan '02, Jul '01 and Jul '99 episodes. To the extent that this Phase I information can help guide the Phase II diagnostics analyses, we will capitalize on this earlier work.

If necessary, Process Analysis extraction outputs can be included in these Level II diagnostic sensitivity simulations in order to provide insight into why the model responds in a particular way to each input modification. Again, the number, complexity, and importance of these types of traditional sensitivity simulations can only be determined once the initial CMAQ annual 2002 simulation(s) are executed.

Level III sensitivity analyses have two main purposes. First, they facilitate the emissions control scenario identification and evaluation processes. Today, four complimentary sensitivity "tools" can be used in regional photochemical models depending upon the platform being used. These methods include: (a) traditional or 'brute force' testing, (b) the direct decoupled method (DDM), (c) Ozone Source Apportionment Technology (OSAT) and PM Source Apportionment Technology (PSAT), and (d) Process Analysis (PA). Each method has its strong points and they will be employed in Phase II where needed. The second purpose of Level III sensitivity analyses is to help quantify the estimated reliability of the air quality model in simulating the atmosphere's response to significant emissions changes. This important model evaluation need is addressed in further detail in section 7.9 below.

Based on experience in other regional studies, examples of Level III monthly or annual sensitivity runs for Phase II might include:

> Ozone, sulfate, nitrate, ammonium and other aerosol sensitivities to SO_2 emissions;
> Ozone, sulfate, nitrate, ammonium and other aerosol sensitivities to elevated point source NO_x emissions;
> Ozone, sulfate, nitrate, ammonium and other aerosol sensitivities to ground level NO_x emissions; and
> Sulfate, nitrate, ammonium and other aerosol sensitivities to ammonia.

Of course, traditional 'brute force' sensitivity experiments are just one way of quantifying these or other Level III sensitivities. Other methods that can be applies include DDM, OSAT, or PSAT simulations.

The need to perform sensitivity experimentation (Levels I, II, or III) will depend on the outcome of the initial operational performance evaluations. If such a need arises, the ability to actually carry out selected sensitivity and/or diagnostic experiments will hinge on the availability of resources and sufficient time to carry out the analyses. Clearly, selection of the specific analysis method will depend upon the nature of the technical question(s) being addressed at the time. Note that as part of VISTAS modeling, Georgia Institute of Technology will be performing emissions sensitivities with CMAQ.

7.8.2 Diagnostic Tests

A rich variety of diagnostic probing tools are available for investigating model performance issues and devising appropriate means for improving the model and/or its inputs. Previously, in section 7.4.4 we introduced the suite of 'probing tools' available for use in the CMAQ and CAMx modeling system for use in Phase II. Where the need exists (i.e., if performance problems are encountered) and assuming VISTAS elects to fund the use of the probing tool applications, these techniques could be employed as appropriate to assist in the model performance improvement efforts associated with the annual 2002 CMAQ basecase development. Here we describe an additional diagnostic method – indicator species and species ratios -- that is potentially useful not only in model performance improvement activities but also in judging the models reliability in estimating the impacts on air quality from future emissions. This method involves the use of so-called 'indicator species' and species ratios. If, during the conduct of Phase II, we determine that application of indicator species and species ratio techniques would be beneficial to the study (and if existing project resources allow), we will discuss with the VISTAS TAWG and ASIP the merits of including this additional probing tool as part of the evaluation effort.

Beginning in the mid 1990s, considerable interest arose in the calculation of indicator species and species ratios as a means of diagnosing photochemical model performance and in assessing model credibility in estimating the effects of emissions changes. Major contributions to the development and refinement of this general diagnostic method over the past decade have been made many scientists including Milford et al., (1994), Sillman (1995, 1999), Sillman et al., (1997), Blanchard (2000), Blanchard and Fairley (2001), and Arnold et al., (2003). Indeed, a recent evaluation of CMAQ using indicator species ratios such as O_3/NO_x, NO_z/NO_y (a measure of chemical aging), and O_3/NO_z (a measure of the ozone production efficiency per NO_x converted), showed not only good agreement with measurements (Arnold et al., 2003) but also convincingly demonstrated the utility of the method for diagnosing model performance in a variety of ways.

Traditionally, indicator species analyses have focused on ozone and its precursor and product species. However the method is equally applicable to PM species and species ratios given sufficient measurement data for comparisons. With some of the high-resolutions monitoring data available from the SEARCH program and the EPA Supersites, it is indeed feasible to compute relevant indicator species and ratios for PM and its component species. For example, Ansara and Pandis (1998) demonstrated how indicator species ratios could be applied to show how the modeled mass of PM might respond to sulfate, nitrate and ammonia emissions-related reductions.

7.9 Corroborative and Weight of Evidence Modeling Analyses

This section identifies additional modeling analyses that might be worth pursuing to add strength to the core model evaluation efforts already planned as part of the VISTAS/ASIP efforts.

7.9.1 Corroborative Models

Noteworthy in EPA's new ozone, PM, and regional haze guidance documents is the encouragement of the use of alternative modeling methods to corroborate the performance findings and control strategy response of the primary air quality simulation model. This endorsement of the use of corroborative methodologies stems from the common understanding that no single photochemical modeling system can be expected to provide exact predictions of the observed ozone and PM species concentrations in a region the size of VISTAS/ASIP, especially over time scales spanning 1-hr to 1 year. Although the photochemical/PM models identified in EPA's PM/regional haze guidance document possess many up-to-date science and computational features, there still can be important differences in modeled gas-phase and aerosol predictions when alternative models are exercised with identical inputs.

As we discovered in the VISTAS/Phase I CMAQ/CAMx inter-comparisons, the general levels of difference revealed between the two model's ozone and PM predictions is typical of what one encounters when inter-comparing alternative state-of-science regional models. These differences provide some insight into the current limits of predictability and reproducibility of today's best photochemical/PM models. In light of these understandable differences in modeling results between state-of-science "One Atmosphere" models, not only is the issue of model selection for VISTAS/ASIP critical[3], but the procedures for the selected model (CMAQ in this instance) and interpreting its output are important as well. Thus, recognizing the uncertainty that attends even the most sophisticated models, the EPA's draft PM/regional haze modeling guidance explicitly addresses the issue of modeling uncertainty by recommending that alternative models (photochemical and observation-based) be considered in the attainment demonstration 'weight of

[3] Model selection is a key issue that all RPOs have addressed and some such as WRAP and VISTAS have chosen CMAQ. Others, such as the MRPO have adopted CAMx instead. Still other RPO's have yet to decide between these two or another model. Clearly, there does not appear to be any one 'right' selection at the present time.

evidence' analyses. Indeed, the Relative Reduction Factor (RRF) approach in the formal attainment demonstration process is designed to address the fact that no model is fully capable of giving precise predictions. In fact the RRF approach was developed in response to the findings of many modelers that alternative, comparable models give somewhat divergent ozone and secondary aerosol predictions.

7.9.2 Weight of Evidence Analyses

EPA's guidance recommends three general types of 'weight of evidence' analyses in support of the attainment demonstration: (a) use of air quality model output, (b) examination of air quality and emissions trends, and (c) the use of corroborative modeling such as alternative models including observation-based (OBM) or observation-driven (OBD) models. We will consider the use of one or more methods in conducting the CMAQ modeling because it could significantly strengthen the credibility and reliability of the modeling available to the states for their subsequent use. The exact details of the 'weight of evidence' analyses must wait until ASIP evolves further. It is premature to prescribe which, if any of the WOE analyses would be performed since the model's level of performance with the 2002 episode is obviously not known at this time and the time and remaining project resources available to support WOE analyses is unknown as well. Also, how much of this WOE analyses will be performed by the modeling team verses states or other has not been determined. Nonetheless, we outline below our thoughts regarding what would likely be considered should the operational CMAQ model evaluation need to be bolstered with WOE analyses.

Use of Air Quality Models. As just discussed, we recommend augmenting the CMAQ annual 2002 and episodic simulations with the use of CAMx to provide additional information on model uncertainty and sensitivity. More specifically the use of CAMx on a somewhat limited basis to corroborate the key model performance evaluation results and emissions control findings of the primary model, CMAQ would be useful. Second, applying the DDM and OSAT/PSAT methods to develop corroborative information on source-receptor relationships and model sensitivities would strengthen the analyses. These supplemental calculations would be performed with one or both models for one or more key periods within the annual 2002 cycle. The results of this additional modeling would be used directly in the 'weight of evidence' analyses to quantify the degree of modeling uncertainty and to corroborate appropriateness of the subsequent PM emissions reductions scenarios.

Use of Emissions and Air Quality Trends. A limited scope emissions and trend analysis could be employed in VISTAS/ASIP to support the 'weight of evidence' determinations. However, traditionally, these types of analyses are performed by the lead agency's own staff. With this expectation, we would coordinate our efforts with the States to develop a trends analysis supporting the future year applications of CMAQ.

Use of Corroborative Observational Modeling. While regulatory modeling studies for ozone attainment demonstrations have traditionally relied upon photochemical models to evaluate ozone control strategies, there has recently been growing emphasis on the use of data-driven models to corroborate the findings of air quality models. As noted, EPA's guidance now encourages the use of such observation-based or observation-driven models (OBMs/ODMs). As part of VISTAS/ASIP, we will consider the merits of using these techniques as supportive weight of evidence. While the OBD/OBM models cannot predict future year air quality levels, they do provide useful corroborative information on the extent to which specific subregions may be VOC-limited or NOx-limited, for example, or where controls on ammonia or SO2 emissions might be most influential in reducing $PM_{2.5}$. Information of this type, together with results of DDM and traditional 'brute-force' sensitivity simulations, can be extremely helpful in postulating emissions control scenarios since it helps focus on which pollutant(s) to control.

7.10 Assessing Model Reliability in Estimating the Effects of Emissions Changes

EPA identifies three methods (EPA, 2001, pg. 228) potentially useful in quantifying a model's reliability in predicting air quality response to changes in model inputs, e.g., emissions. These include:

- Examination of conditions for which substantial changes in (accurately estimated) emissions occur;
- Retrospective modeling, that is, modeling before and after historical significant changes in emissions to assess whether the observed air pollution changes are adequately simulated; and
- Use of predicted and observed ratios of 'chemical indicator species'.

We note that in some urban-scale analyses, the use of weekday/weekend information has been helpful in assessing the model's response to emissions changes.

The first two methods have actually been considered for over 15 years and were the subject of intensive investigations in the early 1990s in Southern California in studies sponsored by the South Coast Air Quality Management District (Tesche, 1991) and the American Petroleum Institute (Reynolds et al., 1996). To date, neither method has proven useful largely because of the great difficulty in developing historical emissions inventories of sufficient quality to make such an analysis credible and the difficulties in removing the influences of different meteorological conditions such that the modeling signal reflects only the model's response to emissions changes. It is difficult enough to construct reliable emissions inventories using today's modeling technology let alone construct retrospective inventories 5-10 years ago prior to the implementation of significant emissions control programs or major land use changes. The use of indicator species, however, offers some promise.

However, recent analytical and numerical modeling studies have demonstrated how the use of ambient data and indicator species ratios can be used to corroborate the future year control strategy estimates of Eulerian air quality models. Blanchard et al., (1999), for example used data from environmental (i.e., smog) chambers and photochemical models to devise a method for evaluating the 1-hr ozone predictions of models due to changes in precursor NOx and VOC emissions. Reynolds et al., (2003) followed up this analysis, augmented with process analysis, to assess the reliability of SAQM photochemical model estimate of 8-hr ozone to precursor emissions cutbacks. With respect to secondary aerosol PM, the recent CMAQ evaluation by Arnold et al. (2003) clearly demonstrated how the use of indicator species analysis could be use to develop insight into the expected reliability and adequacy of a photochemical/PM model for simulating the effects of emissions control scenarios. These researchers used three indicator ratios (or diagnostic ‘probes’) to quantify the model’s response to input changes:

> The ozone response surface probe [O_3/NO_x];
> The chemical aging probe [NO_z/NO_y]; and
> The ozone production efficiency probe [O_3/NO_z].

By closely examining CMAQ’s response to key input changes, properly focused in time and spatial location, Arnold et al., (2003) were able to conclude that the photochemical processing in CMAQ was substantially similar to that in the atmosphere

Thus, the extension of these techniques to address CMAQ predictions for secondary aerosols will doubtless be quite challenging, but the use of indicator species (e.g., ammonia or HNO_3 limitation for nitrate particle formation) and species ratios appears to offer, at this time, the only real opportunity to quantify the expected reliability of the air quality model to correctly simulate the effects of emissions changes. In the CMAQ model evaluation, we will remain alert to opportunities to extend the indicator species ratio analyses to the problem of fine particulate and regional haze. This is one area where technical collaboration between the Emissions and Air Quality Modeling team and the VISTAS and ASIP States and Stakeholders can be especially fruitful in terms of identifying and testing emergent methods for challenging the model’s ability to correctly simulate the effects of future year emissions changes. Finally, we note that this is truly a current research area and as such falls outside the scope of the current modeling effort. However, given its importance, we will remain alert to opportunities to utilize newly available methods should this prove feasible within resources and schedule.

Table 7-1. Ground-Level Ambient Data Monitoring Networks and Stations Available in VISTAS 12 Km Domain for CY-2002.

Monitoring Network	Chemical Species Measured	Sampling Frequency; Duration	Approximate Number of Monitors
IMPROVE	Speciated $PM_{2.5}$ and PM_{10}	1 in 3 days; 24 hr	38
CASTNET	Speciated $PM_{2.5}$, Ozone	Hourly, Weekly; 1 hr, Week	74
SEARCH	24.hr PM25 (FRM Mass, OC, BC, SO4, NO3, NH4, Elem.); 24-hr PM coarse (SO4, NO3, NH4, elements); Hourly PM2.5 (Mass, SO4, NO3, NH4, EC, TC); and Hourly gases (O3, NO, NO2, NOy, HNO3, SO2, CO)	Daily, Hourly;	8
NADP	WSO4, WNO3, WNH4	Weekly	100
EPA-FRM	Only total fine mass ($PM_{2.5}$)	1 in 3 days; 24 hr	313 **(?)**
EPA-SPEC	Speciated $PM_{2.5}$	Varies; Varies	43 **(?)**
AIRS/AQS	CO, NO, NO_2, NO_x, O_3	Hourly; Hourly	6,407

Table 7-2. Aircraft Sampling Programs Performed in the VISTAS 12 Km Domain for CY-2002.

Aircraft Program	Meteorological Parameters & Chemical Species Measured	Sampling Program & Flight Duration	Approximate Number of Flights; Days; Aircraft
University of Maryland (UMD); Univ. Research Foundation (URF)	***Meteorology:*** WS, WD, Temp, RH, ***Air Quality***: O_3, NO, NO_2, CO, SO_2, aerosol absorption, aerosol scattering.	23 May to 3 Oct; Typically 3 hrs	54 flights, 54 days, 1 aircraft
Midwest RPO & Wisconsin DNR	***Meteorology***: WS, WD, Temp, RH, dew point, pressure ***Air Quality***: O_3, NO, NO_2, NO_x, NO_y, speciated VOCs, carbonyls, HNO_3, NH_3, Hg, SO_4, OC, EC, $PM_{2.5}$, light scattering (Neph), visibility pictures.	1 June to 22 Nov; Typically 3-5 hrs	133 flights; 29 days; 2 aircraft (WDNR and Jacko Aircraft)

Table 7-3. Core Statistical Measures to be used in the VISTAS Phase II Air Quality Model Evaluation with Ground-Level Data (see ENVIRON, 2003b,d for details).

Statistical Measure	Shorthand Notation	Mathematical Expression	Notes
Accuracy of paired peak (***A$_p$***)	**Paired_Peak**	$$\frac{P - O_{peak}}{O_{peak}}$$	P_{peak} = paired (in both time and space) peak prediction
Coefficient of determination (***r^2***)	**Coef_Determ**	$$\frac{\left[\sum_{i=1}^{N}(P_i-\overline{P})(O_i-\overline{O})\right]^2}{\sum_{i=1}^{N}(P_i-\overline{P})^2\sum_{i=1}^{N}(O_i-\overline{O})^2}$$	P_i = prediction at time and location *i*; O_i = observation at time and location *i*; $\overline{P}$ = arithmetic average of P_i, i=1,2,…, N; $\overline{O}$ = arithmetic average of O_i, i=1,2,…,N
Normalized Mean Error (***NME***)	**Norm_Mean_Err**	$$\frac{\sum_{i=1}^{N}\lvert P_i-O_i\rvert}{\sum_{i=1}^{N}O_i}$$	Reported as %
Root Mean Square Error (***RMSE***)	**Rt_Mean_Sqr_Err**	$$\left[\frac{1}{N}\sum_{i=1}^{N}(P_i-O_i)^2\right]^{1/2}$$	Reported as %

Statistical Measure	Shorthand Notation	Mathematical Expression	Notes
Fractional Gross Error (F_E)	**Frac_Gross_Err**	$\frac{2}{N}\sum_{i=1}^{N}\left\lvert\frac{P_i - O_i}{P_i + O_i}\right\rvert$	Reported as %
Mean Absolute Gross Error (***MAGE***)	**Mean_Abs_G_Err**	$\frac{1}{N}\sum_{i=1}^{N}\lvert P_i - O_i\rvert$	
Mean Normalized Gross Error (***MNGE***)	**Mean_Norm_G_Err**	$\frac{1}{N}\sum_{i=1}^{N}\frac{\lvert P_i - O_i\rvert}{O_i}$	Reported as %
Mean Bias (***MB***)	**Mean_Bias**	$\frac{1}{N}\sum_{i=1}^{N}(P_i - O_i)$	Reported as concentration (e.g., $\mu g/m^3$)
Mean Normalized Bias (***MNB***)	**Mean_Norm_Bias**	$\frac{1}{N}\sum_{i=1}^{N}\frac{(P_i - O_i)}{O_i}$	Reported as %
Mean Fractionalized Bias (Fractional Bias, ***MFB***)	**Mean_Fract_Bias**	$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$	Reported as %
Normalized Mean Bias (***NMB***)	**Norm_Mean_Bias**	$\frac{\sum_{i=1}^{N}(P_i - O_i)}{\sum_{i=1}^{N}O_i}$	Reported as %
Bias Factor (***BF***)	**Bias Factor**	$\frac{1}{N}\sum_{i=1}^{N}\left(\frac{P_i}{O_i}\right)$	Reported as BF:1 or 1: BF or in fractional notation (BF/1 or 1/BF).

8.0 OZONE AND $PM_{2.5}$ ATTAINMENT DEMONSTRATION

This chapter provides a summary of how the modeling results will be used to demonstrate attainment of the 8-hour ozone and $PM_{2.5}$ standards. The procedures for demonstrating attainment of the 8-hour ozone standard follow those outlined in EPA's final 8-hour ozone modeling guidance (EPA, 2005b). Whereas the procedures for demonstrating attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) follow those given in EPA's draft $PM_{2.5}$ and regional haze modeling standard (EPA, 2001) with updates from the Clean Air Interstate Rule (CAIR; EPA, 2005c) augmented by more recent procedures that use the SANDWICH (Frank, 2005) and Speciated Model Attainment Test (SMAT; Timin, 2005). These procedures are being refined and may be updated during the course of the study including the expected release of EPA's final $PM_{2.5}$ and regional haze modeling guidance in 2006.

8.1 8-Hour Ozone Attainment Demonstration

The procedures for demonstrating attainment of the 8-hour ozone standard are outlined in EPA's final 8-hour ozone modeling guidance document (EPA, 2005b). These procedures include a modeled attainment demonstration test along with performing additional analysis that can be used to support and corroborate the modeled attainment demonstration.

8.1.1 Modeled 8-Hour Ozone Attainment Demonstration Test

The 8-hour ozone modeled attainment demonstration procedures use the modeling results in a relative sense to scale or project the current baseline observed 8-hour ozone Design Values (DVB) to estimate a future-year 8-hour ozone Design Value (DVF) that is compared with the 8-hour ozone NAAQS to determine whether attainment has been demonstrated (DVF < 85 ppb) or not (DVF $\geq$ 85 ppb). The ratio of future-year to current year modeling results is called the Relative Reduction Factor (RRF) and the basic Design Value projection approach for a site i is expressed as follows:

$$DVF_i = RRF_i \times DVB_i$$

Where,

DVB_i = the baseline (current year) 8-hour ozone Design Value (ppb) at monitor i;

DVF_i = the future-year projected 8-hour ozone Design Value (ppb) at monitor i; and

RRF_i = the relative reduction factor, calculated near site i that is the ratio of future to baseline year predicted concentrations near the monitoring site averaged over multiple days.

Although the basic equation for projecting future-year 8-hour ozone Design Values is conceptually simple, there are several assumptions and issues that need to be resolved as follows:

How is the site-specific baseline Design Value [DVB_i] calculated? The baseline 8-hour ozone Design Value is calculated as the three–year average of 8-hour ozone Design Values centered on the 2002 modeling year. As an 8-hour ozone Design Value is the three-year average of the fourth highest daily maximum 8-hour ozone concentration at a site, the DVB "5-year Design Value" will weigh the fourth highest 8-hour ozone concentration from 2000 and 2004 once, 2001 and 2003 twice and 2002 three times.

In calculating the site-specific RRF_i, what is meant by "near the monitor" and which predicted 8-hour ozone concentrations "near" the monitor should be used? Near the monitor is roughly defined as the highest estimated daily maximum 8-hour ozone concentration within 15 km of the monitor. This is obtained by looking for the highest estimated daily maximum 8-hour ozone concentration in an array of NX by NY grid cells centered on the grid cell containing the monitor. EPA guidance presents defaults for the number of cells to use in the array as a function of grid resolution (EPA, 2005b, pg. 16) and for the ASIP 12 km and 36 km resolution grid array sizes centered on the monitor of, respectively, 3 x 3 and 1 x 1 (i.e., just the grid cell containing the monitor) will be used. Thus for each modeling day under consideration, the highest daily maximum 8-hour ozone concentrations near the monitor is extracted for the baseline-year base case simulation out of the 3 x 3 array of cells centered on the monitor for the 12 km simulation. Similarly, the highest daily maximum 8-hour ozone concentrations in the 3 x 3 array of 12 km cells is extracted from the future-year simulation; note that the baseline-year and future-year cell extractions may not be from the same grid cell.

How are future-year projected 8-hour ozone Design Values calculated in unmonitored areas? EPA's 8-hour modeling guidance lists a multistep procedure for projecting future-year 8-hour ozone Design Values away from the monitors:

- Interpolate the observed 8-hour ozone Design Values to generate spatial fields of 8-hour ozone Design Values;
- Adjust the spatial fields using the gridded model output ozone concentrations gradients for the baseline year simulation;
- Apply gridded RRFs to the model adjusted spatial fields of current-year Design Values to obtain gridded fields of future-year projected 8-hour ozone Design Values; and
- Compare spatial fields of projected 8-hour ozone Design Values with the standard to determine whether attainment has been demonstrated across the region.

EPA notes that the Design Value projections in the unmonitored areas is more uncertain and recommends it be done as a separate test to the monitor-based Design Value projections. The procedures for interpolating the observed 8-hour ozone Design Values using modeled ozone gradient predictions is not well defined at this time and EPA is in the process of developing software so that a uniform unmonitored ozone attainment test can be defined. Consequently, initially we will just perform the monitor-based attainment test for the ASIP 8-hour ozone modeling and as a sensitivity we will examine the spatial distribution of the RRFs in each nonattainment area.

Which days should be used in calculating the RRFs? For the ASIP modeling, RRFs will be based on the ratio of the average highest daily maximum 8-hour ozone concentrations near the monitor of the future-year to baseline year for all days in which the baseline year modeled estimated highest daily maximum 8-hour ozone concentration is greater or equal to a threshold-ozone concentration. Initially, a threshold of 85.0 ppb will be used. However, if this results in less than 10 modeling days in the RRF calculation, then the threshold will be successively lowered by 1 ppb until at least 10 modeling days are used in the RRFs or when a minimum threshold of 70.0 ppb is reached. If using a threshold of 70 ppb still results in less than 10 days, then the data will be flagged and discussed with ASIP, especially if less than 5 days are being utilized.

8.1.2 Additional Analysis to Support the Attainment Demonstration

EPA's guidance (EPA, 2005b) lists a series of additional analysis that can be conducted to support and corroborate the modeled ozone attainment demonstration test listed above. EPA notes that cases when the future-year projected 8-hour ozone Design Value is well below (< 82 ppb) the ozone NAAQS less supporting evidence is required then if the projected Design Value is closer to the NAAQS. In fact, EPA recommends that a complete suite of Weight of Evidence (WOE) supporting analysis be performed when the future-year projected 8-hour ozone Design Value is in the 82 to 87 ppb range. EPA notes that with projected Design Values of 88 ppb or above it is very unlikely that supporting analysis could be sufficiently convincing to conclude that the NAAQS will be attained given the results of the modeled attainment test.

EPA lists several additional modeling metrics, supplemental modeling analysis, use of observational models and analyzing emissions and air quality trends data that should be performed as part of the supporting analysis. With the possible exception of calculating additional modeling metrics, most of this additional supporting and WOE analysis will be carried out by the States, although the ENVIRON/Alpine Team may be recruited to assist in this matter at a future date.

8.2 $PM_{2.5}$ Attainment Demonstration

Currently, only the annual average $PM_{2.5}$ NAAQS is violated in the ASIP States so only it will be addressed. However, EPA has proposed to lower the 24-hour $PM_{2.5}$ standard to it may have to be addressed in the future. EPA has issued draft modeling guidance that describes procedures for combining PM monitoring data with modeling results to project future-year $PM_{2.5}$ Design Values for comparison with the NAAQS in an attainment demonstration (EPA, 2001). These procedures are called the Speciated Modeled Attainment Test (SMAT). A preliminary version of the SMAT was applied as part of the proposed Clean Air Interstate Rule (CAIR; EPA, 2004) with the approach refined in the final CAIR (EPA, 2005c,d). Like the ozone projection procedures described above, SMAT uses the modeling results in a relative sense to scale baseline $PM_{2.5}$ Design Values to estimate future-year projected $PM_{2.5}$ Design Values. However, unlike ozone, $PM_{2.5}$ consists of several different components (e.g., sulfate, nitrate, ammonium, etc.). The SMAT develops site-specific separate RRFs for each PM component, projects each PM component to the future-year and then recombines all of the PM components to obtain total $PM_{2.5}$ mass for comparisons with the $PM_{2.5}$ NAAQS.

The SMAT procedures consists of two components: (1) the combination of the $PM_{2.5}$ mass measurements from the Federal Reference Method (FRM) with the speciated $PM_{2.5}$ measurements, such as those from the Speciated Trends Network (STN); and (2) the combination of the modeling results with the speciated FRM $PM_{2.5}$ Design Values to obtain future-year projected $PM_{2.5}$ Design Values.

8.2.1 Speciation of FRM $PM_{2.5}$ Mass Measurements

$PM_{2.5}$ attainment/nonattainment can only be determined from the FRM $PM_{2.5}$ measurements that measure just total $PM_{2.5}$ mass. The FRM $PM_{2.5}$ measurements are used to develop the $PM_{2.5}$ Design Values that determine attainment classification and are used as the starting point for projecting future-year $PM_{2.5}$ Design Values for demonstrating attainment. Thus, representative speciated $PM_{2.5}$ measurements need to be mapped to the FRM measurements. For most FRM sites there is a speciated $PM_{2.5}$ in the same general area that can be used in the mapping. However, in some cases, there is no nearby speciated $PM_{2.5}$ site so speciated $PM_{2.5}$ data must be interpolated from sites surrounding the FRM site.

Speciated $PM_{2.5}$ measurements are routinely collected on the same 1:3 day sampling frequency as used by the FRM network at two monitoring networks in the US: the Speciated Trends Network (STN) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. Each of these three monitoring networks use different measurement technologies each of which have their own measurement artifacts. For example, FRM uses a single Teflon filter and includes water in the measurement (after equilibration at ~35% RH) and just measures total $PM_{2.5}$ on the filter. Particulate nitrate may volatilize off of the FRM Teflon filter. The STN measurement technology uses Teflon, Nylon and Quartz filters for measuring the speciated data and does not measure the water component of the $PM_{2.5}$. The STN Quartz filters are also not blank corrected which results in inaccurate OC measurements. IMPROVE also uses multiple filters and does not include ammonium in its measurements.

As the FRM is the de facto regulatory definition of $PM_{2.5}$, EPA has developed procedures for adjusting the STN and IMPROVE speciated $PM_{2.5}$ measurements to account for the measurement artifacts of the different networks and make the speciated PM measurements consistent with the FRM $PM_{2.5}$ mass measurements. These adjustments include the following:

- Adjust nitrates downward to account for volatilization off of the FRM nylon filter;
- Add particle bound water (PBW) that are associated with nitrate and sulfate in the FRM measurements; and
- Estimate total carbonaceous mass accounting for lack of blank correction in the STN measurements.

The resultant fine particle chemical speciation approach has been named the Sulfates, Adjusted Nitrates, Derived Water, Inferred Carbonaceous mass and estimated aerosol acidity (H+), or SANDWICH. Details on the SANDWICH procedures is given in Frank (2005).

8.2.2 Speciated Modeled Attainment Test (SMAT)

The SMAT procedures have been applied for the proposed and final CAIR analysis (EPA, 2004; 2005c) each time with refinements. A SMAT Tool has been developed using the SAS programming language that is populated with 1999-2003 FRM and SANDWICH speciated $PM_{2.5}$ data. Use of 1999-2003 $PM_{2.5}$ data is appropriate for the CAIR modeling since it is centered on the 2001 CAIR modeling year. However, for the ASIP $PM_{2.5}$ projections, FRM and speciated PM data are needed for the 2000-2004 period so that it is centered on the ASIP 2002 modeling year.

Because the CAIR SMAT projections were looking at all FRM monitors, including many without nearby associated speciated $PM_{2.5}$ monitors, the SANDWICH speciated $PM_{2.5}$ data were interpolated to obtained gridded fields of $PM_{2.5}$ speciation that were then used to speciate the FRM data. EPA used a Voroni Nearest-neighbor Approach (VNA) to interpolate the SANDWICH $PM_{2.5}$ speciation components for sulfate, nitrates, OC, EC, crustal/other and a Degree of Neutralization (DON). DON was interpolated instead of ammonium because the IMPROVE network does not measure ammonium and using the DON ammonium can be backed out of the interpolated sulfate values.

Updating the CAIR SMAT Tool with the 2004 data in a consistent fashion and extending it to the 12km grid would be a major undertaking. The interpolation procedures are not well defined. Furthermore, the ENVIRON/Alpine Team has applied the CAIR SMAT Tool and been unable to exactly duplicate EPA's CAIR results, which has been attributable to different versions of SAS used by EPA (PC) and the ENVIRON/Alpine Team (Linux).

ASIP has reviewed the FRM monitors in nonattainment areas in the Southeast US and found that most have an associated STN monitor. However, there is a small subset of FRM sites that the ASIP States did not link to a nearby STN site. In these cases, the State of North Carolina will revise parts of the existing EPA SMAT Tool to get an approximated speciation mix for the FRM site. The State of North Carolina will work with the ASIP States to identify the FRM-STN pairs and process the STN data for 2000-2004 using the SANDWICH procedures so that the FRM PM 2.5 mass measurements can be speciated for the application of the SMAT. Once we have the FRM and associated SANDWICH $PM_{2.5}$ speciation data for the 2000-2004 period, the SMAT procedures involves the following steps:

1. Derive quarterly mean average concentrations for each of the major components of $PM_{2.5}$ and each of the quarters from the 2000-2004 baseline period. This is done by applying the fractional contribution of each major component of $PM_{2.5}$ from the SANDWICH $PM_{2.5}$ speciation data for the same quarter and year. Major components are as follows:

   - Sulfate (SO4);
   - Nitrate (NO3);
   - Ammonium (NH4);
   - Elemental Carbon (EC);
   - Organic Mass Carbon (OMC);
   - Final Crustal/Other; and
   - Particle Bound Water (PBW).

2. Use the model estimated $PM_{2.5}$ components near each monitor and for each of the four quarters of 2002 from the 2009 and 2002 simulations to develop monitor-, quarter- and $PM_{2.5}$ species-specific Relative Reduction Factors (RRFs) using the ratio of the 2009 to 2002 quarterly average modeling results.

3. Apply the monitor-, quarter- and species-specific RRF to each quarterly average observed $PM_{2.5}$ species concentrations from 2000-2004 to obtain 5-years of quarterly average $PM_{2.5}$species concentrations representative of 2009 conditions.

4. Recalculate the Particle Bound Water (PRB) component from the 2009 projected quarterly average sulfate and nitrate concentrations.

5. Average the four quarterly mean 2009 species concentrations to make an annual average $PM_{2.5}$ species concentrations at each monitor and for each of the 5 years (2000-2004). Sum the annual average species components for each of the five years and each monitor to obtain five years of annual average total $PM_{2.5}$ mass concentrations.

6. Calculate the $PM_{2.5}$ Design Values from the five years of 2009 projected annual average $PM_{2.5}$ concentrations and compare against the NAAQS $PM_{2.5}$ in the attainment test.

As in the ozone projections, there are a few issues that need to be resolved and defined to apply the above $PM_{2.5}$ attainment test.

What quarterly average model estimated $PM_{2.5}$ species components are used "near" the monitor? As in the ozone projections, a grid resolution dependent array of cells centered on the monitor is used (i.e., 3 x 3 for 12 km grid and 1 x 1 for 36 km grid). However, for the $PM_{2.5}$ projections the average of the estimated $PM_{2.5}$ species across the array of cells is used, rather than the highest value that is used in the ozone projections.

What $PM_{2.5}$ Design Values should be used in the projections? An average of the 2001, 2002 and 2003 $PM_{2.5}$ Design Values will be used in the $PM_{2.5}$ projections. As a Design Value is a three-year average of annual values, then this three year average of $PM_{2.5}$ Design Values will weigh the annual average $PM_{2.5}$ concentrations from the years 2000 and 2004 once, 2001 and 2003 twice and 2002 three times.

When is $PM_{2.5}$ attainment demonstrated? The SMAT attainment test is passed when the 2009 projected 3-year average Design Value is 14.9 $\mu g/m^3$ or lower. [should this be 15.4 ug/m3???]

8.2.3 Additional Supporting Analysis

Additional supporting analysis to the SMAT modeled $PM_{2.5}$ attainment test will be conducted to corroborate the modeling analysis. The exact definition of the supporting analysis is being analyzed but would like consist of additional modeling metrics as well as emissions and air quality trends and alternative modeling and projection approaches. The supporting analysis to be performed as part of the ASIP $PM_{2.5}$ attainment demonstration will be better defined once EPA has released their final $PM_{2.5}$ modeling guidance. Currently, this additional supporting analysis is planned to be carried out by the ASIP States, although the ENVIRON/Alpine Team may assist at a future date.

9.0 DATA MANAGEMENT

Data management and data security procedures are critical components of the ASIP regional fine particulate and 8-hour ozone modeling. Very large data files are used in each component of the modeling process, including processing of the meteorology data, emissions processing, and $PM_{2.5}$ and ozone modeling with CMAQ. An annual simulation on the ASIP 36-km domain requires approximately 2 Terabytes (Tb) of disk storage, whereas an annual simulation on the ASIP 12-km domain requires over 3 Tb of disk storage. This chapter describes data management practices that will be used in the ASIP 8-hour ozone and $PM_{2.5}$ modeling analyses.

For all critical files we will maintain backup copies either on tapes, storage disks or redundant disk systems. In addition, because ASIP model simulations will be performed separately by the ENVIRON and AG modeling centers, each institution will maintain its own copy and backup of critical input and output files. Because there are differences in system configurations at each of the modeling centers the data backup and archiving are discussed separately for each center, below. Some of the ASIP States will also maintain copies of the modeling data files relevant to their particular nonattainment areas.

CMAQ generates large output files of which most information is rarely used. For example, model output for layers other than the surface layer are typically only used to define boundary conditions for finer grid simulations. Thus, once the boundary condition files have been generated for the ASIP States 12 km and 4 km refined modeling domain, the 3-D CONC files of instantaneous concentrations do not have to be archived. We do not plan redundant archiving for model output files (including output from MCIP and SMOKE) except for key final model outputs (e.g., 2002 and 2009 model-ready emissions) because these files can be regenerated by repeating model simulations, and this is approach more efficient and more cost effective than redundant archiving.

To promote efficient, reliable communication among project participants, the modeling team has created 4 different listservs for VISTAS to aid in dissemination of information and as a primary means for distributing emissions and air quality modeling information. As the ASIP States are a subset of the VISTAS states the same listservs will also be used for ASIP. The listservs are:

- vistas-all@cert.ucr.edu: general project information for all interested persons.
- vistas-modeling@cert.ucr.edu: private list for the VISTAS/ASIP project management team and modeling contractors.
- vistas-emissions@cert.ucr.edu: list for sharing information on emissions processing and QA.
- vistas-met@cert.ucr.edu: list for sharing information on meteorology modeling and processing of MM5 data using MCIP.

These separate listservs are aimed at providing better organization of communications and allowing for detailed discussions of specific topics such as emissions QA.

9.1 Project Website

Depending on the amount of data generated by ASIP, a project website will be established to facilitate the distribution of information. Whether the ASIP website will be part of the VISTAS website or its own has yet to be determined.

9.2 Data Transfer

Data transfer among the modeling centers and between other ASIP participants or contractors will be accomplished using a combination of email, ftp downloads and portable disk drives depending on the size of the data transfer. For data files smaller than a few MB email typically works well and is most efficient. For data files of less than about 500 MB file transfer protocol (ftp) is typically the fastest and most efficient method. ENVIRON and AG each maintain webpages and ftp pages that can be used for exchanging data. In addition, each modeling center has several portable disk drives with both USB2 and firewire interfaces that can be FedEx among project participants to exchange large data sets. Portable disk drives range in size from 80 to 300 GB and are adequate for all large files data transfers. The approach described here has been used throughout the VISTAS project, as well as WRAP, CENRAP and MRPO, and has proven to be economical and efficient.

9.3 Data Backup and Archiving

Data backup and archiving will be performed at each of the modeling centers. Copies of critical project data will be maintained at each modeling center to provide redundant backup of key project data. Each modeling center stores key model inputs on RAID systems that have self re-generation capabilities in case a disk drive fails. In addition, each modeling center will perform backups of key project data to tape or redundant disk storage systems. Data storage and back up resources at each modeling center are described next.

9.3.1 ENVIRON

Over 20,000 Gigabytes (>20 Terabytes, Tb) of disk storage are available to the UNIX/Linux workstations. All of the workstations are networked together and are accessible from each employee's desktop PC. All workstations have CD-ROM drives and can access DLT, 4mm DAT and 8mm Exabyte tape drives for data backup and data transfer. ENVIRON can also create CDs (CD-R and CD-RW) and DVDs (DVD+ and DVD-) for data backup and distribution. For ASIP modeling, all CMAQ simulations will be performed on one of two 13 node Beowulf Linux Clusters that included one master node and 12 processing nodes. Each node consists of two AMD Athlon 2600+ processors. The master nodes have 2 Gb of memory and are connected to a ~3-4 Tb RAID disk system. Each secondary processing node includes 1 Gb of memory. The ENVIRON Novato computing center also includes approximately 10 dual processor Linux workstations with processing speeds of 1700+ to 3000+. Three older Unix workstations are also available, SUN, DEC and SGI. The Linux computer systems are located in their own room with their own dedicated air conditioning (AC) system. The room includes a temperature sensitive power shut off device that will shut off the power to all computers in case the AC breaks down

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so that catastrophic failure due to too high temperatures does not occur. Backups are made on IDE disk drives that are removed from the computer and stored on a shelf to protect against power surges destroying the backup data.

9.3.2 Alpine Geophysics

Alpine Geophysics' computing facilities consist of SUN Microsystems SPARCstation computers and a very powerful array of over 20 multiprocessor Linux-based workstations. Disk storage systems include ~20 Tb of aggregate disk space and over 8 Tb of SCSI and IDE Raid-5 protected space. All client data is stored on at least one RAID-5 protected disk array. To further protect client data, two of our main servers backup their disk drives on a weekly basis to a second server that is physically disconnected from the power supply when not doing an active transfer. This way a catastrophic power failure will not compromise the ability for Alpine Geophysics to deliver.

10.0 DOCUMENTATION

This section describes the documentation that be provided during ASIP and the potential for modifications to this Modeling Protocol and Quality Assurance Project Plan (QAPP) that might become necessary as this phase of the study unfolds.

10.1 Planned Documentation

Documentation associated with the ASIP emissions and air quality modeling will include all relevant input data bases and scripts associated with the pre- and post-processing associated with model input development, model application, sensitivity and diagnostic analyses, and performance evaluations. At this time the deliverables consists of disk drives with modeling results and databases for the ASIP States and PowerPoint presentations of the 2009 projections of 8-hour ozone and $PM_{2.5}$ Design Value Projections. Deliverables under the current ASIP modeling contract are as follows:

- ASIP Modeling Protocol (this document)
- ASIP Quality Assurance Project Plan (QAPP)
- CMAQ-ready 2002 36/12 km Typical emissions with every day mobile emissions on the 12 km grid
- CMAQ-ready 2009 36/12 km Typical emissions with every day mobile emissions on the 12 km grid
- PowerPoint presentations of 2009 8-hour ozone and $PM_{2.5}$ Design Value projections
- Disk drive of modeling results and boundary conditions for the NC, ALGA and VA subdomains
- Archive drives of modeling results

Additional deliverables by the modeling team may be added by ASIP at a later date. Chapter 11 contains the current Scope of Work (SOW) for the ENVIRON/Alpine team under the ASIP work effort and the schedule for the deliverables.

10.2 Procedures for Updating Modeling Protocol and QA Plan

One of the underlying realizations stemming from the VISTAS modeling activities was the awareness that the science of 'One-Atmosphere' PM/regional haze modeling is advancing very rapidly. Part of this stems from the parallel activities being carried out by the RPOs; some if it is due to other ongoing 8-hour ozone and PM modeling studies being performed by various states. In addition, EPA is in the process of revising its $PM_{2.5}$ and regional haze guidance documents. Collectively, it is quite likely that there will be new opportunities to strengthen the modeling algorithms, input data sets, and evaluation procedures throughout the duration of the ASIP and VISTAS modeling efforts. Moreover, the ASIP emissions and air quality modeling activities involve the collaboration with the ASIP States as well as other ASIP contractors who will provide the required emissions and meteorological inputs to the SMOKE and CMAQ models. Given the ongoing model refinement activities and the need for strong coordination with other ASIP contractors, it may be necessary to modify certain aspects of this modeling protocol. In this event, modification will be made in consultation with the ASIP project coordinator and the revised protocol will be submitted to the ASIP States for approval.

11.0 ASIP STATEMENT OF WORK AND SCHEDULE

This section describes the current ASIP Statement of Work (SOW) for the ENVIRON/Alpine Modeling Team, the schedule and deliverables under the ASIP work effort. This work currently includes four Tasks that focus on the emissions and air quality modeling for the 2002 calendar year using a 36/12 km grid for two emission scenarios: (1) a 2002 Typical Base Case; and (2) a 2009 Base Case. Unlike VISTAS, ASIP is performing everyday on-road mobile source modeling on the 12 km grid (on the 36 km grid and for VISTAS 36/12 km modeling on-road mobile source emissions modeling are performed for one week from each month). The 2002 and 2009 modeling results will be used to project 2009 8-hour ozone and $PM_{2.5}$ Design Values for the attainment demonstration. The ENVIRON/Alpine Team may be charged with additional Tasks for ASIP in the future at which time this Modeling Protocol will be updated accordingly.

11.1 Task 1: Project Management

The objective of this task is to manage project activities, participate in conference calls, manage the ASIP contract and subcontractors, general oversight and overall quality assurance and the preparation of the Quality Assurance Project Plan (QAPP) and Modeling Protocol (this document).

The management structure for the ASIP Emissions and Air Quality Modeling is similar to what was used in VISTAS with Ralph Morris of ENVIRON serving as Project Manager and Ralph Morris and Gregory Stella of Alpine Geophysics serving as Co-Principal Investigators (Co-PIs) and managing the activities in the ENVIRON and Alpine Geophysics modeling centers, respectively. Section 1.7 provides more details of the ASIP Emissions and Air Quality Modeling management structure. Under this task we are performing all management activities for the ASIP modeling study, including:

- Participation in scheduled conference calls to be held approximately once per month as well as expected ad hoc conference calls to be held as needed.
- Preparation and review of contracts between SESARM and ENVIRON and subcontracts between ENVIRON and Alpine.
- Develop and refine the Scope of Work and conduct contract discussions with the ASIP modeling team and the ASIP technical and project representatives.
- Preparation of monthly reports, invoicing to SESARM and payments to subcontractors.
- Internal project conference calls and discussions among the ENVIRON/Alpine project team.
- Develop and implement the ASIP Quality Assurance Project Plan (QAPP).

- Develop the ASIP Modeling Protocol.

Table 11-1 summarizes the deliverables and expected delivery dates under Task 1 of the ASIP regional ozone and $PM_{2.5}$ SIP support modeling analysis.

Table 11-1. ASIP Task 1 Project Management task deliverables and due dates.

Item	Description	Due Date
1	ASIP Quality Assurance Project Plan (QAPP)	11/30/05
2	ASIP Modeling Protocol	12/15/05
3	Conference Calls with ASIP States	Monthly; 11/05-2006
4	Monthly Reports and Invoices	Monthly; 11/05-2006

11.2 Task 2: 2002/2009 Emissions Modeling

The objective of this task is to perform SMOKE emissions modeling to generate 2002 36/12 km Typical "Base F4" and 2009 36/12 km "Base F4" CMAQ-ready emission inputs using the every day mobile source emissions modeling approach.

Version 2.1 of the SMOKE emissions modeling system will be used to generate 2002 Typical 12 km on-road mobile sources emissions using daily meteorology and the SMOKE MOBILE module. VISTAS has generated 2002 Typical Base F emissions using weekly MOBILE model run for 36 km and 12 km grid as well as generating 2002 Typical Base F 36/12 km emissions for the other source categories (e.g., area, point, non-road, etc.). Under ASIP this task will provide supplemental 2002 daily MOBILE modeling for the 12-km grid. The 2002 12 km Typical daily mobile source emissions will be merged with the other source categories to generate 2002 Typical 12 km emissions inputs based on daily mobile source modeling that will be used in the ASIP ozone and PM modeling.

Also under this task we will process the 2009 Base F annual emissions through the SMOKE emissions processor for all anthropogenic emission source categories to prepare the emissions for use in the CMAQ air quality model. Base F emissions include outputs of the Integrated Planning Model (IPM) for utilities and all inventory revisions from VISTAS and other RPOs that are available by July 2005. Daily 2009 MOBILE run will be used in SMOKE for the 12 km grid and weekly MOBILE run for the 36 km grid.

Table 11-2. ASIP Task 2 2002/2009 Emissions Modeling task deliverables and due dates.

Item	Description	Due Date
1	2002 12 km Typical Base F daily mobile source SMOKE emissions modeling	11/28/05
2	2002 36/12 km Typical Base F CMAQ-ready emissions w/daily mobile source emissions	12/3/05
3	2009 36/12 km Base F CMAQ-ready emissions w/daily mobile sources	12/15/05

11.3 Task 3: 2002/2009 36/12 km Base F CMAQ Modeling

The objective of this task is to run the CMAQ model on the 36 km and 12 km grid for the typical 2002 and 2009 Base F emission scenarios using every day mobile source emissions.

The CMAQ model is applied for the 2002 and 2009 Base F emission scenarios with weekly mobile emissions modeling for the 36 km grid and every day mobile sources emissions on the 12 km grid. QA/QC is performed on the runs including comparisons of the modeling results to the observed PM concentrations. Extractions are made at the ozone and PM monitoring sites, where values at the monitoring site are extracted from the 36 km results and a 3 x 3 grid cell average concentration centered on the monitoring site is extracted for the 12 km modeling results. The 12 km modeling results will be processed to generate boundary condition inputs for the Alabama/Georgia (ALGA) and North Carolina (NC) subdomains and provided to the states of North Carolina and Georgia. Table 11-3 list the deliverables for the ASIP Task 3 CMAQ modeling.

Table 11-3. ASIP Task 3 2002/2009 36/12/ km Base F CMAQ Modeling.

Item	Description	Due Date
1	CMAQ 36/12 km simulations for 2002 Typical Base F w/everyday mobile sources emissions	12/21/05
2	CMAQ 36/12 km simulations for 2009 Base F w/everyday mobile sources emissions	1/15/06
3	Disk with boundary conditions for ALGA and NC subdomains	1/31/06

11.4 Task 4: Data Analysis and Data Management

The objective of this task is to analyze the results of the Task 2 emissions and Task 3 CMAQ air quality modeling, archive and distribute the modeling results.

The SMOKE emissions and CMAQ air quality modeling results will be analyzed. 8-hour ozone projections and annual $PM_{2.5}$ projections will be made at all monitoring sites in and adjacent to the VISTAS states using both the 36 km and the 12 km modeling results. These results will be documented in PowerPoint presentations and presented ASIP states (Table 11-4). The results from the emissions and air quality modeling will also be archived on USB portable disks and delivered to the ASIP states. Summaries of the results will also be available on the Internet.

Table 11-4. ASIP Task 4 2002 CMAQ Modeling task deliverables and due dates.

Item	Description	Due Date
1	PowerPoint Presentation on 2009 8-hour ozone projections	1/31/06
2	PowerPoint Presentation on 2009 $PM_{2.5}$ projections	1/31/06
3	Archive disks of ASIP 2002/2009 modeling results	2/10/06

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Appendix E
Emissions Inventory Summary

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1. INTRODUCTION

This Appendix contains emission summary tables for the Hickory and Greensboro-Winston Salem-High Point, NC PM2.5 nonattainment areas, all of North Carolina's counties, and the Association for Southeastern Integrated Planning (ASIP) states. The ASIP states include Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. All the emissions are representative of annual emissions.

The emission summaries are obtained from the emissions modeling reports. In addition to emission summary totals by counties, the stationary point source 2002 emissions are presented by facility for the Hickory county and Greensboro-Winston Salem–High Point counties. The entire county source lists include both EGU and non-EGU. Similarly, the area source and nonroad mobile source 2002 emissions are presented by source category for both Hickory and Greensboro-Winston Salem-High Point areas. These emission summaries are created from an annual source category emissions modeling reports.

2. BASELINE YEAR (2002) INVENTORIES

The emissions in all of the tables of this section are reported in tons/year of pollutant. The emission summary tables below are in the following order:

- 2002 Nonattainment Areas Emissions (Actual and Typical)
- 2002 North Carolina Counties Emissions
- 2002 ASIP States Emissions
- Biogenic Emissions
- 2002 Point Source Emissions by County by Facility
- 2002 Area Source Emissions by Source Category
- 2002 Nonroad Mobile Source Emissions by Source Category

Actual and Typcial emissions for the counties in both nonattainment areas are presented first in Tables 1a, 1b, 2a, and 2b. The "Actual" emissions were used in the air quality model performance evaluation. However, usual wildfire activity and unexpected major point source outages could make the Actual emissions inventory atypical for future year projections. Therefore, a "Typical" emissions inventory was developed to normalize the wildfire activity and include all expected major point sources at usual emissions levels in the nonattainment areas and throughout the entire ASIP region.

Biogenic emissions are temperature dependent and vary from episode to episode. However, since the meteorological inputs are kept constant when modeling the baseline year and future years, the biogenic emissions will remain at the episodic level in both cases. Therefore, the biogenic emissions are only presented at the end of this section.

Note 1: Area source (nonpoint) emissions are as inventoried rather than as modeled. For eight SCC categories, a transport adjustment factor was applied to the particulate emissions (PM 10 and PM 2.5) to reduce the emissions to what will actually travel any significant distance. Also, emissions for SCC 2610000500 (open burning of land clearing debris) and 2801500262 (wheat backfire burning) were accidentally omitted from the modeling by VISTAS. When discovered, there was insufficient money to correct the modeling. See Appendix F.2 for additional information.

Table 1a. Actual 2002 Annual Emissions Summaries For Hickory Nonattainment County

County	Point						Non-road						Area						Mobile					
	VOC	Nox	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Catawba Co	4083.7	19088.6	82320.1	5016.7	4240.1	4.98	1107.3	1619.7	99.7	90.4	86.5	1.4	5051.9	769.6	91.3	4513.4	1189.2	477.3	6040.4	7049.9	259.8	142.0	100.1	206.4

Emissions reported as tons/year.
See Note 1 in section 2

Table 1b. Typical 2002 Annual Emissions Summaries For Hickory Nonattainment County

County	Point						Non-road						Area						Mobile					
	VOC	Nox	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Catawba Co	4083.7	19269.6	82371.7	5011.3	4238.9	5.0	1107.3	1619.7	99.7	90.4	86.5	1.4	5053.2	770.4	91.5	4516.2	1191.5	477.5	6040.4	7049.9	259.8	142.0	100.1	206.4

Emissions reported as tons/year.
See Note 1 in section 2

Table 2a. Actual 2002 Annual Emission Summaries For Greensboro-Winston Salem-High Point Nonattainment Counties

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Davidson Co	2791.3	3240.7	408.0	457.5	391.7	6.5	809.1	1545.1	101.7	77.3	73.2	0.9	4804.6	655.6	97.2	4464.1	1217.9	558.8	5072.0	6456.2	229.9	128.9	92.2	175.5
Guilford Co	3931.8	218.7	282.2	221.6	135.0	10.6	3394.1	4408.0	376.3	358.9	344.1	3.7	9393.7	2295.8	231.7	9006.3	2332.3	585.2	12727.2	16815.5	675.2	331.4	227.2	538.1

Emissions reported as tons/year.
See Note 1 in section 2

Table 2b. Typical 2002 Annual Emission Summaries For Greensboro-Winston Salem-High Point Nonattainment Counties

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Davidson Co	2791.3	3240.7	408.0	457.5	391.7	6.5	809.1	1545.1	101.7	77.3	73.2	0.9	4806.8	656.7	97.5	4468.8	1221.9	559.0	5072.0	6456.2	229.9	128.9	92.2	175.5
Guilford Co	3931.8	218.7	282.2	221.6	135.0	10.6	3394.1	4408.0	376.3	358.9	344.1	3.7	9393.6	2296.0	231.8	9006.4	2332.4	585.3	12727.2	16815.5	675.2	331.4	227.2	538.1

Emissions reported as tons/year.
See Note 1 in section 2

Table 3. Typical 2002 Annual Emission Summaries For North Carolina Counties

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Alamance Co	327.2	154.5	23.9	70.0	51.3	6.9	1017.5	1038.1	77.2	76.8	73.1	0.9	3516.5	612.6	75.6	3358.9	898.3	537.2	4687.2	6080.4	210.8	116.4	82.6	165.0
Alexander Co	348.1	6.0	4.0	40.6	26.2	0.0	287.2	234.5	17.4	20.1	19.2	0.2	1761.9	173.1	23.5	1454.9	429.4	1772.5	671.5	657.1	28.2	15.0	10.5	23.2
Alleghany Co	5.3	0.1	0.3	0.6	0.2	0.0	71.4	88.0	8.8	8.8	8.5	0.1	889.0	90.1	13.0	970.6	319.7	337.1	261.2	247.6	10.7	5.7	3.9	8.9
Anson Co	60.2	72.2	172.1	46.7	38.3	0.6	147.0	526.9	36.8	22.0	20.5	0.1	912.2	110.4	20.3	1216.8	355.2	2475.2	878.9	1024.8	39.4	21.9	15.6	30.5
Ashe Co	5.1	13.0	22.0	14.4	9.3	0.0	170.6	165.8	16.8	17.3	16.6	0.2	1990.9	203.6	31.1	1729.5	655.3	216.5	721.7	666.0	29.2	15.3	10.6	24.5
Avery Co	27.5	5.1	12.2	1.3	0.8	0.0	295.2	143.3	15.7	19.7	18.7	0.2	1061.6	159.4	43.7	963.6	340.0	83.5	551.2	602.9	24.3	13.2	9.3	19.4
Beaufort Co	99.9	625.8	4813.7	667.7	406.5	536.7	1675.6	959.3	84.7	89.9	85.1	0.7	1951.9	263.2	29.2	2892.8	809.2	1183.4	1186.1	1133.1	48.5	25.4	17.5	41.0
Bertie Co	216.2	86.6	268.4	28.9	19.5	6.8	449.1	270.3	28.5	31.3	30.0	0.3	1529.6	125.5	22.6	1952.3	559.6	1680.3	769.9	832.2	33.6	18.3	12.9	26.7
Bladen Co	190.4	276.3	1079.9	62.9	40.2	0.4	348.9	477.4	37.1	33.4	31.8	0.3	1641.1	212.0	41.2	2937.7	910.4	8799.5	1177.5	1136.4	49.3	26.1	18.1	40.9
Brunswick Co	1288.1	2391.5	5609.9	195.6	113.1	2.3	1196.9	1166.1	133.8	98.3	93.3	0.8	2164.0	397.3	51.6	2461.4	814.3	1074.3	2901.1	3240.2	126.9	69.2	48.7	101.2
Buncombe Co	403.5	5329.3	17031.5	528.7	263.0	2.8	1703.0	1643.2	137.5	138.4	131.9	1.3	7090.2	1324.7	235.0	6391.7	2059.8	318.4	5879.0	8438.3	278.4	157.2	112.7	210.6
Burke Co	737.6	117.3	242.3	192.4	174.8	1.1	427.7	594.3	36.9	32.2	30.7	0.5	3159.8	393.9	70.5	2752.0	881.5	373.1	3423.5	5156.2	166.6	97.5	71.2	118.4
Cabarrus Co	782.9	915.8	2081.4	79.2	50.5	10.1	864.3	1550.6	126.9	102.9	97.9	0.9	3243.1	546.0	57.0	3953.4	1030.9	520.1	7353.7	5681.1	233.2	123.8	85.9	190.4
Caldwell Co	4105.7	410.3	37.8	220.9	156.0	0.0	510.1	551.5	34.3	35.5	34.0	0.6	3340.7	385.3	56.9	2772.3	998.1	326.1	2537.0	2382.8	101.5	53.0	36.5	85.8
Camden Co	0.0	0.0	0.0	0.0	0.0	0.0	610.8	201.0	22.3	27.4	26.1	0.2	306.8	45.0	7.3	1680.8	400.1	192.2	302.4	337.4	13.5	7.4	5.2	10.8
Carteret Co	97.8	38.9	182.3	38.6	6.8	0.0	5692.3	2618.0	346.0	216.5	201.2	1.7	1982.2	541.5	99.0	3071.0	1368.8	182.1	1738.0	1908.7	77.1	41.6	29.2	62.3
Caswell Co	0.0	0.0	0.0	0.0	0.0	0.0	94.0	217.1	17.4	12.4	11.7	0.1	1536.8	132.0	18.9	1550.7	486.3	174.8	625.7	669.0	27.1	14.7	10.4	21.7
Catawba Co	4083.7	19269.6	82371.7	5011.3	4238.9	5.0	1107.3	1619.7	99.7	90.4	86.5	1.4	5053.2	770.4	91.5	4516.2	1191.5	477.5	6040.4	7049.9	259.8	142.0	100.1	206.4
Chatham Co	726.7	3305.0	11871.7	1246.4	677.0	0.4	519.2	580.7	55.2	50.9	48.9	0.5	2426.0	273.1	42.3	2603.3	883.2	2450.6	2291.4	2417.9	99.9	54.9	38.8	78.8
Cherokee Co	0.0	0.0	0.0	0.0	0.0	0.0	301.2	144.9	14.6	17.4	16.6	0.2	1820.6	205.4	32.4	1384.2	577.0	146.9	724.8	825.9	32.5	17.8	12.6	25.6
Chowan Co	94.5	33.0	168.7	48.0	16.8	0.1	583.9	172.7	17.3	22.6	21.5	0.2	556.8	76.3	10.9	1015.4	250.2	610.4	330.6	333.0	13.7	7.1	4.9	11.6
Clay Co	0.0	0.0	0.0	0.5	0.1	0.0	203.9	67.2	7.2	10.4	9.9	0.1	505.9	68.7	8.1	620.3	193.8	29.2	254.8	261.5	11.1	6.0	4.2	9.0
Cleveland Co	670.3	291.0	172.4	275.5	241.1	0.2	471.2	745.2	54.6	46.4	44.3	0.6	2916.7	465.6	88.9	3237.1	829.7	1029.6	3026.5	2832.4	119.8	64.4	45.0	96.3
Columbus Co	2670.0	2608.5	2829.3	1590.5	1372.8	128.2	566.3	548.1	48.7	48.9	46.6	0.4	2323.8	339.5	55.3	2749.8	804.2	3063.6	1794.6	1882.7	77.0	41.3	28.8	62.8
Craven Co	2533.1	1693.6	1477.9	721.9	521.4	65.8	973.8	569.2	54.2	56.2	53.6	0.5	2298.1	376.5	46.8	2805.2	756.9	1257.5	2995.1	2884.6	119.7	62.5	43.0	101.4
Cumberland Co	1219.6	736.9	1545.2	280.2	132.0	0.4	1319.6	1703.6	140.5	122.6	116.6	1.2	5258.6	790.5	107.9	5913.6	1419.4	1517.4	10473.5	12143.9	446.2	244.4	172.5	353.4
Currituck Co	0.0	0.0	0.0	6.0	2.5	0.0	2005.2	537.0	60.2	74.6	70.5	0.7	713.7	115.8	16.5	1412.9	362.9	219.6	876.5	971.6	40.6	22.2	15.7	32.3
Dare Co	2.3	75.4	7.6	2.6	1.6	0.0	8509.7	1062.0	105.2	193.3	180.2	2.1	871.8	273.1	36.0	1732.9	433.8	16.6	1521.7	1592.9	66.5	35.8	25.0	54.1
Davidson Co	2791.3	3240.7	408.0	457.5	391.7	6.5	809.1	1545.1	101.7	77.3	73.2	0.9	4806.8	656.7	97.5	4468.8	1221.9	559.0	5072.0	6456.2	229.9	128.9	92.2	175.5
Davie Co	258.1	35.1	16.0	68.1	58.1	1.2	398.0	280.3	24.3	28.9	27.6	0.3	1714.0	179.8	24.7	1681.5	500.1	445.7	1270.5	2569.9	75.4	47.7	36.2	45.9
Duplin Co	17.3	299.2	599.1	150.0	106.8	0.0	186.5	412.0	41.3	42.0	40.6	0.3	1882.0	251.2	33.9	4565.2	1041.3	23702.1	1835.7	2676.8	89.8	52.7	38.6	63.5
Durham Co	236.0	352.2	593.3	22.9	17.4	0.5	1517.5	2328.2	215.6	189.6	182.4	2.0	4047.7	1053.9	117.3	4624.6	1179.7	133.2	5434.5	8250.5	337.8	160.5	108.6	279.3
Edgecombe Co	281.4	2108.9	331.7	79.6	49.0	0.0	284.2	874.6	61.4	47.1	44.8	0.4	2091.4	271.1	49.4	3460.0	854.9	1913.2	2078.8	2117.5	87.1	45.9	31.8	72.8

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Forsyth Co	2296.4	1529.5	3784.3	346.8	200.1	19.4	1579.5	1844.4	157.6	145.9	139.8	1.7	6077.5	1541.5	244.0	7141.2	1746.2	286.4	8787.1	11599.3	455.3	224.0	154.0	360.5
Franklin Co	444.8	26.9	6.7	10.0	6.3	0.0	266.6	282.6	26.2	26.4	25.3	0.3	2066.3	262.1	33.2	2266.1	669.0	577.1	1653.2	1798.3	74.3	40.3	28.3	59.8
Gaston Co	907.1	14609.5	54597.3	3101.0	2669.8	12.3	944.0	1448.7	106.2	87.7	83.4	1.0	4587.4	775.6	90.8	4044.7	1011.0	291.1	5217.5	6611.5	296.1	134.9	89.8	243.5
Gates Co	0.0	0.0	0.0	0.5	0.2	0.0	98.3	127.9	14.7	14.8	14.3	0.1	650.7	64.2	10.3	1138.5	316.5	589.4	324.8	381.3	14.8	8.2	5.8	11.6
Graham Co	504.5	25.0	25.8	19.8	13.9	0.0	120.3	44.1	3.5	4.5	4.2	0.1	546.4	59.8	8.8	585.7	207.3	19.3	178.8	167.5	7.3	3.8	2.6	6.1
Granville Co	621.6	23.6	1.5	49.0	45.9	29.0	346.4	527.2	49.6	44.8	43.1	0.5	2603.4	254.4	33.6	2476.4	809.2	179.6	1608.8	3519.8	117.6	61.0	43.8	81.5
Greene Co	0.0	1.9	9.1	0.6	0.2	0.0	85.9	219.8	23.6	21.8	21.0	0.1	1079.9	94.2	12.1	1688.8	391.3	4505.9	603.6	605.8	25.7	13.7	9.6	21.1
Guilford Co	3931.8	218.7	282.2	221.6	135.0	10.6	3394.1	4408.0	376.3	358.9	344.1	3.7	9393.6	2296.0	231.8	9006.4	2332.4	585.3	12727.2	16815.5	675.2	331.4	227.2	538.1
Halifax Co	484.5	4039.7	2426.6	361.7	264.7	5.3	383.5	748.6	59.5	49.8	47.3	0.3	2606.1	268.6	35.6	3387.5	905.3	1122.7	1837.0	3018.9	93.9	56.4	41.8	63.5
Harnett Co	0.0	3.4	0.0	13.4	11.2	0.0	520.8	938.9	72.4	55.3	52.1	0.4	2705.5	449.8	62.1	3671.3	972.3	2263.8	2272.1	3008.4	107.0	60.8	43.8	80.0
Haywood Co	1506.9	5599.9	8731.4	898.8	877.8	77.6	619.6	329.1	32.4	39.8	37.8	0.3	2972.8	374.3	69.2	2565.5	952.3	333.4	2136.0	4069.2	120.8	74.7	56.0	77.3
Henderson Co	781.3	75.8	1.7	34.8	27.9	0.5	1349.5	655.4	58.2	78.0	73.9	0.7	3396.2	496.9	62.2	3416.1	1081.5	261.6	2251.6	3073.1	105.4	59.7	43.0	79.2
Hertford Co	181.5	176.7	148.7	152.4	134.0	0.0	223.8	187.5	18.9	21.3	20.4	0.2	894.5	139.8	37.6	1426.2	347.8	933.6	584.8	575.2	24.5	13.0	9.1	20.1
Hoke Co	181.0	62.2	127.3	21.4	21.4	0.0	164.6	204.2	20.4	20.9	20.1	0.2	1062.5	186.4	34.6	1786.8	631.7	934.8	830.6	847.9	34.7	18.8	13.2	27.8
Hyde Co	0.3	16.5	1.4	4.2	1.6	0.0	6489.8	675.9	64.1	132.2	122.9	1.5	470.8	46.1	6.4	2044.3	479.3	145.8	166.4	161.1	6.9	3.7	2.6	5.7
Iredell Co	774.3	3967.1	539.6	121.5	105.1	19.9	839.8	1148.7	102.4	92.8	89.2	1.0	3999.3	579.8	108.2	4751.7	1310.4	1904.2	6425.0	10172.6	323.6	194.5	143.9	217.1
Jackson Co	37.7	76.7	13.0	41.1	31.8	0.0	365.6	275.4	31.0	31.7	30.3	0.3	2177.4	268.2	33.6	1725.6	722.8	46.4	1272.2	1600.5	61.6	34.5	24.7	47.1
Johnston Co	179.7	48.3	28.9	10.0	9.7	1.7	841.6	1705.9	138.6	113.0	107.4	0.9	3810.7	626.3	75.1	5519.6	1369.5	2855.4	6225.8	10847.5	335.0	205.4	153.4	218.1
Jones Co	0.0	0.0	0.0	10.1	3.2	0.0	69.7	136.3	15.2	14.5	13.9	0.1	534.1	54.3	8.3	1042.1	247.0	2480.8	509.8	611.6	23.7	13.1	9.3	18.5
Lee Co	286.1	96.3	90.7	171.5	155.2	0.0	306.5	564.3	45.3	38.5	37.0	0.5	1427.3	278.1	31.1	1495.6	415.2	484.5	1575.4	1571.1	64.8	33.5	22.9	55.6
Lenoir Co	353.2	755.2	1122.2	75.9	46.9	17.5	335.5	411.0	35.4	36.7	35.2	0.3	1852.3	246.4	31.4	3501.7	753.2	3666.7	1767.4	1569.9	69.7	35.4	23.9	61.3
Lincoln Co	767.5	119.0	17.8	72.3	64.8	0.3	409.9	553.6	42.5	37.4	35.6	0.4	2229.4	306.7	68.5	2606.3	730.5	345.1	2535.5	2051.6	90.4	46.1	31.2	77.8
Mc Dowell Co	730.8	244.9	50.7	242.9	182.6	0.0	417.1	883.9	55.5	37.1	34.6	0.4	2065.9	264.8	32.2	1670.3	695.4	72.8	1543.0	2988.2	88.9	55.4	41.7	56.0
Macon Co	4.9	0.0	0.0	0.8	0.2	0.0	489.9	210.4	21.8	28.6	27.1	0.3	1602.6	142.7	30.7	1250.6	469.2	117.6	927.5	1059.7	42.0	23.1	16.3	33.1
Madison Co	0.0	0.0	0.0	0.0	0.0	0.0	159.3	327.2	23.5	16.1	15.1	0.1	1431.8	160.9	22.2	1935.0	484.7	620.5	516.3	591.8	23.5	12.9	9.1	18.5
Martin Co	1085.1	4606.2	3426.0	640.2	523.0	102.6	251.6	242.6	23.9	26.1	25.0	0.2	2014.4	223.8	43.6	1759.5	603.8	240.7	939.6	979.7	39.8	21.3	14.9	32.4
Mecklenburg Co	2082.4	765.4	867.7	528.0	390.5	72.2	7653.1	8351.7	836.8	929.4	894.8	7.6	11422.2	3424.8	356.5	13585.6	2167.0	414.0	26067.1	25981.4	1122.0	506.7	335.3	933.9
Mitchell Co	467.8	75.8	23.6	54.8	48.9	0.0	262.3	667.2	42.9	25.7	23.6	0.1	1045.7	122.1	21.1	844.7	297.8	35.8	385.3	391.2	16.2	8.6	6.0	13.3
Montgomery Co	544.3	117.7	54.2	195.4	144.2	0.1	264.0	241.1	18.8	18.1	17.3	0.2	1467.9	166.8	31.8	1366.9	478.6	1446.1	1058.5	1201.0	46.8	25.9	18.4	36.5
Moore Co	8.0	12.2	14.7	4.1	2.8	0.0	535.5	503.7	48.9	46.3	44.2	0.5	2578.1	464.7	54.3	2317.9	786.3	2275.2	2191.5	2051.3	87.1	45.2	31.1	74.1
Nash Co	378.9	172.8	95.7	19.2	14.1	0.8	406.2	715.7	61.4	53.0	50.6	0.4	3275.7	520.7	65.7	3900.1	1059.9	1925.4	4356.3	6824.2	223.6	131.5	96.2	158.0
New Hanover Co	2275.1	10332.3	27675.4	1154.3	609.2	5.5	1586.2	3633.9	478.4	233.4	220.1	1.6	2723.5	632.8	72.2	2614.5	689.3	126.0	3470.9	3305.8	140.1	72.4	49.5	120.3
Northampton Co	162.7	23.1	8.6	65.3	20.2	1.3	230.9	582.5	47.0	35.7	33.8	0.2	1160.4	140.9	25.3	3215.3	793.6	1706.1	871.1	1413.0	45.4	27.3	20.2	30.6
Onslow Co	64.3	23.1	32.1	3.5	3.1	0.0	1247.2	566.2	60.9	69.3	66.0	0.6	3107.9	509.6	75.9	3079.1	940.6	2547.2	3586.5	3239.0	138.1	72.1	49.6	116.8
Orange Co	70.9	527.5	148.6	24.0	16.1	0.0	893.8	903.6	96.0	91.6	87.6	0.7	3257.0	606.4	122.9	3344.7	977.8	401.1	3187.4	7610.2	247.7	130.6	94.6	165.2

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Pamlico Co	0.0	0.0	0.0	0.0	0.0	0.0	0.0	758.6	89.0	88.2	84.5	0.7	498.6	72.3	10.0	980.2	248.3	107.8	343.0	297.7	13.3	6.9	4.7	11.5
Pasquotank Co	3.0	8.3	4.3	7.3	18.1	5.7	0.0	379.7	41.1	52.4	50.2	0.4	891.7	188.7	25.2	3137.8	699.5	149.0	723.5	667.8	28.9	14.7	10.0	25.2
Pender Co	0.0	0.0	0.0	0.6	0.1	0.0	397.4	288.3	32.4	31.1	29.8	0.3	1637.9	302.7	53.1	2034.2	780.6	3259.7	1668.6	2753.1	88.2	53.0	39.2	59.7
Perquimans Co	0.0	230.1	20.2	358.2	304.8	4.7	772.8	246.7	26.7	34.5	32.9	0.3	621.6	69.0	10.0	2112.6	505.2	548.0	384.1	441.2	17.0	9.4	6.7	13.2
Person Co	381.1	33688.0	126780.3	4165.9	1802.2	29.4	290.3	267.4	23.2	23.4	22.3	0.2	1872.3	195.0	40.8	1538.4	535.0	220.7	836.6	766.8	33.8	17.4	11.9	29.0
Pitt Co	616.1	256.4	62.8	57.4	44.9	3.9	662.4	1181.0	108.0	97.5	93.7	0.8	3629.4	568.2	66.5	4014.4	1005.1	2271.8	3111.2	2973.0	128.0	66.6	45.7	109.1
Polk Co	0.2	2.0	1.2	0.5	0.3	0.0	166.5	123.5	11.1	11.7	11.1	0.1	932.7	130.5	28.2	869.7	292.3	55.5	720.8	1417.3	41.7	26.1	19.7	25.9
Randolph Co	2532.9	19.3	3.0	188.1	173.0	0.0	735.2	971.6	66.4	62.6	59.8	0.9	5669.1	664.6	88.1	4411.3	1357.0	3555.5	4904.2	5954.3	218.2	119.1	83.9	173.8
Richmond Co	20.7	289.7	64.8	60.1	35.7	7.2	302.5	632.7	47.4	33.5	31.6	0.3	1333.0	231.9	37.9	1439.5	445.6	1797.8	1562.8	1624.4	65.5	34.8	24.2	54.1
Robeson Co	220.7	3092.6	7762.4	219.5	98.0	0.9	458.0	1239.1	100.3	83.7	79.9	0.6	4500.6	606.4	100.4	8866.4	2429.5	5390.3	4230.6	6445.4	209.7	123.1	90.0	148.4
Rockingham Co	766.1	7858.9	5290.8	539.9	358.4	4.0	496.9	805.8	56.4	45.2	42.8	0.5	3757.7	456.1	66.6	3250.9	1017.4	312.4	2633.6	2610.3	109.3	57.0	39.2	92.8
Rowan Co	2297.3	3924.1	10600.6	835.7	674.6	9.7	749.3	1280.5	86.6	69.3	65.4	0.7	3504.5	508.3	116.1	3997.6	1020.1	524.5	5342.4	6703.6	229.0	129.1	92.5	171.4
Rutherford Co	761.3	5118.1	29902.4	2252.0	1795.1	0.5	434.9	640.3	45.0	36.5	34.4	0.4	2448.0	320.3	47.3	2475.3	752.2	377.6	1809.9	1703.9	71.8	38.0	26.3	59.6
Sampson Co	24.4	27.0	18.3	74.0	22.1	0.0	227.5	477.8	48.5	50.0	48.3	0.4	2293.8	314.7	47.7	7801.4	1731.5	21430.0	2026.4	2556.3	92.8	52.4	37.6	70.1
Scotland Co	818.9	1597.8	252.1	426.8	410.0	2.6	150.4	484.6	31.9	22.1	20.9	0.2	1113.0	225.9	46.1	1899.9	712.6	632.4	1176.2	1147.2	48.0	25.1	17.3	40.5
Stanly Co	357.9	521.1	1654.0	233.5	166.4	0.0	524.6	500.5	39.2	40.9	38.9	0.4	1927.7	289.4	40.9	2389.0	663.3	1442.2	2662.0	2001.1	92.0	46.5	31.4	79.8
Stokes Co	199.7	35861.1	83483.9	4688.5	4060.3	7.1	265.0	293.2	24.7	22.9	21.7	0.2	2565.3	227.0	45.8	2087.6	712.3	333.3	1067.4	1051.9	43.9	23.4	16.4	35.9
Surry Co	1531.3	257.1	320.5	199.8	125.7	0.0	560.3	467.1	36.2	41.5	39.6	0.5	2976.6	406.9	55.2	2903.4	814.6	1817.3	2588.9	3735.0	125.5	73.2	53.5	89.6
Swain Co	0.0	0.0	0.0	0.0	0.0	0.0	755.4	112.2	12.3	29.4	27.4	0.2	1162.0	121.1	16.5	824.0	345.4	204.8	580.1	610.1	24.8	13.5	9.5	19.8
Transylvania Co	148.6	890.4	1545.5	62.0	58.8	0.6	947.3	221.4	21.8	42.6	40.0	0.3	1428.5	174.2	20.1	1326.6	462.0	96.9	800.5	773.1	33.8	17.7	12.2	28.6
Tyrrell Co	0.0	0.0	0.0	0.0	0.0	0.0	1845.2	287.9	30.0	47.7	44.7	0.5	345.3	31.0	4.9	3043.9	693.2	277.4	152.8	178.1	6.8	3.8	2.7	5.3
Union Co	375.3	74.5	169.1	116.2	37.3	0.0	1460.2	1994.5	187.0	174.2	166.8	1.6	3616.0	611.1	62.5	5238.4	1452.5	5909.7	4546.0	3778.1	170.7	88.6	60.7	143.6
Vance Co	212.2	824.6	267.1	147.3	134.8	0.1	458.0	245.9	22.3	26.5	25.2	0.3	1671.7	237.3	33.5	1717.3	523.3	88.9	1347.4	1998.6	66.1	38.0	27.6	48.3
Wake Co	1060.4	204.6	76.4	244.9	68.2	2.2	5741.6	6299.5	657.4	725.1	698.4	5.7	12700.5	3472.9	346.1	15940.0	4165.6	455.7	14782.2	24086.6	961.5	468.7	322.6	759.2
Warren Co	0.7	2.1	0.2	2.6	1.7	0.0	198.7	136.4	15.1	14.2	13.6	0.1	1213.5	127.3	20.4	1199.3	412.4	651.5	627.6	1075.1	33.1	20.2	15.1	21.5
Washington Co	0.0	0.0	0.0	8.9	3.6	0.0	732.4	338.6	32.6	38.9	37.1	0.3	739.4	109.4	13.8	1569.1	500.0	523.4	425.4	458.0	18.6	10.0	7.0	15.1
Watauga Co	26.7	46.2	40.1	17.3	13.4	0.0	680.8	411.3	46.3	52.8	50.4	0.4	2063.8	353.7	85.0	1863.6	665.6	253.9	1128.4	1173.1	47.6	25.6	17.9	38.6
Wayne Co	1104.8	5324.0	14731.4	722.6	459.0	0.0	508.6	708.3	65.2	63.7	61.4	0.6	2843.6	549.9	69.1	5738.2	1324.3	8197.4	3061.5	2803.1	119.3	61.3	41.7	103.2
Wilkes Co	1212.3	310.1	95.1	139.1	110.0	2.8	397.7	331.6	26.6	29.6	28.3	0.4	3031.8	357.4	83.8	2811.2	900.5	4606.8	1926.3	2013.3	82.6	44.6	31.2	66.9
Wilson Co	1049.4	443.8	1122.2	228.8	191.4	5.4	531.0	1091.2	82.7	66.1	62.7	0.6	2294.5	319.7	37.5	3172.8	727.7	574.2	2537.4	3009.0	112.7	61.6	43.5	89.3
Yadkin Co	38.1	1.2	7.0	3.5	2.5	0.0	182.4	224.6	21.3	22.2	21.4	0.2	1691.5	199.2	28.2	2058.8	545.1	1488.7	1362.2	2260.3	72.0	43.5	32.2	48.3
Yancey Co	12.6	2.8	5.3	0.1	0.1	0.0	283.6	400.6	26.6	19.9	18.3	0.1	1405.5	141.0	29.5	1051.0	417.5	67.9	417.7	487.1	18.9	10.4	7.4	14.8

Emissions reported as tons/year.
See Note 1 in section 2

Table 4. Typical 2002 Annual Emission Summaries For 12 km ASIP States

State	Point						Non-road						Area						Mobile					
	VOC	Nox	SO2	PM10	PM2.5	NH3	VOC	NOx	SO2	PM10	PM2.5	NH3	VOC	NOx	SO2	PM10	PM2.5	NH3	VOC	NOx	SO2	PM10	PM2.5	NH3
AL	49332	244348	544309	32886	23291	2200	60487	65366	7584	4949	4526	33	209200	34900	54812	444259	101442	60275	127295	158212	6900	3903	2799	5588
FL	40995	302833	518721	57244	46147	1657	272072	180627	20614	18281	17415	134	455828	48664	44619	541816	147633	40603	527209	465640	20915	11275	7868	18114
GA	34401	196731	568726	32740	22333	3696	85965	97961	9005	8618	8226	60	333045	49987	60370	757656	159438	83066	283421	307732	12184	7246	5168	10546
KY	46321	237209	518086	21327	14174	1000	44805	104571	14043	6425	6046	31	98713	40966	41941	240226	51763	51246	103503	156417	6308	3723	2697	5055
MS	43852	104661	103389	21105	11044	1359	41081	88787	11315	5010	4690	23	145433	7528	871	358070	64080	58899	87672	111914	4614	2859	2112	3585
NC	61484	196731	522093	36539	26953	1233	94480	84284	7693	7348	7005	65	250044	41517	5815	300838	83520	162176	263766	327329	12420	6579	4623	9702
SC	38928	130394	259917	35542	27399	1553	55016	50249	4866	4152	3945	33	175665	24602	14087	287161	63802	29074	116163	140489	5972	3452	2501	4694
TN	78230	221638	413735	49174	39511	1746	66450	96827	10441	6819	6458	43	151436	20063	29956	220789	50833	34368	179807	238577	9226	5371	3949	6625
VA	43906	147301	305107	17212	12771	3231	75993	63219	8663	8728	8288	48	173901	52396	105989	255738	61350	44064	159790	222374	8294	4549	3102	7852
WV	15775	277589	570154	22076	15523	453	18566	33239	2112	1850	1728	9	62627	13631	11683	118622	24289	9975	42174	58999	2464	1381	995	1908

Emissions reported as tons/year
See Note 1 in section 2

Table 5. Biogenic Annual Emission Summary For Hickory and Greensboro-Winston Salem-High Point Counties.

County	NOx	VOC
Catawba	104	9,886
Davidson	187	12,850
Guildford	193	11,940
NC Total	17,888	1,213,819

Emissions reported as tons/year

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
DUKE ENERGY – MARSHALL STEAM – 3703500073								
	G-1	10100212	51.5797	6021.807	26468.56	1836.039	1445.153	0
	G-1	10100501	0.0301	3.3209	10.8457	0.3813	0.2809	0
	G-2	10100212	50.4644	4935.479	25869.42	1427.49	1252.048	0
	G-2	10100501	0.0189	2.1398	6.9969	0.2367	0.1799	0
	G-4	10100212	29.0336	4867.094	14931.31	690.3903	664.6189	0
	G-4	10100501	0.0109	1.4245	4.6649	0.1631	0.1196	0
	G-5	10100212	28.6145	3259.115	15042.42	915.1579	762.75	0
	G-5	10100501	0.0203	2.2628	7.4073	0.2537	0.1928	0
	Plant Total		159.7724	19092.64	82341.62	4870.112	4125.344	0
APAC - ATLANTIC, INC. – HICKORY PLANT -3703500009								
	G-1	30500242	3.88	10.84	8.76	2.06	1.32	0
	Plant Total	30500242	3.88	10.84	8.76	2.06	1.32	0
BROPHILL FURNITURE CONOVER PLANT - 3703500017								

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-1	10300903	0.06	2.11	0.11	1.24	0.76	0
	G-1	10300501	0	0.04	0.07	0	0	0
	G-2	10300903	0.07	2.65	0.14	1.55	0.96	0
	G-25	40201999	0.01	0	0	0	0	0
	G-26	30700939	1.07	0	0	0	0	0
	G-27	40201901	304.69	0	0	1.53	1.36	0
	G-3	30703001	0	0	0	0.03	0.022	0
	Plant Total		305.9	4.8	0.32	4.35	3.102	0
CAROLINA SOLVENTS, INC. - 3703500029								
	G-1	10300501	0.001	0.11	0.003	0.006	0.006	0
	G-5	49099998	21.25	0	0	0	0	0.001
	G-6	40202601	1.99	0	0	0.044	0.039	0
	Plant Total		23.241	0.11	0.003	0.05	0.045	0.001
CARPENTER COMPANY CONOVER – 3703500031								
	G-1	40100217	0.1	0	0	0	0	0
	G-10	39000699	0.05	1.08	0.007	0.08	0.08	0
	G-14	20200401	0.03	0.45	0.03	0.03	0.03	0
	G-16	49099998	479.6	0	0	0	0	0
	G-16	49099998	0	0	0	0.14	0.07	0
	G-17	40588805	0.76	0	0	0	0	0
	G-17	49099999	2.94	0	0	0	0	0
	GR25	40299996	0.19	0	0	0	0	0
	GR26	40188898	0.71	0	0	0	0	0
	Plant Total		484.38	1.53	0.037	0.25	0.18	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
CENTURY FURNITURE INSTRUDIES, INC. PLAN - 3703500043								
	G-15	30703099	0	0	0	0.09	0	0
	G-50	30703099	0	0	0	0.01	0	0
	G-51	40201901	139.9	0	0	2.46	2.46	0.001
	G-53	10300601	0	0.1	0	0	0	0
	Plant Total		139.9	0.1	0	2.56	2.46	0.001
CENTURY FURNITURE INSTRUDIES PLANT#1 - 3703500044								
	G-1	10300502	0	0.04	0.13	0.02	0.019	0
	G-2	10300502	0	0.04	0.13	0.02	0.019	0
	G-41	10300503	0	0.01	0.04	0	0	0
	G-44	10300903	0.25	9.6	0.49	4.53	2.82	0
	G-45	10300903	0.25	9.6	0.49	8.04	4.9	0
	G-46	30702002	0	0	0	0.71	0.53	0
	G-47	40201901	585.9	0	0	20.5	20.5	0.001
	Plant Total		586.4	19.29	1.28	33.82	28.788	0.001
DÉCOR ORIGINALS, INC. - 3703500066								
	G-11	40202101	43.65	0	0	0	0	0
	G-2	40200610	2.05	0	0	0	0	0
	G-8	40202101	6.8	0	0	0	0	0
	Plant Total		52.5	0	0	0	0	0
DUKE ENERGY – MARSHALL STEAM – 3703500073								
	G-6	30531009	0	0	0	3.58	1.25	0
	G-7	39999992	0	0	0	0	0	0.15

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-8	39999994	0	0	0	1	0.722	0
	G-9	40188898	0.11	0	0	0	0	0
	Plant Total		0.11	0	0	4.58	1.972	0.15
FINE FURNITYRE, INC. - 3703500079								
	G-1	30703098	0	0	0	0.29	0.16	0
	Plant Total		0	0	0	0.29	0.16	0
CAROLINA GLOVE COMPANY, PLANT #8 - 3703500087								
	G-4	10200603	3.44	0.08	0	0.01	0.01	0
	Plant Total		3.44	0.08	0	0.01	0.01	0
CENTURY FURNITURE INDUSTRIES TECHNICAL - 3703500093								
	G-11	10300503	0	0.13	0.45	0.02	0.02	0
	G-12	30703001	0	0	0	0.007	0.007	0
	Plant Total		0	0.13	0.45	0.027	0.027	0
HICKORY CHAIR COMPANY, PLANT 7 - 3703500102								
	G-1	10300903	0.03	1.36	0.06	0.93	0.82	0
	G-1	10301201	0	0	0	0.36	0.356	0
	G-27	10300401	0	1.8	8.47	0.33	0.21	0.031
	G-32	30703098	0	0	0	0.01	0.007	0
	G-33	40201901	37.9	0	0	1.05	0.935	0
	Plant Total		37.93	3.16	8.53	2.68	2.328	0.031
HWS COMPANY INC. DBA HICKORY WHITE - 3703500106								
	G-1	10300903	0.21	8.07	0.41	8.98	0.16	0
	G-2	10300501	0	0.009	0.3	0	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-29	40188805	0.18	0	0	0	0	0
	G-3	10300602	0.01	0.73	0.003	0.07	0.07	0
	G-30	30703098	0	0	0	0.48	0.307	0
	G-31	40201901	89.5	0	0	1.26	1.26	0
	G-4	10300602	0.01	0.35	0.003	0.06	0.06	0
	Plant Total		89.91	9.159	0.716	10.85	1.857	0
HICKORY SPRINGS MANUFACTURING – CONOVER - 3703500107								
	G-24	40299999	12.44	0	0	0	0	0
	G-46	39990003	0	0.16	0.001	0.006	0.006	0.001
	G-47	10200603	0	0.04	0	0.002	0.002	0
	G-48	10200603	0	0.04	0	0.002	0.002	0
	G-49	10200603	0	0.04	0	0.002	0.002	0
	G-50	10200603	0	0.04	0	0.002	0.002	0
	G-51	10200603	0	0.04	0	0.002	0.002	0
	G-53	10200603	0.004	0.05	0.003	0.004	0.004	0
	G-54	20100102	0.002	0.03	0.002	0.002	0.002	0
	G-55	20100106	0.003	0.03	0.002	0.002	0.002	0
	G-58	49099998	99.5	0	0	0	0	0
	G-59	30900198	0	0	0	20.2	20.2	0
	G-60	31299999	1.44	0	0	0	0	0
	Plant Total		113.389	0.47	0.008	20.224	20.224	0.001
HICKORY SPRINGS MFG – METAL COMPLEX –3703500108								
	G-10	40202013	8.43	0.92	0.007	0.05	0.05	0.006
	G-12	40299999	0.005	0	0	0	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-13	40202001	3.11	0	0	0	0	0
	G-14	39000699	0.02	0.04	0.003	0.02	0.02	0
	G-16	40202001	9.06	1.26	0.005	0.04	0.04	0.004
	G-18	39999996	6.24	0	0	0	0	0
	G-19	39000699	0	2.29	0.01	0.1	0.1	0.01
	Plant Total		26.865	4.51	0.025	0.21	0.21	0.02
TRADEWINDS INTERNATIONAL, INC - 3703500117								
	G-1	10200603	0	0.06	0	0	0	0
	G-2	10200906	0.73	2.7	0.14	2.08	1.81	0
	Plant Total		0.73	2.76	0.14	2.08	1.81	0
KLINGSPOR ABRASIVES, INC. - 3703500118								
	G-11	31299999	0.54	0	0	0	0	0
	G-14	39999993	0	0	0	0.064	0.046	0
	G-15	40200711	0.93	0	0	0	0	0
	G-16	40100399	0.03	0	0	0	0	0
	Plant Total		1.5	0	0	0.064	0.046	0
KAROLINA POLYMERS, INC. - 3703500130								
	G-1	10300602	0.01	0.2	0	0.01	0.01	0
	G-2	10300602	0.01	0.2	0	0.01	0.01	0
	G-3	10300602	0.01	0.2	0	0.01	0.01	0
	G-6	39999994	0	0	0	0.002	0.001	0
	G-7	39999994	0	0	0	0.002	0.001	0
	Plant Total		0.03	0.6	0	0.034	0.032	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
HOOKER FURNITURE COPORATION - 3703500164								
	G-1	30702098	0	0	0	1.1	1.1	0
	G-13	40201901	0.06	0	0	0	0	0
	G-18	10300602	0.01	0.31	0.002	0.02	0.02	0.01
	G-18	10300903	0.11	4.31	0.22	2.53	1.56	0
	G-19	10300602	0.001	0.009	0	0.001	0.001	0
	G-20	40201901	161.9	0	0	6.27	6.27	0
	Plant Total		162.081	4.629	0.222	9.921	8.951	0.01
PROGRESSIVE FURNITURE INC - 3703500180								
	G-38	30702099	0	0	0	0.05	0.009	0
	G-39	10200602	0.04	0.86	0.005	0.06	0.06	0
	G-44	40201901	216.97	0	0	1.82	1.82	0.001
	G-45	40201901	3.62	0	0	0.04	0.04	0
	G-7	40201901	1.43	0	0	0.007	0.007	0
	GR2	30702099	0	0	0	0.07	0.01	0
	GR3	30702099	0	0	0	0.06	0.01	0
	GR4	30702099	0	0	0	0.07	0.01	0
	GR5	30702099	0	0	0	0.04	0.008	0
	Plant Total		222.06	0.86	0.005	2.217	1.974	0.001
PLASTIC PACKAGING INC - 3703500184								
	G-47	49099999	0.41	0	0	0	0	0
	G-61	39000699	0.01	0.26	0	0.02	0.02	0
	G-63	40500311	63.37	0	0	0	0	0
	G-64	40500311	35.67	0	0	0	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-65	40500311	34.16	0	0	0	0	0
	G-66	40500311	36.99	0	0	0	0	0
	G-67	40500311	50.55	0	0	0	0	0
	Plant Total		221.16	0.26	0	0.02	0.02	0
SHURTAPE TECHNOLOGIES – HICKORY/HIGHLAND -3703500206								
	G-100	10200603	0.01	0.29	0.004	0.04	0.04	0
	G-16	10200602	0.02	0.66	0.01	0.1	0.1	0
	G-163	40201399	0	0	0	4.19	4.19	0
	G-167	40201301	109.4	2.5	0.008	0.14	0.14	0
	G-169	40201301	262.3	0.77	0.009	0.12	0.12	0
	G-170	40201301	314.7	0	0	0	0	0
	G-171	40201399	0.14	0	0	0	0	0.013
	G-172	40201399	7.33	0	0	0	0	0
	G-173	40201399	0.04	0	0	0	0	0
	G-174	40201399	0.51	0	0	0	0	0
	G-175	40201399	0.02	0	0	0	0	0
	G-176	40201399	1.4	0	0	0	0	0
	G-177	40201399	0	0	0	0.001	0.001	0
	G-178	40201399	0	0	0	0.001	0.001	0
	G-179	40201399	0.04	0	0	0	0	0.016
	G-18	40201399	0.25	0	0	0	0	0
	G-180	40201399	78.33	0	0	0	0	0
	G-207	40201399	0.11	0	0	0	0	0.042
	G-208	40201301	2.65	0.33	0.004	0.05	0.05	0.981
	G-213	40100398	0.23	0	0	0	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-214	40100398	0.23	0	0	0	0	0
	G-215	40201399	0.01	0	0	0	0	0
	G-77	10200603	0	0.02	0	0.002	0.002	0
	G-78	10200603	0.01	0.25	0.003	0.03	0.03	0
	G-82	40201399	0.01	0	0	0	0	0
	G-83	40201301	0.01	0.05	0	0.003	0.003	0.001
	G-84	40201301	0.51	0.13	0.002	0.02	0.02	0.045
	G-85	40201301	0.44	0.08	0.001	0.01	0.01	0.039
	G-86	40201301	9.36	1.42	0.01	0.22	0.22	0.816
	G-87	40201301	8.25	0.71	0.008	0.11	0.11	0.721
	G-97	10200602	0.08	2.2	0.03	0.33	0.33	0
	G-98	10200602	0.04	1.16	0.01	0.18	0.18	0
	Plant Total		796.43	10.57	0.099	5.547	5.547	2.674
LANEVENTURE, PLANT NO. 14 - 3703500242								
	G-31	10300602	0.01	0.26	0.002	0.01	0.01	0.009
	G-33	40201901	92.73	0	0	2.65	2.36	0.035
	G-34	30703098	0	0	0	0.42	0.42	0
	G-35	39000699	0.009	0.17	0	0.01	0.01	0.005
	Plant Total		92.749	0.43	0.002	3.09	2.8	0.049
UNIFOUR FINISHERS, INC., DIVISION I - 3703500258								
	G-1	33000104	0.1	0.14	0.009	0.01	0.01	0.007
	G-14	10200603	0.01	0.19	0.01	0.01	0.01	0
	G-15	33000106	0.009	0.01	0.009	0.01	0.01	0
	G-2	33000104	0.07	0.1	0.006	0.009	0.009	0.005
	G-3	33000199	0	0	0	0.04	0.04	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-4	33000199	0	0	0	0.21	0.21	0
	G-5	33000199	0	0	0	0.26	0.26	0
	G-6	33000199	0	0	0	0.32	0.32	0
	G-7	33000101	2.02	0	0	0	0	0
	Plant Total		2.209	0.44	0.034	0.869	0.869	0.012
ETHAN ALLEN MAIDEN DIVISION - 3703500264								
	G-13	40188805	0.07	0	0	0	0	0
	G-14	10200603	0.02	0.48	0	0.03	0.03	0
	G-15	10200602	0.007	0.12	0.001	0.01	0.01	0
	G-16	10200603	0.01	0.19	0	0.01	0.01	0
	G-17	10200603	0.008	0.15	0	0.01	0.01	0
	G-22	10200602	0.01	0.21	0.001	0	0	0
	G-22	10300903	0.08	2.9	0.15	1.73	1.1	0
	G-31	40201901	75.97	0	0	6.18	5.5	0.001
	G-33	30702098	0	0	0	0.21	0.01	0
	Plant Total		76.175	4.05	0.152	8.18	6.67	0.001
MORAL MATERIAL TECHNOLOGIES. INC., MARS - 3703500269								
	G-1	30599999	0	0	0	0.09	0	0
	G-10	30599999	0	0	0	0.13	0.127	0
	G-11	30599999	0	0	0	0.13	0.127	0
	G-2	30599999	0	0	0	0.09	0	0
	G-3	30599999	0	0	0	0.09	0	0
	G-4	30599999	0	0	0	0.002	0.002	0
	G-6	30599999	0	0	0	0.11	0.107	0
	G-7	30599999	0	0	0	0.08	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-8	30599999	0	0	0	0.08	0	0
	G-9	30599999	0	0	0	0.13	0.123	0
	G-9	30599999	0	0	0	0.13	0.123	0
	Plant Total		0	0	0	1.062	0.609	0
SOUTHERN FURN CO OF CONOVER CATAWBA PLT - 3703500273								
	G-26	10300501	0	0.02	0	0.001	0.001	0
	G-26	10300903	0.02	1.03	0.05	0.62	0.39	0
	G-27	10300501	0	0.02	0	0.001	0	0
	G-27	10300903	0.01	0.43	0.02	0.26	0.16	0
	G-30	30700939	0.03	0	0	0	0	0
	G-31	40201901	10.8	0	0	0.006	0.006	0
	G-32	30702098	0	0	0	0.65	0.65	0
	Plant Total		10.86	1.5	0.07	1.538	1.207	0
HICKORY CHAIR COMPANY PLANT #20 -3703500277								
	G-16	10300903	0.24	9.17	0.47	5.37	4.96	0
	G-16	10500202	0.003	0.57	1.3	0.33	0.19	0
	G-16	10301201	0	0	0	0.39	0	0
	G-17	10300501	0.002	0.29	0.95	0.01	0.003	0
	G-24	30703098	0	0	0	0.06	0	0
	G-25	40201901	76.9	0	0	1.38	1.23	0
	Plant Total		77.145	10.03	2.72	7.54	6.383	0
THOMSVILLE FURNITURE INDUSTRIES, INC., - 3703500290								
	G-6	10200603	0	0.06	0	0	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-7	40201901	12.09	0	0	0.02	0.018	0
	Plant Total		12.09	0.06	0	0.02	0.018	0
HARDWOOD FURNITURE, INC., - 3703500296								
	G-1	30703099	0	0	0	1.29	0.71	0
	GR1	40201901	16.79	0	0	0	0	0
	Plant Total		16.79	0	0	1.29	0.71	0
DIRECTION FURNITURE COMPANY - 3703500297								
	G-1	30703099	0	0	0	1.28	0.71	0
	G-3	40201901	0.3	0	0	0	0	0
	Plant Total		0.3	0	0	1.28	0.71	0
DEMINSION WOOD PRODUCTS, INC., PLANT #1 –3703500303								
	G-4	30703098	0	0	0	0.05	0.04	0
	Plant Total		0	0	0	0.05	0.04	0
SPECIAL METALS WELDING PRODUCTS COMPANY - 3703500305								
	G-19	39000699	0.03	0.59	0	0.04	0.023	0
	GR2	30599999	0	0	0	0.05	0.049	0
	Plant Total		0.03	0.59	0	0.09	0.072	0
NULL INDUSTRIES INC - 3703500324								
	G-1	30703098	0	0	0	0.01	0.01	0
	G-11	40201001	0	0.02	0	0	0	0
	G-12	40201001	0	0.02	0	0	0	0
	G-14	40201901	0.13	0	0	0	0	0
	G-15	40201901	81.69	0	0	1.75	1.75	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	Plant Total		81.82	0.04	0	1.76	1.76	0
HICKORY LEATHER COMPANY INC -3703500355								
	G-5	40201901	7.8	0	0	0	0	0
	Plant Total		7.8	0	0	0	0	0
DISTINCTION LEATHER CO PLT #1 -3703500361								
	G-1	40201901	2.4	0	0	0	0	0
	Plant Total		2.4	0	0	0	0	0
CORNING CABLE SYSTEMS LLC-OPTICAL ASSEMB – 3703500363								
	G-13	31499999	0.08	0	0	0	0	0
	G-20	49099998	0.01	0	0	0	0	0
	G-21	40188805	0.04	0	0	0	0	0
	G-22	39999996	0.07	0	0	0	0	0
	G-23	31299999	0	0	0	0.001	0.001	0
	G-5	40288822	0.02	0	0	0	0	0
	G-8	40100311	0.07	0	0	0	0	0
	GR1	31399999	0.39	0	0	0	0	0
	Plant Total		0.68	0	0	0.001	0.001	0
PERRY'S FRAME. INC., - 3703500364								
	G-1	30703002	0	0	0	0.07	0.057	0
	Plant Total		0	0	0	0.07	0.057	0
CORNING CABLE SYSTEMS LLC (TCP) – 3703500365								
	G-197	49099999	0.08	0	0	0	0	0
	G-226	40299996	0.02	0	0	0	0	0.011

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	GR1	40299996	0.1	0	0	0	0	0
	GR3	40299996	0.79	0	0	0	0	0
	GR43	40299996	0.51	0	0	0	0	0
	GR44	49099999	0.45	0	0	0	0	0
	GR46	49099999	0.001	0	0	0	0	0
	GR51	49099999	0.1	0	0	0	0	0
	GR52	49099999	0.001	0	0	0	0	0
	GR53	49099999	0.45	0	0	0	0	0
	GR54	49099999	0.02	0	0	0	0	0
	GR55	49099999	0.2	0	0	0	0	0.113
	GR56	49099999	0.02	0	0	0	0	0
	GR57	49099999	0.11	0	0	0	0	0
	GR59	40299996	0.04	0	0	0	0	0
	Plant Total		2.892	0	0	0	0	0.124
KERRS HICKORY READY-MIXED CONCRETE CO., - 3703500370								
	G-9	30500240	0	0	0	0	0.641	0
	Plant Total		0	0	0	0	0.641	0
BLUE RIDGE PRODUCTS INC., - 3703500374								
	GR1	49099998	2.92	0	0	0	0	0
	Plant Total		2.92	0	0	0	0	0
MERIDIAN AUTOMOTIVE SYSTEMS, INC., -NEWTO - 3703500380								
	G-12	49099998	4.01	0	0	0	0	0
	G-13	49099998	0.01	0	0	0	0	0
	G-15	49099998	1.99	0	0	0	0	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-16	49099998	0.07	0	0	0	0	0
	G-22	39000699	0.05	0.86	0.01	0.07	0.07	0
	G-5	40588805	0.15	0	0	0	0	0
	G-6	49099998	0.03	0	0	0	0	0
	G-7	49099998	2.67	0	0	0	0	0
	GR1	49099999	8.8	0	0	0	0	0
	GR2	39999993	0	0	0	1.62	1.62	0
	GR3	40702098	0.07	0	0	0	0	0
	Plant Total		17.85	0.86	0.01	1.69	1.69	0
GETRAT CORPORATION - 3703500418								
	G-1	30900207	0	0	0	0.57	0.31	0
	G-2	30900299	0	0	0	0.24	0.155	0
	Plant Total		0	0	0	0.81	0.465	0
ALCATEL OPTICAL FIBER DIVISION - 3703500419								
	G-12	30900303	0	0	0	0.03	0.01	0
	G-123	40204531	0.09	0	0	0.07	0.02	0
	G-124	40204531	0.53	0	0	0.27	0.08	0
	G-138	40204531	2.44	0	0	0.04	0.01	0
	G-139	40100336	3.32	0	0	0	0	0
	G-141	40500101	0.25	0	0	0	0	0
	G-142	40500101	0.07	0	0	0	0	0
	G-146	31299999	0	0	0	0.01	0.005	0
	G-149	40202801	0	0	0	0.48	0.46	0
	G-151	20200401	0.002	0.06	0.01	0.002	0.002	0
	G-157	10200603	0.03	0.54	0.001	0.03	0.03	0

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-158	10200603	0.03	0.23	0.001	0.03	0.03	0
	G-173	39999997	0	6.35	0	0.2	0.13	0
	G-52	40202802	0	63.38	5.17	0.36	0.34	0
	G-75	40202801	0	0	0	0.09	0.09	0
	G-76	40202899	0	0	0	0.12	0.03	0
	G-80	40202899	0	0	0	0.004	0.001	0
	G-83	40202899	0.06	0	0	0	0	0
	Plant Total		6.822	70.56	5.182	1.736	1.238	0
APPALACHIAN HARDWOOD FLOORING - 3703500422								
	G-4	30700898	0.4	0	0	0	0	0
	G-6	10300603	0.03	0.47	0	0.4	0.4	0
	Plant Total		0.43	0.47	0	0.4	0.4	0
STRUCTURED FURNITURE, INC., -3703500425								
	G-2	30703098	0	0	0	1.03	0.57	0
	Plant Total		0	0	0	1.03	0.57	0
CAROLINA HOUSE FURNITURE INC -3703500425								
	G-3	10300501	0	0.01	0.09	0	0	0
	GR4	40201901	5.5	0	0	0	0	0
	Plant Total		5.5	0.01	0.09	0	0	0
SYNTHETICS FINISHING HICKORY -3703500427								
	G-1	40200898	18.6	0	0	0	0	0
	G-2	40200898	0.01	0.25	0.002	0.02	0.018	0.18
	G-3	40200898	0.02	0.3	0.002	0.02	0.018	0.27

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-4	39000699	0.02	0.35	0.002	0.02	0.01	0
	Plant Total		18.65	0.9	0.006	0.06	0.046	0.45
PARKER SOUTHERN, INC., -3703500429								
	G-4	40201901	11.92	0	0	0	0	0
	Plant Total		11.92	0	0	0	0	0
SYNTHETICS FINISHING CONOVER -3703500431								
	G-2	39000699	0.02	0.27	0.002	0.02	0.012	0
	Plant Total		0.02	0.27	0.002	0.02	0.012	0
THE HICKORY PRINTING GROUP INC - 3703500432								
	G-10	40500415	69.01	0	0	0	0	0
	G-11	39000699	0.01	0	0	0	0	0
	Plant Total		69.02	0	0	0	0	0
CITY OF HICKORY, HENRY FORK WWTP** INAC - 3703500433								
	G-1	20400402	0.006	0.32	0.03	0.006	0.006	0
	G-2	20400402	0.005	0.3	0.03	0.006	0.006	0
	Plant Total		0.011	0.62	0.06	0.012	0.012	0
W & M FRAME, INC., - 3703500436								
	G-1	40201999	0.2	0	0	0	0	0
	G-2	30703002	0	0	0	0.5	0.28	0
	Plant Total		0.2	0	0	0.5	0.28	0
UNIFOUR FINISHERS, INC., DIVISION II - 3703500437								
	G-1	33000499	0.59	0.35	0	4.3	4.3	0.029

Table 6. Catawba County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	NOx	SO2	PM10	PM2.5	NH3
	G-2	33000499	0.57	0	0	0	0	0.029
	G-4	10300602	0.01	0.14	0	0.01	0.01	0
	Plant Total		1.17	0.49	0	4.31	4.31	0.058
BLACKBURN SANITARY LANDFILL - 3703500488								
	G-2	30704002	0.22	2.7	0.18	0.19	0.19	0
	G-5	30704002	0.18	6	1	0.18	0.18	0
	G-6	50100420	79	0	0	0	0	0
	Plant Total		79.4	8.7	1.18	0.37	0.37	0
NEWTON SANITARY LANDFILL – 3703500492								
	G-1	50100410	0	1.06	0	0.45	0.45	0
	Plant Total		0	1.06	0	0.45	0.45	0
SYNTHETICS FINISHING LONGVIEW -3703500493								
	G-2	G-2	0	0	0	0	0	0.42
	G-3	G-3	0.04	0.65	0.004	0.05	0.05	0.42
	G-4	G-4	0.02	0.35	0.002	0.02	0.02	0.36
	G-5	G-5	0	0	0	0	0	0.21
	G-6	G-6	54.1	0	0	0	0	0
	G-7	G-7	0.02	0.6	0.003	0.04	0.04	0
	G-8	G-8	0.02	0.4	0.002	0.03	0.03	0
	Plant Total		54.2	2	0.011	0.14	0.14	1.41
CATAWBA COUNTY TOTAL			**4083.7**	**19269.6**	**82371.7**	**5011.3**	**4238.9**	**5.0**

Emissions reported as tons per year

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
ACME FACE VENEER COMPANY - 3705700001								
	G-1	10300902	0.01	0.28	0.01	0.17	0.1	0
	G-2	30700801	0	0	0	0.54	0.346	0
	Plant Total		0.01	0.28	0.01	0.71	0.446	0
STANLEY FURNITURE COMPANY - LEXINGTON MF- 3705700023								
	G-19	40201999	0.02	0	0	0	0	0
	G-35	10200602	0	0.01	0	0	0	0
	G-36	10200906	1.73	22.3	1.14	16.95	10.36	0
	G-36	10201201	0.01	0.08	0	0.02	0.01	0
	G-37	30703098	0	0	0	0.12	0.088	0
	G-38	40201901	315.93	0	0	3.64	3.24	0
	G-45	30700898	1.18	0	0	0	0	0
	Plant Total		318.87	22.39	1.14	20.73	13.698	0
COUNCILL COMPANY, LLC - PLANT #1 - 3705700039								
	G-12	10200906	0.07	2.59	0.13	1.52	0.94	0
	G-35	10200501	0.01	0.23	0.41	0.01	0.01	0
	G-36	40201901	35.38	0	0	0.17	0.17	0
	G-4	40201999	0.24	0	0	0	0	0
	G-6	40201999	0.07	0	0	0	0	0
	Plant Total		35.77	2.82	0.54	1.7	1.12	0
DIMENSION MILLING COMPANY, INC - 3705700048								
	G-2	10200906	0.19	7.34	0.37	4.3	2.67	0
	Plant Total		0.19	7.34	0.37	4.3	2.67	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
LEXINGTON FURNITURE INDUSTRIES PLANT 2 - 3705700049								
	G-31	40201901	0.02	0	0	0	0	0
	G-47	10200404	0.05	2.78	16.67	0.31	0.12	0
	G-48	10200906	0.49	18.43	0.94	16.55	10.07	0
	G-49	10200906	0.29	10.99	0.56	3.37	2.15	0
	G-67	40201901	164.9	0	0	5.97	5.97	0.001
	G-68	30703098	0	0	0	0.12	0.03	0
	G-78	30703098	0.63	0	0	0	0	0
	Plant Total		166.38	32.2	18.17	26.32	18.34	0.001
LEXINGTON FURNITURE PLANT 1 - 3705700050								
	G-10	10200906	0.29	10.99	0.56	5.25	3.19	0
	G-116	40201901	210.17	0	0	8.75	8.75	0
	G-117	30703098	0	0	0	0.19	0.19	0
	G-5	40201901	2.25	0	0	0	0	0
	G-6	30703098	0.68	0	0	0	0	0
	G-7	10200602	0	0.006	0	0.001	0.001	0
	G-8	10200602	0	0.001	0	0	0	0
	G-9	10200906	0.85	32.19	1.64	15.4	9.34	0
	Plant Total		214.24	43.187	2.2	29.591	21.471	0
T I INDUSTRIES - 3705700076								
	G-1	30704003	0	0	0	0.66	0.508	0
	G-3	10200906	0.09	3.31	0.17	2.21	1.36	0
	G-49	30700898	1.03	0	0	0	0	0
	G-50	40201901	172.5	0	0	1.37	1.22	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-56	40201901	2.76	0	0	0	0	0.006
	G-63	30703098	0	0	0	0.09	0.066	0
	Plant Total		176.38	3.31	0.17	4.33	3.154	0.006
LEXINGTON FURNITURE PLANT 12 ** INACTIVE - 3705700087								
	G-32	40201901	0.008	0	0	0	0	0
	G-33	10200404	0.1	4.97	28.37	0.56	0.21	0
	G-52	10200906	0.63	23.78	1.21	13.8	8.67	0
	G-53	10200501	0.02	2.38	8.44	0.12	0.03	0
	G-56	40201901	245.2	0	0	4.66	4.66	0
	G-57	30703098	0	0	0	0.11	0.02	0
	G-58	30703098	0.79	0	0	0	0	0
	Plant Total		246.748	31.13	38.02	19.25	13.59	0
COMPONENT CONCEPTS INC - 3705700094								
	G-1	40201901	0.87	0	0	0	0	0
	G-10	40201901	71.7	0	0	0	0	0
	G-11	40201901	71.7	0	0	0	0	0
	G-12	40201901	71.7	0	0	0	0	0
	G-13	40201901	0.3	0	0	0	0	0
	G-14	40201901	1.52	0	0	0	0	0
	G-15	40201901	0.07	0	0	0	0	0
	G-16	30703096	0	0	0	0.02	0.015	0
	G-3	10200906	0.17	6.24	0.32	4.8	4.16	0
	G-7	30703096	0	0	0	0.003	0.002	0
	G-9	40201901	71.7	0	0	0	0	0
	Plant Total		289.73	6.24	0.32	4.823	4.177	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
OWENS-BROCKWAY GLASS CONTAINER PLT 6 – 3705700106								
	G-17	40188898	0.36	0	0	0	0	0
	G-18	40100296	0.71	0	0	0	0	0
	G-26	30501402	0.6	113.4	49.18	17.21	16.39	0
	G-27	30501402	0.6	201.54	43.4	22.24	21.15	0
	G-28	30501402	1.2	283.85	71.77	39.15	37.75	0
	G-29	30501410	0	0	0	4.36	4.36	0
	G-3	30501406	0	0	0	0.55	0.55	5.51
	G-32	30501416	0	0	0	0.003	0.003	0
	G-36	30501410	0	0	0	0.002	0.002	0
	G-37	30501410	0	0	0	0.001	0.001	0
	G-4	30501406	0	0	0	0.004	0.004	0
	G-40	30501410	0	0	0	0.001	0.001	0
	G-41	30501406	0.02	0.45	0.003	0.03	0.03	0
	G-42	30501410	0	0	0	0.001	0.001	0
	G-5	30501406	0	0	0	0.03	0.03	0
	G-6	30501406	0	0	0	14.14	14.14	0
	GR4	30501402	0.16	2.93	0.01	0.22	0.22	0
	Plant Total		3.65	602.17	164.363	97.942	94.632	5.51
PPG INDUSTRIES FIBER GLASS PRODUCTS, INC - 3705700109								
	G-10	30501222	0	0	0	0.81	0.403	0
	G-11	30501222	0	0	0	0.11	0.055	0
	G-12	30501222	0	0	0	0.003	0.001	0
	G-14	30501221	0	0	0	0.002	0.001	0
	G-16	30501222	0	0	0	0.009	0.004	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-20	10200602	0.07	1.4	0.008	0.1	0.1	0
	G-22	10200602	0.07	1.4	0.008	0.1	0.1	0
	G-23	10200602	0.17	3.2	0.01	0.24	0.24	0
	G-24	10200602	0.17	3.2	0.01	0.24	0.24	0
	G-35	30501212	0.4	11.6	28.95	9.66	9.29	0
	G-37	30501212	0.24	6.01	3	3.89	3.74	0
	G-38	30501212	0.68	45.37	53.44	20.49	19.7	0
	G-39	39999994	0	0	0	0.008	0.007	0
	G-40	30501221	0	0	0	0.3	0.105	0
	G-41	30501222	0	0	0	0.32	0.159	0
	G-44	30501224	0	0	0	0.34	0.205	0
	G-45	30501224	0	0	0	0.43	0.259	0
	G-46	30501224	0	0	0	0.43	0.259	0
	G-47	30501224	0	0	0	1.64	0.99	0
	G-48	20100102	0.03	0.43	0	0.03	0.03	0
	G-49	20100102	0.03	0.43	0	0.03	0.03	0
	G-5	30501222	0	0	0	0.12	0.06	0
	G-50	20100102	0.005	0.06	0	0.004	0.004	0
	G-51	20100102	0.02	0.28	0	0.02	0.02	0
	G-52	10300603	0.02	0.45	0.003	0.03	0.03	0
	G-53	30501215	0.008	0.15	0.001	0.01	0.01	0
	G-54	30501223	1	0	0	0	0	0
	G-55	30501215	0.19	0	0	0	0	0
	G-56	30501215	0.89	0	0	0	0	0
	G-6	30501222	0	0	0	0.76	0.266	0
	G-7	30501222	0	0	0	0.85	0.423	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-8	30501222	0	0	0	0.25	0.124	0
	G-9	30501222	0	0	0	0.83	0.413	0
	Plant Total		3.993	73.98	85.43	42.056	37.268	0
EXOPACK - THOMASVILLE, LLC - 3705700116								
	G-1	40588805	0.2	0	0	0	0	0
	G-2	40588805	1.11	0	0	0	0	0
	G-22	40500311	0.27	0	0	0	0	0.017
	G-55	39999994	0.2	0	0	0.35	0.253	0
	G-56	40500311	150	0.12	0.001	0.009	0.009	0.05
	G-57	40500311	80	0	0	0	0	0
	G-58	40500311	1.04	0.17	0.001	0.01	0.01	0.942
	Plant Total		232.82	0.29	0.002	0.369	0.272	1.009
SOUTHERN VENEER COMPANY, INC. - 3705700128								
	G-1	10200906	0.07	1.24	0.14	1.73	1.5	0
	Plant Total		0.07	1.24	0.14	1.73	1.5	0
MARTIN MARIETTA MATERIALS, INC. – THOMA - 3705700132								
	G-1	30504030	0	0	0	1.27	0.543	0
	Plant Total		0	0	0	1.27	0.543	0
SUPERIOR WOOD PRODUCTS, INC - 3705700133								
	G-1	10200906	0	0.08	0	0.06	0.05	0
	G-13	30703098	0	0	0	0.39	0.22	0
	G-15	40201901	7.83	0	0	0.02	0.02	0
	Plant Total		7.83	0.08	0	0.47	0.29	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
THOMAS MANUFACTURING CO OF THOMASVILLE - 3705700137								
	G-3	30999999	0	0	0	0.03	0.022	0
	G-6	10200603	0.03	0.67	0.004	0.05	0.05	0
	Plant Total		0.03	0.67	0.004	0.08	0.072	0
THOMASVILLE FURNITURE PLANT A/X/OLD V -3705700147								
	G-102	30703098	0.15	0	0	0	0	0
	G-103	30703098	0	0	0	0.9	0.659	0
	G-58	10201202	0	0	0	0.13	0	0
	G-58	10200204	0.01	3.68	7.89	2.1	1.23	0
	G-58	10200906	0.34	12.97	0.66	7.6	7.02	0
	G-59	10200906	0.34	12.97	0.66	7.6	7.02	0
	G-83	40201901	1.19	0	0	0	0	0
	G-85	40201999	0.06	0	0	0	0	0
	G-85	40201999	0.07	0	0	0	0	0
	G-85	40201999	0.08	0	0	0	0	0
	G-85	40201999	0.81	0	0	0	0	0
	G-85	40201901	164.2	0	0	14.3	12.73	0
	G-86	40201901	0.32	0	0	0	0	0
	Plant Total		167.57	29.62	9.21	32.63	28.659	0
THOMASVILLE FURNITURE PLANT B – 3705700148								
	G-15	10200204	0.01	2.28	4.73	1.37	0.53	0
	G-15	10200906	0.23	8.66	0.44	0.45	0.45	0
	G-16	10200204	0.01	2.28	4.73	1.3	0.76	0
	G-16	10200905	0.23	8.66	0.44	4.94	4.56	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-16	10201201	0	0	0	0.03	0.028	0
	G-56	40201999	0.01	0	0	0	0	0
	G-68	40201999	0.13	0	0	0	0	0
	G-68	40201901	0.03	0	0	0	0	0
	G-68	40201999	3.93	0	0	0	0	0
	G-68	40201999	1.14	0	0	0	0	0
	G-68	40201999	0.67	0	0	0	0	0
	G-68	40201901	168.9	0	0	3.87	3.87	0
	G-68	40201999	0.007	0	0	0	0	0
	G-69	30703098	0	0	0	0.01	0.007	0
	Plant Total		175.297	21.88	10.34	11.97	10.205	0
THOMASVILLE FURNITURE PLANT C/M/W/SB – 3705700149								
	G-100	40201999	0.23	0	0	0.07	0.062	0
	G-100	40201901	0.24	0	0	0.009	0.008	0
	G-100	40201999	0.54	0	0	0	0	0
	G-100	40201999	0.01	0	0	0	0	0
	G-100	40201999	0.13	0	0	0	0	0
	G-100	40201999	0.35	0	0	0	0	0
	G-100	40201901	354.9	0	0	38.9	34.63	0.019
	G-101	40201901	4.16	0	0	0	0	0
	G-121	30703098	0.35	0	0	0	0	0
	G-122	30703098	0	0	0	0.09	0.066	0
	G-25	30703098	0	0	0	0.01	0.007	0
	G-26	10200906	0.25	9.27	0.47	4.22	3.94	0
	G-27	10201202	0	0	0	0.14	0	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-27	10200204	0.02	3.59	7.32	2.05	1.21	0
	G-27	10200906	0.08	3.18	0.16	1.98	1.84	0
	G-28	10200204	0.05	10.49	21.38	5.98	3.52	0
	G-28	10200906	0.25	9.27	0.47	6.61	5.78	0
	G-4	40201901	0.05	0	0	0	0	0
	G-67	30703098	0	0	0	0.01	0.007	0
	G-97	10200602	0	0.05	0	0	0	0
	G-98	10200602	0.01	0.1	0	0.01	0.01	0
	G-99	10200602	0	0.04	0	0	0	0
	Plant Total		361.62	35.99	29.8	60.079	51.08	0.019
THOMASVILLE FURNITURE PLANT D – 3705700150								
	G-11	40201901	0.16	0	0	0	0	0
	G-27	10200204	0	0.57	1.21	0.32	0.19	0
	G-27	10200906	0.13	4.81	0.25	3.11	2.84	0
	G-29	10200204	0	0.54	1.15	0.31	0.18	0
	G-29	10200906	0.12	4.57	0.23	3.35	2.96	0
	G-29	10201201	0	0	0	0.06	0.057	0
	G-65	40201901	0.53	0	0	0	0	0
	G-66	40201901	0.01	0	0	0	0	0
	G-66	40201999	0.06	0	0	0	0	0
	G-66	40201999	0.6	0	0	0	0	0
	G-66	40201999	0.11	0	0	0	0	0
	G-66	40201999	0.13	0	0	0	0	0
	G-66	40201999	0.33	0	0	0	0	0
	G-66	40201901	154.3	0	0	16.6	14.78	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-67	30703098	0	0	0	0.01	0.007	0
	Plant Total		156.48	10.49	2.84	23.76	21.014	0
THOMASVILLE VENEER COMPANY – 3705700164								
	G-1	10300902	0.5	0.5	0	1.5	1.5	0
	Plant Total		0.5	0.5	0	1.5	1.5	0
COMMERCIAL CARVING COMPANY FINISHING PLA – 3705700168								
	G-13	40201901	14.1	0	0	0	0	0
	Plant Total		14.1	0	0	0	0	0
LEXINGTON FURNITURE INC., PLANT 5 – 3705700179								
	G-131	40201901	0.006	0	0	0	0	0
	G-132	40201901	0.78	0	0	0	0	0
	G-134	30703098	0	0	0	0.02	0.007	0
	G-137	40201901	36.75	0	0	0.48	0.48	0
	G-138	40201901	23.1	0	0	2.6	2.6	0.001
	G-5	10200906	0.16	6.08	0.31	1.23	0.81	0
	G-85	10200906	0.06	2.44	0.12	1.5	0.94	0
	G-86	10200905	0.21	8.23	0.42	2.07	1.34	0
	G-87	10200905	0.14	5.51	0.28	1.08	0.72	0
	G-88	10200404	0.04	2.02	12.11	0.72	0.47	0
	Plant Total		61.246	24.28	13.24	9.7	7.367	0.001
CUNNINGHAM BRICK COMPANY INC – 3705700222								
	G-19	30500301	0.002	0.03	0	0.33	0.33	0
	G-22	30500311	1.06	15.57	29.81	38.71	38.71	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-31	30500350	6.35	0	0	4.89	4.89	0
	G-39	30500302	0	0	0	0.13	0.13	0
	G-40	30500306	0.26	3.24	0.21	0.49	0.49	0
	Plant Total		7.672	18.84	30.02	44.55	44.55	0
LEGGETT & PLATT, INCORPORATED - METAL BE – 3705700255								
	G-3	39000699	0.001	0.02	0	0	0	0
	G-4	39000699	0.002	0.04	0	0.001	0.001	0
	G-5	39000699	0	0.06	0	0.001	0.001	0
	G-6	40202003	0.11	0	0	0	0	0
	G-7	40202001	1.57	0	0	0	0	0
	Plant Total		1.683	0.12	0	0.002	0.002	0
KIMBERLY CLARK CORPORATION – 3705700257								
	G-1	33000199	12.57	0.75	0	1.44	1.07	0
	G-11	39000699	0.01	0.12	0.001	0.01	0.01	0
	G-12	39000603	0.01	0.24	0.001	0.02	0.02	0
	G-13	33000199	2.22	0	0	0.25	0.146	0
	G-16	39000699	0.01	0.1	0	0.01	0.01	0
	G-17	39000699	0	0.03	0	0	0	0
	G-18	39000699	0.01	0.1	0.001	0.01	0.01	0
	G-19	39000699	0	0.02	0	0	0	0
	G-20	39000699	0.09	0.14	0.01	0.07	0.07	0
	G-21	10200602	0.31	4.04	0.03	0.43	0.43	0
	G-3	39000699	0.02	0.4	0	0.03	0.03	0
	G-4	39000699	0.02	0.38	0	0.03	0.03	0
	G-5	33000199	10.82	0	0	1.28	0.745	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-7	39000699	0.02	0.34	0.002	0.03	0.03	0
	G-8	39000699	0.08	1.44	0.001	0.11	0.11	0
	G-9	33000199	5.58	0	0	0.66	0.384	0
	Plant Total		31.77	8.1	0.046	4.38	3.095	0
JELD-WEN, INC. D/B/A JELD-WEN – 3705700258								
	G-1	30703099	0	0	0	1.1	0.806	0
	G-10	40100398	5.4	0	0	0	0	0
	G-11	30703002	0	0	0	1.4	0.896	0
	G-12	40200701	1.9	0	0	0	0	0
	G-13	40200110	1.8	0	0	0.5	0.445	0
	G-15	40200410	2.2	0	0	1.25	1.11	0
	G-2	30703001	0	0	0	0.01	0.007	0
	G-5	40200712	2.9	0	0	0	0	0
	G-6	30703099	0	0	0	1.4	1.03	0
	G-7	49090013	28.12	0	0	0	0	0
	G-8	30703097	7.4	0	0	0.1	0.064	0
	Plant Total		49.72	0	0	5.76	4.358	0
KURZ TRANSFER PRODUCTS LP – 3705700268								
	G-23	49000207	0.01	0	0	0	0	0
	G-24	10300501	0.01	0.5	1.06	0.03	0.02	0
	G-25	40500511	11.44	0	0	0	0	0
	G-26	40799999	0.22	0	0	0	0	0
	Plant Total		11.68	0.5	1.06	0.03	0.02	0
STERLING & ADAMS BENTWOOD, INC. – 3705700277								

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-1	30703099	0	0	0	0.03	0.03	0
	Plant Total		0	0	0	0.03	0.03	0
CENTRAL LUMBER COMPANY, INC – 3705700291								
	G-2	30700820	0	0	0	0.864	0.537	0
	G-3	30700804	0	0	0	0.09	0.05	0
	G-4	10200904	0.04	0.64	0.07	0.9	0.78	0
	G-5	30700701	1.66	0	0	0	0	0
	Plant Total		1.7	0.64	0.07	1.854	1.367	0
TRANSCONTINENTAL GAS PIPELINE CORP – 3705700300								
	G-20	20200202	0.2	4.2	0.001	0.01	0.01	0
	G-27	20200202	0.9	275.7	0.06	0.47	0.47	0
	G-28	20200202	0.9	268.3	0.06	0.46	0.46	0
	G-29	20200202	1.3	409.2	0.08	0.7	0.7	0
	G-30	20200202	19.7	574.2	0.1	0.85	0.85	0
	G-31	20200202	13.7	379	0.12	1	1	0
	G-32	20200202	12.6	348.8	0.11	0.92	0.92	0
	G-33	20200202	0.01	2.7	0.001	0.004	0.004	0
	G-34	10300603	0.005	0.21	0.001	0.02	0.02	0
	GR46	31299999	3.3	0	0	0	0	0
	Plant Total		52.615	2262.31	0.533	4.434	4.434	0
LKF INC – 3705700308								
	G-1	40188805	0	0	0	0.86	0.621	0
	G-10	49090013	0	0.15	0	0.01	0.01	0
	Plant Total		0	0.15	0	0.87	0.631	0

Table 7. Davidson County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
CREATIVE METAL AND WOOD, INC. – 3705700329								
	G-4	40202001	0.55	0	0	0	0	0
	Plant Total		0.55	0	0	0	0	0
CAROLINA DRAWERS INC - 3705700330								
	G-1	30703098	0	0	0	0.26	0.166	0
	GR2	40202106	0.09	0	0	0	0	0
	GR3	40202106	0.001	0	0	0	0	0
	GR4	40202199	0.32	0	0	0	0	0
	Plant Total		0.411	0	0	0.26	0.166	0
DAVIDSON COUNTY TOTAL			**2791.3**	**3240.7**	**408.0**	**457.5**	**391.7**	**6.5**

Emissions reported as tons/year

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
GORIA ENTERPRISES - BURIAL VAULT PLANT - 3708100006								
	G-4	39999995	1.5	0	0	0	0	0
	Plant Total		1.5	0	0	0	0	0
CONCEPT PLASTICS INC – 3708100024								
	GR14	30101837	6.8	0	0	0.2	0.102	0
	GR15	40200101	14	0	0	0.601	0.535	0.006
	Plant Total		20.8	0	0	0.801	0.637	0.006
TIMCO – 3708100042								
	G-5	39000699	0.004	0	0	0	0	

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-7	40202406	12.09	0	0	0	0	
	Plant Total		12.094	0	0	0	0	
BROOKS LUMBER COMPANY – 3708100049								
	G-1	30703001	0	0	0	0.27	0.173	0
	G-2	49099998	0.01	0	0	0	0	0
	Plant Total		0.01	0	0	0.27	0.173	0
SHAMROCK CORPORATION - GATEWOOD AVE – 3708100065								
	G-8	39999992	0	0	0	1.14	0.823	0
	Plant Total		0	0	0	1.14	0.823	0
AMETEK, INC. - ROTRON TECHNICAL PRODUCTS – 3708100095								
	G-1	40202542	0.34	0	0	0	0	0
	Plant Total		0.34	0	0	0	0	0
SHIONOGI QUALICAPS INC – 3708100099								
	G-3	40288822	1.53	0	0	0	0	0
	GR1	40100251	0.29	0	0	0	0	0
	GR2	10200602	0.01	0.18	0.001	0.01	0.01	0
	GR4	10200602	0.12	2.34	0.01	0.17	0.17	0
	Plant Total		1.95	2.52	0.011	0.18	0.18	0
GLASS UNLIMITED OF HIGH POINT, INC. – 3708100109								
	G-22	40299996	1.5	0	0	0	0	0
	Plant Total		1.5	0	0	0	0	0
APEX OIL COMPANY – 3708100121								

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-1	40400152	18.83	0	0	0	0	0
	G-14	40400172	1.36	0	0	0	0	0
	G-15	40400172	1.15	0	0	0	0	0
	G-16	40400179	0.01	0	0	0	0	0
	G-17	40400172	1.61	0	0	0	0	0
	G-18	40400172	0.96	0	0	0	0	0
	G-19	40400172	1.63	0	0	0	0	0
	G-20	40400172	0.55	0	0	0	0	0
	G-21	40400179	0.01	0	0	0	0	0
	G-22	40400199	0.4	0	0	0	0	0
	G-23	40400199	0.14	0	0	0	0	0
	G-24	40400199	0.29	0	0	0	0	0
	G-25	40400199	0.18	0	0	0	0	0
	Plant Total		27.12	0	0	0	0	0
MARTIN MARIETTA MATERIALS, INC. – JAMEST – 3708100127								
	G-1	30504030	0	0	0	2.87	1.23	0
	GR1	30588801	0	0	0	14.46	6.73	0
	Plant Total		0	0	0	17.33	7.96	0
MARTIN MARIETTA MATERIALS, INC. – POMONA – 3708100128								
	G-1	30502001	0	0	0	3.12	0.403	0
	Plant Total		0	0	0	3.12	0.403	0
THE MOSES H CONE MEMORIAL HOSPITAL – 3708100132								
	G-22	20300101	0	0.06	0	0	0	0
	G-23	20300101	0.01	0.23	0.04	0.004	0.003	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-24	20300101	0.01	0.23	0.04	0.004	0.003	0
	G-25	20300101	0.01	0.31	0.05	0.004	0.003	0
	G-26	20300101	0.01	0.31	0.05	0.004	0.003	0
	G-28	20300101	0.01	0.25	0.04	0.004	0.003	0
	G-29	20300101	0.01	0.25	0.04	0.004	0.003	0
	G-33	10300502	0	0.04	0.12	0	0	0
	G-33	10300602	0.4	7.16	0.04	0.4	0.14	0
	G-34	31299999	0.18	0	0	0	0	0
	Plant Total		0.64	8.84	0.42	0.424	0.158	0
ENGINEERED POLYMER SOLUTIONS INC D.B.A. – 3708100143								
	G-346	40714698	0.07	0	0	0	0	0
	G-347	40188898	4.96	0	0	0	0	0
	G-348	49099998	5.5	0	0	0	0	0
	G-37	39999995	0	0	0	0.08	0.08	0
	G-51	10200602	0.76	13.8	0.08	1.05	1.05	0
	G-55	39999995	0	0	0	0.08	0.08	0
	Plant Total		11.29	13.8	0.08	1.21	1.21	0
LORILLARD TOBACCO COMPANY – 3708100198								
	G-10	30203399	0.35	0	0	0.34	0.25	0.002
	G-11	40700897	0.33	0	0	0	0	0
	G-12	40700897	0.33	0	0	0	0	0
	G-13	40700897	0.45	0	0	0	0	0
	G-17	10200602	0.12	2.12	0.02	0.16	0.16	0
	G-17	10200401	0.02	3.03	18.17	1.08	0.7	0
	G-18	10200602	0.12	2.12	0.02	0.16	0.16	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-18	10200401	0.02	3.03	18.17	1.08	0.7	0
	G-19	30203399	0	0	0	1.7	1.27	0
	G-20	30203399	267.7	0	0	0.9	0.7	0.239
	G-21	30203399	0	0	0	2	1.5	0
	G-23	10200602	0.23	4.24	0	0.32	0.32	0
	G-23	10200401	0.03	6.06	36.35	2.15	1.4	0
	G-24	30203399	3.77	0	0	1.97	0.5	1.05
	G-25	20200401	0.04	0.56	0.03	0.03	0.03	0
	G-26	20100202	0.13	0.06	0.004	0.004	0.004	0
	G-9	30203399	0.23	4.93	0	0.91	0.91	0.953
	Plant Total		273.87	26.15	72.764	12.804	8.604	2.244
HANSON BRICK - PLEASANT GARDEN PLANT #1 – 3708100206								
	G-30	30500311	0.9	13.12	20.32	32.62	0.54	0
	G-38	30500399	0	0	0	0.04	0.024	0
	G-39	30500301	0	0.01	0	0.71	0.404	0
	G-69	30500302	0	0	0	0.1	0.019	0
	Plant Total		0.9	13.13	20.32	33.47	0.987	0
PLANTATION PIPE LINE COMPANY – 3708100268								
	G-1	39090001	4.3	0	0	0	0	0
	G-10	40400261	2.7	0	0	0	0	0
	G-11	40400261	3.08	0	0	0	0	0
	G-12	40400261	1.54	0	0	0	0	0
	G-13	40400261	3.39	0	0	0	0	0
	G-14	40400261	3.92	0	0	0	0	0
	G-15	40400261	4.83	0	0	0	0	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-16	40400261	4.94	0	0	0	0	0
	G-17	40400261	4.78	0	0	0	0	0
	G-18	40400230	0.13	0	0	0	0	0
	G-19	40400230	0.19	0	0	0	0	0
	G-2	40400202	1.87	0	0	0	0	0
	G-20	40400206	3.04	0	0	0	0	0
	G-21	40400270	0.04	0	0	0	0	0
	G-22	40400206	0.49	0	0	0	0	0
	G-23	39091003	0.01	0	0	0	0	0
	G-24	40400261	0.92	0	0	0	0	0
	G-25	40400202	0.003	0	0	0	0	0
	G-26	40400201	0.62	0	0	0	0	0
	G-27	40400203	0.002	0	0	0	0	0
	G-28	40400202	0.79	0	0	0	0	0
	G-29	40400201	0.002	0	0	0	0	0
	G-3	40400202	0.55	0	0	0	0	0
	G-30	40400201	0.54	0	0	0	0	0
	G-31	39090001	5.77	0	0	0	0	0
	G-32	40400261	1.13	0	0	0	0	0
	G-33	40400262	0.96	0	0	0	0	0
	G-34	40400262	3.46	0	0	0	0	0
	G-35	40400262	4.23	0	0	0	0	0
	G-36	40400261	2.45	0	0	0	0	0
	G-37	40400261	3.12	0	0	0	0	0
	G-38	40400261	2.91	0	0	0	0	0
	G-4	40400202	0.38	0	0	0	0	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-5	39090001	0.38	0	0	0	0	0
	G-6	39090001	0.38	0	0	0	0	0
	G-8	40400251	1.92	0	0	0	0	0
	G-9	40400261	1.92	0	0	0	0	0
	Plant Total		71.687	0	0	0	0	0
COLONIAL PIPELINE COMPANY – 3708100272								
	G-1	31299999	0.008	0.001	0.001	0.03	0.03	0
	G-131	40400262	164.31	0	0	0	0	0
	G-132	20100102	0	0.002	0	0	0	0
	G-2	39092051	0.02	0	0	0	0	0
	G-26	31299999	0.01	0	0	0	0	0
	G-28	31299999	0.14	0	0	0	0	0
	G-30	31299999	0.25	0	0	0	0	0
	G-31	31299999	4.32	0	0	0	0	0
	G-32	31299999	0.08	0	0	0	0	0
	G-37	31299999	0.33	2.99	0.2	0.21	0.21	0
	G-4	40714697	0.004	0	0	0	0	0
	G-6	31299999	33.88	0	0	0	0	0
	G-7	31299999	0.51	0	0	0	0	0
	G-94	40400260	0.98	0	0	0	0	0
	G-95	40400230	0.64	0	0	0	0	0
	G-96	40400249	14.41	0	0	0	0	0
	G-97	39090004	36.77	0	0	0	0	0
	GR1	40400251	9.16	0	0	0	0	0
	Plant Total		265.822	2.993	0.201	0.24	0.24	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
THE SHERWIN - WILLIAMS CO, CONSUMER GROU – 3708100404								
	G-184	10200603	0.05	0.88	0.01	0.11	0.11	0
	G-275	40714698	0.79	0	0	0	0	0
	G-393	30101401	85.8	0	0	0.04	0.01	0
	G-394	30101498	0.24	0	0	0	0	0
	Plant Total		86.88	0.88	0.01	0.15	0.12	0
ENGINEERED POLYMER SOLUTIONS, INC. DBA V – 3708100421								
	G-413	40200110	16.76	0	0	0.19	0.19	0
	G-477	40714698	0.99	0	0	0	0	0
	G-478	10200603	0.02	0.36	0	0	0	0
	G-483	10200602	0	0.16	0	0	0	0
	Plant Total		17.77	0.52	0	0.19	0.19	0
TRANSMONTAIGNE PRODUCT SERVICES, INC. – 3708100434								
	G-1	40400151	33.08	3.78	0	0	0	0
	G-1	40400151	0.22	0	0	0	0	0
	G-1	40400152	12.27	0	0	0	0	0
	G-10	40714697	0.28	0	0	0	0	0
	G-11	40400172	2.53	0	0	0	0	0
	G-12	40400172	2.39	0	0	0	0	0
	G-2	40714697	0.28	0	0	0	0	0
	G-3	40714697	0.61	0	0	0	0	0
	G-4	40714697	0.42	0	0	0	0	0
	G-6	40400172	2.48	0	0	0	0	0
	G-7	40400172	2.82	0	0	0	0	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-9	40400172	3.85	0	0	0	0	0
	Plant Total		61.23	3.78	0	0	0	0
DREXEL HERITAGE FURNISHINGS INC – 3708100518								
	G-11	10200602	0	0.36	0	0.02	0.02	0
	G-12	40201901	10.5	0	0	0.38	0.38	0
	G-9	30702001	0	0	0	0.03	0.03	0
	Plant Total		10.5	0.36	0	0.43	0.43	0
CUSTOM FINISHERS INC – 3708100570								
	G-1	40200898	35.73	0.17	0	0.01	0.01	0
	G-4	40201901	0.73	0	0	0	0	0
	Plant Total		36.46	0.17	0	0.01	0.01	0
CLYDE PEARSON COMPANY, A DIVISION OF THO – 3708100609								
	G-16	40201901	12.82	0	0	0	0	0
	G-18	30703002	0	0	0	0.015	0.01	0
	Plant Total		12.82	0	0	0.015	0.01	0
SHERRILL FURNITURE COMPANY - HICKORY WHI – 3708100703								
	G-3	40202132	1.82	0	0	0.02	0.02	0
	G-3	40202132	1.82	0	0	0.02	0.02	0
	Plant Total		3.64	0	0	0.04	0.04	0
MARSHALLS FINISHING – 3708100705								
	G-5	40201901	15.8	0	0	0.08	0.08	0
	Plant Total		15.8	0	0	0.08	0.08	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
RESCO PRODUCTS INC – 3708100748								
	G-13	30500599	0	0	0	1.04	0.774	0
	G-14	30500599	0	0	0	0.02	0.013	0
	G-29	30500351	0	0	0	0.009	0.006	0
	G-29	30500351	0.003	0.04	0	0.004	0.004	0
	G-32	30500599	0	0	0	1.3	0.968	0
	G-33	30500599	0	0	0	0.61	0.454	0
	G-48	30500501	0	0	0	4.7	2.84	0
	G-48	30500501	0.02	0.39	0.002	0.03	0.03	0
	G-56	30500504	0	0	0	0	0	0
	G-56	30500504	0.2	0.66	0	0.351	0.235	0
	G-56	30500504	0.02	0.43	0.003	0.03	0.03	0
	G-58	30500502	0	0	0	1.23	0.916	0
	G-59	30500502	0	0	0	0.13	0.097	0
	G-60	30500502	0	0	0	0.13	0.097	0
	G-63	30500502	0	0	0	0.01	0.007	0
	G-64	30500502	0	0	0	0.18	0.134	0
	G-65	30500502	0	0	0	0.2	0.149	0
	G-66	30500502	0	0	0	0.08	0.06	0
	G-67	30500502	0	0	0	0.18	0.134	0
	G-68	30500507	0.07	1.1	16	2.8	2.24	0
	G-68	30500507	0.004	0.33	1.16	0.01	0.004	0
	G-69	30500502	0	0	0	0.34	0.253	0
	G-70	30500502	0	0	0	0.35	0.261	0
	G-71	30500599	0	0	0	0.81	0.603	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	Plant Total		0.317	2.95	17.165	14.544	10.309	0
HICKORY PRINTING GROUP, INC. – 3708100757								
	G-8	40500411	23.44	0	0	0	0	0.008
	Plant Total		23.44	0	0	0	0	0.008
LANE FURNITURE INDUSTRIES INC. ROYAL DEV – 3708100764								
	G-4	10200601	0	0.006	0	0	0	0
	G-7	40202501	25.5	0	0	0	0	0
	Plant Total		25.5	0.006	0	0	0	0
CARPENTER CO – 3708100772								
	G-10	39999994	15.7	0	0	0	0	0
	G-11	39999994	10.7	0	0	0	0	0
	G-5	39999995	2.88	0	0	0	0	0
	G-6	10200603	0.02	0.39	0	0.02	0.01	0
	G-7	10200603	0	0.01	0	0	0	0
	G-8	39999994	17.13	0	0	0	0	0
	G-9	39999994	10.7	0	0	0	0	0
	Plant Total		57.13	0.4	0	0.02	0.01	0
TREEFORMS INC – 3708100789								
	G-5	40201901	12.9	0	0	0	0	0
	Plant Total		12.9	0	0	0	0	0
ECOFLO INC – 370810795								
	G-18	40714698	639.71	0	0	0	0	0
	G-8	40188898	0.1	0	0	0	0	0.061

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-9	40188898	0.2	0	0	0	0	0.022
	Plant Total		640.01	0	0	0	0	0.083
MICKEY TRUCK BODIES INC – 3708100804								
	G-1	40201631	0.01	0.06	0.01	2.4	2.14	0
	G-10	40201631	3.9	0	0	3.6	3.2	0
	G-11	39999993	0	0	0	2.65	1.91	0
	G-12	39999993	2.45	0	0	0	0	0
	G-13	39999993	0	0	0	0.36	0.26	0
	G-14	39999993	0.19	0	0	0	0	0
	G-15	40201631	1.62	0	0	0.167	0.154	0
	G-16	40201631	1.62	0	0	0.167	0.154	0
	G-17	40201631	3.94	0	0	0.167	0.154	0
	G-25	40201631	3.85	0	0	3.6	3.2	0
	G-26	40201631	0.8	0	0	0.199	0.183	0
	G-3	40201627	39.8	0	0	0.5	0.445	0
	G-5	40201631	25.59	0	0	3.89	3.46	0
	G-7	39999993	0.01	0.06	0.01	3.5	2.53	0
	G-9	39999993	4.13	0	0	0	0	0
	Plant Total		87.91	0.12	0.02	21.2	17.79	0
THOMAS BUILT BUSES - FAIRFIELD ROAD – 3708100810								
	G-1	40201001	0.01	0.11	0	0.01	0.01	0
	G-19	40200101	80.68	0	0	0.05	0.05	0
	G-2	40288805	2.25	0	0	0	0	0
	G-23	39090003	0.3	0	0	0	0	0
	G-6	10200602	0.05	0.88	0.01	0.07	0.07	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-7	10300603	0.01	0.26	0	0.02	0.02	0
	GR1	30905000	0	0	0	0.04	0.04	0
	Plant Total		83.3	1.25	0.01	0.19	0.19	0
METAL CREATIONS INC – 3708100811								
	G-1	39999993	0	0	0	0.02	0.02	0
	G-3	39000699	0.01	0.08	0	0.01	0.01	0
	G-7	10200603	0.02	0.4	0	0.03	0.03	0
	G-8	40202001	3.26	0	0	0.006	0.006	0
	Plant Total		3.29	0.48	0	0.066	0.066	0
THOMAS BUILT BUSES - COURTESY ROAD – 3708100822								
	G-12	39999994	0	0	0	1.83	1.83	0
	G-15	40201001	0.01	0.05	0	0.24	0.24	0
	G-2	40299997	0.02	0.45	0	0.03	0.03	0
	G-20	30700710	0	0	0	0.01	0.005	0
	G-21	40200701	19.8	0	0	0	0	0
	G-22	40299997	0.05	0.85	0.01	0.06	0.06	0
	G-23	10200602	0.06	1.09	0.01	0.08	0.08	0
	G-24	10200602	0.01	0.12	0	0.01	0.01	0
	G-28	10200602	0.07	1.36	0.01	0.1	0.1	0
	G-29	40200101	94.6	0	0	0.07	0.07	0
	G-30	40299996	27.1	0	0	0	0	0
	G-32	39090003	0.4	0	0	0	0	0
	Plant Total		142.12	3.92	0.03	2.43	2.425	0
GREENSBORO FLEXIBLE PACKAGING LLC DBA NO – 3708100823								

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-10	49000207	1.36	0	0	0	0	0
	G-11	40500319	30.3	0	0	0	0	0
	G-12	40500311	240.42	0.41	0	0.03	0.03	0
	G-13	40100501	0.02	0	0	0	0	0
	Plant Total		272.1	0.41	0	0.03	0.03	0
GUILFORD COLLEGE - MAIN CAMPUS – 3708100824								
	G-3	10200602	0.05	1	0.006	0.07	0.07	0
	GR1	10200206	0.007	0.04	0.16	0.03	0.01	0
	GR18	10500206	0.05	1.1	0.006	0.08	0.08	0
	Plant Total		0.107	2.14	0.172	0.18	0.16	0
KONICA MINOLTA MANUFACTURING USA INC – 3708100835								
	G-13	49000201	0.42	0	0	0	0	0
	G-15	40201301	4.75	0	0	0	0	0
	G-196	10200602	0.48	8.72	0.05	0.66	0.66	0
	G-198	49099999	0.59	0	0	0	0	0
	G-199	49099999	0.59	0	0	0	0	0
	G-202	40201301	26.7	0	0	0	0	0
	G-214	40201304	0.16	0	0	0	0	0
	G-215	40201304	0.46	0	0	0	0	0
	Plant Total		34.15	8.72	0.05	0.66	0.66	0
UNITED METAL FINISHING INC – 3708100842								
	G-16	10200603	0.02	0.3	0	0.02	0.02	0
	G-17	10200603	0	0.06	0	0	0	0
	G-21	30900299	0	0	0	0.006	0.003	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	Plant Total		0.02	0.36	0	0.026	0.023	0
MARSH FURNITURE COMPANY – 3708100854								
	G-1	40201999	5.26	0	0	0	0	0
	G-132	40201901	325.1	0	0	1.96	1.96	0
	G-133	40201901	0.89	0	0	0.001	0.001	0
	G-136	30702098	0	0	0	5.7	4.22	0
	G-137	49099998	13.8	0	0	0	0	0
	G-138	39000699	0.002	0.03	0	0.003	0.002	0.001
	G-4	10200903	0.45	17.04	0.87	9.98	6.16	0
	G-59	40201901	42.9	0	0	0.23	0.23	0
	G-62	40201901	8.99	0	0	0.11	0.11	0
	Plant Total		397.392	17.07	0.87	17.984	12.683	0.001
CONE MILLS CORP - WHITE OAK PLANT – 3708100863								
	G-10	33000101	0	0	0	0.39	0.04	0
	G-100	33000199	0	0	0	1.74	0.17	0
	G-11	33000101	0	0	0	0.02	0.002	0
	G-17	33000101	0	0	0	0.2	0.02	0
	G-19	33000199	0	0	0	0.9	0.18	0
	G-20	33000199	0	0	0	0.058	0.039	0
	G-21	33000105	0	0	0	0.17	0.02	0
	G-24	40206035	3.3	0.1	0	0.009	0.007	0
	G-25	33000105	0	0	0	0.43	0.04	0
	G-26	10200601	0.93	32.22	0.1	1.29	1.29	0
	G-26	10200501	0	0.12	0.69	0.01	0.007	0
	G-28	10200601	0.04	1.34	0	0.05	0.05	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-28	10200401	0.02	1.13	7.9	0.39	0.28	0
	G-29	10200401	0.14	8.77	61.51	3	2.18	0
	G-29	10200601	0	0.07	0	0	0	0
	G-43	33000499	0.03	0.46	0	0.04	0.04	0
	G-44	30700804	0	0	0	0.003	0	0
	G-48	40206035	1.88	0	0	0	0	0
	G-49	40206035	0.59	0	0	0	0	0
	G-50	40206035	0.01	0	0	0	0	0
	G-51	40206035	4.63	0	0	0	0	0
	G-52	40206035	2.19	0	0	0	0	0
	G-60	40299999	0.3	0	0	0	0	0
	G-89	40204430	10.99	0.3	0	0.02	0.02	0
	G-98	33000198	0.98	0	0	0	0	0
	Plant Total		26.03	44.51	70.2	8.72	4.385	0
PACTIV CORPORATION – 3708100866								
	G-30	39999994	212.47	0	0	0.05	0.05	0
	G-31	39999994	0	0	0	1.06	1.06	0
	G-32	39999994	0	0	0	0.005	0.005	0
	Plant Total		212.47	0	0	1.115	1.115	0
THE SHERWIN - WILLIAMS COMPANY - STAGECO – 3708100868								
	G-135	49099998	72.5	0.07	0	0.47	0.47	0
	Plant Total		72.5	0.07	0	0.47	0.47	0
SWAIM, INC. – 3708100873								
	G-3	30703002	0	0	0	3.35	2.48	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-4	40202132	6	0	0	0.022	0.019	0
	Plant Total		6	0	0	3.372	2.499	0
MILLER DESK INC – 3708100876								
	G-13	30702002	0	0	0	0.28	0.21	0
	G-39	10200602	0.01	0.27	0	0.02	0.02	0
	G-40	40201901	69.7	0	0	0.73	0.73	0
	Plant Total		69.71	0.27	0	1.03	0.96	0
HOOKER FURNITURE CORPORATION – 3708100910								
	G-1	40201901	0.12	0	0	0	0	0
	G-26	10200906	0.01	0.56	0.02	0.34	0.21	0
	G-27	10200906	0.13	5.1	0.26	3.03	1.93	0
	G-28	30703098	0	0	0	1.45	1.45	0
	G-29	40201901	212.2	0	0	17.02	15.79	0
	Plant Total		212.46	5.66	0.28	21.84	19.38	0
CITY OF GREENSBORO - THOMAS Z. OSBORNE P – 3708100923								
	G-42	50100732	0.007	0	0	0	0	0
	G-62	31299999	0.07	0	0	0	0	0
	G-66	50100760	0.01	0	0	0	0	0
	G-68	50100791	0.006	0	0	0	0	0
	G-69	50100792	0.001	0	0	0	0	0
	G-70	20300101	0.001	0.002	0.001	0.001	0.001	0
	G-70	20300101	0.09	3.66	0.58	0.11	0.103	0
	G-70	20300101	0.09	3.7	0.58	0.12	0.113	0
	G-72	10200603	0.02	0.5	0.003	0.03	0.03	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-73	50100516	5.5	11.7	5.5	0.39	0.238	0
	Plant Total		5.795	19.562	6.664	0.651	0.485	0
BRAYTON INTERNATIONAL INC – 3708100925								
	G-13	49099999	3.61	0	0	0	0	0
	G-27	40201999	0.001	0	0	0	0	0
	G-28	40201901	29.22	0	0	0	0	0
	G-29	39000699	0	0	0	0	0	0.001
	Plant Total		32.831	0	0	0	0	0.001
UNITEX CHEMICAL CORPORATION – 3708100939								
	G-10	49099998	0.17	0	0	0	0	0
	G-11	49099998	0.8	0	0	0	0	0
	G-12	49099998	3.7	0	0	0	0	0
	G-15	49099998	0.19	0	0	0	0	0
	G-2	10200603	0.13	0	0	0	0	0
	G-4	49099998	0.85	0	0	0	0	0
	G-45	30184001	0.19	0	0	0	0	0
	G-5	49099998	2.4	0	0	0	0	0
	G-6	49099998	1.41	0	0	0	0	0
	G-7	49099998	3	0	0	0	0	0
	G-8	49099998	2.8	0	0	0	0	0
	G-9	49099998	4.6	0	0	0	0	0
	G-94	10200602	0.14	2.6	0.01	0.2	0.2	0
	G-96	49099998	0.47	0	0	0	0	0
	G-97	40714698	0.18	0	0	0	0	0
	G-98	40188898	0.13	0	0	0	0	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-99	31299999	0.009	0	0	0	0	0
	Plant Total		21.169	2.6	0.01	0.2	0.2	0
FIBER DYNAMICS, INC – 3708100946								
	G-4	33000199	1.42	0	0	0	0	4.91
	G-7	10200602	0.23	4.05	0.02	0.23	0.08	0
	G-8	10200602	0	0.04	0	0	0	0
	Plant Total		1.65	4.09	0.02	0.23	0.08	4.91
SHAMROCK CORP - BRUCE ST – 3708100950								
	G-1	40588805	0.59	0	0	0	0	0
	G-2	49090013	0	0.005	0	0	0	0.337
	G-8	40500511	26	0.44	0.003	0.03	0.03	2.74
	Plant Total		26.59	0.445	0.003	0.03	0.03	3.077
SHAMROCK CORPORATION TIPPING DIVISION – 3708100951								
	G-15	40500511	309.47	0.19	0	0.01	0.01	0
	Plant Total		309.47	0.19	0	0.01	0.01	0
MORFLEX CHEMICAL COMPANY INC – 3708100956								
	G-204	10200401	0.07	13.69	82.06	4.86	3.41	0
	G-204	10200602	0.14	6.8	0.04	0.13	0.13	0
	G-205	40714697	15.76	0	0	0	0	0
	G-206	30103399	3.57	0	0	0	0	0
	G-207	30113299	0	0	0	0.001	0.001	0
	G-34	30182001	0.01	0	0	0	0	0
	G-8	10201302	0.01	1.38	8.3	0.49	0.477	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-8	10200602	0.04	0.79	0	0.02	0.02	0
	Plant Total		19.6	22.66	90.4	5.501	4.038	0
PUROLATOR FACET, INC. – 3708100966								
	G-13	49099999	0.001	0	0	0	0	0
	G-16	31299999	0.001	0	0	0	0	0
	G-2	40202501	9.7	0	0	0.07	0.066	0
	G-30	31299999	7.69	0	0	0	0	0
	G-31	49099999	7.69	0	0	0	0	0
	G-39	49099999	0.22	0	0	0	0	0
	Plant Total		25.302	0	0	0.07	0.066	0
PATRICIAN FURNITURE, INC. D/B/A PATRICIA – 3708100968								
	G-6	39000699	0	0.09	0	0.01	0.01	0
	G-8	49099999	15.51	0	0	0.03	0.03	0
	Plant Total		15.51	0.09	0	0.04	0.04	0
FLOWERS BAKING COMPANY OF JAMESTOWN, INC – 3708100996								
	G-1	10200603	0.01	0.24	0.001	0.01	0.01	0
	G-2	10200603	0.01	0.24	0.001	0.01	0.01	0
	G-3	30203202	23.15	0	0	0	0	0
	G-3	30290003	0.06	1.2	0.007	0.09	0.09	0
	G-4	30290003	0.01	0.3	0.002	0.02	0.02	0
	G-4	30203202	6.82	0	0	0	0	0
	G-5	30290003	0.04	0.81	0.005	0.06	0.06	0
	G-5	30203202	16.55	0	0	0	0	0
	G-6	30203204	0	0	0	0.12	0	0

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-7	30203204	0	0	0	0.12	0	0
	G-8	30203204	0	0	0	0.01	0	0
	GR1	31299999	1.03	0	0	0	0	0
	Plant Total		47.68	2.79	0.016	0.44	0.19	0
SNYDER PAPER CORPORATION - SYNDER CUSHIO – 3708101006								
	G-17	10300603	0.004	0.08	0	0.005	0.002	0
	G-18	40299998	3.92	0	0	0.002	0.002	0
	G-19	40299998	2.18	0	0	0.001	0.001	0
	G-20	40200902	0.11	0	0	0	0	0
	Plant Total		6.214	0.08	0	0.008	0.005	0
RF MICRO DEVICES, INC. - FAB 1, FAB 3 AN – 3708101022								
	G-46	31306500	84.1	0	0	0	0	0.244
	G-47	10200502	0.009	0.32	1.16	0.02	0.014	0
	G-47	10200602	0.06	0.58	0.007	0.08	0.08	0
	G-48	20200102	0.009	0.31	1.1	0.01	0.009	0
	G-49	10200603	0.08	0.75	0.009	0.11	0.11	0
	G-57	40714697	0.01	0	0	0	0	0
	Plant Total		84.268	1.96	2.276	0.22	0.213	0.244
CITY OF GREENSBORO - WHITE STREET LANDFI – 3708101086								
	G-7	39090012	0.07	0	0	0	0	0
	G-9	50300601	3.36	0.72	0.19	0.3	0.3	0
	Plant Total		3.43	0.72	0.19	0.3	0.3	0
GREENSBORO NEWS & RECORD, INC – 3708101097								

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-1	40500432	0.19	0	0	0	0	0
	G-1	40500413	3.68	0	0	0	0	0
	G-2	10300602	0.01	0.26	0	0.02	0.01	0
	G-3	10300602	0.01	0.26	0	0.02	0.01	0
	Plant Total		3.89	0.52	0	0.04	0.02	0
HIGH POINT FIBERS, INC – 3708101098								
	G-1	33000306	0	0	0	1.34	0.23	0
	G-2	39000699	0	0.22	0.001	0	0	0
	G-2	39000699	1.21	0	0	0.27	0.27	0
	G-3	40700401	0.005	0	0	0	0	0
	Plant Total		1.215	0.22	0.001	1.61	0.5	0
PALLET EXPRESS, INC – 3708101104								
	G-1	39999994	0	0	0	44.66	32.25	0
	Plant Total		0	0	0	44.66	32.25	0
PHILCO, INC. D/B/A MAACO OF HIGH POINT – 3708101106								
	G-1	40201606	8.13	0	0	0.62	0.552	0
	Plant Total		8.13	0	0	0.62	0.552	0
SOUTH ASIA FURNITURE MANUFACTURING COMPA – 3708101113								
	G-1	30703002	0.68	0	0	0.005	0.003	0
	G-2	30703002	0.68	0	0	0.005	0.003	0
	Plant Total		1.36	0	0	0.01	0.006	0
RF MICRO DEVICES, INC. WAFER FAB. 2 – 3708101116								
	G-57	31306501	0	0	0	0	0	0.072

Table 8. Guilford County Point Sources - 2002 Annual Emissions

Plant Name	Unit ID	SCC	VOC	Nox	SO2	PM10	PM2.5	NH3
	G-58	20100102	0.05	0.58	0.005	0.07	0.066	0
	G-59	10200603	0.04	0.4	0.005	0.06	0.06	0
	Plant Total		0.09	0.98	0.01	0.13	0.126	0.072
RMC MID ATLANTIC, LLC D/B/A RMC METROMON – 3708101117								
	G-1	30501110	0	0	0	0.45	0.224	0
	G-2	10200603	0.02	0.35	0	0.02	0.01	0
	Plant Total		0.02	0.35	0	0.47	0.234	0
PREMIERE CUSHION – 3708101132								
	G-1	49099998	3.4	0	0	0	0	0
	Plant Total		3.4	0	0	0	0	0
HARPER CONSTRUCTION, INC. – 3708101153								
	G-6	30501110	0	0	0	0.57	0.199	0
	Plant Total		0	0	0	0.57	0.199	0
GUILFORD COUNTY TOTAL			**3931.8**	**218.7**	**282.2**	**221.6**	**135.0**	**10.6**

Emissions reported as tons/year

Table 9. 2002 Annual Area Emissions by SCC Classification

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
Hickory								
2102002000	Indust. Bituminous/Subbitu. Coal, All Boiler Types							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2102004000	IndustrialDistillate OilTotal: Boilers and IC Engines							
		CATAWBA	0.83	136.03	16.14	20.10	13.84	2.79
2102006000	IndustrialNatural GasTotal: Boilers and IC Engines							
		CATAWBA	0.99	149.74	0.49	6.47	6.47	3.11
2102007000	Indus. Liquified Petroleum Gas (LPG), All Boiler Types							
		CATAWBA	0.70	40.34	0.10	2.52	2.52	0.00
2103002000	Com./Institu. Bituminous/Subbitu.Coal, All Boiler Types							
		CATAWBA	0.06	13.75	33.75	11.28	4.14	0.02
2103004000	Com./Institu.Distillate Oil, Boilers and IC Engines							
		CATAWBA	0.84	39.96	0.00	5.15	2.93	0.88
2103006000	Com./Institu.Natural GasTotal: Boilers and IC Engines							
		CATAWBA	2.12	66.04	0.23	2.68	2.68	0.18
2103007000	Com./Institu.Liquified Petroleum Gas (LPG), All Combustor Types							
		CATAWBA	0.17	7.06	0.02	4.41	0.47	0.00
2103008000	Commercial/InstitutionalWoodTotal: All Boiler Types							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.14
2104002000	Residential, Bituminous/Subbitu. Coal, All Combustor Types							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2104004000	ResidentialDistillate OilTotal: All Combustor Types							
		CATAWBA	1.42	36.08	8.54	2.80	2.80	2.00
2104006000	Residential, Natural Gas, All Combustor Types							
		CATAWBA	2.74	46.98	0.29	3.79	3.79	9.99
2104007000	Residential, Liquified Petroleum Gas (LPG), All Combustor Types							
		CATAWBA	0.31	14.77	0.05	9.55	9.55	0.00
2104008001	ResidentialWoodFireplaces: General							
		CATAWBA	1420.85	34.33	5.28	456.89	388.36	23.76
2275900000	Aircraft Refueling, All Fuels, All Processes							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2294000000	Paved Roads, All Paved Roads Fugitives							
		CATAWBA	0.00	0.00	0.00	1856.62	168.84	0.00
2296000000	Unpaved Roads, All Unpaved RoadsTotal: Fugitives							
		CATAWBA	0.00	0.00	0.00	414.07	41.61	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2302002000	Commercial CharbroilingTotal							
		CATAWBA	4.91	0.00	0.00	0.00	0.00	0.00
2302050000	Food and Kindred Products, Bakery ProductsTotal							
		CATAWBA	2.55	0.00	0.00	0.00	0.00	0.00
2311010000	Construction, General Building Construction, Total							
		CATAWBA	0.00	0.00	0.00	53.75	7.20	0.00
2311020000	Construction: SIC 15 - 17Heavy ConstructionTotal							
		CATAWBA	0.00	0.00	0.00	423.38	56.74	0.00
2311030000	Construction: SIC 15 - 17Road ConstructionTotal							
		CATAWBA	0.00	0.00	0.00	305.67	40.96	0.00
2325000000	Mining and Quarrying: SIC 14All ProcessesTotal							
		CATAWBA	0.00	0.00	0.00	180.90	36.18	0.00
2399000000	Industrial Processes: NECIndustrial Processes: NECTotal							
		CATAWBA	0.00	0.00	0.00	47.95	33.23	0.00
2401001000	Surface Coating, Architectural Coatings, All Solvent Types							
		CATAWBA	235.88	0.00	0.00	0.00	0.00	2.54
2401005000	Surface Coating, Auto Refinishing, All Solvent Types							
		CATAWBA	36.77	0.00	0.00	0.00	0.00	0.00
2401008000	Surface CoatingTraffic Markings All Solvent Types							
		CATAWBA	101.94	0.00	0.00	0.00	0.00	0.00
2401015000	Surface Coating,Factory Finished Wood, All Solvent Types							
		CATAWBA	35.10	0.00	0.00	0.00	0.00	0.00
2401020000	Surface Coating, Wood Furniture, All Solvent Types							
		CATAWBA	1210.20	0.00	0.00	0.00	0.00	0.00
2401040000	Surface Coating, Metal Cans, All Solvent Types							
		CATAWBA	45.21	0.00	0.00	0.00	0.00	0.00
2401045000	Surface Coating, Metal Coils, All Solvent Types							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2401055000	Surface Coating, Machinery & Equipment, All Solvent Types							
		CATAWBA	17.82	0.00	0.00	0.00	0.00	0.00
2401060000	Surface Coating, Large Appliances, All Solvent Types							
		CATAWBA	0.46	0.00	0.00	0.00	0.00	0.00
2401065000	Surf. Coat.Electronic, Electrical, All Solvent Types							
		CATAWBA	0.43	0.00	0.00	0.00	0.00	0.00
2401070000	Surf. Coat.Motor Vehicles: SIC 371Total: All Solvent Types							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2401080000	Surf. Coat.Marine, All Solvent Types							
		CATAWBA	0.30	0.00	0.00	0.00	0.00	0.00
2401085000	Surf. Coat.Railroad, All Solvent Types							
		CATAWBA	0.82	0.00	0.00	0.00	0.00	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2401090000	Surf. Coat.Misc.Manufacturing, All Solvent Types							
		CATAWBA	43.82	0.00	0.00	0.00	0.00	0.00
2401100000	Surf. Coat.Indust. Maint.Coatings, All Solvent Types							
		CATAWBA	58.43	0.00	0.00	0.00	0.00	0.00
2401200000	Surf. Coat.Special Purpose Coatings, All Solvent Types							
		CATAWBA	58.43	0.00	0.00	0.00	0.00	0.00
2415130000	Electronic & Other Elec.Open Top Degreasing, All Solvent Types							
		CATAWBA	15.34	0.00	0.00	0.00	0.00	0.00
2415145000	Degreasing, Open Top Degreasing, All Solvent Types							
		CATAWBA	35.79	0.00	0.00	0.00	0.00	0.00
2415345000	Degreasing, Cold Cleaning, All Solvent Types							
		CATAWBA	80.35	0.00	0.00	0.00	0.00	0.00
2415360000	Degreasing, Auto Repair, Cold Cleaning, All Solvent Types							
		CATAWBA	182.62	0.00	0.00	0.00	0.00	0.00
2420020055	Dry Cleaning, Coin-operated Perchloroethylene							
		CATAWBA	282.60	0.00	0.00	0.00	0.00	0.00
2425000000	Graphic Arts, All Processes, All Solvent Types							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2460500000	Misc.Consu. & Comm. Coatings and Related, All Solvent Types							
		CATAWBA	69.39	0.00	0.00	0.00	0.00	0.00
2460800000	FIFRA Related Productsl: All Solvent Types							
		CATAWBA	130.02	0.00	0.00	0.00	0.00	0.00
2460900000	Consu.& Comm.Misc.Prod., All Solvent Types							
		CATAWBA	5.11	0.00	0.00	0.00	0.00	0.00
2461021000	Commercial, Cutback Asphalt, All Solvent Types							
		CATAWBA	1.30	0.00	0.00	0.00	0.00	0.00
2461023000	Commercial, Asphalt Roofing, All Solvent Types							
		CATAWBA	0.37	0.00	0.00	0.00	0.00	0.00
2461850000	Pesticide Application, Agricultural, All Processes							
		CATAWBA	11.05	0.00	0.00	0.00	0.00	0.00
2465100000	Personal Care Products, All Solvent Types							
		CATAWBA	169.47	0.00	0.00	0.00	0.00	0.00
2465200000	Consumer Household Products, All Solvent Types							
		CATAWBA	5.77	0.00	0.00	0.00	0.00	2.26
2465400000	Consumer Automotive Aftermarket Products, All Solvent Types							
		CATAWBA	99.34	0.00	0.00	0.00	0.00	0.00
2465600000	Consumer Adhesives and SealantsTotal: All Solvent Types							
		CATAWBA	41.63	0.00	0.00	0.00	0.00	0.00
2501060050	Gasoline Service Stations Stage 1: Total							
		CATAWBA	34.33	0.00	0.00	0.00	0.00	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2501060201	Gasoline Ser.StationsUnderground Tank: Breathing and Emptying							
		CATAWBA	50.20	0.00	0.00	0.00	0.00	0.00
2501060300	Residential and Commercial Portable Gas Cans, Total							
		CATAWBA	143.38	0.00	0.00	0.00	0.00	0.00
2505030120	TransportTruck, Gasoline							
		CATAWBA	3.77	0.00	0.00	0.00	0.00	0.00
2601010000	On-site Incineration Industrial Total							
		CATAWBA	14.37	4.20	4.20	18.48	18.48	1.99
2601020000	On-site IncinerationCommercial/Institutional, Total							
		CATAWBA	14.37	4.20	4.20	18.48	18.48	1.99
2610000100	Open BurningYard Waste - Leaf Species Unspecified							
		CATAWBA	83.75	0.00	0.00	0.00	0.00	0.00
2610000500	Open Burning of Land Clearing Debris							
		CATAWBA	159.87	68.91	0.00	234.29	234.29	0.00
2610030000	Open Burning, Household Waste							
		CATAWBA	117.63	105.71	17.62	0.00	0.00	0.00
2630020000	Wastewater Treatment,Public Owned, Total Processed							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.26
2801000003	Agriculture, CropsTilling							
		CATAWBA	0.00	0.00	0.00	232.93	46.59	0.00
2801500262	Agricultural Burning, Wheat Backfire Burning							
		CATAWBA	10.58	0.00	0.00	16.83	16.83	0.00
2801700001	Fertilizer Application, Anhydrous Ammonia							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2801700002	Fertilizer Application, Aqua Ammonia							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2801700003	Fertilizer Application, Nitrogen Solutions							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	26.64
2801700004	Fertilizer Application, Urea							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	33.35
2801700005	Fertilizer Application, Ammonium Nitrate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	1.33
2801700006	Fertilizer Application, Ammonium Sulfate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	9.74
2801700007	Fertilizer, Ammonium Thiosulfate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2801700010	Fertilizer Application, N-P-K							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	30.12
2801700011	Fertilizer Application, Calcium Ammonium Nitrate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2801700012	Fertilizer Application, Potassium Nitrate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2801700013	Fertilizer Application, Diammonium Phosphate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	8.07
2801700014	Fertilizer Application, Monoammonium Phosphate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2801700015	Fertilizer, Liquid Ammonium Polyphosphate							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2801700099	Fertilizer Application, Miscellaneous Fertilizers							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.74
2805001000	Beef Cattle FeedlotsTotal							
		CATAWBA	0.00	0.00	0.00	178.15	26.72	0.00
2805001100	Beef cattle, finishing on feedlots Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805001200	Beef cattle, finishing on feedlots, Manure handling & storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805001300	Beef cattle, finishing on feedlots, Land app.of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805002000	Beef cattle production Not Elsewhere Classified							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805003100	Beef cattle, finishing, pasture/rangeConfinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	60.03
2805007100	Poultry, layers, dry manure Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	14.54
2805007300	Poultry, layers, dry manure Land application							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.32
2805008100	Poultry, layers, wet manure Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	2.93
2805008200	Poultry, layers, wet manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	7.39
2805008300	Poultry, layers, wet manure Land application							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	1.29
2805009100	Poultry, broilers, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	81.85
2805009200	Poultry, broilers, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	14.81
2805009300	Poultry, broilers, Land application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	66.91
2805010100	Poultry production - turkeys, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.03

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2805010200	Poultry production - turkeys, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.01
2805010300	Poultry production - turkeysLand application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.03
2805018000	Dairy cattle composite,Not Elsewhere Classified							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805019100	Dairy cattle - flush dairy, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.30
2805019200	Dairy cattle - flush dairy, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.86
2805019300	Dairy cattle - flush dairy, Land application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.08
2805021100	Dairy cattle - scrape dairy, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	2.63
2805021200	Dairy cattle - scrape dairy, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	3.49
2805021300	Dairy cattle - scrape dairyLand application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	5.14
2805022100	Dairy cattle - deep pit dairy, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.34
2805022200	Dairy cattle - deep pit dairy, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.01
2805022300	Dairy cattle, deep pit, Land application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.19
2805023100	Dairy cattle, drylot/pasture, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	8.56
2805023200	Dairy cattle, drylot/pasture, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.47
2805023300	Dairy cattle, drylot/pasture, Land application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	6.66
2805025000	Hogs and Pigs CompositeTotal							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	4.49
2805030000	Poultry and Chickens CompositeTotal							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805030007	Poultry Waste Emissions,Ducks							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.26
2805030008	Poultry Waste Emissions,Geese							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.15
2805035000	Horses and Ponies CompositeTotal							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	18.64

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2805039100	Swine operations with lagoons, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805039200	Swine operations with lagoons, Manure handling and storage							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805039300	Swine operations with lagoons, Land application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805040000	Sheep and Lambs CompositeTotal							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.53
2805045000	Goats Waste Emissions, Not Elsewhere Classified							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	7.20
2805047100	Swine, deep-pit house operations, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805047300	Swine, deep-pit house, Land application of manure							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2805053100	Swine, outdoor operations, Confinement							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2810001000	Forest Wildfires							
		CATAWBA	4.39	2.00	0.55	9.06	7.77	0.42
2810030000	Other Combustion,Structure FiresTotal							
		CATAWBA	1.70	0.21	0.00	0.00	0.00	0.00
2810050000	Other Combustion,Motor Vehicle FiresTotal							
		CATAWBA	0.59	0.07	0.00	0.00	0.00	0.00
2870000002	Domestic Activity, Infant Diapered WasteTotal							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.12
2870000015	Domestic Activity, Non-agricultural FertilizersTotal							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	4.89
	Hickory total		**5053.2**	**770.4**	**91.5**	**4516.2**	**1191.5**	**477.5**
Triad								
2102002000	Indust. Bituminous/Subbitu. Coal, All Boiler Types							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2102004000	IndustrialDistillate OilTotal: Boilers and IC Engines							
		GUILFORD	2.56	430.65	0.00	56.38	42.25	9.57
		DAVIDSON	0.27	70.26	0.00	10.49	7.57	1.69
2102006000	IndustrialNatural GasTotal: Boilers and IC Engines							
		GUILFORD	12.39	452.72	1.56	20.64	20.64	10.67
		DAVIDSON	2.06	82.35	0.26	3.30	3.30	1.89

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2102007000	Indus. Liquified Petroleum Gas (LPG), All Boiler Types							
		DAVIDSON	0.42	24.51	0.06	1.53	1.53	0.00
		GUILFORD	2.42	138.44	0.35	8.65	8.65	0.00
2103002000	Com./Institu. Bituminous/Subbitu.Coal, All Boiler Types							
		GUILFORD	0.20	47.21	115.82	38.71	14.22	0.08
		DAVIDSON	0.03	8.35	20.50	6.85	2.51	0.01
2103004000	Com./Institu.Distillate Oil, Boilers and IC Engines							
		GUILFORD	2.89	145.80	18.07	17.69	10.88	3.15
		DAVIDSON	0.50	25.32	2.16	3.13	1.90	0.55
2103006000	Com./Institu.Natural GasTotal: Boilers and IC Engines							
		DAVIDSON	1.34	41.28	0.14	1.84	1.84	0.12
		GUILFORD	7.34	228.88	0.80	10.56	10.56	0.69
2103007000	Com./Institu.Liquified Petroleum Gas (LPG), All Combustor Types							
		GUILFORD	0.58	24.23	0.08	15.14	1.62	0.00
		DAVIDSON	0.10	4.29	0.01	2.68	0.28	0.00
2103008000	Commercial/InstitutionalWoodTotal: All Boiler Types							
		GUILFORD	1.46	18.92	2.15	37.11	31.32	0.49
		DAVIDSON	0.00	2.57	0.37	4.90	3.94	0.08
2104002000	Residential, Bituminous/Subbitu. Coal, All Combustor Types							
		GUILFORD	0.04	5.51	19.16	3.75	2.30	1.21
		DAVIDSON	0.02	3.67	12.77	2.50	1.53	0.80
2104004000	ResidentialDistillate OilTotal: All Combustor Types							
		DAVIDSON	2.47	62.48	14.78	4.86	4.86	3.47
		GUILFORD	2.23	56.50	13.37	4.39	4.39	3.13
2104006000	Residential, Natural Gas, All Combustor Types							
		GUILFORD	17.79	304.16	1.94	24.59	24.59	64.71
		DAVIDSON	1.96	33.64	0.21	2.71	2.71	7.15
2104007000	Residential, Liquified Petroleum Gas (LPG), All Combustor Types							
		GUILFORD	0.85	39.86	0.15	25.79	25.79	0.00
		DAVIDSON	0.44	20.75	0.08	13.43	13.43	0.00
2104008001	ResidentialWoodFireplaces: General							
		GUILFORD	2049.38	49.52	7.61	659.00	560.15	34.28
		DAVIDSON	1985.46	47.97	7.38	638.44	542.67	33.21
2275900000	Aircraft Refueling, All Fuels, All Processes							
		GUILFORD	2.24	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2294000000	Paved Roads, All Paved Roads Fugitives							
		GUILFORD	0.00	0.00	0.00	4001.70	348.85	0.00
		DAVIDSON	0.00	0.00	0.00	1763.17	167.84	0.00
2296000000	Unpaved Roads, All Unpaved RoadsTotal: Fugitives							

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
		GUILFORD	0.00	0.00	0.00	666.69	67.00	0.00
		DAVIDSON	0.00	0.00	0.00	775.20	77.91	0.00
2302002000	Commercial CharbroilingTotal							
		GUILFORD	13.61	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	2.67	0.00	0.00	0.00	0.00	0.00
2302050000	Food and Kindred Products, Bakery ProductsTotal							
		DAVIDSON	2.63	0.00	0.00	0.00	0.00	0.00
		GUILFORD	7.48	0.00	0.00	0.00	0.00	0.00
2311010000	Construction, General Building Construction, Total							
		DAVIDSON	0.00	0.00	0.00	40.66	5.45	0.00
		GUILFORD	0.00	0.00	0.00	173.15	23.20	0.00
2311020000	Construction: SIC 15 - 17Heavy ConstructionTotal							
		GUILFORD	0.00	0.00	0.00	889.74	119.22	0.00
		DAVIDSON	0.00	0.00	0.00	37.20	4.98	0.00
2311030000	Construction: SIC 15 - 17Road ConstructionTotal							
		DAVIDSON	0.00	0.00	0.00	256.35	34.35	0.00
		GUILFORD	0.00	0.00	0.00	955.58	128.05	0.00
2325000000	Mining and Quarrying: SIC 14All ProcessesTotal							
		DAVIDSON	0.00	0.00	0.00	180.49	36.10	0.00
		GUILFORD	0.00	0.00	0.00	180.49	36.10	0.00
2399000000	Industrial Processes: NECIndustrial Processes: NECTotal							
		GUILFORD	0.00	0.00	2.16	7.59	5.25	0.00
		DAVIDSON	0.00	0.00	0.00	30.36	21.03	0.00
2401001000	Surface Coating, Architectural Coatings, All Solvent Types							
		GUILFORD	690.54	0.00	0.00	0.00	0.00	7.44
		DAVIDSON	242.99	0.00	0.00	0.00	0.00	2.61
2401005000	Surface Coating, Auto Refinishing, All Solvent Types							
		GUILFORD	83.59	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	31.73	0.00	0.00	0.00	0.00	0.00
2401008000	Surface CoatingTraffic Markings All Solvent Types							
		GUILFORD	163.50	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	145.30	0.00	0.00	0.00	0.00	0.00
2401015000	Surface Coating,Factory Finished Wood, All Solvent Types							
		DAVIDSON	57.37	0.00	0.00	0.00	0.00	0.00
		GUILFORD	37.46	0.00	0.00	0.00	0.00	0.00
2401020000	Surface Coating, Wood Furniture, All Solvent Types							
		GUILFORD	717.91	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	427.16	0.00	0.00	0.00	0.00	0.00
2401040000	Surface Coating, Metal Cans, All Solvent Types							
		GUILFORD	39.18	0.00	0.00	0.00	0.00	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2401045000	Surface Coating, Metal Coils, All Solvent Types							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	31.64	0.00	0.00	0.00	0.00	0.00
2401055000	Surface Coating, Machinery & Equipment, All Solvent Types							
		GUILFORD	43.42	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	24.02	0.00	0.00	0.00	0.00	0.00
2401060000	Surface Coating, Large Appliances, All Solvent Types							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2401065000	Surf. Coat.Electronic, Electrical, All Solvent Types							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.43	0.00	0.00	0.00	0.00	0.00
2401070000	Surf. Coat.Motor Vehicles: SIC 371Total: All Solvent Types							
		DAVIDSON	17.46	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.39	0.00	0.00	0.00	0.00	0.00
2401080000	Surf. Coat.Marine, All Solvent Types							
		DAVIDSON	0.15	0.00	0.00	0.00	0.00	0.00
		GUILFORD	1.69	0.00	0.00	0.00	0.00	0.00
2401085000	Surf. Coat.Railroad, All Solvent Types							
		GUILFORD	1.82	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.87	0.00	0.00	0.00	0.00	0.00
2401090000	Surf. Coat.Misc.Manufacturing, All Solvent Types							
		GUILFORD	128.30	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	45.15	0.00	0.00	0.00	0.00	0.00
2401100000	Surf. Coat.Indust. Maint.Coatings, All Solvent Types							
		DAVIDSON	60.20	0.00	0.00	0.00	0.00	0.00
		GUILFORD	171.07	0.00	0.00	0.00	0.00	0.00
2401200000	Surf. Coat.Special Purpose Coatings, All Solvent Types							
		GUILFORD	171.07	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	60.20	0.00	0.00	0.00	0.00	0.00
2415130000	Electronic & Other Elec.Open Top Degreasing, All Solvent Types							
		GUILFORD	44.90	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	15.80	0.00	0.00	0.00	0.00	0.00
2415145000	Degreasing, Open Top Degreasing, All Solvent Types							
		GUILFORD	104.78	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	36.87	0.00	0.00	0.00	0.00	0.00
2415345000	Degreasing, Cold Cleaning, All Solvent Types							
		GUILFORD	235.23	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	82.77	0.00	0.00	0.00	0.00	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2415360000	Degreasing, Auto Repair, Cold Cleaning, All Solvent Types							
		GUILFORD	534.61	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	188.12	0.00	0.00	0.00	0.00	0.00
2420020055	Dry Cleaning, Coin-operated Perchloroethylene							
		DAVIDSON	73.80	0.00	0.00	0.00	0.00	0.00
		GUILFORD	710.10	0.00	0.00	0.00	0.00	0.00
2425000000	Graphic Arts, All Processes, All Solvent Types							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2460500000	Misc.Consu. & Comm. Coatings and Related, All Solvent Types							
		GUILFORD	203.15	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	71.48	0.00	0.00	0.00	0.00	0.00
2460800000	FIFRA Related Productsl: All Solvent Types							
		DAVIDSON	133.94	0.00	0.00	0.00	0.00	0.00
		GUILFORD	380.64	0.00	0.00	0.00	0.00	0.00
2460900000	Consu.& Comm.Misc.Prod., All Solvent Types							
		DAVIDSON	5.26	0.00	0.00	0.00	0.00	0.00
		GUILFORD	14.96	0.00	0.00	0.00	0.00	0.00
2461021000	Commercial, Cutback Asphalt, All Solvent Types							
		DAVIDSON	1.85	0.00	0.00	0.00	0.00	0.00
		GUILFORD	2.08	0.00	0.00	0.00	0.00	0.00
2461023000	Commercial, Asphalt Roofing, All Solvent Types							
		DAVIDSON	0.19	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.62	0.00	0.00	0.00	0.00	0.00
2461850000	Pesticide Application, Agricultural, All Processes							
		DAVIDSON	86.31	0.00	0.00	0.00	0.00	0.00
		GUILFORD	200.50	0.00	0.00	0.00	0.00	0.00
2465100000	Personal Care Products, All Solvent Types							
		GUILFORD	496.12	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	174.58	0.00	0.00	0.00	0.00	0.00
2465200000	Consumer Household Products, All Solvent Types							
		DAVIDSON	5.94	0.00	0.00	0.00	0.00	2.33
		GUILFORD	16.89	0.00	0.00	0.00	0.00	6.62
2465400000	Consumer Automotive Aftermarket Products, All Solvent Types							
		GUILFORD	290.83	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	102.34	0.00	0.00	0.00	0.00	0.00
2465600000	Consumer Adhesives and SealantsTotal: All Solvent Types							
		GUILFORD	121.89	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	42.89	0.00	0.00	0.00	0.00	0.00
2501060050	Gasoline Service Stations Stage 1: Total							

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
		GUILFORD	97.85	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	39.45	0.00	0.00	0.00	0.00	0.00
2501060201	Gasoline Ser.StationsUnderground Tank: Breathing and Emptying							
		GUILFORD	128.02	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	51.62	0.00	0.00	0.00	0.00	0.00
2501060300	Residential and Commercial Portable Gas Cans, Total							
		GUILFORD	586.41	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	102.62	0.00	0.00	0.00	0.00	0.00
2505030120	TransportTruck, Gasoline							
		DAVIDSON	3.87	0.00	0.00	0.00	0.00	0.00
		GUILFORD	9.60	0.00	0.00	0.00	0.00	0.00
2601010000	On-site Incineration Industrial Total							
		DAVIDSON	14.80	4.32	4.32	19.03	19.03	2.05
		GUILFORD	42.08	12.29	12.29	54.10	54.10	5.85
2601020000	On-site IncinerationCommercial/Institutional, Total							
		GUILFORD	42.08	12.29	12.29	54.10	54.10	5.85
		DAVIDSON	14.80	4.32	4.32	19.03	19.03	2.05
2610000100	Open BurningYard Waste - Leaf Species Unspecified							
		GUILFORD	113.26	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	140.08	0.00	0.00	0.00	0.00	0.00
2610000500	Open Burning of Land Clearing Debris							
		DAVIDSON	94.90	40.90	0.00	139.08	139.08	0.00
		GUILFORD	428.43	184.67	0.00	627.87	627.87	0.00
2610030000	Open Burning, Household Waste							
		DAVIDSON	196.75	176.82	29.47	0.00	0.00	0.00
		GUILFORD	159.07	142.96	23.82	0.00	0.00	0.00
2630020000	Wastewater Treatment,Public Owned, Total Processed							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.21
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.87
2640000000	Toxic Storage & Disposal Facility, All TSDF Types, All Processes							
		GUILFORD	0.33	0.00	0.00	0.00	0.00	0.00
2801000003	Agriculture, CropsTilling							
		DAVIDSON	0.00	0.00	0.00	356.13	71.23	0.00
		GUILFORD	0.00	0.00	0.00	323.62	64.73	0.00
2801500262	Agricultural Burning, Wheat Backfire Burning							
		GUILFORD	16.37	0.00	0.00	26.05	26.05	0.00
		DAVIDSON	4.53	0.00	0.00	7.21	7.21	0.00
2801700001	Fertilizer Application, Anhydrous Ammonia							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2801700002	Fertilizer Application, Aqua Ammonia							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2801700003	Fertilizer Application, Nitrogen Solutions							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	28.40
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	16.12
2801700004	Fertilizer Application, Urea							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.11
		GUILFORD	0.00	0.00	0.00	0.00	0.00	9.83
2801700005	Fertilizer Application, Ammonium Nitrate							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	3.91
		GUILFORD	0.00	0.00	0.00	0.00	0.00	5.89
2801700006	Fertilizer Application, Ammonium Sulfate							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	4.01
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.34
2801700007	Fertilizer, Ammonium Thiosulfate							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2801700010	Fertilizer Application, N-P-K							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	27.86
		GUILFORD	0.00	0.00	0.00	0.00	0.00	44.16
2801700011	Fertilizer Application, Calcium Ammonium Nitrate							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2801700012	Fertilizer Application, Potassium Nitrate							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.01
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2801700013	Fertilizer Application, Diammonium Phosphate							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	1.31
		GUILFORD	0.00	0.00	0.00	0.00	0.00	1.70
2801700014	Fertilizer Application, Monoammonium Phosphate							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2801700015	Fertilizer, Liquid Ammonium Polyphosphate							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.06
2801700099	Fertilizer Application, Miscellaneous Fertilizers							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	11.31
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	1.76
2805001000	Beef Cattle FeedlotsTotal							

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
		DAVIDSON	0.00	0.00	0.00	136.51	20.47	0.00
		GUILFORD	0.00	0.00	0.00	120.48	18.08	0.00
2805001100	Beef cattle, finishing on feedlots Confinement							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2805001200	Beef cattle, finishing on feedlots, Manure handling & storage							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2805001300	Beef cattle, finishing on feedlots, Land app.of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805002000	Beef cattle production Not Elsewhere Classified							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805003100	Beef cattle, finishing, pasture/rangeConfinement							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	56.59
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	71.01
2805007100	Poultry, layers, dry manure Confinement							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	38.74
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	23.00
2805007300	Poultry, layers, dry manure Land application							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.43
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.25
2805008100	Poultry, layers, wet manure Confinement							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	4.65
		GUILFORD	0.00	0.00	0.00	0.00	0.00	7.84
2805008200	Poultry, layers, wet manure handling and storage							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	11.20
		GUILFORD	0.00	0.00	0.00	0.00	0.00	18.91
2805008300	Poultry, layers, wet manure Land application							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	1.86
		GUILFORD	0.00	0.00	0.00	0.00	0.00	3.13
2805009100	Poultry, broilers, Confinement							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	119.94
		GUILFORD	0.00	0.00	0.00	0.00	0.00	6.05
2805009200	Poultry, broilers, Manure handling and storage							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	1.09
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	21.81
2805009300	Poultry, broilers, Land application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	97.98

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
		GUILFORD	0.00	0.00	0.00	0.00	0.00	4.94
2805010100	Poultry production - turkeys, Confinement							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.01
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805010200	Poultry production - turkeys, Manure handling and storage							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805010300	Poultry production - turkeysLand application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.01
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805018000	Dairy cattle composite,Not Elsewhere Classified							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805019100	Dairy cattle - flush dairy, Confinement							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.60
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.61
2805019200	Dairy cattle - flush dairy, Manure handling and storage							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	1.73
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	1.70
2805019300	Dairy cattle - flush dairy, Land application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.16
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.16
2805021100	Dairy cattle - scrape dairy, Confinement							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	5.11
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	5.13
2805021200	Dairy cattle - scrape dairy, Manure handling and storage							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	6.78
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	6.79
2805021300	Dairy cattle - scrape dairyLand application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	10.01
		GUILFORD	0.00	0.00	0.00	0.00	0.00	9.98
2805022100	Dairy cattle - deep pit dairy, Confinement							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.70
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.68
2805022200	Dairy cattle - deep pit dairy, Manure handling and storage							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.03
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.03
2805022300	Dairy cattle, deep pit, Land application of manure							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.38
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.39

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
2805023100	Dairy cattle, drylot/pasture, Confinement							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	16.66
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	16.66
2805023200	Dairy cattle, drylot/pasture, Manure handling and storage							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.92
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.92
2805023300	Dairy cattle, drylot/pasture, Land application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	12.94
		GUILFORD	0.00	0.00	0.00	0.00	0.00	12.94
2805025000	Hogs and Pigs CompositeTotal							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	7.84
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805030000	Poultry and Chickens CompositeTotal							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2805030007	Poultry Waste Emissions,Ducks							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.69
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.01
2805030008	Poultry Waste Emissions,Geese							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.03
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.02
2805035000	Horses and Ponies CompositeTotal							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	27.77
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	20.62
2805039100	Swine operations with lagoons, Confinement							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	24.06
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2805039200	Swine operations with lagoons, Manure handling and storage							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	44.03
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
2805039300	Swine operations with lagoons, Land application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	3.55
2805040000	Sheep and Lambs CompositeTotal							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.78
		GUILFORD	0.00	0.00	0.00	0.00	0.00	1.57
2805045000	Goats Waste Emissions, Not Elsewhere Classified							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	6.61
		GUILFORD	0.00	0.00	0.00	0.00	0.00	10.28
2805047100	Swine, deep-pit house operations, Confinement							

SCC	Description	County	VOC T/Y	NOX T/Y	SO2 T/Y	PM10 T/Y	PM25 T/Y	NH3 T/Y
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	3.41
2805047300	Swine, deep-pit house, Land application of manure							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	1.45
2805053100	Swine, outdoor operations, Confinement							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.01
2810001000	Forest Wildfires							
		DAVIDSON	4.77	2.17	0.60	9.85	8.44	0.46
		GUILFORD	1.39	0.63	0.17	2.87	2.46	0.13
2810015000	Prescribed Burning for Forest Management							
		DAVIDSON	0.92	0.42	0.11	1.90	1.63	0.09
2810030000	Other Combustion,Structure FiresTotal							
		GUILFORD	4.97	0.63	0.00	0.00	0.00	0.00
		DAVIDSON	1.75	0.22	0.00	0.00	0.00	0.00
2810050000	Other Combustion,Motor Vehicle FiresTotal							
		GUILFORD	0.99	0.12	0.00	0.00	0.00	0.00
		DAVIDSON	0.85	0.10	0.00	0.00	0.00	0.00
2870000002	Domestic Activity, Infant Diapered WasteTotal							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.34
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.11
2870000015	Domestic Activity, Non-agricultural FertilizersTotal							
		GUILFORD	0.00	0.00	0.00	0.00	0.00	14.32
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	5.04
	Triad Total		**14200.45**	**2952.70**	**329.33**	**13475.25**	**3554.29**	**1144.28**

See Note 1 in section 2

Table 10.   2002 Annual Nonroad Emissions by Seven Digit Level SCC Classification

7-digit SCC	Description	County	VOC_TY	NOX_TY	SO2_TY	PM10_TY	PM25_TY	NH3_TY
Hickory								
2260001	Recreational Equipment; 2-Stroke							
		CATAWBA	85.75	0.33	0.04	3.05	2.81	0.01
2260002	Construction and Mining Equipment; 2-Stroke							
		CATAWBA	13.21	0.14	0.01	0.78	0.72	0.00
2260003	Industrial Equipment; 2-Stroke							
		CATAWBA	0.75	0.00	0.00	0.03	0.03	0.00
2260004	Lawn and Garden Equipment; 2-Stroke							
		CATAWBA	190.42	0.99	0.14	8.35	7.68	0.02
2260005	Agricultural Equipment; 2-Stroke							
		CATAWBA	0.09	0.00	0.00	0.00	0.00	0.00
2260006	Commercial Equipment; 2-Stroke							
		CATAWBA	19.85	0.06	0.01	0.85	0.78	0.00
2260007	Logging Equipment; 2-Stroke							
		CATAWBA	1.81	0.02	0.00	0.11	0.10	0.00
2265001	Recreational Equipment; 4-Stroke							
		CATAWBA	30.92	3.99	0.25	0.31	0.28	0.02
2265002	Construction and Mining Equipment; 4-Stroke							
		CATAWBA	7.91	2.24	0.08	0.06	0.06	0.01
2265003	Industrial Equipment; 4-Stroke							
		CATAWBA	43.27	30.14	0.54	0.35	0.32	0.04
2265004	Lawn and Garden Equipment; 4-Stroke							
		CATAWBA	231.90	35.83	1.57	1.39	1.28	0.13
2265005	Agricultural Equipment; 4-Stroke							
		CATAWBA	1.07	0.40	0.01	0.01	0.01	0.00
2265006	Commercial Equipment; 4-Stroke							
		CATAWBA	122.32	23.74	0.98	0.82	0.75	0.08
2265007	Logging Equipment; 4-Stroke							
		CATAWBA	0.40	0.06	0.00	0.00	0.00	0.00
2265010	Industrial Equipment; 4-Stroke							
		CATAWBA	0.11	0.03	0.00	0.00	0.00	0.00
2267001	Recreational Equipment; LPG							
		CATAWBA	0.01	0.05	0.00	0.00	0.00	0.00
2267002	Construction and Mining Equipment; LPG							
		CATAWBA	0.32	1.17	0.00	0.01	0.01	0.00

7-digit SCC	Description	County	VOC_TY	NOX_TY	SO2_TY	PM10_TY	PM25_TY	NH3_TY
2267003	Industrial Equipment; LPG							
		CATAWBA	163.69	600.34	0.65	2.83	2.83	0.64
2267004	Lawn and Garden Equipment; LPG							
		CATAWBA	0.27	0.97	0.00	0.00	0.00	0.00
2267005	Agricultural Equipment; LPG							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2267006	Commercial Equipment; LPG							
		CATAWBA	2.18	10.06	0.01	0.05	0.05	0.01
2268002	Construction and Mining Equipment; CNG							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
2268003	Industrial Equipment; CNG							
		CATAWBA	0.69	42.91	0.04	0.20	0.20	0.00
2268005	Agricultural Equipment; CNG							
		CATAWBA	0.00	0.10	0.00	0.00	0.00	0.00
2268006	Commercial Equipment; CNG							
		CATAWBA	0.10	6.57	0.01	0.03	0.03	0.00
2268010	Industrial Equipment; CNG							
		CATAWBA	0.00	0.15	0.00	0.00	0.00	0.00
2270001	Recreational Equipment; Diesel							
		CATAWBA	0.15	0.48	0.06	0.09	0.08	0.00
2270002	Construction and Mining Equipment; Diesel							
		CATAWBA	33.75	292.05	36.79	28.35	27.50	0.20
2270003	Industrial Equipment; Diesel							
		CATAWBA	22.73	221.24	31.01	21.42	20.77	0.17
2270004	Lawn and Garden Equipment; Diesel							
		CATAWBA	1.91	12.71	1.57	1.37	1.32	0.01
2270005	Agricultural Equipment; Diesel							
		CATAWBA	5.63	46.28	5.21	5.72	5.55	0.03
2270006	Commercial Equipment; Diesel							
		CATAWBA	8.97	51.23	6.49	6.36	6.17	0.03
2270007	Logging Equipment; Diesel							
		CATAWBA	0.28	3.91	0.55	0.29	0.28	0.00
2270010	Industrial Equipment; Diesel							
		CATAWBA	0.04	0.43	0.05	0.03	0.03	0.00
2282005	Pleasure Craft; Gasoline 2-Stroke							
		CATAWBA	101.60	1.44	0.15	1.73	1.59	0.01
2282010	Pleasure Craft; Gasoline 4-Stroke							
		CATAWBA	5.27	2.14	0.05	0.02	0.02	0.00
2282020	Pleasure Craft; Diesel							
		CATAWBA	0.10	2.70	0.34	0.08	0.07	0.00

7-digit SCC	Description	County	VOC_TY	NOX_TY	SO2_TY	PM10_TY	PM25_TY	NH3_TY
2285002	Railroad Equipment; Diesel							
		CATAWBA	9.77	224.76	13.06	5.67	5.11	0.00
2285004	Railroad Equipment; Gasoline, 4-Stroke							
		CATAWBA	0.04	0.01	0.00	0.00	0.00	0.00
2285006	Railroad Equipment; LPG							
		CATAWBA	0.00	0.00	0.00	0.00	0.00	0.00
	Hickory Total		**1107.26**	**1619.69**	**99.68**	**90.36**	**86.46**	**1.41**
				Triad				
2260001	Recreational Equipment; 2-Stroke							
		DAVIDSON	42.87	0.17	0.02	1.53	1.41	0.00
		GUILFORD	42.87	0.17	0.02	1.53	1.41	0.00
2260002	Construction and Mining Equipment; 2-Stroke							
		DAVIDSON	9.00	0.10	0.01	0.53	0.49	0.00
		GUILFORD	79.54	0.85	0.07	4.72	4.34	0.01
2260003	Industrial Equipment; 2-Stroke							
		DAVIDSON	0.37	0.00	0.00	0.02	0.02	0.00
		GUILFORD	0.88	0.00	0.00	0.04	0.04	0.00
2260004	Lawn and Garden Equipment; 2-Stroke							
		DAVIDSON	144.72	0.68	0.10	6.12	5.63	0.01
		GUILFORD	909.37	5.15	0.67	41.38	38.07	0.09
2260005	Agricultural Equipment; 2-Stroke							
		DAVIDSON	0.13	0.00	0.00	0.01	0.00	0.00
		GUILFORD	0.12	0.00	0.00	0.00	0.00	0.00
2260006	Commercial Equipment; 2-Stroke							
		DAVIDSON	11.75	0.04	0.01	0.50	0.46	0.00
		GUILFORD	87.82	0.28	0.06	3.77	3.47	0.01
2260007	Logging Equipment; 2-Stroke							
		DAVIDSON	4.70	0.05	0.00	0.27	0.25	0.00
		GUILFORD	3.95	0.04	0.00	0.23	0.21	0.00
2265001	Recreational Equipment; 4-Stroke							
		DAVIDSON	15.46	2.00	0.12	0.15	0.14	0.01
		GUILFORD	35.34	6.99	0.37	0.34	0.31	0.03
2265002	Construction and Mining Equipment; 4-Stroke							
		DAVIDSON	5.39	1.53	0.05	0.04	0.04	0.00
		GUILFORD	47.64	13.49	0.46	0.37	0.34	0.04
2265003	Industrial Equipment; 4-Stroke							
		DAVIDSON	21.42	14.91	0.27	0.17	0.16	0.02

7-digit SCC	Description	County	VOC_TY	NOX_TY	SO2_TY	PM10_TY	PM25_TY	NH3_TY
		GUILFORD	50.97	35.47	0.63	0.41	0.37	0.05
2265004	Lawn and Garden Equipment; 4-Stroke							
		DAVIDSON	198.11	28.23	1.26	1.12	1.03	0.10
		GUILFORD	960.72	164.42	7.01	6.22	5.72	0.56
2265005	Agricultural Equipment; 4-Stroke							
		DAVIDSON	1.52	0.57	0.02	0.01	0.01	0.00
		GUILFORD	1.36	0.50	0.01	0.01	0.01	0.00
2265006	Commercial Equipment; 4-Stroke							
		DAVIDSON	72.41	14.06	0.58	0.48	0.45	0.05
		GUILFORD	541.23	105.06	4.33	3.62	3.33	0.35
2265007	Logging Equipment; 4-Stroke							
		DAVIDSON	1.03	0.16	0.01	0.01	0.01	0.00
		GUILFORD	0.87	0.14	0.01	0.00	0.00	0.00
2265008	Airport Ground Support Equipment; 4-Stroke							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.67	0.47	0.01	0.01	0.00	0.00
2267001	Recreational Equipment; LPG							
		DAVIDSON	0.01	0.02	0.00	0.00	0.00	0.00
		GUILFORD	0.01	0.02	0.00	0.00	0.00	0.00
2267002	Construction and Mining Equipment; LPG							
		DAVIDSON	0.22	0.79	0.00	0.00	0.00	0.00
		GUILFORD	1.92	7.03	0.01	0.03	0.03	0.01
2267003	Industrial Equipment; LPG							
		DAVIDSON	80.93	296.83	0.32	1.40	1.40	0.32
		GUILFORD	192.51	706.04	0.77	3.33	3.33	0.75
2267004	Lawn and Garden Equipment; LPG							
		DAVIDSON	0.17	0.62	0.00	0.00	0.00	0.00
		GUILFORD	1.48	5.41	0.01	0.03	0.03	0.01
2267005	Agricultural Equipment; LPG							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
2267006	Commercial Equipment; LPG							
		DAVIDSON	1.29	5.96	0.01	0.03	0.03	0.01
		GUILFORD	9.64	44.53	0.05	0.21	0.21	0.05
2267008	Airport Ground Support Equipment; LPG							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.17	0.63	0.00	0.00	0.00	0.00
2268002	Construction and Mining Equipment; CNG							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.02	0.00	0.00	0.00	0.00

7-digit SCC	Description	County	VOC_TY	NOX_TY	SO2_TY	PM10_TY	PM25_TY	NH3_TY
2268003	Industrial Equipment; CNG							
		DAVIDSON	0.34	21.23	0.02	0.10	0.10	0.00
		GUILFORD	0.81	50.50	0.05	0.24	0.24	0.00
2268005	Agricultural Equipment; CNG							
		DAVIDSON	0.00	0.14	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.12	0.00	0.00	0.00	0.00
2268006	Commercial Equipment; CNG							
		DAVIDSON	0.06	3.89	0.00	0.02	0.02	0.00
		GUILFORD	0.46	29.06	0.03	0.14	0.14	0.00
2270001	Recreational Equipment; Diesel							
		DAVIDSON	0.08	0.24	0.03	0.04	0.04	0.00
		GUILFORD	0.08	0.24	0.03	0.04	0.04	0.00
2270002	Construction and Mining Equipment; Diesel							
		DAVIDSON	22.99	198.92	25.06	19.31	18.73	0.13
		GUILFORD	203.26	1758.95	221.59	170.76	165.64	1.18
2270003	Industrial Equipment; Diesel							
		DAVIDSON	12.75	120.57	16.97	11.89	11.53	0.09
		GUILFORD	31.72	297.02	41.88	29.47	28.58	0.22
2270004	Lawn and Garden Equipment; Diesel							
		DAVIDSON	1.23	8.17	1.01	0.88	0.85	0.01
		GUILFORD	10.61	70.72	8.75	7.60	7.37	0.05
2270005	Agricultural Equipment; Diesel							
		DAVIDSON	8.01	65.79	7.40	8.13	7.88	0.04
		GUILFORD	7.12	58.49	6.58	7.22	7.01	0.04
2270006	Commercial Equipment; Diesel							
		DAVIDSON	5.31	30.33	3.84	3.76	3.65	0.02
		GUILFORD	39.67	226.68	28.71	28.14	27.29	0.15
2270007	Logging Equipment; Diesel							
		DAVIDSON	0.74	10.17	1.43	0.76	0.74	0.01
		GUILFORD	0.62	8.54	1.20	0.64	0.62	0.01
2270008	Airport Ground Support Equipment; Diesel							
		DAVIDSON	0.00	0.01	0.00	0.00	0.00	0.00
		GUILFORD	2.06	24.43	2.97	2.01	1.95	0.02
2275001	Aircraft; Military Aircraft							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.40	0.04	0.00	0.04	0.04	0.00
2275020	Aircraft; Commercial Aircraft							
		GUILFORD	30.23	104.79	10.05	27.25	26.71	0.00
2275050	Aircraft; General Aviation							
		DAVIDSON	0.40	0.07	0.00	0.13	0.13	0.00

7-digit SCC	Description	County	VOC_TY	NOX_TY	SO2_TY	PM10_TY	PM25_TY	NH3_TY
		GUILFORD	1.75	0.29	0.04	0.55	0.54	0.00
2275060	Aircraft; Air Taxi							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	5.88	0.76	0.07	0.38	0.37	0.00
2282005	Pleasure Craft; Gasoline 2-Stroke							
		DAVIDSON	110.30	1.56	0.16	1.88	1.73	0.02
		GUILFORD	58.05	0.82	0.08	0.99	0.91	0.01
2282010	Pleasure Craft; Gasoline 4-Stroke							
		DAVIDSON	5.72	2.32	0.06	0.03	0.02	0.00
		GUILFORD	3.01	1.22	0.03	0.01	0.01	0.00
2282020	Pleasure Craft; Diesel							
		DAVIDSON	0.11	2.94	0.37	0.08	0.08	0.00
		GUILFORD	0.06	1.55	0.20	0.04	0.04	0.00
2285002	Railroad Equipment; Diesel							
		DAVIDSON	29.40	711.98	42.56	17.91	16.15	0.00
		GUILFORD	29.18	677.09	39.57	17.08	15.37	0.00
2285004	Railroad Equipment; Gasoline, 4-Stroke							
		DAVIDSON	0.11	0.03	0.00	0.00	0.00	0.00
		GUILFORD	0.11	0.03	0.00	0.00	0.00	0.00
2285006	Railroad Equipment; LPG							
		DAVIDSON	0.00	0.00	0.00	0.00	0.00	0.00
		GUILFORD	0.00	0.00	0.00	0.00	0.00	0.00
	Triad Total		**4203.21**	**5953.09**	**478.01**	**436.18**	**417.32**	**4.48**

3. FUTURE ATTAINMENT YEAR (2009) EMISSION SUMMARIES

The emissions in all of the tables of this section are reported in tons/year of pollutant. The emission summary tables below are in the following order:

- 2009 Nonattainment Areas Emissions
- 2009 North Carolina Counties Emissions
- 2009 ASIP States Emissions

Table 11. 2009 Annual Emission Summaries For Hickory Nonattainment County

County	Point						Non-road						Area						Mobile					
	VOC	Nox	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Catawba Co	3501.0	13094.5	10797.5	3755.1	3246.6	8.9	819.0	1178.4	17.2	73.5	70.2	1.5	3964.3	830.0	96.0	4783.8	1333.5	512.6	3984.9	4445.7	31.4	119.2	75.2	251.3

Emissions reported as tons/year.
See Note 1 in section 2

Table 12. 2009 Annual Emission Summaries For Greensboro-Winston Salem-High Point Nonattainment Counties

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Davidson Co	2840.9	1434.3	442.0	455.3	389.1	7.3	599.9	1243.3	17.2	61.1	57.7	0.9	3651.1	712.5	104.5	4693.6	1299.5	606.1	3378.3	4185.6	28.5	110.7	71.0	220.4
Guilford Co	4204.3	222.2	251.8	219.0	143.8	10.8	2297.0	3568.5	73.3	297.9	285.3	4.0	7819.4	2488.4	246.7	9654.9	2717.5	620.6	8508.9	9759.0	81.0	284.9	173.8	645.0

Emissions reported as tons/year.
See Note 1 in section 2

Table 13. 2009 Annual Emission Summaries For North Carolina Counties

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Alamance Co	344.3	162.4	25.4	49.8	37.5	6.9	644.7	809.8	13.0	63.1	59.9	1.0	2808.9	670.1	80.6	3544.4	983.0	581.0	3011.9	3789.4	25.0	96.0	61.1	196.3
Alexander Co	366.3	6.5	4.2	40.6	26.1	0.0	228.1	173.1	2.9	17.1	16.2	0.3	1297.3	188.2	25.6	1494.5	424.4	1994.2	453.7	435.7	3.3	12.4	7.7	27.3
Alleghany Co	5.0	0.1	0.3	0.5	0.2	0.0	50.4	70.0	1.4	6.5	6.2	0.1	603.2	97.2	13.9	982.8	300.0	337.1	170.5	158.0	1.2	4.5	2.8	10.1
Anson Co	62.4	72.6	156.4	45.0	38.4	0.6	105.9	453.2	6.0	16.4	15.3	0.1	707.1	119.6	21.6	1273.0	370.3	2734.2	574.1	651.0	4.4	17.0	10.8	34.6
Ashe Co	3.4	14.2	25.8	17.5	11.3	0.0	163.7	132.7	2.7	14.2	13.5	0.2	1344.7	219.2	33.4	1735.1	608.5	226.6	485.6	439.2	3.4	12.6	7.8	28.5
Avery Co	29.6	5.8	13.3	1.5	1.0	0.0	281.0	120.8	2.6	18.1	17.1	0.2	763.4	176.0	46.3	1013.7	345.0	91.9	336.8	361.1	2.6	9.7	6.1	20.5
Beaufort Co	99.1	699.8	5390.7	748.3	455.7	602.2	1376.9	848.7	15.6	69.5	65.6	0.8	1626.3	287.8	31.8	2941.1	832.8	1195.7	729.8	709.2	5.3	19.6	12.2	43.9
Bertie Co	223.9	74.3	213.6	27.4	18.4	7.3	328.8	231.3	5.7	21.6	20.6	0.3	1143.4	138.1	24.2	1950.1	534.1	1834.8	493.5	527.9	3.7	14.2	9.0	30.0
Bladen Co	235.5	801.7	2489.2	60.8	38.3	0.6	329.6	391.1	6.5	26.6	25.2	0.3	1345.0	227.1	43.3	2950.0	918.2	8922.2	770.0	727.8	5.6	20.8	12.9	46.6
Brunswick Co	1508.4	2807.2	7016.0	347.7	262.0	6.7	1021.7	1035.4	51.5	81.9	77.4	0.9	1838.9	428.8	55.6	2623.4	900.4	1088.4	2057.1	2310.6	17.0	64.7	40.9	136.5
Buncombe Co	432.1	1051.4	1750.0	629.4	312.3	1.3	1700.6	1342.6	25.4	125.3	118.8	1.5	5257.8	1419.6	243.0	6582.5	2076.4	331.7	3719.0	5094.5	32.2	125.5	80.7	247.2

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Burke Co	798.5	126.5	275.0	238.2	220.1	1.3	288.8	447.9	6.3	25.6	24.3	0.5	2281.5	426.3	75.4	2856.6	885.3	419.9	2029.8	3072.9	18.6	75.2	49.8	132.9
Cabarrus Co	729.1	854.5	2023.5	80.4	51.4	9.6	568.1	1294.7	21.2	81.0	76.9	1.0	2679.0	594.8	61.9	4234.0	1192.8	553.4	4336.9	3599.4	30.7	113.0	69.4	257.1
Caldwell Co	4102.7	429.9	38.2	221.0	154.8	0.0	422.6	384.0	5.9	30.5	29.1	0.6	2366.9	415.6	61.0	2856.0	986.1	345.0	1488.1	1467.3	11.5	43.0	26.7	95.1
Camden Co	0.0	0.0	0.0	0.0	0.0	0.0	447.9	189.6	4.7	19.0	18.0	0.2	266.0	48.1	7.8	1681.5	406.5	193.4	202.1	214.6	1.5	5.8	3.6	12.5
Carteret Co	94.5	37.3	177.2	46.0	7.4	0.0	4618.5	2594.3	237.0	183.3	170.1	1.6	1950.5	646.4	123.2	3557.8	1747.3	202.8	991.7	1128.3	8.4	32.0	20.2	67.3
Caswell Co	0.0	0.0	0.0	0.0	0.0	0.0	66.9	187.2	2.8	9.2	8.7	0.1	1114.1	144.8	20.8	1566.6	463.6	188.6	418.5	437.9	3.1	11.9	7.5	25.2
Catawba Co	3501.0	13094.5	10797.5	3755.1	3246.6	8.9	819.0	1178.4	17.2	73.5	70.2	1.5	3964.3	830.0	96.0	4783.8	1333.5	512.6	3984.9	4445.7	31.4	119.2	75.2	251.3
Chatham Co	628.3	1976.5	14221.6	949.7	530.6	30.1	355.9	464.3	9.1	38.7	37.1	0.5	1787.2	298.6	45.7	2663.0	872.8	2736.6	1644.3	1727.5	13.3	51.1	32.5	105.4
Cherokee Co	0.0	0.0	0.0	0.0	0.0	0.0	300.1	119.6	2.4	15.6	14.7	0.2	1270.5	238.9	39.1	1458.3	589.0	164.0	502.9	559.8	3.9	14.8	9.4	30.9
Chowan Co	65.9	32.8	168.7	50.2	17.5	0.1	428.4	159.8	3.9	15.8	15.0	0.2	455.4	83.3	11.6	1044.7	260.5	640.7	220.2	222.2	1.6	5.9	3.7	13.5
Clay Co	0.0	0.0	0.0	0.6	0.1	0.0	227.5	57.6	1.2	10.3	9.7	0.1	374.9	74.5	8.9	652.9	195.9	30.1	179.6	179.4	1.3	5.1	3.2	11.0
Cleveland Co	734.3	324.0	192.4	300.1	261.1	0.2	367.3	583.8	9.2	36.8	35.1	0.6	2248.3	507.0	92.7	3385.3	884.5	1119.7	2468.0	2190.6	18.2	68.2	42.6	147.2
Columbus Co	2559.3	2758.0	3013.1	1659.2	1419.2	136.4	519.7	450.7	9.0	39.5	37.4	0.4	1989.8	368.5	59.9	2849.5	857.5	3093.9	1306.3	1415.6	10.0	37.9	23.9	80.4
Craven Co	2702.5	1968.7	1556.9	775.0	560.4	70.2	741.0	480.1	10.6	43.1	40.9	0.6	2168.9	508.5	76.9	3382.6	1213.7	1287.2	2092.0	2027.2	15.8	58.6	36.3	131.3
Cumberland Co	1289.2	579.7	1306.6	229.1	125.2	3.5	990.4	1336.5	22.2	98.7	93.6	1.3	4576.9	866.0	114.2	6287.9	1665.4	1582.2	6521.8	7313.1	51.4	195.8	123.7	410.5
Currituck Co	0.0	0.0	0.0	6.7	2.8	0.0	1584.7	512.4	12.3	57.7	54.5	0.8	628.1	145.1	23.1	1544.4	460.1	230.2	814.5	857.8	6.4	24.3	15.3	52.0
Dare Co	2.0	72.1	8.3	2.8	1.7	0.0	6679.3	1163.7	19.8	148.3	138.2	2.2	939.9	361.3	56.3	2188.7	798.2	32.7	1019.5	1038.0	7.7	29.0	18.1	63.1
Davidson Co	2840.9	1434.3	442.0	455.3	389.1	7.3	599.9	1243.3	17.2	61.1	57.7	0.9	3651.1	712.5	104.5	4693.6	1299.5	606.1	3378.3	4185.6	28.5	110.7	71.0	220.4
Davie Co	259.4	35.1	16.0	68.5	58.2	1.2	391.9	224.3	4.1	26.0	24.6	0.3	1339.8	195.2	27.0	1734.3	502.4	467.8	827.9	1520.7	8.2	34.6	23.7	52.1
Duplin Co	20.0	523.2	2319.7	200.4	157.4	1.1	132.6	340.1	6.7	29.3	28.3	0.3	1643.8	275.6	36.8	4589.2	1085.0	24403.1	1285.7	1811.8	10.8	43.6	28.8	77.6
Durham Co	293.7	368.3	581.6	26.2	20.0	0.5	1084.8	1821.2	36.1	149.4	143.3	2.2	3524.7	1134.8	122.3	5062.5	1439.8	145.8	3622.4	5118.3	44.1	150.2	89.9	356.5
Edgecombe Co	357.5	1978.8	651.8	227.3	213.9	5.5	194.2	712.5	10.3	34.6	32.9	0.5	1729.5	295.0	51.6	3496.3	880.0	1955.8	1309.7	1343.4	10.4	38.7	24.0	85.9
Forsyth Co	2384.2	1507.2	3817.3	345.3	188.7	22.1	1056.5	1456.3	26.6	116.5	111.4	1.9	5120.5	1648.0	250.7	7717.6	2114.6	307.9	5898.4	6540.3	53.9	188.4	114.4	432.7
Franklin Co	501.3	28.3	7.6	11.1	6.8	0.0	175.4	224.2	4.3	20.3	19.4	0.3	1607.9	285.2	36.4	2357.2	694.4	603.9	1304.3	1370.3	10.7	40.5	25.5	86.4
Gaston Co	1072.2	7920.1	49092.5	3627.2	3126.6	104.9	687.9	1162.7	17.9	70.2	66.6	1.1	3878.7	848.6	97.1	4342.5	1149.4	317.2	3453.5	3918.0	38.8	129.0	76.2	312.5
Gates Co	0.0	0.0	0.0	0.5	0.2	0.0	68.4	108.4	3.4	10.4	10.0	0.1	481.6	69.9	11.1	1152.5	308.4	627.5	204.8	233.8	1.6	6.1	3.9	12.6
Graham Co	504.5	25.0	25.8	19.8	13.9	0.0	85.8	34.8	0.6	3.4	3.2	0.1	410.0	79.1	13.4	675.1	255.5	23.4	114.8	106.0	0.8	3.0	1.8	6.9
Granville Co	693.0	25.1	1.7	58.0	54.4	29.1	224.2	408.8	8.2	34.4	33.0	0.5	1934.7	277.6	36.7	2502.5	781.5	186.0	878.1	1901.9	13.1	47.0	30.0	89.9
Greene Co	0.1	2.1	9.5	0.7	0.2	0.0	59.0	185.5	4.9	15.4	14.8	0.1	905.5	102.9	13.3	1725.1	408.0	4599.4	404.1	397.2	3.0	11.1	6.9	24.5
Guilford Co	4204.3	222.2	251.8	219.0	143.8	10.8	2297.0	3568.5	73.3	297.9	285.3	4.0	7819.4	2488.4	246.7	9654.9	2717.5	620.6	8508.9	9759.0	81.0	284.9	173.8	645.0
Halifax Co	509.9	3736.3	2946.8	573.1	466.6	15.7	305.0	639.2	9.8	38.2	36.1	0.4	1963.9	297.8	38.6	3396.5	876.9	1168.8	1118.2	1893.6	10.2	42.7	29.0	68.1
Harnett Co	0.0	3.2	0.0	15.5	12.9	0.0	347.1	809.1	12.0	43.0	40.5	0.4	2314.7	485.6	66.6	3830.3	1073.0	2469.4	1424.0	1837.6	12.4	48.5	31.4	93.5
Haywood Co	1591.7	2945.0	9263.9	930.6	908.2	82.8	681.3	270.4	5.4	38.3	36.1	0.4	2048.4	398.6	71.4	2564.4	871.3	335.9	1320.6	2539.2	13.9	58.7	40.2	90.2
Henderson Co	717.5	82.0	1.8	34.7	27.2	0.6	1562.5	528.5	9.7	79.0	74.2	0.9	2548.0	537.8	66.7	3544.9	1110.5	269.6	1480.3	2055.4	13.2	52.2	34.0	98.2
Hertford Co	202.3	151.6	130.3	136.6	117.9	0.0	200.3	152.2	3.0	16.5	15.8	0.2	743.4	151.2	38.8	1463.7	362.4	986.9	353.2	339.7	2.5	9.5	6.0	21.1
Hoke Co	213.0	62.7	127.3	21.4	21.4	0.0	155.8	163.2	3.4	16.4	15.7	0.2	903.9	196.4	36.2	1849.3	662.9	951.5	593.4	607.5	4.3	16.4	10.4	34.9

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Hyde Co	0.2	15.6	1.6	4.8	1.8	0.0	4797.8	785.3	12.8	88.6	82.4	1.5	370.5	50.4	6.8	2022.5	469.9	148.2	159.6	151.5	1.2	4.3	2.7	9.7
Iredell Co	669.4	1380.8	550.4	127.5	109.9	22.2	671.5	909.6	17.1	72.5	69.5	1.1	3068.2	625.9	113.9	4987.6	1408.4	2070.6	4303.5	6814.8	40.8	169.4	114.7	270.2
Jackson Co	40.5	82.1	13.6	43.2	33.7	0.0	11574.3	3735.1	63.7	376.3	355.7	5.8	1506.2	297.4	38.4	1765.4	698.7	53.1	902.1	1102.4	7.5	29.0	18.6	58.0
Johnston Co	234.4	48.8	30.3	10.7	10.4	1.7	651.5	1446.3	23.0	88.4	83.7	0.9	3238.0	675.5	81.2	5785.3	1527.8	2987.5	4540.9	7532.6	44.0	183.3	124.1	293.6
Jones Co	0.0	0.0	0.0	11.0	3.4	0.0	47.9	116.3	3.5	10.2	9.8	0.1	613.8	126.1	27.4	1377.7	520.8	2512.9	328.8	385.5	2.6	10.1	6.4	20.7
Lee Co	301.7	102.5	96.4	119.3	101.1	0.0	201.2	426.5	7.6	29.6	28.4	0.5	1152.3	301.1	33.4	1587.9	452.9	531.5	1054.5	1061.7	8.2	30.4	18.8	69.1
Lenoir Co	405.5	813.8	1215.2	83.9	51.4	18.4	272.2	329.6	7.0	28.4	27.2	0.4	1607.5	272.9	34.0	3561.4	805.7	3815.7	1055.0	953.3	7.9	29.0	17.7	67.9
Lincoln Co	852.0	40.6	4.3	72.6	65.3	0.3	323.1	451.0	7.1	30.0	28.5	0.4	1698.2	332.3	79.8	2737.1	774.8	372.1	1653.9	1515.2	12.1	44.7	27.6	100.0
Mc Dowell Co	681.5	258.8	50.8	231.2	167.1	0.0	365.6	733.9	9.3	31.6	29.4	0.4	1445.3	297.4	37.8	1731.0	692.2	79.8	1024.6	1870.2	10.0	42.0	28.7	64.6
Macon Co	5.6	0.0	0.0	0.9	0.2	0.0	506.3	175.1	3.6	27.5	25.9	0.3	1098.3	154.3	32.3	1244.7	419.3	118.6	637.4	707.6	4.9	18.9	12.0	39.4
Madison Co	0.0	0.0	0.0	0.0	0.0	0.0	157.5	284.1	3.9	13.5	12.6	0.1	1156.1	177.9	24.3	1954.5	482.6	655.1	356.6	533.7	3.1	12.8	8.5	22.2
Martin Co	1188.4	4400.0	3616.5	682.9	426.7	109.5	206.2	202.5	4.9	20.8	19.8	0.2	1414.9	241.6	46.0	1806.2	581.3	268.1	623.7	666.7	4.7	17.7	11.2	37.6
Mecklenburg Co	1942.3	766.6	788.1	566.2	412.0	81.2	5333.8	7177.9	214.5	825.9	794.7	7.9	10215.2	3734.6	373.8	14973.1	3139.8	452.2	13604.0	14027.2	143.6	471.8	274.6	1193.1
Mitchell Co	474.1	76.4	25.0	56.1	50.1	0.0	314.4	583.7	7.2	23.4	21.5	0.1	735.0	131.6	22.4	865.1	277.2	37.8	250.9	252.0	1.8	6.9	4.3	15.1
Montgomery Co	601.5	127.8	55.6	189.5	142.8	0.1	226.0	180.2	3.1	14.9	14.1	0.2	1162.4	221.6	45.0	1600.8	638.0	1619.0	713.0	806.7	5.5	21.2	13.5	42.9
Moore Co	8.1	12.4	14.7	4.2	2.9	0.0	357.2	412.4	8.0	36.6	34.8	0.5	2038.4	499.1	58.2	2431.8	822.7	2527.9	1418.4	1304.3	10.5	38.9	24.0	88.8
Nash Co	292.3	183.3	101.7	21.4	15.9	0.8	281.2	601.6	10.1	39.8	38.0	0.5	2625.0	564.8	69.9	3999.1	1101.3	2089.5	2713.2	4078.6	25.2	101.5	66.9	182.3
New Hanover Co	2358.5	7088.0	30044.9	1603.2	789.0	19.1	1183.6	3318.5	307.1	202.5	190.4	1.5	2394.7	691.5	75.3	2835.8	819.9	132.3	2276.1	2134.4	17.4	63.8	38.9	149.1
Northampton Co	188.6	24.9	9.7	67.5	22.2	1.5	168.0	508.5	7.7	25.4	24.0	0.2	898.1	151.7	26.7	3198.9	783.3	1768.1	565.5	880.8	5.1	20.7	13.9	35.0
Onslow Co	46.7	24.0	36.2	4.1	3.6	0.0	1148.8	495.7	11.1	59.2	56.0	0.7	2678.9	538.9	79.8	3247.7	1031.0	2664.2	2358.0	2154.5	17.4	64.1	39.4	146.5
Orange Co	81.4	530.1	148.4	20.8	14.1	0.0	863.8	768.1	15.9	77.7	73.8	0.8	2572.9	658.3	127.1	3531.7	1045.5	415.6	1625.6	3648.1	23.9	86.8	56.1	157.4
Pamlico Co	0.0	0.0	0.0	0.0	0.0	0.0	1813.8	317.6	6.5	43.3	40.4	0.6	429.9	78.7	10.8	1013.2	261.6	109.7	237.9	206.9	1.6	6.0	3.6	14.1
Pasquotank Co	3.7	10.4	9.1	22.1	6.9	0.0	600.6	340.6	8.3	40.3	38.6	0.4	766.0	202.8	26.6	3157.1	733.0	152.0	504.6	493.0	3.6	13.4	8.2	30.5
Pender Co	0.0	0.0	0.0	0.2	0.1	0.0	273.1	243.1	7.3	24.0	22.8	0.3	1373.5	320.7	55.7	2127.5	818.9	3322.6	1143.7	1727.7	10.1	41.1	27.3	71.4
Perquimans Co	0.0	0.0	0.0	0.6	0.1	0.0	568.1	234.1	5.4	23.6	22.4	0.3	487.0	75.2	10.8	2103.1	501.1	594.7	274.3	318.9	2.1	8.2	5.3	16.8
Person Co	348.6	9148.9	26525.6	4332.8	2080.4	35.4	195.7	210.9	3.8	17.9	17.1	0.3	1398.5	212.7	43.1	1565.9	513.7	226.3	559.2	518.4	4.0	14.7	9.0	33.7
Pitt Co	652.1	263.8	58.5	60.5	47.3	3.8	456.0	975.2	21.5	75.4	72.4	0.9	3195.1	617.5	71.5	4185.0	1118.4	2310.0	1952.1	1828.7	15.0	55.3	33.9	127.4
Polk Co	0.3	2.5	1.5	0.6	0.4	0.0	104.3	102.1	1.8	9.7	9.2	0.1	663.6	141.5	29.5	902.5	283.2	57.8	514.2	951.9	5.0	21.2	14.5	32.2
Randolph Co	2771.5	20.7	3.5	189.0	173.0	0.0	527.9	725.3	11.2	50.4	48.0	0.9	4219.3	723.1	95.0	4544.5	1360.5	3962.6	3150.5	3834.4	26.2	100.8	64.2	206.1
Richmond Co	11.3	91.7	56.2	28.9	17.4	0.0	203.7	533.7	7.9	26.1	24.6	0.3	1075.8	250.1	40.0	1522.7	476.7	1978.6	1013.3	1071.0	7.5	28.3	17.8	61.1
Robeson Co	155.6	3460.0	8307.0	350.0	153.4	32.4	318.4	1038.9	15.9	60.0	57.2	0.7	3696.5	652.9	106.8	8916.6	2484.5	5570.1	2558.2	3770.5	23.2	93.6	61.9	166.5
Rockingham Co	802.7	4000.3	10371.5	665.1	497.3	49.6	431.1	654.9	9.4	37.2	35.1	0.5	2779.0	500.4	71.6	3327.7	1001.8	324.9	1499.3	1515.1	11.8	44.1	27.4	98.5
Rowan Co	2416.6	3019.7	12321.7	857.6	692.1	107.2	651.6	1048.1	14.5	56.4	53.1	0.7	2741.2	551.2	121.1	4216.3	1111.1	543.5	3397.7	3767.8	26.4	98.9	61.6	215.6
Rutherford Co	773.8	2923.6	38083.5	2635.5	2101.9	32.1	378.2	518.1	7.5	30.9	29.1	0.4	1777.3	347.3	50.9	2546.6	751.7	395.6	1079.2	1047.5	8.2	30.8	19.2	67.4
Sampson Co	23.7	28.8	19.9	78.4	22.3	0.0	161.1	391.9	7.9	34.8	33.6	0.4	1969.0	340.8	51.1	7721.9	1748.8	22001.7	1328.1	1675.3	10.7	42.0	27.3	80.1
Scotland Co	906.9	1789.1	281.4	473.7	455.3	3.1	104.9	392.8	5.3	16.4	15.5	0.2	957.0	236.5	47.7	1969.5	746.7	688.5	759.8	766.5	5.5	20.7	12.9	45.7

County	Point						Non-road						Area						Mobile					
	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3	VOC	NOx	SO2	PM-10	PM-2.5	NH3
Stanly Co	377.8	547.9	1773.0	257.2	183.4	0.0	484.3	405.5	6.6	34.6	32.8	0.4	1518.5	311.3	43.6	2497.4	708.0	1598.5	1457.0	1171.5	10.1	36.7	22.3	85.8
Stokes Co	151.3	4299.8	10511.0	3009.0	2602.3	4.5	272.4	248.3	4.1	19.5	18.4	0.2	1833.3	247.5	48.8	2110.5	669.8	346.4	654.4	646.1	5.1	19.0	11.9	41.6
Surry Co	1388.2	264.6	330.6	205.9	130.5	0.0	401.8	351.1	6.1	34.5	32.8	0.6	2250.3	439.1	58.8	2987.0	817.4	2000.0	1465.9	2274.5	13.8	56.1	37.4	96.4
Swain Co	0.0	0.0	0.0	0.0	0.0	0.0	992.6	102.8	2.0	35.5	33.0	0.3	811.9	132.2	17.8	822.1	303.2	215.6	354.6	362.1	2.6	9.9	6.2	21.0
Transylvania Co	131.4	945.4	1567.8	54.2	51.2	0.7	1245.5	188.2	3.6	49.8	46.4	0.4	1073.9	191.2	21.8	1363.2	451.9	107.9	541.3	531.0	4.1	15.1	9.4	33.8
Tyrrell Co	0.0	0.0	0.0	0.0	0.0	0.0	1365.6	307.2	7.3	32.1	30.1	0.5	280.1	33.5	5.3	2979.7	677.5	280.2	117.6	139.4	0.9	3.6	2.3	7.2
Union Co	389.4	78.4	171.1	88.7	39.9	0.0	968.9	1641.2	31.1	137.6	131.4	1.7	2999.8	663.1	68.4	5487.8	1609.5	6671.2	3171.3	2363.4	20.8	73.9	44.0	183.4
Vance Co	248.9	929.9	301.3	163.8	150.5	0.1	395.9	197.2	3.7	23.0	21.7	0.3	1293.2	257.2	35.7	1773.1	528.9	91.6	898.7	1319.0	7.7	31.0	20.5	56.2
Wake Co	1135.2	216.6	77.4	263.7	74.8	3.0	3863.0	5420.7	165.3	636.6	612.9	5.9	11257.2	3733.4	358.4	17383.2	5096.3	493.8	10141.6	13813.8	122.3	414.7	246.9	997.6
Warren Co	0.7	2.1	0.2	2.6	1.7	0.0	142.6	105.2	2.3	10.2	9.8	0.1	887.3	138.1	22.0	1221.4	395.8	680.2	428.6	702.0	3.9	16.0	10.8	25.8
Washington Co	0.0	0.0	0.0	10.8	4.3	0.0	535.7	300.2	6.4	27.0	25.7	0.3	682.9	152.8	24.7	1759.7	653.6	572.3	272.2	288.3	2.1	7.8	4.9	16.8
Watauga Co	27.5	46.5	42.2	18.0	13.8	0.0	716.4	345.0	7.6	48.5	45.9	0.5	1508.6	376.0	86.9	1911.2	652.0	259.1	680.4	710.5	5.0	18.9	11.9	40.3
Wayne Co	856.8	3524.7	15683.2	766.8	469.8	27.6	397.3	566.0	10.7	48.2	46.2	0.7	2517.3	591.5	73.3	5909.1	1474.6	8632.2	2022.1	1802.5	14.7	53.5	32.6	126.2
Wilkes Co	1243.0	327.9	77.4	145.2	115.4	3.2	307.5	249.4	4.4	24.5	23.3	0.4	2160.2	387.3	87.8	2865.6	873.9	5219.3	1150.2	1194.4	9.2	34.8	21.8	75.0
Wilson Co	753.1	364.5	881.1	203.1	167.4	5.2	398.6	907.4	13.8	51.5	48.8	0.6	1971.6	354.6	40.3	3271.7	791.1	584.6	1525.4	1980.9	13.2	51.6	33.4	99.9
Yadkin Co	38.6	1.2	7.0	3.5	2.5	0.0	123.2	179.7	3.5	16.4	15.8	0.2	1276.6	215.8	30.6	2104.6	545.5	1635.1	897.5	1359.4	7.9	32.1	21.4	55.0
Yancey Co	15.6	3.0	5.3	0.2	0.1	0.0	274.7	351.0	4.4	18.4	17.0	0.1	964.3	151.7	31.0	1054.7	376.1	70.6	256.4	294.0	2.0	7.7	4.9	15.8

Emissions reported as tons/year.
See Note 1 in section 2

Table 14. 2009 Annual Emission Summary for 12 km ASIP States (tons)

State	Point						Non-road						Area						Mobile					
	VOC	Nox	SO2	PM10	PM2.5	NH3	VOC	Nox	SO2	PM10	PM2.5	NH3	VOC	Nox	SO2	PM10	PM2.5	NH3	VOC	Nox	SO2	PM10	PM2.5	NH3
AL	49117	151714	479298	32390	23151	2491	50249	56862	3471	4027	3776	36	170956	35831	50910	465666	105211	66318	76990	101831	810	3171	2032	6364
FL	38790	132185	251566	48879	39856	3175	209543	163794	8967	15613	14866	148	471699	47979	40827	601700	153344	41773	340947	315840	2612	9911	6173	21781
GA	35758	148809	471432	40888	29813	4649	67686	85733	2725	7521	7175	68	306337	51925	60604	840245	169011	91439	195125	209349	1585	6072	3840	12687
KY	49155	129779	326611	23637	15965	1160	38558	94752	9180	5544	5203	34	97379	43548	43222	248844	52553	53115	73942	101182	759	2976	1920	5796
MS	38151	92409	102143	24202	13976	1002	36197	80567	7191	4270	3985	25	139636	8048	982	373154	67173	63985	52107	70743	537	2275	1508	4035
NC	62161	101236	284802	36007	26360	1730	74056	70997	1892	6055	5760	72	200873	45382	6281	315004	90729	170734	168676	201609	1503	5572	3493	11825
SC	36325	86934	172933	32765	25432	1921	43061	43235	1701	3471	3294	36	162152	25259	14411	307452	67567	31595	72603	92499	721	2862	1855	5523
TN	67470	124274	326067	49753	40171	1991	55358	86641	5651	5877	5557	48	151980	20717	30614	234285	52357	35222	115181	151912	1076	4206	2751	7782
VA	44504	117265	288213	18556	14055	3743	57009	54993	1707	7510	7136	53	146587	53596	106083	270648	61875	46798	96770	134232	1079	3747	2241	9086
WV	15171	124359	333462	22747	15709	671	18069	30133	359	1640	1528	11	57472	14384	12300	118365	23903	10637	24843	35635	279	1068	684	2148

Emissions reported as tons/year.
See Note 1 in section 2

Appendix F.1
Point Source Emissions
Inventory Documentation

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1. INTRODUCTION

The attainment modeling for Hickory and Greensboro-Winston Salem-High Point, North Carolina PM2.5 non-attainment areas was performed in conjunction with the regional haze modeling being done by the Southeast Regional Planning Organization, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the fine particulate matter (PM2.5) and ozone modeling being done by the Association of Southeastern Integrated Planning (ASIP). VISTAS and ASIP are run by the ten southeast states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia). Since the regional haze and PM2.5 modeling uses annual simulations and includes an intermediate year that is the attainment year required for Hickory and Greensboro-Winston Salem-High Point areas, the North Carolina Division of Air Quality (NCDAQ) decided to use the this modeling for its attainment demonstration.

VISTAS/ASIP developed emission estimates for all pollutants of concern for regional haze, fine particulate matter and ozone. The emissions inventory discussions relevant to PM2.5 formation will be discussed in this document.

2. 2002 POINT SOURCE INVENTORY DEVELOPMENT

This section details the development of the 2002 base year inventory for point sources. There were two major components to the development of the point source sector of the inventory. The first component was the incorporation of data submitted by State and Local (S/L) agencies to the United States Environmental Protection Agency (USEPA) as part of the Consolidated Emissions Reporting Rule (CERR) requirements. Work on incorporating the CERR data into the revised base year involved: 1) obtaining the data from the USEPA or the S/L agencies, 2) evaluating the emissions and pollutants reported in the CERR submittals, 3) augmenting CERR data with annual emission estimates for primary coarse particulate matter (PM_{10}-PRI) and $PM_{2.5}$-PRI; 4) evaluating the emissions from electric generating units, 5) completing quality assurance reviews for each component of the point source inventory, and 6) updating the database with corrections or new information from S/L agencies based on their review of the 2002 inventory. The processes used to perform the emission inventory development are described in the first portion of this section.

The second component was the development of a “typical” year inventory for electric generating units (EGUs). The VISTAS/ASIP states determined that a typical year EGU inventory was necessary to smooth out any anomalies in emissions from the EGU sector due to meteorology, economic, and outage factors in 2002. This is consistent with the USEPA's guidance for SIP modeling. The typical year EGU inventory is intended to represent the five-year (2000-2004) period that will be used for the attainment demonstration for the PM2.5 and ozone SIPs, and to determine the regional haze reasonable progress goals. The second part of this section discusses the development of the typical year EGU inventory.

A list of sources located in Hickory and Greensboro-Winston Salem-High Point areas, as well as the annual emissions can be found in Appendix E.

2.1 Development of 2002 Actual Point Source Inventory

VISTAS/ASIP contracted with MACTEC to develop the 2002 emission inventory. NCDAQ submitted the most updated statewide emission inventory to the contractor with the exception of the emissions from the three local programs. For the three local programs, Forsyth, Mecklenburg, and Buncombe Counties, the CERR submittal from the USEPA was used. Once all of the files were obtained, MACTEC ran the files through the USEPA's National Emissions Inventory (NEI) Input Format (NIF) Basic Format and Content checking tool to ensure that the files were submitted in standard NIF format and that there were no referential integrity issues with those files.

The primary task in preparing the 2002 base year inventory was the incorporation of corrections and new information as submitted by the S/L agencies based on their review of the previous draft versions of the inventory. The following subsections document the data sources for the inventory, the checks made on the CERR submittals, the evaluation of EGU emissions, and other quality assurance/quality control (QA/QC) checks. The final subsection summarizes the 2002 NOx and VOC inventory by sector (EGU and non-EGU).

Throughout the development of the point source emissions inventory, the NCDAQ completed detailed reviews of the inventories prepared by the VISTAS/ASIP contractor and provided comments and data corrections when needed.

2.1.1 Consolidated Emissions Reporting Rule

The CERR was published in the Federal Register on Monday, June 10, 2002 (FR Volume 67, Number 111, pp 39602 - 39616). This brief summary is provided as a quick introduction to the CERR and covers the major items in the rule.

The purpose of the CERR is to simplify reporting, offer options for data collection and exchange, and unify reporting dates for various categories of criteria pollutant emission inventories. The rule applies to S/L agencies. Previous reporting requirements have, at times, forced reporting agencies into inefficient collecting and reporting activities. This rule consolidates the emission inventory reporting requirements found in various parts of the Clean Air Act (CAA). Consolidation of reporting requirements will enable S/L agencies to better explain to program managers and the public the necessity for a consistent inventory program, increases the efficiency of the emission inventory program, and provide more consistent and uniform data.

States are required to prepare a comprehensive statewide inventory every three years. The first inventory was for the year 2002 and was due June 1, 2004. This CERR inventory was used for the VISTAS/ASIP 2002 base year.

2.1.2 Initial Data Evaluation

MACTEC conducted an initial review of the 2002 point source CERR data. The following evaluations were completed to identify potential data quality issues associated with the CERR data:

- Compared the number of sites in the CERR submittal to the number of sites in the VISTAS draft 2002 inventory; the number of sites in the CERR submittal was less than in the VISTAS draft 2002 inventory, since the CERR data was limited to major sources, while the VISTAS draft 2002 inventory contained data for both major and minor sources; verified with S/L contacts that minor sources not included in the CERR point source inventory were included in the CERR area source inventory.

- Checked for correct pollutant codes and corrected to make them NIF-compliant.

- Checked for types of particulate matter (PM) codes reported (i.e., PM-FIL, PM-CON, PM-PRI, PM10-PRI, PM10-FIL, PM25-PRI, PM25-FIL); corrected codes with obvious errors (i.e., changed PMPRI to PM-PRI). The PM augmentation process for filling in missing PM pollutants is discussed later in Section 2.1.3.

- Converted all emission values that were not in tons to tons to allow for preparation of emission summaries using consistent units.

- Checked start and end dates in the NIF files to confirm consistency with the 2002 base year.

- Compared annual and daily emissions when daily emissions were reported; in some cases, the daily value was non-zero (but very small) but the annual value was zero. This was generally the result of rounding in an S/L agency's submittal.

- Compared ammonia (NH_3) emissions as reported in the CERR submittals and the 2002 Toxics Release Inventory; worked with S/L agencies to resolve any outstanding discrepancies.

- Compared sulfur dioxide (SO_2) and nitrogen oxides (NOx) emissions for EGUs to the USEPA's Clean Air Markets Division (CAMD) continuous emission monitoring (CEM) database to identify any outstanding discrepancies. A full discussion of the EGU emissions analysis is discussed later in Section 2.1.4.

- Prepared State-level emission summaries by pollutant for both the EGU and non-EGU sectors to allow S/L agencies to compare emissions as reported in the 1999 NEI Version 2, the VISTAS draft 2002 inventory, and the CERR submittals.

- Prepared facility-level emission summaries by pollutant to allow S/L agencies to review facility level emissions for reasonableness and accuracy.

MACTEC communicated the results of these analyses through email/telephone exchanges with the S/L point source contacts as well as through Excel summary spreadsheets. The VISTAS S/L agencies submitted corrections and updates as necessary to resolve any QA/QC issues from these checks.

2.1.3 PM Augmentation

Particulate matter emissions can be reported in many different forms, as follows:

PM Category	**Description**
PM-PRI	Primary PM (includes filterable and condensable)
PM-CON	Primary PM, condensable portion only (all less than 1 micron)
PM-FIL	Primary PM, filterable portion only
PM_{10}-PRI	Primary PM_{10} (includes filterable and condensable)

PM_{10}-FIL	Primary PM_{10}, filterable portion only
$PM_{2.5}$-PRI	Primary $PM_{2.5}$ (includes filterable and condensable)
$PM_{2.5}$-FIL	Primary $PM_{2.5}$, filterable portion only

North Carolina reports PM-PRI, PM_{10}-PRI, and $PM_{2.5}$–PRI in the CERR. From any one of these pollutants, the USEPA has developed augmentation procedures to estimate PM10-PRI, PM_{10}-FIL, $PM_{2.5}$-PRI, $PM_{2.5}$-FIL, and PM-CON. If not included in a S/L inventory, PM_{10}-PRI and $PM_{2.5}$-PRI were calculated by adding PM_{10}-FIL and PM-CON or $PM_{2.5}$ -FIL and PM-CON, respectively.

The procedures for augmenting point source PM emissions are documented in detail in the USEPA's document *Documentation for the Final 1999 National Emissions Inventory {Version 3} for Criteria Air Pollutants and Ammonia – Point Sources*, January 31, 2004. (http://www.epa.gov/ttn/chief/net/1999inventory.html). Briefly, the PM data augmentation procedure includes the following five steps:

- Step 1: Prepare S/L/Tribal PM and PM_{10} Emissions for Input to the PM Calculator
- Step 2: Develop and Apply Source-Specific Conversion Factors
- Step 3: Prepare Factors from PM Calculator
- Step 4: Develop and Apply Algorithms to Estimate Emissions from S/L/Tribal Inventory Data
- Step 5: Review Results and Update the NEI with Emission Estimates and Control Information.

Please refer to the USEPA documentation for a complete description of the PM augmentation procedures.

Table 2.1.3-1 compares the original PM emission estimates from the North Carolina CERR submittals and the revised 2002 VISTAS emissions estimates calculated using the above methodology. This table is intended to show that MACTEC took whatever State/Local provided in the way of PM and filled in gaps to add in PM-CON where emissions were missing in order to calculate PM_{10}-PRI and $PM_{2.5}$ -PRI for all processes to get a complete set of particulate data.

MACTEC did not compare any other pollutants besides PM, since for other pollutants CERR emissions equal VISTAS emissions

Table 2.1.3-1. Comparison of North Carolina PM Emissions: CERR versus the 2002 VISTAS Point Source Inventory

Database	PM-PRI	PM-FIL	PM-CON	PM10-PRI	PM10-FIL	PM2.5-PRI	PM2.5-FIL
CERR	48,110	0	0	36,222	0	24,159	0
VISTAS	48,114	41,407	6,708	36,992	30,284	27,512	21,113

Note 1: CERR refers to data as submitted by S/L agencies; VISTAS refers to data calculated by MACTEC using the PM augmentation methodologies described in this document.

Note 2: The emission values in the VISTAS emission rows above differ slightly from the final values in the inventory. This is due to several corrections and updates to the 2002 inventory submitted by S/L agencies after the PM augmentation was performed as discussed in Section 2.1.3.

After the PM augmentation process was performed, MACTEC executed a series of checks to identify potential inconsistencies in the PM inventory. These checks included:

- PM-PRI less than PM_{10}-PRI, $PM_{2.5}$ -PRI, PM_{10}-FIL, $PM_{2.5}$ -FIL, or PM-CON;
- PM-FIL less than PM_{10}-FIL or $PM_{2.5}$ -FIL;
- PM_{10}-PRI less than $PM_{2.5}$ -PRI, PM_{10}-FIL, $PM_{2.5}$ -FIL or PM-CON;
- PM_{10}-FIL less than $PM_{2.5}$ -FIL;
- PM25-PRI less than $PM_{2.5}$ -FIL or PM-CON;
- The sum of PM_{10}-FIL and PM-CON not equal to PM_{10}-PRI; and
- The sum of $PM_{2.5}$ -FIL and PM-CON not equal to $PM_{2.5}$ -PRI.

MACTEC asked S/L agencies to review this information and provide corrections where the inconsistencies were significant.

Note that for the inventory, only the PM_{10}-PRI and $PM_{2.5}$-PRI emission estimates were retained since they are the only two PM species that are included in the air quality modeling. Other PM species were removed from the inventory to facilitate emissions modeling.

2.1.4 EGU Analysis

MACTEC made a comparison of the annual sulfur dioxide (SO2) and NO_x emissions for EGUs as reported in the S/L agencies CERR submittals and the data from the USEPA's Clean Air Markets Division (CAMD) continuous emission monitoring (CEM) database to identify any outstanding discrepancies. Facilities report hourly CEM data to the USEPA for units that are subject to CEM reporting requirements of the NOx SIP Call rule and Title IV of the CAA. The USEPA sums the hourly CEM emissions to the annual level, and MACTEC compared these annual CEM emissions to those in the S/L inventories. The 2002 CEM inventory containing NOx and SO2 emissions and heat input data were downloaded from the USEPA CAMD web site (www.epa.gov/airmarkets). The data were provided by quarter and emission unit.

The first step in the EGU analysis involved preparing a crosswalk file to match facilities and units in the CAMD inventory to facilities and units in the S/L inventories. In the CAMD inventory, the Office of Regulatory Information Systems (ORIS) identification (ID) code identifies unique facilities and the unit ID identifies unique boilers and internal combustion engines (i.e., turbines and reciprocating engines). In the North Carolina point source emissions inventories, the State and county code (FIPS code) and State facility ID together identify unique facilities and the emission unit ID identifies unique boilers or internal combustion engines. In most cases, there is a one-to-one correspondence between the CAMD identifiers and the S/L identifiers. However, in some of the S/L inventories, the emissions for multiple emission units are summed and reported under one emission unit ID. MACTEC created an Excel spreadsheet that contained an initial crosswalk with the ORIS ID and unit ID in the CEM inventory matched to the State and county FIPS, State facility ID, and emission unit ID in the emissions inventories. The initial crosswalk contained both the annual emissions summed from the CAMD database, as well as, the S/L emission estimate. The matching at the facility level was nearly complete. In some cases, however, S/L agencies or stakeholders' assistance was needed to match some of the CEM units to emission units in the S/L inventories.

The second step in the EGU analysis was to prepare an Excel spreadsheet that compared the annual emissions from the hourly CAMD inventory to the annual emissions reported in the S/L inventory. The facility-level comparison of CEM to emission inventory NOx and SO2 emissions found that for most facilities, the annual emissions from the S/L inventory equaled the CAMD CEM emissions. Minor differences could be explained because the facility in the S/L inventory contained additional small or emergency units that were not included in the CAMD database.

The final step in the EGU analysis was to compare the SO2 and NOx emissions for select Southern Company units in the VISTAS/ASIP region. Southern Company is a super-regional company that owns EGUs in four VISTAS/ASIP States – Alabama, Florida, Georgia, and Mississippi – and participates in VISTAS as an industry stakeholder. Southern Company independently provided emission estimates for 2002 as part of the development of the preliminary VISTAS 2002 inventory. Emission estimates were reviewed by the States and incorporated into the States CERR submittal. There were no major inconsistencies between the Southern Company data, the CAMD data, and the S/L CERR data.

The minor inconsistencies found included small differences in emission estimates (<2 percent difference), exclusion/inclusion of small gas-fired units in the different databases, and grouping of emission units in S/L CERR submittals where CAMD listed each unit individually. MACTEC compared SO_2 and NO_x emissions on a unit-by-unit basis and did not find any major inconsistencies.

2.1.5 Emission Inventory QA Review

Throughout the inventory development process, QA steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for VISTAS. QA was an important component to the inventory development process and MACTEC performed the following QA steps on the point source component of the VISTAS revised 2002 base year inventory:

1. Facility level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.

2. State-level EGU and non-EGU comparisons (by pollutant) were developed between the 2002 base year inventory, the draft VISTAS 2002 inventory, and the 1999 NEI Version 2 inventory.

3. Data product summaries and raw NIF 3.0 data files were provided to the VISTAS Emission Inventory Technical Advisor and to the Point Source, EGU, and non-EGU Special Interest Work Group representatives for review and comment. Changes based on these comments were reviewed and approved by the S/L point source contact prior to implementing the changes in the files.

Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes.

2.1.6 Summary of the 2002 Actual Inventory

Tables 2.1.6-1 summarize the final 2002 actual base year inventory for North Carolina. All values are in tons per year. The EGU emissions include the emissions from all processes with a Source Classification Code (SCC) of either 1-01-xxx-xx (External Combustion Boilers – Electric Generation) or 2-01-xxx-xx (Internal Combustion Engines – Electric Generation). Emissions for all other SCCs are included in the non-EGU column.

Table 2.1.6-1 2002 Actual Point Source Inventory for North Carolina

State	All Point Sources	EGUs	Non-EGUs
SO2	522,113	477,990	44,123
NOx	196,782	151,854	44,928
VOC	62,170	988	61,182
CO	64,461	13,885	50,576
PM_{10}-PRI	36,592	22,754	13,838
$PM_{2.5}$-PRI	26,998	16,498	10,500
NH_3	1,234	54	1,180

2.2 Development of Typical Year EGU Inventory

VISTAS/ASIP developed a typical year 2002 emission inventory for EGUs to avoid anomalies in emissions due to variability in meteorology, economic, and outage factors in 2002. The typical year inventory represents the five year (2000-2004) period, which are the years used to calculate the average design value.

Data from the USEPA's CAMD were used to develop normalization factors for producing a 2002 typical year inventory for EGUs. The VISTAS/ASIP contractor used the ratio of the 2000-2004 average heat input and the 2002 actual heat input to normalize the 2002 actual emissions. MACTEC obtained data from the USEPA CAMD for utilities regulated by the Acid Rain program. Annual data for the period 2000 to 2004 were obtained from the CAMD web site. The parameters available were the SO2 and NOx emission rates, heat input, and operating hours.

MACTEC used the actual 2002 heat input and the average heat input for the 5-year period from 2000-2004 as the normalization factor, as follows:

$$\text{Normalization Factor:} \quad \frac{\text{2000-2004 average heat input}}{\text{2002 actual heat input}}$$

If the unit did not operate for all five years, then the 2000-2004 average heat input was calculated for the one or two years in which the unit did operate. The annual actual emissions were multiplied by the normalization factor to determine the typical emissions for 2002, as follows:

Typical Emissions = 2002 actual emissions x Normalization Factor

After applying the normalization factor, some adjustments were needed for special circumstances. For example, a unit may not have operated in 2002 and thus have zero emissions. If the unit had been permanently retired prior to 2002, then MACTEC used zero emissions for the typical year. If the unit had not been permanently retired and would normally operate in a typical year, then MACTEC used the 2001 (or 2000) heat input and emission rate to calculate the typical year emissions.

The final step was to replace the 2002 actual emissions with the 2002 typical year data described above. MACTEC provided the raw data and results of the typical year calculations in a spreadsheet for S/L agency to review and comment. Any comments made were incorporated into the typical 2002 inventory.

Table 2.2-1 summarizes emissions by State and pollutant for the actual 2002 EGU inventory and the typical year EGU inventory. For the entire VISTAS region, actual 2002 NOx emissions were about 0.1 percent lower than the typical year emissions. North Carolina's actual 2002 NOx emissions were 2.0 percent higher than the typical year emissions.

Table 2.2-1 2002 NO_x Emissions Comparison for EGUs

	NO_x Emissions (tons/year)		
State	**Actual 2002**	**Typical 2002**	**Percentage Difference**
AL	161,038	154,704	3.9
FL	257,677	282,507	-9.6
GA	147,517	148,126	-0.4

KY	198,817	201,928	-1.6
MS	43,135	40,433	6.3
NC	151,854	148,812	2.0
SC	88,241	88,528	-0.3
TN	157,307	152,137	3.3
VA	86,886	85,081	2.1
WV	230,977	222,437	3.7

3. 2009 POINT SOURCE EMISSIONS INVENTORY DEVELOPMENT

Different approaches were used for different sectors of the point source inventory. For the EGUs, VISTAS/ASIP relied primarily on the Integrated Planning Model® (IPM) to project future generation, as well as, to calculate the impact of future emission control programs. The IPM results were adjusted based on S/L agency knowledge of planned emission controls at specific EGUs. For non-EGUs, VISTAS/ASIP used recently updated growth and control data consistent with the data used in the USEPA's Clean Air Interstate Rule (CAIR) analyses, and supplemented these data with available S/L agency input and updated fuel use forecast data for the United States Department of Energy.

For both sectors, VISTAS/ASIP generated 2009 inventory with control scenarios that account for post-2002 emission reductions from promulgated and proposed federal, State, local, and site-specific control programs as of July 1, 2004. Section 3.1 discusses the EGU projection inventory development, while Section 3.2 discusses the non-EGU projection inventory development.

3.1 EGU Emission Projections

The following subsections discuss the aspects of the development of the EGU projections.

- A chronology of the EGU development process used by MACTEC and discuss key decisions in selecting the final methods for performing the emissions projections.
- The development of the final set of IPM runs that are included in the VISTAS/ASIP 2009 inventory.
- The process of transforming the IPM parsed files into NIF format.

- The process for ensuring that units accounted for in IPM were not double-counted in the non-EGU inventory.

- The QA/QC checks that were made to ensure that the IPM results were properly incorporated into the VISTAS/ASIP inventory.

- The changes to the IPM results that S/L agencies requested be included in the VISTAS/ASIP inventory based on new information that was not accounted for in the IPM runs.

- Summary of 2002 and 2009 EGU emissions by state for NOx and VOC

3.1.1 Chronology of the Development of EGU Projections

Initially, VISTAS/ASIP considered three options for developing the 2009 projection inventory for EGUs:

- Option 1 – Use the results of IPM modeling conducted in support of the proposed CAIR base and control case analyses as the starting point and refine the projections with readily available inputs from stakeholders; these IPM runs were conducted for 2010, which VISTAS would use to represent projected emissions in 2009.

- Option 2 – Use the VISTAS/ASIP 2002 typical year as the starting point, apply growth factors from the Energy Information Administration, and refine future emission rates with stakeholder input regarding utilization rates, capacity, retirements, and new unit information.

- Option 3 – Use the results of a new round of IPM modeling sponsored by VISTAS and the Midwest Regional Planning Organization (MRPO). These runs incorporated VISTAS specific unit and regulation modified parameters, and generate results for 2009 explicitly.

An additional consideration for each of the three options was the inclusion of emission projections developed by the Southern Company specifically for their units. Southern Company is a super-regional company that owns EGUs in Alabama, Florida, Georgia, and Mississippi and participates in VISTAS as an industry stakeholder. Southern Company used their energy budget forecast to project net generation and heat input for every existing and future Southern Company EGU for the year 2009. Further documentation of how Southern Company generated the 2009 inventory for their units can be found in *Developing Southern Company Emissions and Flue Gas*

Characteristics for VISTAS Regional Haze Modeling (April 2005, presented at 14th International Emission Inventory Conference).

Each of these three options and the Southern Company projections were discussed in a series of conference calls with the VISTAS EGU Special Interest Work Group (SIWG) during the fall of 2004. During a conference call on December 6, 2004, the VISTAS EGU SIWG approved the use of the latest VISTAS/MRPO sponsored IPM runs (Option 3) to represent 2009 EGU forecasts of emissions the future year cases.

The Option 3 IPM modeling resulted from a joint agreement by VISTAS and MRPO to work together to develop future year utility emissions based on IPM modeling. The decision to use IPM modeling was based in part on a study of utility forecast methods by E.H. Pechan and Associates, Inc. (Pechan) for MRPO, which recommended IPM as a viable methodology (see *Electricity Generating Unit {EGU} Growth Modeling Method Task 2 Evaluation*, February 11, 2004). Although the USEPA used IPM recently to support their rulemaking for the CAIR, VISTAS stakeholders felt that certain model inputs needed to be improved. Thus, VISTAS and MRPO decided to hire contractors to conduct new IPM modeling and to post-process the IPM results. Southern Company projections in 2009 were roughly comparable with IPM.

In August 2004, VISTAS/ASIP contracted with ICF to run IPM to provide utility forecasts for 2009 under two future scenarios – Base Case and CAIR Case. The Base Case represents the current operation of the power system under currently known laws and regulations, including those that come into force in the study horizon. The CAIR Case is the Base Case with the proposed CAIR rule superimposed. The run results were parsed at the unit level for 2009. The IPM output files were delivered by ICF in November, and the post-processed data files were delivered by Pechan in December 2004. Only the CAIR case was used in the final 2009 modeling.

On March 10, 2005, the USEPA issued the final CAIR. VISTAS and MRPO, in conjunction with other RPOs, conducted another round of IPM modeling, which reflected changes to control assumptions based on the final CAIR as well as additional changes to model inputs based on S/L agency and stakeholder comments. Several conference calls were conducted in the spring/summer of 2005 to discuss and provide comments on IPM assumptions related to six main topics: power system operation, generating resources, emission control technologies, set-up parameters and rule, financial assumptions, and fuel assumptions.

For the summer 2006 set of IPM runs, ICF generated two different parsed files. One file includes all fuel burning units (fossil, biomass, landfill gas), as well as, non-fuel burning units (hydro, wind, etc.). The second file contains just the fossil-fuel burning units (e.g., emissions from biomass and landfill gas are omitted). The RPOs decided to use the fossil-only file for modeling to be consistent with the USEPA, since the USEPA used the fossil only results for CAIR analyses. For the 10 VISTAS states, non-fossil fuels accounted for only 0.13 percent of the NOx emissions and 0.04 percent of the SO2 emissions in the 2009 IPM runs

VISTAS/ASIP asked S/L agencies to review the results of the summer 2006 set of IPM runs, which were incorporated into the VISTAS inventory. The NCDAQ primarily reviewed and commented on the IPM results with respect to IPM decisions on NOx post-combustion controls and SO2 scrubbers.

3.1.2 VISTAS/MRPO IPM runs for EGU sources

The following summary of the VISTAS/MRPO IPM® modeling is based on ICF's documentation *Future Year Electricity Generating Sector Emission Inventory Development Using the IPM® in Support of Fine Particulate Mass and Visibility Modeling in the VISTAS and Midwest RPO Regions,* April 2005. The ICF documentation is to be used as an extension to EPA's proposed CAIR modeling runs documented in *Documentation Supplement for EPA Modeling Applications (V.2.1.6) Using the IPM,* EPA 430/R-03-007, July 2003.

IPM provides "forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints." The underlying database in this modeling is USEPA's National Electric Energy Data System (NEEDS) released with the CAIR Notice of Data Availability (NODA). The NEEDS database contains the existing and planned/committed unit data in the USEPA modeling applications of IPM. NEEDS includes basic geographic, operating, air emissions, and other data on these generating units. VISTAS States and stakeholders provided changes for:

- NO_x post-combustion control on existing units
- SO_2 scrubbers on existing units
- SO_2 emission limitations
- PM controls on existing units
- Summer net dependable capacity
- Heat rate for existing units
- SO_2 and NO_x control plans based on State rules or enforcement settlements

The years 2009 and 2018 were explicitly modeled in this set of runs.

3.1.3 Post-Processing of IPM Parsed Files

The following summary of the VISTAS/MRPO IPM modeling is based on Pechan's documentation *LADCO IPM Model Parsed File Post-Processing Methodology and File Preparation*, February 8, 2005. The essence of the IPM model post-processing methodology is to take an initial IPM model output file and transform it into air quality model input files. ICF via VISTAS/MRPO provided an initial spreadsheet file containing unit-level records of both (1) "existing" units and (2) committed or new generic aggregates.

All records have unit and fuel type data; existing, retrofit (for SO2 and NOx), and separate NOx control information; annual SO2 and NOx emissions and heat input; summer season (May-September) NOx and heat input; July day NOx and heat input; coal heat input by coal type; nameplate capacity (MW), and State FIPS code. Existing units also have county FIPS code, a unique plant identifier (ORISPL) and unit ID (also called boiler ID) (BLRID); generic units do not have these data. The processing includes estimating various types of emissions and adding in control efficiencies, stack parameters, latitude-longitude coordinates, and State identifiers (plant ID, point ID, stack ID, process ID). Additionally, the generic units are sited in a county and given appropriate IDs. This processing is described in more detail below.

The data are prepared by transforming the generic aggregates into units similar to the existing units in terms of the available data. The generic aggregates are split into smaller generic units based on their unit types and capacity, are provided a dummy ORIS unique plant and boiler ID, and are given a county FIPS code based on an algorithm that sites each generic by assigning a sister plant that is in a county based on its attainment/nonattainment status. Within a State, plants (in county then ORIS plant code order) in attainment counties are used first as sister sites to generic units, followed by plants in PM2.5 nonattainment counties, followed by plants in 8-hour ozone nonattainment counties. Note that no LADCO or VISTAS States provided blackout counties that would not be considered when siting generics, so this process is identical to the one used for the USEPA IPM post-processing.

SCCs were assigned for all units; unit/fuel/firing/bottom type data were used for existing units' assignments, while only unit and fuel type were used for generic units' assignments. Latitude-longitude coordinates were assigned, first using the USEPA-provided data files, secondly using the September 17, 2004 Pechan in-house latitude-longitude file, and lastly using county centroids. These data were only used when the data were not provided in the 2002 NIF files. Stack parameters were attached, first using the USEPA-provided data files, secondly using a

March 9, 2004 Pechan in-house stack parameter file based on previous EIA-767 data, and lastly using an USEPA June 2003 SCC-based default stack parameter file. These data were only used when the data were not provided in the 2002 NIF files.

Additional data were required for estimating VOC, CO, filterable primary PM_{10} and PM2.5, PM condensable, and NH_3 emissions for all units. Thus, ash and sulfur contents were assigned by first using 2002 EIA-767 values for existing units or SCC-based defaults; filterable PM10 and PM2.5 efficiencies were obtained from the 2002 EGU NEI that were based on 2002 EIA-767 control data and the PM Calculator program (a default of 99.2 percent is used for coal units if necessary); fuel use was back calculated from the given heat input and a default SCC-based heat content; and emission factors were obtained from an USEPA-approved October 7, 2004 Pechan emission factor file based on AP-42 emission factors. Note that this updated file is not the one used for estimating emissions for previous USEPA post-processed IPM files. Emissions for 28 temporal-pollutant combinations were estimated since there are seven pollutants (VOC, CO, primary PM_{10} and $PM_{2.5}$, NH_3, SO_2 and NO_x) and four temporal periods (annual, summer season, winter season, July day).

The next step was to match the IPM unit IDs with the identifiers in VISTAS/ASIP 2002 inventory. A crosswalk file was used to obtain FIPS State and county, plant ID (within State and county), and point ID. If the FIPS State and county, plant ID and point ID are in the 2002 VISTAS NIF tables, then the process ID and stack ID are obtained from the NIF; otherwise, defaults, described above, were used.

Pechan provided the post-processed files in NIF 3.0 format. Two sets of tables were developed: "NIF files" for IPM units that have a crosswalk match and are in the 2002 VISTAS inventory, and "NoNIF files" for IPM units that are not in the 2002 VISTAS inventory (which includes existing units with or without a crosswalk match as well as generic units).

For the 2009 projections, VISTAS/ASIP states reviewed the PM and NH_3 emissions from EGUs as provided by Pechan and identified significantly higher emissions in 2009 than in 2002. It was determined that Pechan used a set of PM and NH_3 emission factors that are "the most recent USEPA approved uncontrolled emission factors" for estimating 2009 emissions. These factors are most likely not the same emission factors used by States for estimating these emissions in 2002 for EGUs in the VISTAS/ASIP region. Thus, the emission increase from 2002 to 2009 was simply an artifact of the change in emission factor, not anything to do with changes in activity or control technology application. Also, VISTAS/ASIP states identified an inconsistent use of SCCs for determining emission factors between the base and future years. The resolution of the PM and NH_3 problem is fully documented in *EGU Emission Factors and Emission Factor*

Assignment, memorandum from Greg Stella to VISTAS State Point Source Contacts and VISTAS EGU Special Interest Workgroup, June 13, 2005 (attached in Appendix P). The first step was the adjustment of the 2002 base year emissions inventory. Using the latest "USEPA-approved" uncontrolled emission factors by SCC, Alpine Geophysics utilized CERR or VISTAS/ASIP reported annual heat input, fuel throughput, heat, ash and sulfur content to estimate annual uncontrolled emissions for units identified as output by IPM. This step was conducted for non-CEM pollutants (CO, VOC, PM, and NH_3) only. For PM emissions, the condensable component of emissions was calculated and added to the resulting PM primary estimations. The resulting emissions were then adjusted by any control efficiency factors reported in the CERR or VISTAS data collection effort. The second adjustment was to the future year inventories. Alpine Geophysics updated the SCCs in the future year inventory to assign the same base year SCC. Using the same methods as described for the 2002 revisions, those non-IPM generated pollutants were estimated using IPM predicted fuel characteristics and base year 2002 SCC assignments.

3.1.4 Eliminating Double Counting of EGU Units

The following procedures were used to avoid double counting of EGU emissions in the 2009 point source inventory. The 2002 VISTAS point source emission inventory contains both EGUs and non-EGUs. Since this file contains both EGUs and non-EGU point sources, and EGU emissions are projected using the IPM, it was necessary to split the 2002 point source file into two components. The first component contains those emission units accounted for in the IPM forecasts. The second component contains all other point sources not accounted for in IPM.

As described in the previous section, Pechan developed 2009 NIF files for EGUs from the IPM parsed files. All IPM matched units were initially removed from the 2009 Point source inventory to create the non-EGU inventory (which was projected to 2009 using the non-EGU growth and control factors described in Section 3.2.1). This was done on a unit-by-unit basis based on a cross-reference table that matches IPM emission unit identifiers (ORISPL plant code and BLRID emission unit code) to VISTAS NIF emission unit identifiers (FIPSST state code, FIPSCNTY county code, State Plant ID, State Point ID). When there was a match between the IPM ORISPL/BLRID and the VISTAS emission unit ID, the unit was assigned to the EGU inventory; all other emission units were assigned to the non-EGU inventory.

If an emission unit was contained in the NIF files created by Pechan from the IPM output, the corresponding unit was removed from the initial 2009 Point source inventory. The NIF 2009 EGU files from the IPM parsed files were then merged with the non-EGU 2009 files to create the 2009 Point source files.

Next, MACTEC prepared several ad-hoc QA/QC queries to verify that there was no double-counting of emissions in the EGU and non-EGU inventories:

- MACTEC reviewed the IPM parsed files to identify EGUs accounted for in IPM. MACTEC compared this list of emission units to the non-EGU inventory derived from the VISTAS cross-reference table to verify that units accounted for in IPM were not double-counted in the non-EGU inventory. As a result of this comparison, MACTEC made a few adjustments in the cross-reference table to add emission units for four plants to ensure these units accounted for in IPM were moved to the EGU inventory.

- MACTEC reviewed the non-EGU inventory to identify remaining emission units with a Standard Industrial Classification (SIC) code of "4911 Electrical Services" or SCC of "1-01-xxx-xx External Combustion Boiler, Electric Generation".

- MACTEC compared the list of sources meeting these selection criteria to the IPM parsed file to ensure that these units were not double-counted.

MACTEC asked S/L agencies to review the 2009 Point source inventory to verify whether there was any double counting of EGU emissions.

3.1.5 Quality Assurance steps

Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the EGU component of the VISTAS revised 2009 EGU inventory:

1. Provided parsed files (i.e., Excel spreadsheets that provide unit-level results derived from the model plant projections obtained by the IPM) to the VISTAS EGU SIWG for review and comment.

2. Provided facility level emission summaries for 2009 for both the base case and CAIR case to the VISTAS EGU SIWG to ensure that emissions were consistent and that there were no missing sources.

3. Compared State-level emissions from the IPM parsed files with the post-processed NIF files to verify that the post-processed NIF files were consistent with the IPM parsed file results.

VISTAS requested S/L review of these files – the changes specified by North Carolina as a result of this review are documented in the following subsection.

3.1.6 S/L Adjustments to IPM Modeling Results

After the S/L agency review of the final set of IPM runs, S/L agencies specified a number of changes to the IPM results to better reflect current information on when and where future controls would occur. These changes to the IPM results primarily involved S/L agency addition or subtraction of future emission controls based on the best available data from state rules, enforcement agreements, compliance plans, permits, and discussions/commitments from individual companies.

For example,Duke Energy and Progress Energy have updated their plans for complying with North Carolina's Clean Smokestack Act. The emissions outlined in the North Carolina's Clean Smokestacks Act compliance plans varied substantially from the IPM results. As a result, NCDAQ requested that the IPM emission projections for 2009 be adjusted to correspond with the compliance plans submitted in 2006 from the Duke Energy and Progress Energy.

Some S/L agencies specified changes to the controls assigned by IPM to reflect their best estimates of emission controls. The VISTAS/ASIP contractors used a scrubber control efficiency of 90 percent when adding or removing SO2 scrubber controls, used a control efficiency of 90 percent when adding or removing NOx SCR controls at coal-fired plants, 80 percent when adding or removing NOx SCR controls at gas-fired plants, and 35 percent when adding or removing NOx SNCR controls. The specific changes from NCDAQ to the IPM results are also summarized in Table 3.1.6-1.

S/L agencies provided information and/or comment on changes in stack parameters from the 2002 inventory for the 2009 inventory. Changes to stack parameters were also made in cases where new controls are scheduled to be installed. In cases where an emission unit projected to have a SO_2 scrubber in 2009, some states were able to provide revised stack parameters for some units based on design features for the new control system. Other units projected to install scrubbers by 2009 are not far enough along in the design process to have specific design details. For those units, the VISTAS EGU SIWG made the following assumptions: 1) the scrubber is a wet scrubber; 2) keep the current stack height the same; 3) keep the current flow rate the same, and 4) change the stack exit temperature to 169 degrees F (this is the virtual temperature derived from a wet temperature of 130 degrees F). VISTAS determined that exit temperature (wet) of 130 degrees F +/- 5 degrees F is representative of different size units and wet scrubber technology.

Table 3.1.6-1 NCDAQ Adjustments to IPM Results for the 2009 EGU Inventory.

Plant Name and ID	Unit	Nature of Update/Correction
G G Allen (2718) Belews Creek (8042)1 Buck (2720) Cliffside (2721) Dan River (2723) Marshall (2727) Riverbend (2732)	All	Replaced all IPM 2009 results with emission projections from Duke Power's NC Clean Smokestacks Act Compliance Plan for 2006.
Asheville (2706) Cape Fear (2708) Lee (2709) Mayo (6250) Roxboro (2712) Sutton (2713) Weatherspoon (2716)	All	Replaced all IPM 2009 results with emission projections from Progress Energy's NC Clean Smokestacks Act Compliance Plan for 2006.
Dwayne Collier Battle Cogeneration Facility ORISID=10384	GEN1 GEN2	Dwayne Collier Battle is a duplicate entry. This is Cogentrix of Rocky Mount (37-065-3706500146, stacks G-26 and G-27). Duplicate entries were removed from the 2009 inventory.
Kannapolis Energy Partners ORISID=10626	GEN2 GEN3	Kannapolis Energy emissions are being used as credits for another facility. IPM emissions from this facility (37-025-ORIS10626) were removed from the EGU inventory for 2009. Emissions from Kannapolis Energy (37-025-3702500113) were carried forward in the 2009 inventory.

3.1.7 Summary of 2009 EGU Point Source Inventory

Tables 3.1.7-1 and 3.1.7-6 summarize the 2002 base year inventory and 2009 projection inventory for the EGU source sector. The 2009 inventory include the adjustments to the IPM results specified by the S/L agencies in the previous section.

Table 3.1.7-1 EGU Point Source SO_2 Emission Comparison for 2002 and 2009

State	2002 VISTAS	2009 IPM Based with S/L Adjustments
AL	447,828	378,052
FL	453,631	186,055
GA	514,952	417,449
KY	484,057	290,193
MS	67,429	76,579
NC	477,990	242,286
SC	206,399	124,608
TN	334,151	255,410
VA	241,204	225,653
WV	516,084	277,489
Total	**3,743,725**	**2,473,774**

Table 3.1.7-2 EGU Point Source NOx Emission Comparison for 2002 and 2009.

State	2002 VISTAS	2009 IPM Based with S/L Adjustments
AL	161,038	82,305
FL	257,677	86,165
GA	147,517	98,497
KY	198,817	92,021
MS	43,135	36,011
NC	151,854	66,522
SC	88,241	46,915
TN	157,307	66,405
VA	86,886	66,219
WV	230,977	86,328
Total	**1,523,449**	**727,388**

Table 3.1.7-3 EGU Point Source VOC Emission Comparison for 2002 and 2009.

State	2002 VISTAS	2009 IPM Based with S/L Adjustments
AL	2,295	2,473
FL	2,524	1,910
GA	1,244	2,314
KY	1,487	1,369
MS	648	404
NC	988	954
SC	470	660
TN	926	932
VA	754	778
WV	1,180	1,361
Total	**12,516**	**13,155**

Table 3.1.7-4 EGU Point Source PM_{10}-PRI Emission Comparison for 2002 and 2009

State	2002 VISTAS	2009 IPM Based with S/L Adjustments
AL	7,646	6,969
FL	21,387	9,007
GA	11,224	17,891
KY	4,701	6,463
MS	1,633	4,957
NC	22,754	22,152
SC	21,400	19,395
TN	14,640	15,608
VA	3,960	5,508
WV	4,573	5,657
Total	**113,918**	**113,607**

Table 3.1.7-5 EGU Point Source $PM_{2.5}$ -PRI Emission Comparison for 2002 and 2009

State	2002 VISTAS	2009 IPM Based with S/L Adjustments
AL	4,113	3,921
FL	15,643	5,910
GA	4,939	10,907
KY	2,802	4,279
MS	1,138	4,777
NC	16,498	15,949
SC	17,154	16,042
TN	12,166	13,092
VA	2,606	4,067
WV	2,210	2,940
Total	**79,269**	**81,884**

Table 3.1.7-6 EGU Point Source NH_3 Emission Comparison for 2002 and 2009

State	2002 VISTAS	2009 IPM Based with S/L Adjustments
AL	317	359
FL	234	1,631
GA	83	686
KY	326	400
MS	190	333
NC	54	445
SC	142	343
TN	204	227
VA	127	694
WV	121	330
Total	**1,798**	**5,448**

Note: Emission summaries above are based on SCC's 1-01-xxx-xx and 2-01-xxx-xx-xx

3.2 Non-EGU Emission Projections

The general approach for assembling future year data was to use recently updated growth and control data consistent with the data used in the USEPA's CAIR analyses, supplement these data with available stakeholder input, and provide the results for stakeholder review to ensure credibility. The VISTAS/ASIP contractor used the 2002 VISTAS/ASIP base year inventory, based on the 2002 CERR submittals as the starting point for the non-EGU projection inventory. The 2002 VISTAS/ASIP point source emission inventory contains both EGUs and non-EGUs. Since this file contains both EGUs and nonEGU point sources, and EGU emissions are projected using the IPM, it was necessary to split the 2002 point source file into two components. The first component contains those emission units accounted for in the IPM forecasts. The second component contains all other point sources not accounted for in IPM and constitutes the non-EGU emissions inventory.

MACTEC performed the following activities to apply growth and control factors to the 2002 non-EGU emissions inventory to generate the 2009 projection inventory:

- Obtained, reviewed, and applied the most current growth factors developed by EPA, based on forecasts from an updated Regional Economic Models, Inc. (REMI) model (version 5.5) and the latest *Annual Energy Outlook* published by the Department of Energy (DOE);

- Obtained, reviewed, and applied any State-specific or sector-specific growth factors submitted by stakeholders;

- Obtained and incorporated information regarding sources that have shut down after 2002 and set the emissions to zero in the projection inventories;

- Obtained, reviewed, and applied control assumptions;

- Provided data files in NIF3.0 format and emission summaries in EXCEL format for review and comment; and

- Updated the database with corrections or new information from S/L agencies based on their review of the 2009 inventory.

The following sections discuss each of these steps.

3.2.1 Growth assumptions for non-EGU sources

The growth factor data used in developing the emission inventory were consistent with the USEPA's analyses for the CAIR rulemaking. These growth factors are fully documented in the reports entitled *Development of Growth Factors for Future Year Modeling Inventories* (dated April 30, 2004) and *CAIR Emission Inventory Overview* (dated July 23, 2004). Three sources of data were used in developing the growth factors for the 2009 emissions inventory:

- State-specific growth rates from the Regional Economic Model, Inc. (REMI) Policy Insight® model, version 5.5 (being used in the development of the EGAS Version 5.0). The REMI socioeconomic data (output by industry sector, population, farm sector value added, and gasoline and oil expenditures) are available by 4-digit SIC code at the State level.

- Energy consumption data from the DOE's Energy Information Administration's (EIA) *Annual Energy Outlook 2004, with Projections through 2025* for use in generating growth factors for non-EGU fuel combustion sources. These data include regional or national fuel-use forecast data that were mapped to specific SCCs for the non-EGU fuel use sectors (e.g., commercial coal, industrial natural gas). Growth factors for the residential natural gas combustion category, for example, are based on residential natural gas consumption forecasts that are reported at the Census division level. These Census divisions represent a group of States (e.g., the South Atlantic division includes eight southeastern States and the District of Columbia). Although one would expect different growth rates in each of these States due to unique demographic and socioeconomic trends, all States within each division received the same growth rate.

- Specific changes for sectors (e.g., plastics, synthetic rubber, carbon black, cement manufacturing, primary metals, fabricated metals, motor vehicles and equipment) where the REMI-based rates were unrealistic or highly uncertain. Growth projections for these sectors were based on industry group forecasts, Bureau of Labor Statistics (BLS) projections and Bureau of Economic Analysis (BEA) historical growth from 1987-2002.

In addition to the growth data described above, VISTAS received two sets of growth projections from stakeholders. The American Forest and Paper Association (AF&PA) supplied growth projections for the pulp and paper sector, which were applied to SIC 26xx Paper and Allied Products, for growth from 2002 to 2009. The AF&PA projection factor (1.067) is for the United States industry and apply to all States equally. The number come from the 15-year forecast for world pulp and recovered paper prepared by Resource Information Systems Inc. (RISI). The

VISTAS/ASIP contractor used the above AF&PA growth factors by SIC instead of the factors obtained from the USEPA's CAIR analysis for the 2009 emission inventory.

NCDAQ considered recent projections for three key sectors in North Carolina where declining production was anticipated – SIC 22xx Textile Mill Products, 23xx Apparel and Other Fabrics, and 25xx Furniture and Fixtures. For the 2009 inventory, NCDAQ decided to use a growth factor of 1.0 for these SIC codes. Although NCDAQ has data that shows a steady decline in these industries in North Carolina, NCDAQ wanted to maintain the emission levels at 2002 levels so the future emission reduction credits were available in the event that they are needed for nonattainment areas.

For the 2009 inventory, the VISTAS/ASIP contractor made one additional change to the growth factors. The AEO2004 data was replaced with the more recent AEO2006 forecasts (released in February 2006) to reflect changes in the energy market and to improve the emissions growth factors produced. The VISTAS/ASIP contractor obtained the corresponding AEO2006 projection tables from DOE's web site. VISTAS developed tables comparing the growth factors based on AEO2004 and AEO2006 and these comparison tables were reviewed by the S/L agencies. Based on this review, the VISTAS/ASIP states decided to use the AEO2006 growth factors for fuel burning SCCs.

VISTAS used the USEPA's EGAS model and updated the corresponding AEO2006 projection tables to create growth factors by SCC. VISTAS applied the updated growth factors to 2002 actual emissions and replaced the 2009 emissions in NIF EM tables for the affected SCCs.

3.2.2 Control Programs applied to non-EGU sources

VISTAS developed two control scenarios: on-the-books (OTB) controls and on-the-way (OTW) controls. The OTB control scenario accounts for post-2002 emission reductions from recently promulgated federal, State, local, and site-specific control programs. The OTW control scenario accounts for proposed (but not final) control programs that are reasonably anticipated to result in post-2002 emission reductions. The methodologies used to account for the emission reductions associated with these emission control programs are discussed in the following sections.

Table 3.2.2-1 Non-EGU Point Source Control Programs Included in 2009 Inventory.

On-the-Books (Cut-off of July 1, 2004 for Base 1 adoption)
• Atlanta / Northern Kentucky / Birmingham 1-hr SIPs

- Industrial Boiler/Process Heater/RICE MACT
- NO_x RACT in 1-hr NAA SIPs
- NO_x SIP Call (Phase I- except where States have adopted II already e.g. NC)
- RFP 3 percent Plans where in place for one hour plans
- VOC 2-, 4-, 7-, and 10-year MACT Standards
- Combustion Turbine MACT

On-the-Way

- NO_x SIP Call (Phase II – remaining States & IC engines)

3.2.2.1 OTB - NOx SIP Call (Phase I)

Phase I of the NOx SIP call applies to certain large non-EGUs, including large industrial boilers and turbines, and cement kilns. States in the VISTAS region affected by the NOx SIP call have developed rules for the control of NOx emissions that have been approved by the USEPA. VISTAS reviewed the available State rules and guidance documents to determine the affected sources and ozone season allowances. VISTAS also obtained and reviewed information in the EPA's CAMD NOx Allowance Tracking System – Allowances Held Report. Since these controls are to be in effect by the year 2007, VISTAS capped the emissions for NOx SIP call affected sources at 2007 levels and carried forward the capped levels for the 2009 future year inventory.

3.2.2.2 OTB - Industrial Boiler/Process Heater MACT

The USEPA anticipates reductions in PM and SO2 as a result of the Industrial Boiler/Process Heater MACT standard. The methods used to account for these reductions are the same as those used for the CAIR analysis. Reductions were included for existing units firing solid fuel (coal, wood, waste, biomass), which had a design capacity greater than 10 mmBtu/hr. The USEPA prepared a list of SCCs for solid fuel industrial, commercial/ institutional boilers and process heaters. The VISTAS/ASIP contractor identified boilers greater than 10 mmBtu/hr using either the boiler capacity from the VISTAS 2002 inventory, or if the boiler capacity was missing, a default capacity based on a methodology developed by the USEPA for assigning default capacities based on SCC code. The applied MACT control efficiencies were 4 percent for SO2 and 40 for percent for PM10 and PM2.5.

3.2.2.3 OTB - 2, 4, 7, and 10-year MACT Standards

Maximum achievable control technology (MACT) requirements were also applied, as documented in the report entitled *Control Packet Development and Data Sources,* dated July 14, 2004. The point source MACTs and associated emission reductions were designed from Federal Register (FR) notices and discussions with the USEPA's Emission Standards Division (ESD) staff. VISTAS did not apply reductions for MACT standards with an initial compliance date of 2001 or earlier, assuming that the effects of these controls are already accounted for in the 2002 inventories supplied by the States. Emission reductions were applied only for MACT standards with an initial compliance date of 2002 or greater.

3.2.2.4 OTB Combustion Turbine MACT

The projection inventory does not include the NOx co-benefit effects of the MACT regulations for Gas Turbines or stationary Reciprocating Internal Combustion Engines, which the USEPA estimates to be small compared to the overall inventory.

3.2.2.5 OTW - NOx SIP Call (Phase II)

The final Phase II NOx SIP call rule was finalized on April 21, 2004. States had until April 21, 2005, to submit SIPs meeting the Phase II NOx budget requirements. The Phase II rule applies to large IC engines, which are primarily used in pipeline transmission service at compressor stations. VISTAS identified affected units using the same methodology as was used by the USEPA in the proposed Phase II rule (i.e., a large IC engine is one that emitted, on average, more than 1 ton per day during 2002). The final rule reflects a control level of 82 percent for natural gas-fired IC engines and 90 percent for diesel or dual fuel categories. North Carolina provided more specific information on the anticipated controls at the compressor stations. This information was used in the 2009 inventory instead of the default approach used by the USEPA in the proposed Phase II rule.

3.2.2.6 Clean Air Interstate Rule

CAIR does not require or assume additional emission reductions from non-EGU boilers and turbines.

3.2.3 Quality Assurance steps

Final QA checks were run on the revised projection inventory data set to ensure that all corrections provided by the S/L agencies and stakeholders were correctly incorporated into the

S/L inventories and that there were no remaining QA issues that could be addressed during the duration of the project. After exporting the inventory to ASCII text files in NIF 3.0, the USEPA QA program was run on the ASCII files and the QA output was reviewed to verify that all QA issues that could be addressed were resolved.

Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for North Carolina. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the point source component of the VISTAS inventory:

1. Facility level emission summaries were prepared and evaluated to ensure that emissions were consistent and reasonable. The summaries included base year 2002 emissions, 2009 projected emissions accounting only for growth, 2009 projected emissions accounting for both growth and emission reductions from CAA controls.

2. State-level non-EGU comparisons (by pollutant) were developed for the base year 2002 emissions, 2009 projected emissions accounting only for growth, 2009 projected emissions accounting for both growth and emission reductions from CAA controls.

3. Data product summaries and raw NIF 3.0 data files were provided to the VISTAS Emission Inventory Technical Advisor and to the Point Source, EGU, and non-EGU Special Interest Work Group representatives for review and comment. Changes based on these comments were reviewed and approved by North Carolina point source contact prior to implementing the changes in the files.

4. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes.

3.2.4 Summary of 2009 non-EGU Point Source Inventory

Tables 3.2.4-1 and 3.2.4-6 summarize the 2009 non-EGU point source inventory for NOx and VOC emissions.

Table 3.2.4-1 Non-EGU Point Source SO_2 Emission Comparison for 2009 and 2009

State	2002	2009
AL	96,481	101,246
FL	65,090	65,511
GA	53,778	53,987
KY	34,029	36,418
MS	35,960	25,564
NC	44,123	42,536
SC	53,518	48,324
TN	79,604	70,678
VA	63,903	62,560
WV	54,070	55,973
Total	**580,556**	**562,797**

Table 3.2.4-2 Non-EGU Point Source NO_x Emission Comparison for 2002 and 2009

State	2002	2009
AL	83,310	69,409
FL	45,156	46,020
GA	49,251	50,353
KY	38,392	37,758
MS	61,526	56,397
NC	44,928	34,767
SC	42,153	40,019
TN	64,344	57,883
VA	60,415	51,046
WV	46,612	38,031
Total	**536,087**	**481,683**

Table 3.2.4-3 Non-EGU Point Source VOC Emission Comparison for 2002 and 2009

State	2002	2009
AL	47,037	46,644
FL	38,471	36,880
GA	33,709	34,116
KY	44,834	47,785
MS	43,204	37,747
NC	61,182	61,925
SC	38,458	35,665
TN	84,328	74,089
VA	43,152	43,726
WV	14,595	13,810
Total	**448,970**	**432,387**

Table 3.2.4-4 Non-EGU Point Source PM_{10}-PRI Emission Comparison for 2002 and 2009

State	2002	2009
AL	25,240	25,421
FL	35,857	39,872
GA	21,610	23,103
KY	16,626	17,174
MS	19,472	19,245
NC	13,838	13,910
SC	14,142	13,370
TN	35,174	34,833
VA	13,252	13,048
WV	17,503	17,090
Total	**212,714**	**217,066**

Table 3.2.4-5 Non-EGU Point Source PM25-PRI Emission Comparison for 2002 and 2009

State	2002	2009
AL	19,178	19,230
FL	30,504	33,946
GA	17,462	18,982
KY	11,372	11,686
MS	9,906	9,199
NC	10,500	10,458
SC	10,245	9,390
TN	27,807	27,577
VA	10,165	9,988
WV	13,313	12,769
Total	**160,452**	**163,225**

Table 3.2.4-6 Non-EGU Point Source NH_3 Emission Comparison for 2002 and 2009

State	2002	2009
AL	1,883	2,132
FL	1,423	1,544
GA	3,613	3,963
KY	674	760
MS	1,169	668
NC	1,180	1,285
SC	1,411	1,578
TN	1,613	1,841
VA	3,104	3,049
WV	332	341
Total	**16,402**	**17,161**

Appendix F.2

Area and Nonroad Mobile Sources Emissions Inventory Documentation

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List of Acronyms

Acronym	Definition
AEO	Annual Energy Outlook
ATADS	Air Traffic Activity Data System
BTS	Bureau of Transportation Statistics
BTU	British Thermal Units
CAIR	Clean Air Interstate Rule
CERR	Consolidated Emissions Reporting Rule
CMU	Carnegie Mellon University
CMV	Commercial Marine Vessel
CNG	Compressed Natural Gas
EDMS	Emissions and Dispersion Modeling System
EF	Emission Factor
EGAS 5.0	Economic Growth Analysis System version 5.0
EIA	Energy Information Administration
EIIP	Emissions Inventory Improvement Program
FAA	Federal Aviation Administration
GF	Growth Factor
HDD	Heavy Duty Diesel
IAQTR	Interstate Air Quality Transport Rule
LPG	Liquid Petroleum Gas
LTO	Landing and Takeoff
MSW	Municipal Solid Waste
NAAQS	National Ambient Air Quality Standards
NAICS	North American Industry Classification System
NCDAQ	North Carolina Division of Air Quality
NCDFR	North Carolina Division of Forest Resources
NCDOT	North Carolina Department of Transportation
NCSU	North Carolina State University
NEI	National Emissions Inventory
NG	Natural Gas
NIF	National Emissions Inventory Input Format
NOx	Nitrogen Oxides
NWR	National Wildlife Refuge
OTAQ	Office of Transportation and Air Quality
PFC	Portable Fuel Container
PM	Particulate Matter

QA	Quality Assurance
RIA	Regulatory Impact Analysis
SCC	Source Classification Code
SI	Spark-Ignition
SIC	Standard Industrial Classification
SIWG	Special Interest Workgroup
T4	Tier 4
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFA	U.S. Fire Administration
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
VISTAS	Visibility Improvement State & Tribal Association of the Southeast
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds

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1. INTRODUCTION AND SCOPE

The attainment modeling for the Davidson-Guilford-Catawba Counties, North Carolina Annual PM2.5 nonattainment area (referred to as the PM2.5 nonattainment area) was performed by the Association of Southeastern Integrated Planning (ASIP) and done in conjunction with the regional haze modeling being done by the Southeast Regional Planning Organization, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the ozone modeling being done by the ASIP. VISTAS and ASIP are run by the ten Southeast states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia). Since the regional haze modeling uses annual simulations and includes an intermediate year that is the attainment year required for the PM2.5 nonattainment area, the North Carolina Division of Air Quality (NCDAQ) decided to use this modeling for its attainment demonstration.

A portion of the emissions inventory was developed by the NCDAQ and the VISTAS/ASIP contractors developed a portion. In all cases, a statewide emissions inventory was developed for modeling purposes and the emission estimates were calculated in tons per year. Sections 3 documents the portion of the 2002 base year area source annual emissions inventory that was developed by the NCDAQ. Section 4 documents the area source developed by VISTAS/ASIP and Section 5 addresses the development of the 2009 area source emissions inventory. Section 6 and 7 document the nonroad mobile source emissions inventory for 2002 and 2009, respectively.

A summary of the area source and nonroad mobile source annual PM2.5 emissions, by source category, can be found in Appendix E.

2. OVERALL METHODOLOGY

2.1 SOURCE CATEGORY IDENTIFICATION

The area source categories were identified from U. S. Environmental Protection Agency's (USEPA's) guidance document EPA-450/4-91-016, *Procedures for the Preparation of Emission Inventories of Carbon Monoxide and Precursors of Ozone, Vol. 1*, from this point on this document will be referred to as the Procedures document; USEPA guidance document EPA-454/R-05-001, *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulation*; the *Emissions Inventory Improvement Program (EIIP) Technical Reports, Volume 3, Area Sources* as of December 2002 (the most current version at the time of the inventory development), from this point on this document will be referred to as EIIP Tech Report; and a report entitled, *Documentation of the Base G 2002 Base Year, 2009 and 2018, Emission Inventories for VISTAS* and written by the VISTAS contractor company, MACTEC, Inc.

Nonroad mobile sources were identified from the USEPA's guidance document EPA-450/4-91-016, *Procedures for the Preparation of Emissions Inventories for Carbon Monoxide and Precursors of Ozone* (Procedures document); and USEPA guidance document EPA-454/R-05-001, *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulation*. Nonroad mobile source emissions are estimated by the methodologies suggested in the USEPA document, EPA-454/R-05-001, *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*; EPA-450/4-81-026d (Revised) *Procedures for Emission Inventory Preparation, Volume IV; Mobile Sources* (Mobile Source Procedures); and from the USEPA's nonroad mobile model NONROAD2005c released March 21, 2006.

2.2 AREA SOURCE EMISSION ESTIMATION APPROACH

Area source emissions are estimated by multiplying an emission factor by some known indicator of collective activity for each source category within the inventory area. An indicator is any parameter associated with the activity level of a source that can be correlated with the air pollutant emissions from that source, such as production, number of employees, or population.

In general, one of the following emissions estimation approaches is used to calculate the area source emissions: per capita emission factors, employment-related emission factors, commodity consumption-related emission factors, and level of activity based emission factors. The emission factors used were obtained from the EIIP Tech Reports, the Procedures document or the USEPA's *AP-42 Compilation of Air Pollutant Emission Factors, Fifth Edition*, referred to as AP-42.

There are several methods for estimating the activity level for a specific area source category. These are: treating area sources as point sources, surveying local activity levels, apportioning national or statewide activity totals to local inventory areas, using population or employment data. All of these methods were used to estimate area source emissions

Certain emission categories were adjusted for such things as season or rule effectiveness and rule penetration. These are discussed in the particular source categories descriptions.

For certain categories, there can be overlap between the point source emissions and the area source emissions calculated with emission factors. The 2002 point source emissions in these categories were identified so that they could be subtracted where appropriate.

There are a number of categories where emissions were calculated with emission factors based on employment. These emission factors were developed by the USEPA when employment reports were organized by Standard Industrial Classification (SIC) code. Since 1997 employment statistics are organized by the North American Industry Classification System (NAICS). For the solvent cleaning industries, the SIC codes do not directly correspond to single NAICS code. Sometimes several partial NAICS employment values will relate to a SIC code. A crosswalk was used to determine what percentage of a NAICS employment value would correspond to the SIC codes. The tables from the US Census showing the NAICS-SIC crosswalk are reproduced in Section 8 – Additional Data. It should be noted that the crosswalk is based on national totals and is not specific to any particular state. In Section 8.2, the employment fraction of the NAICS codes used to create the SIC code employment data is tabulated.

The employment numbers were obtained from the on-line 2002 County Business Patterns for the various NAICS codes at the county level for North Carolina. In addition to having employment values (or employment ranges due to confidentiality rules) by NAICS, the County Business Patterns breaks down the number of facilities by employment categories. The employment categories are 1 – 4, 5 – 9, 10 – 19, 20 – 49, 50 – 99, 100 – 249, 250 – 499, 500 – 999, >1000 employees. To account for point sources, it was assumed that facilities with 100 employees or greater were point sources and were not considered in the calculations.

When a NAICS category gave a number of employees and there were no establishments with 100 employees or greater, then the value was used. However, in most cases the County Business Patterns gave a range of total employees in the county instead of the actual number. When this occurred, facility sizes were considered and the mid-range of employees was assumed, in accordance with the EIIP Tech. Report. For example, if a NAICS category for a county had a range of employment of 100-249 with two establishments with 1 – 4 employees, one with 20-49 employees, and one with 100-249 employees. Assuming 3 to be the mid-range of 1 –4 and 35 to be the mid-range of 20-49, the employment used for the area source calculation was estimated as:

(2 x 3) + (1 x 35) = 41 employees

The larger establishment was assumed to be a point source and not taken into consideration for the area source calculation.

If a total number of employees was provided and there were establishments with 100 employees or greater, then the mid-range of the smaller facilities were used as described above. The estimated employment was compared to the value given to ensure that remainder would account for the large establishment. In cases where the remainder would not be enough employment to account for the larger establishment, the area source employment was adjusted down. For example, if a NAICS category had 250 employees with one establishment with 20 – 49 employees (mid-range 35), two establishments with 50 – 99 employees (mid-range 75), and one establishment with 100 – 249 employees. The employment estimated for the area source and the remainder employment was estimated as:

(1 x 35) + (2 x 75) = 185 employees
250 – 185 = 65 employees

The remainder of 65 employees is not enough to account for an establishment of 100 – 249 employees. Therefore, the area source employment was adjusted down by 35 so that there were 100 employees remaining to account for the large establishment.

2.3 NONROAD MOBILE SOURCE EMISSION ESTIMATION APPROACH

Non-highway mobile sources, sometimes referred to as off-road mobile, are those sources that can move but do not use the highway system. Off-road mobile sources are further divided into non-road mobile, railroad locomotives, aircraft engines, and commercial marine vessels (CMV).

The estimation of emissions from mobile sources, like area sources, involves multiplying an activity level by an emission factor.

The majority of the off-road mobile emissions were estimated by using the USEPA's off-road mobile model NONROAD2005c. Direct emissions are generated with this model. For aircraft engine emissions, the Federal Aviation Administration (FAA) Emissions and Dispersion Modeling System (EDMS) model was used. Aircraft operations were inputted into the model and the model predicts the engine emissions based on average landing and take-off practices for the aircraft type. For railroad locomotive emissions, emission factors were obtained from the Mobile Source Procedures document and the activity level was obtained from the various railroad companies.

3. NORTH CAROLINA-DEVELOPED 2002 AREA SOURCE INVENTORY

Area sources represent a collection of many small, unidentified points of air pollution emissions within a specified geographical area, emitting less than the minimum level prescribed for point sources. Because these sources are too small and/or too numerous to be surveyed and characterized individually, all area source activities are collectively estimated. The county is the geographic area for which emissions from area sources are compiled, primarily because counties are the smallest areas for which data used for estimating emissions is readily available. Emissions are calculated on an annual basis in tons per year.

3.1 GASOLINE DISTRIBUTION

The area source emissions attributed to this category are associated with various operations related to gasoline and aircraft fuel handling and distribution. Since tank farms and bulk plants are specifically addressed in the point source inventory, the area source category is limited to fuel handling, storage, and distribution operations associated with the service stations and in the refueling of aircrafts.

3.1.1 Gasoline Dispensing Facilities

Since service stations are so numerous, they are collectively considered as an area source. The area source emissions that are derived for this subsection involve determining the estimated emissions that occur at each of the following operations: 1) losses during storage tank filling, 2) storage tank breathing and working losses, 3) spillage and 4) truck transit losses. The emissions from vehicle refueling are captured in the mobile source inventory in the emission factors produced by the USEPA's MOBILE6.2 model and therefore are not estimated as part of the area source inventory.

As part of the air toxics program, Stage I controls for gasoline dispensing facilities were adopted by the State, effective May 1990 with final compliance by January 1, 1994. Stage I is the vapor recovery technology on the underground storage tanks and reduces the emissions during the tank filling operations at service stations.

The North Carolina Department of Agriculture, Standards Division is responsible for going to all gasoline dispensing facilities and testing the fuels to ensure that they meet the quality standards of the State. The NCDAQ has worked out an agreement with the Standards Division to also check for Stage I controls. A notice is sent to the NCDAQ for every facility checked by the Standards Division verifying if a facility has properly maintained control equipment. If a facility is not found to be properly maintaining the control equipment, then the NCDAQ sends a notice of violation informing the facility that the controls are required and gives the facility time to correct the violation before fines are assessed. From this information the rule effectiveness and rule penetration can be estimated. The rule effectiveness is the percentage of facilities with proper equipment maintenance and use and represents the actual degree of source compliance. Rule penetration is the percentage of facilities covered by the rule and thus require Stage I equipment. Control efficiency is the expected percent reduction from proper application of this control technology.

The volatile organic compound (VOC) emission factor for underground storage tank filling was calculated by using an equation from AP-42, in Section 5.2, Transportation And Marketing Of Petroleum Liquids on page 5.2-4 (equation).

$$EF = 12.46 \left[\frac{SPM}{T}\right] \times [1-(RE \times CE \times RP)]$$

where EF = emission factor in pounds of VOC per 1000 gallons
S = Saturation factor
P = True vapor pressure (in pounds per square inch area)
M = Molecular weight of vapors (lb/lb-mole)
T = Temperature of bulk liquid (^{o} Rankin)
RE = Rule Effectiveness
CE = Control Efficiency
RP = Rule Penetration

The saturation factor was obtained from AP-42, Table 5.2-1 and the true vapor pressure and molecular weight of vapors were obtained from AP-42, Table 7.1-2. For the temperature an average of the June, July and August average monthly temperature for 2002 was used. A worst case temperature estimate was used year round in calculating annual emissions. These temperatures were obtained from the North Carolina Climatological Data, a publication of the National Oceanic and Atmospheric Administration. All of the factors used to calculate the emission factor for Stage I, i.e. balanced submerged filling, are listed in Table 3.1.1-1.

Table 3.1.1-1 Factors Used For Calculating Emission Factor

S	P	M	T
1	6.49	67	537.6^{o}R (77.6^{o}F)

$$EF = 12.46 \left[\frac{1 \times 6.49 \times 67}{537.6}\right] \times [1 - (.97 \times .95 \times .99)]$$

$$= 0.884 \text{ lb VOC/1000 gal. Gasoline}$$

The emission factors for tank truck transit, breathing losses and spillage were obtained from the EIIP Tech Report, Chapter 11 Gasoline Marketing, Table 11.3-1 and are listed below in Table 3.1.1-2. The tank truck transit emission factor includes the emission rate for an empty tank plus a full tank and was adjusted by a factor of 1.25 as recommended by the EIIP Tech Report, pg. 11.5-3.

Table 3.1.1-2 Emission Factors For Gasoline Dispensing

Underground Storage Tank Filling	Tank Truck Transit	Breathing Losses	Spillage
0.884 lb/1000gal	0.000075 lb/gal	0.001 lb/gal	0.00068 lb/gal

The activity data needed to calculate the emissions is number of gallons of fuel sold in each county per year. This was obtained from a report from the North Carolina Petroleum Marketers Association. A weighting factor was devised by producing the sum of county population (1000's), county registered vehicles (1000's), and county motor fuel outlets. The factors were summed for the 100 counties and a fractional part of the whole found for each county. This fraction was multiplied by the state total gallons of gasoline and diesel sold in 2002 to get an estimate of gallons of fuel per county.

According to the EIIP Tech Report, the activity days per week for truck transit and underground storage tank filling are 6 and 7 days per week and for spillage and breathing losses, respectively.

Note that diesel fuel used is combined with gasoline for the sake of simplification. This will result in some overestimation of VOC emissions because the volatility of gasoline is higher than diesel fuel.

Annual VOC emissions for underground storage tank filling, tank truck transit, breathing losses and spillage were calculated and SMOKE modeling was later used to allocate annual emissions to a daily level. Underground storage tank annual VOC emissions for each county were calculated using the following equation.

$$EM = FC \times (1/1000) \times EF \times (1 \text{ ton}/2000 \text{ lbs.})$$

where EM = annual county VOC emissions in tons per year
FC = county fuel consumption of gasoline and diesel in gallons
EF = emission factor in pounds of VOC per 1000 gallons

Tank truck transit, breathing losses, and spillage annual VOC emissions for each county were calculated individually, using the following equation.

$$EM = FC \times EF \times (1 \text{ ton}/2000 \text{ lbs.})$$

where EM = annual county VOC emissions in tons per year for tank truck transit, breathing losses, or spillage
FC = county fuel consumption of gasoline and diesel in gallons
EF = emission factor in pounds of VOC per gallon for tank truck transit, breathing losses, or spillage

3.1.2 Aircraft Refueling

Like vehicle refueling, aircraft refueling results in VOC emissions from displacement of the vapor-laden air in the aircraft's fuel tank. This source category is generally estimated only for large commercial airports. There are a few small commuter and general aviation airports in the State; however, the amount of emissions from these is typically negligible.

The emissions from aircraft refueling were determined by using the number of gallons of fuel supplied to the airports and multiplying it by the appropriate emission factor. The businesses that supply the fuel to the airports were contacted to determine the amount and type of fuel supplied to each airport during 2002. The information obtained was for the two fuel types supplied, Jet A Kerosene and Aviation Gasoline.

The emission factors used are 11.38 lb VOC/1000 gallons of aviation gasoline and 0.065 lb VOC/1000 gallons of Jet A kerosene. Airport refueling occurs on a daily basis, therefore the activity days per week are 7.

The annual emissions for the base year were calculated using equation 3.1.2-1.

$$EM_i = \frac{\text{Thousand Gallons/year} \times EF_i}{(2000 \text{ lbs/ton})} \qquad 3.1.2\text{-}1$$

where EM_i = emissions for source category (i)
EF_i = emission factor for source category (i)

3.2 STATIONARY SOURCE SOLVENT EVAPORATION

There are eleven subcategories that involve stationary source solvent evaporative emissions. They include: dry cleaning, graphic arts, solvent cleaning, automotive refinishing, architectural coatings, traffic markings, industrial surface coating, asphalt paving, roofing operations, pesticide application, and consumer/commercial solvent use. The methodology used to calculate the emissions from these sources are described in detail in each subsection.

3.2.1 Dry Cleaning

The VOC emissions from dry cleaning vary with the type of process and the solvent used. For the most part, dry cleaners (coin-operated and conventional commercial) are small business entities. As a result of their size, dry cleaning emissions are typically not captured as point sources. However, dry cleaning operations can be a significant emission source for VOC emissions, when taken collectively.

The emissions from dry cleaners are estimated by multiplying the number of employees at dry cleaners by a national per-employee emission factor, 1800 lbs. of VOC/employee/year, found in the EIIP Tech. Report. The guidance also stated that the number of employees can be found in the County Business Patterns for SIC code 7215 (coin-operated) and 7216 (commercial). In 1997, the SIC code system was replaced with the NAICS. Thus, the number of employees was obtained for NAICS codes 812310 (coin-operated) and 812320 (commercial). The NAICS employment numbers were previously processed to exclude any facilities with 100 or more employees, which were deemed to be point sources. According to the SIC to NAICS crosswalk, 80% of employment for NAICS 812320 represents the number of employees for commercial dry cleaners (SIC 7216).

As reported in the EIIP Tech. Report, the activity days per week is 6 days. The emissions for 2002 were calculated using equation 3.2.1-1.

$$EM = \frac{\text{Employees x EF}}{(2000\ \text{lb/tons})} \qquad 3.2.1\text{-}1$$

where EM = emissions for source category in tons/year
EF = emission factor for source category, 1800 lbs. VOC/employee/yr

3.2.2 Graphic Arts/Printing

Graphic arts include operations that are involved in printing of newspapers, magazines, books, and other printed materials, which can be divided into several subsets based upon printing technology. Over the last decade ink-jet and offset lithography have emerged as the dominant technologies. The use of oils as ink solvents and the reduction of alcohols in the fountain solution and in the cleanup solutions have resulted in notable reductions in emissions for offset lithography. Ink-jet printing results in essentially no VOC emissions.

A number of establishments that generate emissions in this source category are in-house graphic arts operations at plants that are in non-printing industries. Therefore, an employee per SIC code emission factor is not very reliable. The per-capita emission factor of 1.3 lbs VOC/person/year provided by the EIIP Tech. Report was used to calculate the VOC emissions. This emission factor estimates the emissions from facilities less than 100 tons VOC/year. It assumes that facilities greater than 100 tons VOC/year will be in the point source inventory. The population used to calculate the base year emissions was obtained from the North Carolina Office of State Budget and Management (OSBM).

According to the Procedures document, Table 5.8-1, the activity days per week is 5. The annual emissions for the base year were calculated using equation 3.2.2-1.

$$EM = ((EF)*(Population_{2002})*(1 \text{ ton}/2000 \text{ lb})) \qquad 3.2.2\text{-}1$$

where EM = emissions for source category for county (a) in tons/yr
EF = emission factor for source category, 1.3 lbs VOC/person/yr

3.2.3 Solvent Cleaning and Degreasing

Solvent cleaning operations are integral to many businesses and industries, and are conducted for the purpose of removing grease, oils, waxes, carbon deposits, etc. from metals, plastic, or glass surfaces. Solvent cleaning is usually performed prior to painting, plating, inspection, repair, assembly, etc. The solvents used in the cleaning operations can be either in a liquid or vapor phase. Generally, these solvents have high vapor pressures and therefore emit VOC emissions.

There are two basic types of solvent cleaning techniques, cold cleaning and vapor cleaning. Cold cleaning machines use solvents in the liquid phase to clean and remove foreign material such as oils and grease from the surface of materials. These machines are batch loaded, and cleaning operations include spraying/flushing solvent or parts agitation, wipe cleaning, brushing, and immersion.

The vapor cleaning technique can be further divided into open top degreasing and in-line cleaning. The open top degreasing machines are tanks designed to generate and contain solvent vapor. The tank is equipped with a heating system that boils the liquid solvent. As the solvent boils, dense solvent vapors rise and displace the air in the tank. Coolant is circulated in condensing coils on the top of the tank to create a controlled vapor zone within the tank. Condensing solvent vapors dissolve the contaminants on the surface of the workload and flush both the dissolved and undissolved contaminants from the workload.

In-line cleaning machines employ automated loading on a continuous basis. These machines are often custom made for large-scale operations. A continuous or multiple-batch loading system greatly reduces or even eliminates the manual parts handling associated with batch cleaning. In-line cleaning machines are enclosed to prevent solvent losses; however, entry and exit openings cannot be sealed.

The VOC emissions for this category are estimated by using the per employee factors (from the EIIP Tech. Report, Chapter 6, Table 6.5-2) listed in Table 3.2.3-1 below:

Table 3.2.3-1 Emission Factors Cleaning & Degreasing

Source Category	Lbs. VOC/employee/yr
Electronic and Other Elec: Open Top Degreasing	29
Miscellaneous Manufacturing: Open Top Degreasing	9.8
Miscellaneous Manufacturing: Cold Cleaning	24
Auto Repair Services: Cold Cleaning	270

Employment data was derived from the 2002 County Business Patterns provided by the U. S. Census Bureau. For each of these categories, employment in a number of SIC groups is needed. These employment numbers were generated from the NAICS employment numbers for each county and summed as needed. See SIC Codes from NAICS Codes for Employment Based Categories in Section 8.1 for the full listing of NAICS and SIC for each source category. Fractional employee numbers are a result of the NAICS to SIC conversion process.

The annual emissions for the base year were calculated using equation 3.2.3-1.

$$EM = \frac{(Employment_{2002}) \times EF}{(2000\ lb/tons)} \qquad 3.2.3\text{-}1$$

where EM = emissions for source category, tons per year
EF = emission factor for source category

3.2.4 Auto Body Refinishing

Auto body refinishing operations consist of: vehicle preparation, primer application, topcoat application, and spray equipment cleaning. These operations result in significant VOC emissions. The solvent is typically 100% volatile and can constitute up to 6.5 pounds of VOC per gallon of cleaner or paint.

The EIIP methodology for estimating emissions from this source category recommends apportioning a national VOC emission estimate to the county level by the number of employees reported for NAISC code 811121. The national estimate of 79,429.59 tons of VOC per year was based on 1997 data. In order to estimate the emissions for 2002, the 1997 national VOC estimate provided by the EIIP Tech. Report was divided by the 1997 national employment data to create a per employee emission factor.

This emission factor was used with the 2002 employment data to estimate emissions from auto body refinishing. The employment data was obtained from the 2002 County Business Patterns.

According to the EIIP Tech. Report the activity days per week is 5 days. The emissions for 2002 were calculated using equation 3.2.4-1.

$$EM = Employees \times EF \qquad 3.2.4\text{-}1$$

where EM = emissions for source category
EF = emission factor for source category, 0.387 tons VOC/employee/yr

3.2.5 Architectural Coatings

This category includes the application of paint, primer, varnish or lacquer to architectural surfaces, and the use of solvents as thinners and for cleanup.

The VOC emissions for this source category were estimated by multiplying county population data by a usage factor for either water or solvent based coatings, and an emissions factor for either water or solvent based coatings. This method entails gathering national architectural paint usage from the County Business industrial report MA325F and generating per capita usage factors. It is important to be able to differentiate between the water based usage from the solvent based usage since the emission factor for solvent based paints is over 5 times higher than the factor for water based paints.

Emissions Factor: Water based = 0.74 lb VOC/gallon;
Solvent Based= 3.87 lb VOC/gallon

$VOC_a = (POP_a * UF_b * EF_b)/(2000 lbs/ton)$ -- tons/year

Where:

	VOC_a	=	VOC emissions for county (a)
	POP_a	=	Population for county (a)
	EF_b	=	Emission factor for paint type (b)
	UF_b	=	Usage factor for paint type (b)

The usage factor is found by dividing the national total architectural surface coating quantities for either solvent or water-based coatings by the U.S. population for that year. For 2002, the usage factor for each paint type is estimated below:

UF solvent: (127,703,000 gallons of solvent based) / (287,973,924) = 0.443 gal./person
UF water : (589,527,000 gallons of water based) / (287,973,924) = 2.047 gal./person

3.2.6 Traffic Markings

The paint used in traffic markings operations (the painting of center lines, shoulders, etc.) emits VOC emissions during the drying process. The extent of emissions is largely a function of the paint being solvent or water based. The North Carolina Department of Transportation (NCDOT) utilizes three general types of paint, which can be classified as water based paint, epoxy paint containing organic solvents, and thermoplastic paint. The use of thermoplastic paint results in negligible VOC emissions and therefore is not included in the emissions inventory.

Although the NCDOT utilizes both water and solvent based paints, there is uncertainty with respect to what percentage of the paint used is organic solvent based. To avoid under estimating the emissions from this source category, it is assumed that all paint, excluding thermoplastic, is organic solvent-based.

The NCDOT reported that 854,215 gallons of paint were used statewide in 2002. The gallons of paint by county were apportioned by number of lane miles in the county divided by the state total (equation 3.2.6-1) and the estimated gallons used. The emission factor was obtained from the EIIP Tech. Report, Table-14.4-1, which gave the emission factor as a function of gallons of paint (3.64 lb VOC/gal.). The solvent-based emission factor was chosen because all paint was assumed to be organic solvent-based as described above.

$$\text{Gallons Paint}_{County} = (\text{Gallons Paint}_{State}) \times \frac{(\text{\# Paved Lane Miles})_{County}}{(\text{\# Paved Lane Miles})_{State}} \qquad 3.2.6\text{-}1$$

The emissions for 2002 were calculated using equation 3.2.6-2.

$$EM = \frac{\text{Gallons Paint} \times EF}{(2000 \text{ lb/ton})} \qquad 3.2.6\text{-}2$$

where EM = emissions for source category
EF = emission factor for source category

3.2.7 Industrial Surface Coating

Surface coating operations involve applying a thin layer of coating (e.g. paint, lacquer, enamel, varnish, etc.) to the surface of an object for decorative or protective purposes. The coating products, which are solvent based, emit VOC emissions as the result of solvent evaporation during the drying or curing process.

Ideally, the VOC emissions from industrial surface coating activities should be captured as point sources. From a practical standpoint, this is not always accomplished. For example, three of the industrial surface coating subcategories, namely other product coatings, high-performance maintenance, and other special purpose coatings, only utilized per capita emission factors and have no NAICS associated with them. The emission factors, obtained from the EIIP Tech. Report, Table 8.5-2, for these surface coating subcategories are listed in the Table 3.2.7-1 below.

Table 3.2.7-1 Per Capita Emission Factors For Industrial Surface Coating

Subcategory	Per Capita Factor (lb/yr/person)
Other product coatings	0.6
High-performance maintenance.	0.8
Other special purpose coatings	0.8

The emissions for the remaining industrial surface coating subcategories were estimated using per employee emission factors. These emission factors were obtained from the EIIP Tech. Report, Table 8.5-1 and are listed below in Table 3.2.7-2.

Table 3.2.7-2 Per Employee Emission Factors for Industrial Surface Coating

Subcategory	Per Employee Factor (lb VOC/employee/yr)
Furniture & Fixtures	944
Metal Containers	6,029
Automobile (new)	794
Machinery & Equipment	77
Appliances	463
Other Transportation Equipment	35
Sheet, strip & Coil	2,877
Factory Finished Wood	131
Electrical Insulation	290
Marine Coatings	308

The EIIP Tech. Report also listed SIC codes for these industrial surface coating subcategories. As stated earlier, the SIC codes were replaced in 1997 with NAICS. The employment data was estimated using the method previously outlined in Subsection 3.2.1.

According to the EIIP Tech. Report the activity days per week is 5 days. The annual emissions for population and employment based emission factors were calculated using equations 3.2.7-1 and 3.2.7-2, respectively.

$$EM = \frac{\text{Population} \times EF}{(2000\ \text{lb/ton})} \qquad 3.2.7\text{-}1$$

$$EM = \frac{\text{Employees x EF}}{\text{(2000 lb/ton)}} \qquad 3.2.7\text{-}2$$

where EM = emissions for source category
EF = emission factor for source category

3.2.8 Asphalt Paving

Two types of asphalt paving are used for road paving and repair; emulsified asphalt and cutback asphalt. Emulsified asphalt is a type of liquefied road surfacing material made from a blend of water with an emulsifier. Cutback asphalt is a type of liquefied road surface that is prepared by blending or "cutting back" asphalt cement with various kinds of petroleum distillates. VOC emissions occur as the asphalt cures.

Cutback asphalt emissions are included in the asphalt paving category. Since the assembly of the final VISTAS 2002 inventory, it was found that the NCDOT specification for asphalt in 2002 was hot mix and emulsified asphalt with hot mix but not cutback asphalt. Surrounding states have precluded the use of cut back by statutory provisions; which has driven asphalt manufactures to discontinue cutback production throughout the region. The absence of the use of cutback has resulted in substantial reductions in emissions from asphalt paving operations in North Carolina. Cutback asphalt emissions are included in the 2002 inventory, and 5.23 tons of VOC per year were emitted in 2002 in the PM2.5 nonattainment area. The 5.23 tons of VOC per year represents a relatively small amount and does not significantly affect the accuracy of the inventory.

Hot-mix is composed of high molecular weight organics with minimal vapor pressures; consequently, VOC emissions are negligible. The use of emulsified asphalt does result in VOC emissions; but the emissions are significantly less than cutback. New formulations of emulsified asphalt, such as cationic, continue to result in reduced emissions. The use of emulsified asphalt is primarily for tack coating, which is a surface preparation for the hot-mix layer. The tonnage of hot-mix asphalt is accounted for by the NCDOT districts and not on a county basis. District tonnage was allocated on a county basis by apportioning county paved mileage as reported in the NCDOT 2000 Highway Summary Report. However, the amount of emulsified asphalt used is not tracked by the NCDOT in any useable way. As a consequence, the NCDOT provided the following methodology to predict emulsified usage:

Square Yd. of hot-mix = <u>(Tons of Hot-mix) x (2000 lbs./Ton)</u> 3.2.8-1

(220 lbs/ Square Yd. of Hot-mix)

Gallons of Emulsified asphalt = (Sq. Yd. of hot-mix) x (0.08 gal./Sq. Yd. of hot-mix) 3.2.8-2

The VOC emissions were calculated using the emissions factor for emulsified asphalt (9.2 lb VOC/barrel) and the number of gallons of emulsified asphalt per barrel (42 gal./barrel) from Table 17.5-2 of the EIIP Tech. Report.

The emissions for the base year were calculated using equation 3.2.8-3.

$$EM = \frac{(\text{gallons Emulsified Asphalt}) \times EF}{(42\ \text{gal/barrel}) \times (2000\ \text{lb/tons})} \quad 3.2.8\text{-}3$$

where EM = emissions for source category
EF = emission factor for source category

3.2.9 Roofing Operations

This category covers the installation and repair of asphalt roofs on commercial and industrial buildings. This category includes only hot-applied asphalt roofing, for which the only significant emissions source is the kettle used to heat the asphalt. The amount of asphalt roofing activity is estimated by summing the number of felt, cap, and flashing squares used in North Carolina during the year 2002. This information was ascertained from the Asphalt Roofing Manufacturing Association. The amount of asphalt used is given by the equation 3.2.9-1, which uses the default value of 20 lbs. of asphalt / square found in the EIIP Tech. Report. The emissions by county, shown in equation 3.2.9-2, were apportioned by roofing establishments in the county divided by the state total, using the number of establishments from NAISC code 23561 from the 2000 County Business Patterns. The 2000 County Business Patterns was the latest available data at the time of the inventory development.

$$\text{Asphalt (Ton/yr)} = \frac{(\#\ \text{squares}) \times (20\ \text{lbs. of asphalt/square})}{(2000\ \text{lbs./ton})} \quad 3.2.9\text{-}1$$

$$\text{Asphalt}_{County} = \frac{(\text{Tons Asphalt}_{State}) \times (\#\ \text{Roofing Establishments})_{County}}{(\#\ \text{Roofing Establishments})_{State}} \quad 3.2.9\text{-}2$$

Asphalt roofing activities are assumed to have uniform operations throughout the year with a 5-day work week per the EIIP Tech. Report. Additionally, the EIIP Tech. Report reported the emissions factor as 6.2 lbs. VOC/ton asphalt for roofing operations.

The emissions for the base year inventory were calculated using equation 3.2.9-3.

$$EM = \frac{(\text{tons Asphalt}) \times EF}{(2000 \text{ lb/tons})} \qquad 3.2.9\text{-}3$$

where EM = emissions for source category
EF = emission factor for source category

3.2.10 Pesticide Application

Pesticides broadly include any substance used to kill or retard the growth of insects, rodents, fungi, weeds, or microorganisms. Formulations of organic pesticides are commonly made by combining synthetic materials with various petroleum products. The petroleum products, or inert ingredients, act as a carrier of the active component and usually evaporate into the atmosphere.

Agricultural Pesticides

Agricultural pesticides are applied in various manners, which directly affect the possible emissions associated with the application, regardless of the amount of solvent contained in the pesticide. There are basically three types of pesticide/herbicide application methods. One is the "incorporated" type, in which the product is applied and immediately incorporated into the soil. It is expected that little if any evaporation of solvent occur in this type of application. The next type, "pre-emergence", is where the product is put on the ground immediately after the crop is planted. This provides a protective layer. Some evaporation of solvent would be expected with this type of application. The largest emissions would occur from "over the top" application of pesticides. These pesticides are sprayed directly on the foliage to kill weeds or insects. This application would provide an opportunity for a great deal of solvent to evaporate.

The overall pesticide usage associated with agricultural crop production continues to slowly decrease in North Carolina driven by conservative pest management practices and the cost of pesticides as reported by the North Carolina Cooperative Extension office. The large majority of pesticide usage is confined to the production of tobacco and cotton crops. Because of the small crop size and high cash value, significant tobacco acreage is found in North Carolina.

The planted crop acreage from the North Carolina Agricultural Statistic Division and crop profile reports prepared by the North Carolina Cooperative Extension office, and other university extension services, for the US Department of Agriculture Pest Management Center were used to estimate agricultural pesticide usage. Crop acreage from the North Carolina Agricultural Statistic Division was obtained from http://www.ncagr.com/stats/. Crop profile reports conducted by NCSU are based on surveys; where participation is reported to be as high as 90 percent for the more important cash crops. Crop profile reports for grains and soybeans do not exist for North Carolina, therefore data for these crops were obtained from other state profiles and from discussions with representatives of the North Carolina Cooperative Extension office.

The individual crop profiles outline the current agricultural pesticide practices, i.e. the pesticide agents (insecticides, herbicides, fungicides), the percentage of acres treated, and the pounds of active ingredient pesticide applied per acre. The crop profiles often report the application of the active ingredient (pounds of active ingredient per acre) as a range of values. For the worst case scenario, the highest reported value was used. The number of applications of a single pesticide was usually one per year for all pesticides. The few exceptions to one application are more than accounted for by the conservative practice of using the highest value of application rate.

The pounds of active ingredients for each crop were calculated by using equation 3.2.10-1 and an example calculation for soybeans follows. Table 3.2.10-1 presents the pesticides associated with a particular crop, the % of treated acres, and the lbs. of active pesticide ingredient per year.

$$(\text{lbs. AI/acre})_{CROP} = \sum (\%\ \text{acres treated}) \times (\text{lb AI/acre})_{PESTICIDE} \qquad 3.2.10\text{-}1$$

where AI = active ingredient.

For soybeans, the pounds of active ingredients for the crop is:

Pesticide	% Acres Treated	Lb AI/acre
Paraquat	20	0.47
Glyphosate	10	4
Sulfusate	5	4
Carbaryl	10	1.5

$$(\text{lbs. AI/acre})_{SOYBEAN} = (0.20 \times 0.47) + (0.10 \times 4) + (0.05 \times 4) + (0.10 \times 1.5)$$
$$= 0.844 \text{ lbs. AI/acre for soybeans}$$

Table 3.2.10-1 Agriculture Pesticides Application Rates

Crop/Agent	% Acres Treated	Lbs. active ingredient/Acre	Crop/Agent	% Acres Treated	Lbs. active ingredient/Acre
Soybeans			***Corn Silage***		
Paraquat	20	0.47	Terbufos	35	1
Glyphosate	10	4	Chloropyrifus	10	1
Sulfusate	5	4	Phorate	10	1
Carbaryl	10	1.5	Ethoprop	5	1
Cotton			Carbofuran	5	1
Tribufos	100	0.75	M Parathion	50	0.75
Aldicarb	91	0.75	Thiocarb	90	0.6
Prourgite	0.45	0.73	Methomyl	50	0.45
Dicofol	0.55	1.6	***Corn Grain***		
Dicrotophos	0.45	0.2	Terbufos	35	1
Acephate	2.1	0.5	Chloropyrifus	10	1
M-Parathion	1	0.5	Phorate	10	1
L-cyhalothrin	99	0.145	Ethoprop	5	1
Thiocarb	40	0.75	Carbofuran	5	1
Aldicarb	50	0.725	M Parathion	50	0.75
Tobacco			Thiocarb	90	0.6
Acephate	70	1.5	Methomyl	50	0.45
Spinosad	13	0.05	***Oats***		
Methomyl	11	0.45	M Parathion	5	0.5
Endosulfan	7	1	***Wheat***		
Imidacoloprid	62	0.03	M Parathion	5	0.5
Chloropicrin	41	79.8	***Sweet Potatoes***		
Dichloropropene	35	89.5	Napropamide	50	1.5
Clomazone	75	1	Clomazone	25	0.87
Metalaxyl	49	0.76	Fluazifop	20	0.17
Barley			Carbaryl	25	0.67
M Parathion	0.8	0.5	***Peanuts***		
Irish Potatoes			Chlorpyrifus	60	1
Phorate 3	40	1.20	Disulfoton	90	0.75
Glyphosate	6	5	Esfenvalerate	25	0.03
Metolachor	8	2	Folicur 1	51	0.51
Metribuzin	55	0.5	Vernolate	45	2.5
Sorghum			Dichloropropene	0.16	80
MethyParathion	1	0.75			
Chlorpyrifus	1	1			
Carbaryl	1	2			

The emission factors for each crop were calculated utilizing information from the EIIP Tech. Report, p 9.5-4, which relates active ingredients to VOC emissions. According to the EIIP Tech. Report, for every pound of active ingredient there are 2.45 pounds of VOC, of this 90% is evaporated. The emission factors for each crop were calculated using Equation 3.2.10-2, with an example calculation for soybean following.

$$EF_{CROP} = (\text{lb } AI_{CROP}/\text{acre}) \times (2.45 \text{ lb. VOC/lb. of AI}) \times (0.90) \qquad 3.2.10\text{-}2$$

Where EF_{CROP} = Emission factor in lbs. VOC/active ingredient for each crop
AI_{CROP} = Active ingredient for each crop

For soybeans the emission factor is:
Lbs. AI/acre for soybean = 0.844 lbs. AI/acre

$$EF_{SOYBEAN} = (0.844 \text{ lb active ingredient/acre}) \times (2.45 \text{ lb VOC/active ingredient}) \times (0.90)$$
$$= 1.861 \text{ lbs. VOC/acre}$$

An exception to the above calculation was for the usage of the pesticides: chloropicrin and 1,3 dichloropropene. These fumigants are widely used for treating tobacco beds for nematodes and constitute a major portion of the pesticide inventory. They have a moderate vapor pressure of 18.3 and 34 millimeters of mercury (at 77° F), respectively, and their formulation is approximately 96% to 98% of the active ingredient. In light of these properties, the VOC emissions are assumed to be equal to the application per acre, which are 79 pounds/acre for chloropicrin and 89.5 pounds/acre for 1,3 dichloropropene. Table 3.2.10-2 list the pounds of active ingredients per acre and the calculated emission factor for each crop.

Table 3.2.10-2 Emission Factors by Crop Type

Crop	Lbs. Active Ingredients/acre	Lbs. VOC/Acre
Soybeans	0.844	1.861
Cotton	2.267	4.999
Barley	0.004	0.009
Corn – Silage	1.79	3.947
Corn – Grain	1.79	3.947
Wheat	0.025	0.055
Oats	0.025	0.055
Sweet Potato	1.169	2.578
Tobacco		
- *Non-fumigant*	2.317	5.109
- *Fumigant*	64.043	64.043
Total Tobacco		69.152
Peanuts		
- *Non-fumigant*	2.9175	6.433
- *Fumigant*	0.128	0.282
Total Peanuts		6.715
Irish Potatoes	1.9350	4.267
Sorghum	0.0375	0.083

The emissions for 2002 were calculated using equation 3.2.10-3.

$$EM_a = \frac{\sum (CROP)_a \times EF_{CROP}}{(2000 \text{ lb/tons})} \qquad 3.2.10\text{-}3$$

where EM_a = emissions for source category in county (a)
CROP = acres of specific crop in county (a)
EF_{CROP} = emission factor for specific crop

Nonagricultural Pesticide

Nonagricultural pesticide applications are considered as part of the commercial/consumer solvent use emission factor and no longer a separate subcategory. Please refer to the next section.

3.2.11 Commercial/Consumer Solvent Use

This category includes only non-industrial solvents that are used in commercial or consumer applications. The solvent containing products consist of a diverse grouping, e.g. personal care products, household products, automotive aftermarket products, adhesives and sealants, pesticides, some coatings, and other commercial and consumer products that may emit VOC emissions.

There are seven categories. They are named and their emission factors listed in Table 3.2.11-1 below.

Table 3.2.11-1 Misc. Non-Industrial Consumer-Commercial Emission Factors

Subcategory	lb VOC/yr/person.	lb NH_3/yr/person.
All Coatings and Related Products	0.95	-
All FIFRA Related Products	1.78	-
Miscellaneous Products (Not Otherwise Covered)	0.07	-
Personal Care Products	2.32	-
Household Products	0.079	0.031
Automotive Aftermarket Products	1.36	-
Adhesives and Sealants	0.57	-

VOC emissions for this category is estimated by using nationally based per capita emissions factors. The county population values are used to estimate the emissions from this source category.

According to the EIIP Tech. Report, emissions from this source category occur 365 days per year. The emissions for the base year inventory were calculated using equation 3.2.11-1.

$$EM = \frac{(Population_{2002}) \times EF}{(2000 \text{ lb/tons})} \qquad 3.2.11\text{-}1$$

where EM = emissions for source category, tons per year
EF = emission factor for source category

3.3 BIOPROCESS EMISSION SOURCES

Bioprocess emission sources include those sources whose emissions result from biological processes (e.g., fermentations). Source categories include bakeries, breweries, wineries and distilleries.

3.3.1 Bakeries

Ethanol, a VOC, is a by-product of fermentation of bread dough. The ethanol emissions from large commercial bakeries are accounted for as point sources; however, ethanol emissions occur from grocery store bakery departments and small business bakeries not accounted for under the point source inventory.

The EIIP Tech. Report prescribes accounting for these emissions by the use of a per capita consumption factor of 70 pounds of bread per person per year and an emission factor of 0.5 pounds of VOC per 1000 pounds of baked bread. The county populations obtained from the North Carolina Office of State Budget and Management were used to estimate the emissions from this source category.

According to the EIIP Tech. Report, emissions from this source category occur 365 days per year. The emissions for the base year inventory were calculated using equation 3.3.1-1.

$$EM = \frac{(Population)_b \times CF \times EF}{(2000\ lb/tons)} \qquad 3.3.1\text{-}1$$

where EM = emissions for source category
$Population_b$ = Population in base year
CF = Consumption factor, 70 lb bread/person/year
EF = emission factor for source category, 0.5 lb VOC/1000 lb bread baked

3.4 OTHER MAN MADE AREA SOURCES

Other man made area sources include forest fires, slash burning and prescribed burning, agricultural burning, structure fires, and orchard heaters. The methodology used to calculate the emissions from these sources are described in detail in each subsection.

3.4.1 Structure Fires

Burning fires can produce short term emissions of organic compounds and nitrogen oxides (NOx). The U.S. Fire Administration (USFA) of the Department of Homeland Security maintains statistics on the number of fires per county. The number of fires per county for 2002 was derived from 2001 and 2002 population statistics and 2001 USFA fire statistics. The USFA fire statistics were obtained from the USFA website at http://www.usfa.fema.gov/safety/. As 2002 fire statistics were not available, a fires per person factor for 2001 was calculated and found to be equal to 0.00184 fires/person. The 2001 county population values were obtained from the North Carolina State Demographics website at http://demog.state.nc.us/. The 2001 population values were the latest data available. The 0.00184 fires per person was applied to the 2002 population for each county to determine the number of fires in each county for 2002.

The emission factors and fuel loading factors were obtained from the EIIP Tech. Report, Table 18.4-1 and Table 18.4-2, respectively. The emission factors are 11 pounds of VOC per ton burned, 1.4 pounds of NOx per ton burned, 10.8 pounds of PM_{10} per ton burned, and 10.8 pou/pnds $PM_{2.5}$ per tons burned. The loading factor is 1.15 tons of material burned per structural fire.

According to the EIIP Tech. Report, emissions from this source category occur 365 days per year.

The emissions for the base year 2002 inventory were calculated using Equation 3.4.1-1.

$$EM_P = \frac{(2002\ \text{County population})\ \times\ (FPP) \times\ (CF)\ \times\ (EF_P)}{(2000\ \text{lb/tons})} \qquad 3.4.1\text{-}1$$

where EM_P = emissions for structure fires for pollutant (P)
FPP = fires per person in 2001, 0.00184 fires/person
CF = Conversion factor, 1.15 tons burned/structure fire
EF_P = emission factor for pollutant (P)

3.4.2 Charbroiling

The commercial charbroiling of ground beef emits VOC emissions. According to the methodology in the EIIP Tech. Report, county Health Departments should be able to provide the number of restaurants in a county as well as the percentage of those restaurants that charbroil meat. The NCDAQ was able to ascertain the number of restaurants in each county in 2002 from the North Carolina Division of Environmental Services, Inspection, Statistics, and Fee Branch.

To determine the percentage of charbroiling restaurants, the county Health Departments of several counties were surveyed.

According to the EIIP Tech. Report, the average throughput of meat per restaurant with a charbroiler is 1160 pounds per week and the emissions factor is 3.94 pounds of VOC per 1000 pounds of meat. Emissions from this source category occur 365 days per year.

The emissions for the base year inventory were calculated using Equations 3.4.2-1.

$$EM_a = \frac{(\#\ Restaurants)\ x\ (\%\ Charbroiling)\ x\ (CF)\ x\ (EF)}{(2000\ lb/tons)\ x\ (1\ yr/52\ wks)} \qquad 3.4.2\text{-}1$$

where EM_a = emissions for source category in county (a), tons/yr
CF = conversion factor, 1160 lb meat charbroiled/week
EF = emission factor, lbs. pollutant/1000 lb meat charbroiled

3.4.3 Open Burning – Municipal Solid Waste and Yard Trimmings

This subsection describes the combined emission inventory methodology for source classification code (SCC) 2610030000 Residential Open Burning – Household and SCC 2610000100 Open Burning – Yard Trimmings. Open burning is treated as a means of waste disposal in rural areas. Materials burned generally include agricultural refuse, landscaping refuse, or scrap wood. Local authorities could not provide assistance with estimating the tons of refuse burned or the amount burned. According to local authorities, burning permits are issued year round without requiring a notation for the amount burned.

It was assumed that all municipal solid waste (MSW) and yard trimmings, were burned in the open for solid waste generated outside the municipal corporate limits. According to the EIIP Tech. Report, Table 16.5-1, it is estimated that 3.77 pounds of MSW is generated per person per day and 0.64 pounds of yard trimmings are generated per person per day. Since it is illegal to burn within the corporate limits, the rural population was estimated by using the same percentage of rural population in each county as what was reported in the 2000 census. The 2000 total and rural populations for each county were obtained from the North Carolina Office of State Budget and Management, State Data Center. The 2000 total and rural populations was the latest data available.

VOC, NOx, CO, SO_2, and NH_3 emission factors for open burning of MSW were obtained from EIIP Tech. Report, Table 16.4-1, Open Burning of Municipal Refuse. The emission factors are

6.676 pounds VOC per ton MSW burned, 6 pounds NOx per ton MSW burned, 1 pounds SO_2 per ton MSW burned, and 6.0 E-07 pounds NH_3 per ton MSW burned.

The VOC emission factor for open burning of yard trimmings was obtained from EIIP Chapter 16, Table 16.4-7. The factor is 28 pounds VOC per ton yard trimmings. The rural percent of the populations for the statewide counties were obtained from the 2000 census data. Since burning permits are issued year round, the activity days per year was 365. These values were used to calculate the tons per year emissions for the base year. The emissions from the burning of MSW for the base year 2002 inventory were calculated using equation 3.4.3-1. The emissions from the burning of yard trimmings for the base year 2002 inventory were calculated using equation 3.4.3-2.

$$EM_{P,MSW} = \frac{(\text{Rural Population in 2002}) \times (CF_{MSW}) \times (EF_P) \times (365\ \text{days/yr})}{(2000\ \text{lb/tons})} \qquad 3.4.3\text{-}1$$

$$EM_{P,YT} = \frac{(\text{Rural Population in 2002}) \times (CF_{YT}) \times (EF_P) \times (365\ \text{days/yr})}{(2000\ \text{lb/tons})} \qquad 3.4.3\text{-}2$$

where $EM_{P,MSW}$ = emissions from burning MSW for pollutant (P)
$EM_{P,YT}$ = emissions from burning yard trimmings for pollutant (P)
CF_{MSW} = conversion factor, 3.77 lb MSW/person/day
= 0.001885 ton MSW/person/day
CF_{YT} = conversion factor, 0.64 lb yard trimmings/person/day
= 0.00032 ton yard trimmings/person/day
EF_P = emission factor for pollutant (P)

3.4.4 Small Stationary Source Fossil Fuel Use

In general, fossil fuels are burned for space and hot water heating. This source category covers VOC, NO_x, SO_2, PM_{10}, $PM_{2.5}$, and NH_3 emissions from natural gas (NG) and liquid petroleum gas (LPG), oil, coal, and wood combustion in the residential, commercial/institutional (called commercial), and industrial sectors.

The "demand for energy" for these fuel types is known as fuel usage. Fuel usage data for North Carolina was taken from NC Energy Outlook 2003 by Global Insight, Inc for the base year 2002. The following table shows the data used.

Table 3.4.4-1 Fuel Use in North Carolina 2002

Fuel	Units	Residential	Commercial	Industrial
NG	10^6 ft^3	64,014	40,580	95,718
LPG	gallons	282,775,596	47,960,199	198,606,965
Oil	gallons	215,804,019	113,088,933	343,414,390
Coal	tons	46,872	85,735	0
Wood	tons	1,625,111	164,327	8,583,778

Emission factors used are shown in Table 3.4.4-2 below.

Table 3.4.4-2 Combustion Emission Factors

Sector	Fuel	Units	VOC	NOx	SO_2	PM_{10}	$PM_{2.5}$	NH3
Residential	NG	lb/10^6 ft^3	5.5	94	0.6	7.6	7.6	20
Residential	LPG	Lb/gal	0.0003	0.014	0.000054	0.00906	0.00906	0
Residential	Oil	Lb/gal	0.000713	0.018	0.00426	0	0.001401	0.001
Residential	Coal	Lb/ton	0.07	9.1	31.62	6.2	3.8	2
Residential	Wood	Lb/ton	229.0	2.6	0.4	34.6	0	1.8
Commercial	NG	lb/10^6 ft^3	5.5	167.5	0.6	7.6	7.6	0.49
Commercial	LPG	Lb/gal	0.00035	0.0145	0.0000513	0.00906	0.000975	0
Commercial	Oil	Lb/gal	0.000735	0.037	0.004616	0.00449	0.002762	0.008
Commercial	Coal	Lb/ton	0.07	15.8	38.76	12.9575	4.75988	0.03
Commercial	Wood	Lb/ton	0.255326	3.304224	0.37548	6.48	5.47	0.086
Industrial	NG	lb/10^6 ft^3	4.96	163.33	0.6	7.6	7.6	3.2
Industrial	LPG	Lb/gal	0.00035	0.02	0.0000513	0.001125	0.00125	0
Industrial	Oil	Lb/gal	0.00024	0.039	0.0046275	0.005762	0.003969	0.008
Industrial	Coal	Lb/ton	0.07	14.9	38.76	12.9575	4.75988	0.03
Industrial	Wood	Lb/ton	0.255326	3.304224	0.37548	6.48	5.47	0.086

3.4.4.1 Fuel Oil Combustion

Fuel oil consumption covers the use of kerosene, distillate oil and residual oil. Distillate oil includes fuel oil grades 1, 2, and 4; residual oil includes fuel grades 5 and 6. In most areas, residual oil is not used by residential sources. Kerosene and distillate oils are primarily used for space heating in domestic and small commercial buildings, while residual oils are used primarily for industrial and large commercial applications. It was assumed that residential fuel oils are normally used only for heating and therefore, no residential fuel oil emissions were calculated for summer months.

The base year statewide annual fuel oil demand for energy, obtained from the NC Energy Outlook 2003, was converted British Thermal Units (BTUs) to gallons of fuel used for each heating classification (i.e., residential, commercial, and industrial). The conversion factors used were obtained from the NC Energy Outlook 2003 and are 135,000 BTU per gallon of kerosene, 138,690 BTU per gallon of distillate oil, and 149,690 BTU per gallon of residual oil.

Once converted to gallons of fuel, the statewide fuel use was then apportioned to the county level. This was accomplished by multiplying the number of gallons of fuel used in the state by the fraction of housing units heated by fuel oils in the county compared to that of the whole state (see the equation below).

$$\text{\# gal. fuel for County X} = (\text{\# gal. fuel oil for State}) \times \frac{(\text{\# housing units heated by fuel oil in County X})}{(\text{\# housing units heated by fuel oil in State})}$$

The fraction of housing units was used to distribute the fuel on a county level for the residential heating classifications. The number of housing units heated by fuel oils was obtained from the 2000 Census.

Commercial and industrial fuel usage was apportioned according to the number of business establishments in the State and counties. The numbers were taken from 1997 (last year of SIC based statistics) County Business Patterns. Establishments with SICs from 50*xx* through 99*xx* were summed. Industrial sources were calculated in a manner similar to commercial sources burning oil or coal.

Emission factors were obtained from AP-42, Table 1.3-1 and from AP-42, Table 1.3-3. Fuel oil combustion emission factors are listed in Table 3.4.4-2, as shown above.

According to the Procedures document, Table 5.8-1, the activity days per week is 7 for residential heating and 6 for commercial and industrial heating. These values were used to calculate the emissions in tons per year for the base year.

Point source emissions with SCC 1-03-004-xx and 1-03-005-xx identified commercial residual oil and distillate oil emissions, respectively; while source emissions with SCC 1-02-004-xx and 1-02-005-xx identified industrial residual and distillate oil emissions, respectively. The point source emissions in tons per year were subtracted from the area source emissions.

3.4.4.2 Coal Combustion

There are three types of coal used for space heating: anthracite, bituminous and lignite. According to AP-42, anthracite, or hard coal, is mined almost exclusively in Pennsylvania and is consumed in Pennsylvania and in states that are within easy shipping distance. In addition, lignite coal is mined in North Dakota and Texas and is consumed near where it mined. Since the incidence of anthracite and lignite coal burning is low in North Carolina, the emissions from coal combustion were calculated utilizing only the emission factors for bituminous coal.

It was assumed that residential coal is normally used only for heating and therefore, no residential coal emissions were calculated for summer months.

The base year statewide annual coal demand for energy, obtained from the NC Energy Outlook 2003, were converted from BTU to tons of coal used for each heating classification (i.e., residential, commercial, and industrial). The conversion factor used was 21,100,000 BTU per ton of coal.

Once converted to tons of coal, the statewide coal use was then apportioned to the county level. This was calculated by multiplying the number of tons of coal used in the state by the fraction of housing units heated by coal in the county, compared to that of the whole state (see the equation below).

$$\text{\# ton of coal for County X} = (\text{\# ton of coal for State}) \times \frac{(\text{\# housing units heated by coal in County X})}{(\text{\# housing units heated by coal in State})}$$

The fraction of housing units was used to distribute the coal on a county level for both heating classifications. The number of housing units heated by coal was obtained from the Federal Bureau of the Census and the 2003 NC State Energy Plan (http://www.doa.state.nc.us/doa/energy).

There were several emission factors for bituminous coal combustion listed in AP-42, Table 1.1-3. For the purpose of estimating the emissions from coal combustion, the equipment listed in AP-42, Table 1.1-3 were grouped into industrial, commercial/institutional and residential type equipment. The emission factors were averaged for each type and the averaged emission factors were used to calculate the emissions. Table 3.4.4-2 shown above lists the averaged emission factors used in the calculations. It should be noted that fluidized bed combustors (FBC) were not included in the averaged emission factors because FBC does not constitute a significant percentage of the total boiler population, according to AP-42, Section 1.1. The Procedures document, Table 5.8-1, lists the activity days per week as 7 for residential heating and 6 for commercial and industrial heating. Point source emissions with SCC 1-03-002-xxidentified commercial coal combustion emissions. The point source annual emissions in tons per year were subtracted from the area source emissions.

Residential Coal Combustion Emissions:

$$\text{Pollutant emitted by coal combustion} = \frac{(\text{\# tons/year Coal}) \times EF}{(2000 \text{ pounds/ton})}$$

Commercial Coal Combustion Emissions:

$$\text{Pollutant emitted by coal combustion} = \frac{(\text{\# tons/year Coal}) \times EF}{(2000 \text{ pounds/ton})}$$

Industrial Coal Combustion Emissions:

There is no industrial coal combustion in the area source inventory because it is included in the point source emissions inventory.

3.4.4.3 Natural Gas Combustion

Currently in the United States, natural gas is one of the major types of fuels used for heating. It is mainly used for industrial process stream and heat production, commercial and residential space heating and for electric power generation. Although natural gas is a relatively clean burning fuel, some emissions can result from its combustion.

The base year statewide annual demand for natural gas energy, obtained from the NC Energy Outlook 2003, was converted from BTU to 10^6 cubic feet of natural gas used for each heating classification (i.e., residential, commercial, and industrial). The conversion factor used was 1,000 BTU per cubic foot of natural gas.

Once converted to cubic feet of natural gas, the statewide natural gas use was then apportioned to the county level. This was calculated by multiplying the number of cubic feet of natural gas used in the state by the fraction of housing units heated by natural gas in the county, in comparison to the state (see the equation below).

$$\#\ ft^3 \text{ nat gas for County X} = (\#\ ft^3 \text{ nat gas for State}) \times \frac{(\#\text{ housing units heated by nat gas in County X})}{(\#\text{ housing units heated by nat gas in State})}$$

The fraction of housing units was used to distribute the natural gas usage on a county level for each heating classification. The number of housing units heated by natural gas was obtained from the 2000 Census.

The North Carolina Utilities Commission provided data from the U.S. Department of Energy, Energy Information Administration giving monthly usage of natural gas by residential and commercial customers in North Carolina for 2002.

There were several emission factors listed for industrial and commercial natural gas boilers in AP-42, Table 1.4-1. For the purpose of estimating the emissions from natural gas combustion, an average of the emission factors were used. Table 3.4.4-2 shown above lists averaged emission factors used in the calculations. According to the Procedures document, Table 5.8-1, the activity days per week is 7 for residential heating and 6 for commercial and industrial heating. These values were used to calculate the annual emissions in tons per year for the base year.

Point source emissions with SCC 1-03-006-xxx and 1-02-006-xxx, identified commercial and industrial natural gas combustion emissions, respectively. Where point source emissions were indicated, these were deducted from the 2002 annual emission estimates.

Residential Natural Gas Combustion Emissions:

$$\begin{array}{l}\text{Pollutant emitted by} \\ \text{Nat. gas combustion}\end{array} = \frac{(\#\ ft^3/\text{year natural gas}) \times EF}{(2000 \text{ pounds/ton})}$$

Commercial Natural Gas Combustion Emissions:

$$\begin{array}{l}\text{Pollutant emitted by} \\ \text{Nat. gas combustion}\end{array} = \frac{(\#\ ft^3/\text{year natural gas}) \times EF}{(2000 \text{ pounds/ton})}$$

Industrial Natural Gas Combustion Emissions:

$$\text{Pollutant emitted by Nat. gas combustion} = \frac{(\#\ ft^3/\text{year natural gas}) \times EF}{(2000\ \text{pounds/ton})}$$

3.4.4.4 Liquefied Petroleum Gas Combustion

Liquefied petroleum gas (LPG) consists of propane, propylene, butane, and butylenes. The largest market for LPG is the domestic/commercial market, followed by the chemical industry and agricultural markets. LPG is also used as a stand-by fuel for facilities that have natural gas service contracts that can be interrupted. The form of LPG used primarily for domestic heating is propane. Liquefied petroleum gas is considered a clean fuel because it does not produce visible emissions. However, gaseous pollutants such as VOC, NO_x, SO_2, PM_{10}, and $PM_{2.5}$ do occur.

The base year statewide annual LPG demand for energy, obtained from the NC Energy Outlook 2003, was converted from BTU to 10^3 gallons of LPG used for each heating classification (i.e., residential, commercial, and industrial). The conversion factor was 95,475 BTU per gallon of LPG.

Once converted to gallons of LPG, the statewide LPG use was then apportioned to the county level. This was accomplished by multiplying the number of gallons of LPG used in the state by the fraction of housing units heated by LPG in the county compared to that of the whole state (see the equation below).

$$\#\ \text{gal LPG for County X} = (\#\ \text{gal LPG for State}) \times \frac{(\#\ \text{housing units heated by LPG in County X})}{(\#\ \text{housing units heated by LPG in State})}$$

The fraction of housing units was used to distribute the LPG usage on a county level for each heating classification. The number of housing units heated by LPG was obtained from the 2000 Census.

The North Carolina Utilities Commission provided data from the U.S. Department of Energy, Energy Information Administration giving monthly usage of LPG by residential and commercial customers in North Carolina for 2002.

The emission factors listed in AP-42, Table 1.5-1 were averaged for industrial and commercial sources. There is no residential LPG emission factor listed in AP-42. Since the form of LPG used primarily for domestic heating is propane, the commercial propane emission factor was used for residential LPG combustion. The emission factors listed in AP-42, as well as the average emission factors used for estimating the emissions from LPG combustion are listed in Table 3.4.4.4-1. According to the Procedures document, Table 5.8-1, the activity days per week is 7 for residential heating and 6 for commercial and industrial heating. Point source emissions with SCC 1-03-010-xxx and 1-02-010-xxx, identified commercial and industrial LPG combustion emissions, respectively. Where point source emissions were indicated, these were deducted from the 2002 annual emission estimate.

Residential LPG Emissions:

$$\text{Pollutant emitted by LPG combustion} = \frac{(\#\ \text{gal/year LPG}) \times EF}{(2000\ \text{pounds/ton})}$$

Commercial LPG Combustion Emissions:

$$\text{Pollutant emitted by LPG combustion} = \frac{(\#\ \text{gal/year LPG}) \times EF}{(2000\ \text{pounds/ton})}$$

Industrial LPG Combustion Emissions:

$$\text{Pollutant emitted by LPG combustion} = \frac{(\#\ \text{gal/year LPG}) \times EF}{(2000\ \text{pounds/ton})}$$

Table 3.4.4.4-1 Emission Factors for Liquefied Petroleum Gas

Application/Fuel Type	Emission Factors (lb /gallon)		
	Industrial	*Commercial*	*Residential*
Butane	0.0036	0.0021	-
Propane	0.0032	0.0019	0.0019
Averaged CO Emission Factor	0.0034	0.002	0.002
Butane	0.021	0.015	0.015
Propane	0.019	0.014	0.014
Averaged NOx Emission Factor	0.02	0.0145	0.014
Butane	0.0004	0.0004	0.0004
Propane	0.0003	0.0003	0.0003
Averaged VOC Emission Factor	0.00035	0.00035	0.0003
Butane	-	-	-
Propane	-	-	-
Averaged SO_2 Emission Factor	0.0000513	0.0000513	0.000054
Butane	-	-	-

Propane	-	-	-
Averaged PM_{10} Emission Factor	0.001125	0.00906	0.00906
Butane	-	-	-
Propane	-	-	-
Averaged $PM_{2.5}$ Emission Factor	0.001125	0.00906	0.00906

3.4.4.5 Wood Combustion

The use of wood as a source of heat occurs in the residential and industrial sectors. It was assumed that residential wood is normally used only for heating and therefore, no residential wood emissions were calculated for summer months. The burning of wood waste in boilers is mostly confined to those industries where the wood is available as a byproduct. Most often this is in the lumber, furniture and plywood industries. These types of industries are included in the point source inventory, therefore, no area source emissions will be calculated for industrial wood combustion. Wood stoves, commonly used in residences as space heaters, are used both as the primary source of heat and as a supplement to conventional heating systems.

The base year statewide annual wood demand for energy, obtained from the NC Energy Outlook 2003, was converted from BTU to tons of wood used for residential heating. The conversion factor was 4,500 BTU per pound of wood, which is the mid-point of the range (4,000 to 5,000 BTU per pound of wood) given in AP-42, Section 1.6.

Once converted to tons of wood, the statewide wood use was then apportioned to the county level. This was accomplished by multiplying the number of tons of wood use in the state by the fraction of housing units heated by wood in the county compared to that of the whole state (see the equation below).

$$\text{\# tons Wood for County X} = (\text{\# ton Wood for State}) \times \frac{(\text{\# housing units heated by Wood in County X})}{(\text{\# housing units heated by Wood in State})}$$

The fraction of housing units was used to distribute the wood usage on a county level. The number of housing units heated by wood was obtained from the 2000 Census.

Table 3.4.4-2 shown above lists emission factors used in the calculations. The residential wood combustion emission factors were obtained from the Table 2.4-1 of the EIIP Tech. Report, Volume III, Chapter II. According to the Procedures document, Table 5.8-1, the activity days per week is 7 for residential heating.

Wood Combustion Emissions:

$$\text{Pollutant emitted by Wood combustion} = \frac{(\text{\# ton/year Wood}) \times EF}{(2000 \text{ pounds/ton})}$$

3.4.4.6 Small Electric Utility Boilers

This source subcategory has been treated as a point source since the information was available for each facility. Refer to the point source category discussion in Appendix F.1 for further details.

3.4.5 Vehicle Fires

Vehicle fire emissions within the State demonstration area are estimated by considering the estimated number vehicles burned in the State, the amount of material burned (the fuel loading) in a vehicle fire, and the emission factors for the open burning of automobile components. The assumptions for amount of material burned and the emission factors were based on the USEPA's AP-42, Section 2.5 Open Burning.

The estimated number of vehicle fires was determined by apportioning a national fire statistic to a county level. The USFA of the Department of Homeland Security maintains national-level fire statistics. The number of fires nationwide in 2002 was 1,734,500 and was available from the USFA website at http://www.usfa.fema.gov/statistics/national/. The percentage of vehicle fires was applied to the national-level total number of fires. The number of national-level vehicle fires was then apportioned to a state-level. The ratio of North Carolina vehicle miles traveled (VMT) to U.S. VMT (92,894,000,000 VMT / 2,855,756,000,000 VMT) was applied to the number of national-level vehicle fires to obtain the number of North Carolina vehicle fires. The VMT statistics were obtained from the U.S. Department of Transportation, Federal Highway Administration website at http://www.fhwa.dot.gov/policy/ohim/hs02/vm2.htm. The number of state-level vehicle fires was then apportioned to a county level based on paved mile per county in 2002. Paved mile per county data was obtained from the NCDOT. Using the above method, 2002 vehicle fire emissions were calculated.

The amount of vehicle material burned (the fuel loading) in a vehicle fire was estimated by assuming that an average vehicle has 500 pounds of components (0.25 tons) that can burn in a fire, based on a 3,700 pounds average vehicle weight (CARB, 1995).

The emission factors were obtained from Table 2.5-1, Emission Factors for Open Burning of Municipal Refuse, of the USEPA's AP-42, Section 2.5 Open Burning. The emission factors are 32 pounds of VOC per ton burned and 4 pounds of NOx per ton burned.

The emissions for the base inventory were calculated using equation 3.4.5-1.

$$EM_P = \frac{(\text{\# of Vehicle Fires per year}) \times (CF) \times (EF_P)}{(2000 \text{ lb/tons})} \qquad 3.4.5\text{-}1$$

where EM_P = annual emissions for structure fires for pollutant (P)
CF = Conversion factor, 0.25 tons burned/vehicle fire
EF_P = emission factor for pollutant (P)

3.4.6 Agricultural Burning

This source subcategory covers burning practices used to clear and/or prepare land for planting. These operations include stubble burning, burning of agricultural crop residues, and the burning of stand field crops as part of harvesting (e.g., sugar cane). According to the North Carolina Department of Agriculture, when soybeans are double cropped with wheat, the wheat stubble is usually burned back after harvest about one fourth of the time. According to Dr. J. Dunphy, a soybean specialist at North Carolina State University, the acres of soybean double cropped with wheat in North Carolina is approximately equal to the acres of wheat planted. Therefore, one fourth of the acreage of wheat planted in 2002 was used to calculate the emissions from agricultural burning practices in North Carolina.

The fuel loading factor and the yield of VOC for burning wheat stubble was obtained from AP-42, Table 2.5.5. The fuel loading factor is 1.9 tons of fuel consumed per acre burned. The yield of pollutant was dependent upon whether the field was head-fire burned or back-fire burned. The percentage of each burning type used was not available, therefore, the assumption was made that each type was used 50 percent of the time. The yield of VOC used, 11 pounds of VOC per ton of fuel consumed, is an average of the two types of burning. To calculate the emission factor for VOC emissions, the fuel loading factor is multiplied by the yield of pollutant.

$$EF_{VOC} = (1.9 \text{ tons/acre})\ (11 \text{ lb VOC/ton burned})$$
$$= 20.9 \text{ lb VOC/acre burned}$$

The annual emissions were calculated using the number of acres burned and the per acre emission factor. According to the North Carolina Department of Agriculture, field burning occurs only during June and July.

The number of acres of wheat planted was obtained from the North Carolina Department of Agriculture, Agriculture Statistics Division. The emissions for the 2002 base year inventory were calculated using equation 3.4.6-1.

$$EM = \frac{(\frac{1}{4} \times (\text{wheat acreage})) \times EF}{(2000 \text{ lb/ton})} \qquad 3.4.6\text{-}1$$

where EM = emissions for source category for VOC
EF = emission factor for VOC

3.4.7 On Site Incineration

On-site incineration is the confined burning of waste leaves, landscape refuse and other refuse or rubbish. In North Carolina, commercial/institutional and industrial incinerators are required to have an Air Quality Permit in order to operate. Therefore, all industrial incinerators are identified in the point source inventory. There may be small commercial/institutional incinerators that have not been identified in the point source inventory and as a result emissions were calculated for commercial on-site incinerators.

No data was available to determine the amount of waste burned in on-site incinerators. Therefore, the amount of solid waste burned was estimated with the fuel loading factor (L) given in Table 4.6-1 of the Procedures document. The commercial fuel loading factor is 23 tons of refuse/1,000 population/year. The yield for commercial incineration was obtained from several sources. The yield of NOx, SO_2, PM_{10}, $PM_{2.5}$ (P) was obtained from AP-42, Table 2.1-12 and are listed in Table 2.1.4.7-1. The yield value used of NOx, SO_2, PM_{10}, and $PM_{2.5}$ was the average of the yield values listed in AP-42. The yield of VOC is 8.556 lb/ton of refuse and was obtained from EIIP Technical Report, Open Burning, Table 16.4-1. The yield of NH_3 is 1.19 lb/ton of refuse and was obtained from EIIP Area Source Methods Document, "Estimating Emissions from Anthropogenic Nonagricultural Sources".

Table 3.4.7-1 Yield of Pollutant Values for Uncontrolled Refuse Combustors

Pollutant	Multiple Chamber Combustor Yield Value (lb Pollutant/ton refuse burned)	Single Chamber Combustor Yield Value (lb Pollutant/ton refuse burned)	Average Yield Value (lb Pollutant/ton refuse burned) (lb Pollutant/ton refuse burned)
NOx	3	2	2.5
CO	10	20	15
SO_2	2.5	2.5	2.5
PM_{10}	7	15	11
$PM_{2.5}$	7	15	11

To calculate the per capita pollutant emission factor (EF) for on-site commercial incinerators, the fuel loading factor was multiplied by the yield of the pollutant, as shown in the following equation.

$$EF_P = L_{COMMERCIAL} \times P_{INCINERATION}$$

$$= (23 \text{ tons of refuse/1000 population/year}) \times (2.5 \text{ lb NOx/ton of refuse burned})$$

$$= 57.5 \text{ lb NOx/1000 population/year}$$

The emissions from commercial on-site incineration for the base year 2002 inventory were calculated using equation 3.4.7-1.

$$EM_P = \frac{(\text{Rural Population in 2002}) \times (EF_P)}{(2000 \text{ lb/tons})} \qquad 3.4.7\text{-}1$$

where EM_P = emissions from on-site incineration for pollutant (P) in tons/year

EF_P = emission factor for pollutant (P)

The population was obtained from the 2000 census data. The 2000 census data was the latest data available. According to the Procedures document, on-site incineration occurs uniformly year round and operates 7 days per week. Point source emissions with SCC 5-xx-xxx-xx identified waste incineration emissions. The point source emissions in tons per year were subtracted from the area source emissions.

4. VISTAS DEVELOPED 2002 AREA SOURCE INVENTORY

Section 4.0 details the portion of the 2002 base year area source inventory, which was developed for VISTAS/ASIP by the VISTAS contractor, MACTEC, Inc. This information was obtained from the report entitled *Documentation of the Base G 2002 Base Year, 2009, and 2018, Emission Inventories for VISTAS* prepared for VISTAS by MACTEC, Inc. This report is included in Appendix P.

Several major components of the area source sector of the inventory, which were developed by VISTAS, are discussed in Sections 4.1 through 4.5. Ammonia emissions from livestock and fertilizer sources are discussed in Section 4.1. $PM_{2.5}$ and PM_{10} emissions from paved and unpaved roads are discussed in Section 4.2. Stage II emissions are discussed in Section 4.3 and were removed from the area source inventory and included in the mobile sector of the inventory. Also, emissions from portable fuel containers were added and are discussed in Section 4.4. Section 4.5 describes the development of the fires emissions inventory and distinguishes the difference between an actual versus typical inventory with regards to fires.

The following Sections are based on excerpts, with some editing, taken from a document entitled, *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS* and prepared by MACTEC, Inc.

4.1 Ammonia from Agricultural Sources

VISTAS used version 3.6 of the Carnegie Mellon University (CMU) NH_3 model (http://www.cmu.edu/ammonia/) to calculate NH_3 emission estimates for livestock and fertilizers. Results from this model were used for all VISTAS States. The CMU model version 3.6 was used in large part because it had been just recently been updated to include the latest (2002) Census of Agriculture animal population statistics.

For the ammonia inventory, VISTAS removed all wildlife and human perspiration emissions due to uncertainty of inaccurate emission factors. Thus all emissions from these two categories were deleted in the 2002 inventory.

4.2 Paved and Unpaved Road Emissions

VISTAS used the most recent PM emission estimates developed by EPA as part of the NEI development effort (Roy Huntley, U.S. EPA, email communication, 8/30/2004). EPA had developed and used an improved methodology for estimating paved road emissions for 2002. MACTEC obtained those emissions in March 2004 in NIF format from the EPA FTP site.

$PM_{2.5}$ emissions from several fugitive dust sources were also updated for the 2002 inventory. The Western Regional Air Partnership (WRAP) and U.S. EPA had been investigating overestimation of the $PM_{2.5}$ / PM_{10} ratio in several fugitive dust. Based on data received from U.S. EPA, VISTAS decided to revise the $PM_{2.5}$ emissions from construction, paved roads and unpaved road sources. $PM_{2.5}$ emissions in the emission inventory, which was developed by EPA were multiplied by 0.67, 0.6, and 0.67 for construction, paved roads and unpaved roads respectively to produce the values found in 2002 inventory. No changes were made to PM_{10}, only to $PM_{2.5}$.

4.3 Vehicle Refueling (Stage II) emissions

For the 2002 inventory, the VISTAS/ASIP States all agreed to remove the Stage II refueling emissions from the area source inventory and include them in the non-road and on-road sectors.

4.4 Portable Fuel Containers

Portable fuel containers (PFCs), SCC 2501060300, covers emissions from residential and commercial sector portable gasoline containers. Permeation, diurnal, transport, spillage, and vapor displacement emissions are typically accounted for in this category. Spillage from refueling operations and vapor displacement emissions were not included in the inventory to avoid double counting refueling in the non-road sector.

MACTEC found that the USEPA had prepared a national inventory of emissions by State for portable fuel containers. Data on emissions from this source prepared by the USEPA were presented in the report, *Estimating Emissions Associated with Portable Fuel Containers (PFCs), Draft Report*, Office of Transportation and Air Quality, USEPA, Report # EPA420-D-06-003, February 2006.

The 2002 county-level emission estimates were obtained through an allocation method based on fuel usage. Initially, 2005 emission estimates, except those from vapor displacement and spillage from refueling operations, were obtained from the USEPA’s report and assumed to be equal to 2002 values. Permeation, diurnal, and transport emission estimates were summed and allocated to the county-level, based on the fuel usage information obtained from the NONROAD2005 model. The SCCs that use containers for refueling were acquired from the spillage file of the NONROAD model. Then the fuel usages by county from the NONROAD 2005 runs prepared for VISTAS/ASIP were summed for those SCCs by county. The county level fuel use was then divided by the State total fuel use for the same SCCs to determine the fraction of total State fuel usage and that fraction was used to allocate the State-level emissions to the county.

4.5 Fires Including Forest Fires

The fires source category includes wildfire, prescribed burning, and land clearing fires. These fires can be intermittent in nature, but many of these can produce large quantities of air pollutant emissions. Wildfires in certain rural areas can produce large, short-term organic emissions. Prescribed burning is used a as a forest management practice to establish favorable seedbeds, remove competing underbrush, accelerate nutrient cycling, control tree pests and contribute other ecological benefits. Agricultural burning covers agricultural burning practices used to clear and/or prepare land for planting. In land clearing fires, waste from logging operations is often burned under controlled conditions to reduce the potential fire hazards in forests and to remove brush that can serve as a host for destructive insects.

The total wildfire acreage burned was obtained from the NCDFR for each county in the State. These numbers however are replaced with the 2002 "typical" year for the purpose of modeling. Fire emissions are not easily grown or projected. Thus, the replacement was done so that the fires represented in the area source inventory are considered typical and do not reflect an abnormally low or high year as far as fires. The typical year forest fire inventories were developed by MACTEC, Inc. with input from state and federal forest resource staff. The typical year covered wildfire, prescribed burning, agricultural fires and land clearing fires. The development of the typical year inventory is described below.

State level ratios of acres over a longer-term record (three or more years) developed for each fire type relative to 2002. The 2002 acreage was then scaled up or down based on these ratios to develop a typical year inventory. VISTAS Fire Special Interest Work Group based the ratio on county-level data for States that supplied long-term fire-by-fire acreage data rather than State-level ratios. Where States did not supply long-term fire-by-fire acreage data, MACTEC reverted to using State-level ratios. With one broad exception (wildfires) this method was implemented for all fires. MACTEC solicited long term fire-by-fire acreage data by fire type from each VISTAS State. A minimum of three or more years of data were used to develop the ratios. Those data were then used to develop a ratio for each county based on the number of acres burned in each county for each fire type relative to 2002.

If VISTAS had long term county prescribed fire data from a State, a county acreage ratio, described below, was developed.

$$Ratio = \frac{\text{Long term average county level Rx acres}}{\text{2002 actual county level Rx acreage}}$$

This ratio was then multiplied times the actual 2002 acreage to get a typical value (basically the long term average county level acres). Wherever possible this calculation was performed on a fire-by-fire basis. The acreage calculated using the ratio was then used with the fuel loading and emission factor values to calculate emissions.

There were three exceptions to this method.

Exception 1: Use of State Ratios for Wildfires

Wildfires estimates were developed using State ratios rather than county ratios because some counties were showing unrealistic ratios, which were created by very short term data records or missing data. In addition, exceptionally large and small fires were removed from the database. VISTAS also removed all fires less than 0.1 acres from the dataset.

Exception 2: Correction for Blackened Acres on Forest Service Lands

Acres, submitted by the U.S. Forest Service (USFS) for wildfires and prescribed fires on USFS lands, represented perimeter acres rather than "blackened" acres. Therefore, for prescribed fires greater than 100 acres in size, the acreage was adjusted to be 80 percent of the initial reported value. For prescribed fires of 100 acres or less, the acreage values were maintained as reported. All reported acreage values for wildfires were adjusted to be 66 percent of their values, as initially reported.

Exception 3: Missing/Non-reported data

When VISTAS did not receive data from a VISTAS State for a particular fire type, a composite average for the entire VISTAS region was used to determine the typical value for that type fire. This technique was applied to all fire types when data was missing.

For wildfires and prescribed burning, ratios were also developed for "northern" and "southern" tier States within the VISTAS region and those ratios were applied to each State with missing data depending upon whether they were considered a "northern" or "southern" tier State.

Development of “southern” and “northern” tier data was an attempt to account for a change from a predominantly pine/evergreen ecosystem (southern) to a pine/deciduous ecosystem (northern).

Table 4.5-1 below presents a comparison in tons per year of the 2002 actual fire emissions and the 2002 typical fire emissions for NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$ and NH_3 for wildfires, and prescribed burning in North Carolina.

The typical wildfire and prescribed burning emissions for Catawba, Davidson, and Guilford counties for 2002 are found in Appendix E, Table 9. Note that there were no prescribed burning emissions in Catawba and Guilford counties.

The emissions shown in Table 4.5-2 below were inadvertently omitted from modeling by the VISTAS contractors. This was also true for the same source categories in other counties. There were not sufficient funds to perform new modeling. However, these emissions, compared to total emissions, are believed to be too small to make any noticeable difference in the results.

Table 4.5-1 2002 North Carolina Actual and Typical Fire Emissions

Actual Fire Emissions (TPY)						
Fire Type	**NOx**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
Wildfires	458.18	1005.04	124.89	2126.61	1825.84	95.14
Prescribed Burning	282.28	619.19	67.00	1210.00	1035.00	48.00
Typical Fire Emissions (TPY)						
Wildfires	763.72	1692.57	206.78	3504.44	3002.50	157.69
Prescribed Burning	763.89	1678.59	207.66	3472.12	2977.75	157.87

Table 4.5-2 2002 Fire Emissions Data (Typical) Omitted From Modeling in Tons Per Year (TPY)

County	SCC	SCC Description	VOC	NOX	SO2	PM_{10}	$PM_{2.5}$	NH_3
Catawba	2610000500	Open Burning of Land Clearing Debris	159.87	68.91		234.29	234.29	
Catawba	2801500262	Agricultural Burning, Wheat Backfire Burning	10.58			16.83	16.83	
Hickory		**Total TPY**	**170.45**	**68.91**	**0.00**	**251.12**	**251.12**	**0.00**
Davidson	2610000500	Open Burning of Land Clearing Debris	94.90	40.90		139.08	139.08	
Davidson	2801500262	Agricultural Burning, Wheat Backfire Burning	4.53			7.21	7.21	
Guilford	2610000500	Open Burning of Land Clearing Debris	428.43	184.67		627.87	627.87	
Guilford	2801500262	Agricultural Burning, Wheat Backfire Burning	16.37			26.05	26.05	
Triad		**Total TPY**	**544.24**	**225.57**	**0.00**	**800.21**	**800.21**	**0.00**

4.6 Application of Transportable Fraction Adjustment Factors for Modeling

For modeling purposes only, VISTAS applied a transportable fraction adjustment factor to paved and unpaved road emissions; residential, industrial/commercial/institutional, and road construction emissions; mining and quarrying emissions; crop tilling emissions; and beef cattle finishing emissions. The applicable SCC's are 2294000000, 2296000000, 2311010000, 2311020000, 2311030000, 2325000000, 2801000003, and 2805001000 respectively For additional information about transportable fraction factors, see the paper titled *Methodology to Estimate the Transportable Fraction (TF) of Fugitive Dust Emissions for Regional and Urban Scale Air Quality Analysis* in Appendix P.

5. 2009 AREA SOURCE EMISSION INVENTORY DEVELOPMENT

This Section describes the methodology used to develop the 2009 area source inventory. Separate methods for projecting emissions were used for non-agricultural (stationary area), agricultural area sources and forest fire area sources. The agricultural area sources method is for ammonia emissions, as ammonia contributes to the formation of regional haze and fine particulate matter.

The following Sections are based on excerpts, with some editing, taken from a document entitled, *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS* and prepared by MACTEC, Inc.

5.1 Projection of Stationary Area Sources

VISTAS 2002 base year inventory emissions were used as a starting point for calculating 2009 emissions. MACTEC, Inc. first back calculated uncontrolled emissions from the 2002 base year inventory. Growth and control factors were then applied based on controls initially identified for the Clean Air Interstate Rule (CAIR) and growth factors identified for the CAIR projections. In some cases, Economic Growth Analysis System version 5.0 (EGAS 5.0) growth factors were used if no growth factor was available from the CAIR growth factor files.

The 2009 growth factors were obtained from the USEPA growth factors and indirectly from 2010 and 2015 CAIR growth factors. Using a 2001 base year, interpolation of 2010 and 2015 CAIR growth factors yielded 2009 growth factors. MACTEC used the TREND function of Microsoft Excel for interpolation. Interpolated growth factors were calculated at the State and SCC level.

In a few cases, additional growth factors had to be added for sources that had not initially been included in a draft 2002 inventory. These growth factors were obtained from EGAS 5.0. Finally updates to growth factors from EGAS 5.0 were made for fuel fired emission sources. The updated growth factors reflected the most recent data from the Department of Energy's Annual Energy Outlook (AEO). These data were used to reflect changes in energy efficiency resulting from new or updated fuel firing technologies.

North Carolina provided 2009 updated emission files used to update the emissions for each year for several source categories. However not all sources in the inventory were included in these North Carolina updates. As a consequence, the final 2009 inventory for North Carolina included emissions updated using the North Carolina supplied files and emissions developed using growth and control factors as outlined above.

5.2 Projection of Agricultural Area Sources

MACTEC used the version 3.1 2002 base year inventory data (which was based on the CMU ammonia model version 3.6). MACTEC obtained State specific growth, if available. Otherwise, growth factors were used, which were developed from the USEPA Interstate Air Quality Transport Rule (IAQTR)/Ammonia inventory. Growth factors for several agricultural livestock categories were developed by the USEPA, as part of the NEI.

In addition, ammonia growth factors for a few categories (mainly feedlots) were assigned to be the same as growth factors for PM emissions from the NEI projections. This assignment was made because the CMU model showed emissions from these categories but the NEI projections did not show ammonia emissions but did show PM emissions. No growth factors were found for horse and pony emissions. These emissions were held constant at 2002 levels.

No controls were identified by North Carolina; thus, all projected emissions for agricultural area sources represent simple growth with no controls.

Wild animal and human perspiration emissions were removed from the 2009 inventory because of considerable uncertainty in the accuracy of emission factors. All swine emissions for North Carolina were maintained at 2002 levels for the 2009 inventory to capture a moratorium on swine production in that State.

5.3 Projection of Forest Fires Area Sources

Several Federal agencies indicated that they had plans for increased prescribed fire burning in future years and that the “typical” fire inventory would likely not adequately capture those increases. Thus, MACTEC acquired the data necessary to provide 2009 specific projections for the prescribed fire component of the fire inventory.

The U.S. Fish and Wildlife Service (USFWS) submitted annual acreage data by National Wildlife Refuge (NWR) and by county with estimates of acres burned per day for each NWR. USFS provided fire-by-fire acreage estimates based on mapping projected burning acreage to current 2002 modeling days. However, USFWS did not submit data for VISTAS original base year preparation process, thus there was no known USFWS data in the 2002 actual or typical inventories. MACTEC therefore developed a method that could use the county-level data submitted by USFWS.

Several VISTAS/ASIP States run a prescribed fire-permitting program. To avoid double counting, only State data and not USFWS or USFS data was used in those States for the 2002 actual inventory.

The method used by MACTEC to include the USFS data applied a county level data approach for USFS data where a State had a prescribed fire permitting program and a fire-by-fire replacement for USFS data in States without permit programs. MACTEC used a county level approach for all of the USFWS data. The approach used for each data set is discussed below.

For USFWS data, 2002 annual county acres burned was subtracted from the USFWS projected acreage. A 0.8 factor was applied to the difference to account for blackened acres instead of the total perimeter acres that were reported. The revised total additional USFWS acreage was then added to the total county "typical" acreage to determine future acreage burned for 2009.

MACTEC then allocated the increased acreage to current modeling days. The average daily acres burned data provided by USFWS per NWR/county was used to allocate the acreage to the correct number of days required to burn all of the acres. Guidance supplied by USFWS indicated that up to three times the average daily acres burned could potentially be allocated to any one day.

For the USFS fire-by-fire acreage estimates, MACTEC summed the USFS data at a county-level for States that had permit programs, then added the sum to the typical acreage and allocated the acres to current modeling days. For States that do not have a State prescribed fire permit program, MACTEC simply replaced the current fire-by-fire records in the database with fire-by-fire records from the USFS and recalculated emissions based on fuel model and fuel loading. VISTAS also applied the same 0.8 correction for blackened acres applied to all USFS supplied acreage as the supplied values represented perimeter acres.

An additional problem with developing year-specific prescribed fire projections was how to adequately capture the temporal profile for those fires. In the 2002 actual fire inventory, fires occur on same days as state/FLM records. In the 2002 "typical" year inventory, fire acreage increased or decreased from acreage on the same fire days as were in the 2002 actual inventory, since the acres were simply increased for each day based on a multiplier used to convert from actual to typical.

When prescribed fires acreage was added to a future year, MACTEC added acreage to individual fire days proportional to the annual increase (if acreage on a day is 10 percent of annual, add 10 percent of projected increase to that same day).

6. VISTAS DEVELOPED 2002 NONROAD MOBILE SOURCE INVENTORY

Development of emission estimates for nonroad mobile sources is documented in the MACTEC, Inc. document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018, Emission Inventories for VISTAS*.

Nonroad mobile sources are those sources that can move but do not use the highway system. Examples include lawn mowers, agricultural equipment, construction equipment, aircraft engines, railroad locomotives, powerboats, and commercial marine (ships). All but the aircraft engine, railroad locomotive emissions and commercial marine activity were estimated using the USEPA's off-road mobile model NONROAD2005c, which was released March 21, 2006. Direct emissions are generated with this model. This version incorporates all the USEPA final nonroad mobile engine emission standards, including the recreational and large spark-ignition engines rules that were published in the Federal Register in November 2002. Although this model is considered to be a final model, an updated version is planned that may incorporate revised inputs for the small spark-ignition (SI) (<19 kW) and recreational marine SI categories in conjunction with additional promulgated nonroad mobile engine standards.

Nonroad mobile sources calculated through the NONROAD model are discussed in Section 6.1. Aircraft, railroad and commercial marine emissions are discussed in Sections 6.2 through 6.4.

6.1 NONROAD Model Sources

The nonroad mobile source category includes a diverse collection of equipment such as lawn mowers, chain saws, tractors, all terrain vehicles, fork lifts and construction equipment. The USEPA NONROAD2005c model generates emissions directly and includes more than 80 different types of equipment. To facilitate analysis and reporting, the USEPA grouped the equipment types into ten equipment categories. These include:

Agricultural equipment
Airport ground support equipment
Commercial equipment
Construction equipment
Industrial equipment
Lawn and garden equipment
Logging equipment
Railroad maintenance equipment
Recreational marine equipment
Recreational equipment

Additionally, the emissions are broken out by five different engine types. These include: 2-stroke and 4-stroke spark engines, diesel engines, liquid petroleum gas (LPG) and compressed natural gas (CNG) fueled engines.

One of the default input files was edited to reflect North Carolina specific information. In the "SEASON.DAT" file, the region representative of North Carolina was changed from Mid-Atlantic to Southeast. This was done after an evaluation of the meteorological data in the two files and comparing it to that of Charlotte. Default data was used for the remaining input files used in the NONROAD model.

6.2 Aircraft Engines

Aircraft engines, like other engines, emit pollutants whenever the engines are in operation. However, the only emissions that are of concern for this inventory are the portion of the operation that occurs below the mixing layer. This is because the emissions tend to disperse whenever the aircraft is above the mixing layer and therefore has little or no effect on ground level ozone.

The aircraft operations of interest are termed the landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport, descending below the mixing layer, lands and taxis to the gate. It continues as the aircraft idles at the gate and then taxis back out to the runway for the subsequent takeoff and climbout as it heads back to cruising altitudes, above the mixing layer.

Aircraft can be categorized by use into four classifications: commercial, air taxis, general aviation and military. Commercial aircraft include those used for scheduled service transporting passengers and/or freight. Air taxis, or commuter aircraft, also fly scheduled service carrying passengers and/or freight but usually are smaller aircraft and operate on a more limited basis than commercial carriers. General aviation include all other non-military aircraft used for recreational flying, personal transportation, and various other activities. Military aircraft cover a wide range of sizes, uses and operating missions. The military aircraft are treated as a separate classification since the LTO operations reported at the airports group all military aircraft together.

Emission factors are available for the many aircraft and engine combinations that exist. Factors for each aircraft exist for four operating modes in the LTO cycle. Emissions are calculated by obtaining data for the number of LTO cycles of the various aircraft at each airport in question, multiplying by the appropriate factors, and summing the results for the year under consideration.

Development of the 2002 aircraft emissions are described in the MACTEC document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS* . This document refers back to a document titled *"Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)"* prepared by E.H. Pechan & Associates, Inc. Both of these documents are included in Appendix P.

The starting point for development of aircraft emissions estimates is the 1999 National Emission Inventory (1999 NEI) prepared by the USEPA. These emissions were grown to appropriate values for 2002 and 2009 using growth factors developed by the USEPA for the CAIR. Along the way there was input by the various States including North Carolina to arrive at more accurate emission estimates.

6.3 Railroad Locomotives

Railroads are categorized by size (Class I, Class 2) and passenger service (Amtrak and North Carolina Department of Transportation (NCDOT) Rail Division). Class I railroads are long haul operations, consisting of Norfolk Southern Corporation and CSX Corporation in North Carolina. Class II and Class III railroads are short lines, serving localized markets. Passenger service is provided by Amtrak and the NCDOT Rail Division in North Carolina. These entities lease trackage from Class I railroads.

Development of railroad emissions is described in the MACTEC document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS*. The VISTAS/ASIP railroad emission estimates started with 1999 emission estimates developed for the USEPA's 1999 NEI Version 2 as base year estimates for the VISTAS region. Additional information is provided in *"Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)"* prepared by E.H. Pechan & Associates, Inc.

Projected emissions for 2002 were developed in two steps as described below. For 1999 to 2001, State-level rail fuel consumption was obtained from the Department of Energy, Energy Information Administration's (EIA's) *Fuel Oil and Kerosene Sales.* For 2001 to 2002, VISTAS applied national growth factors developed from fuel consumption projections in EIA's *Annual Energy Outlook.* A growth factor of 1.4 was used for locomotives and applied to 1999 emissions to first develop 2001 emissions. Table 6.3-1 lists the growth factors used to generate 2002 emissions.

Table 6.3-1 2002 National Rail Transportation Energy Use by Fuel Type (Trillion BTU)

	2001	2002	Growth Factor (GF)
Intercity Rail (Electric)	10.17	10.40	1.0226
Intercity Rail (Diesel)	16.60	16.88	1.0169
Transit Rail (Electric)	46.36	47.40	1.0224
Intercity/Transit Rail Average (SCC 2285002008)			**1.0206**
Commuter Rail (Electric)	16.13	16.49	1.0223
Commuter Rail (Diesel)	26.31	26.76	1.0171
Commuter Rail Average (SCC 2285002009)			**1.0197**
Freight Rail (Distillate) (SCCs 2285002000, 2285002005, 2285002006, 2285002007, 2285002010)	512.81	492.32	0.9600

Source: Department of Energy, Energy Information Administration, Annual Energy Outlook 2003: Table 34. Transportation Sector Energy Use by Fuel Type Within a Mode

6.4 Commercial Marine Vessel (CMV)

The following description of development of commercial marine emission estimates is based on excerpts, with some editing, taken from the MACTEC document titled *Documentation of the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS* and a document titled *"Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)"* prepared by E.H. Pechan & Associates, Inc

An initial 2002 base year emissions inventory for commercial marine vessels (CMV) was prepared for VISTAS in early 2004. The methods and data used to develop the inventory are presented in a February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" prepared by E.H. Pechan & Associates, Inc. Revisions to the initial 2002 emissions inventory (prepared by Pechan) were implemented to ensure that the latest State and local data were incorporated. For CMV, North Carolina provided no revised data.

For 2002 commercial marine vessels (CMVs), Pechan used 1999 emission estimates developed for the USEPA's 1999 NEI Version 2 as base year estimates for the VISTAS region. Pechan then improved the spatial distribution of CMV emission estimates for the VISTAS region.

Ideally, CMV emission estimates would be developed using local activity data that account for vessel type, engine type and mode of operation (cruise, maneuvering, and hotelling). Creating this type of "bottom-up" emission inventory requires a large amount of effort. Therefore, Pechan utilized port-specific emission estimates developed for the 1999 NEI, distributed using a revised allocation methodology, which incorporates information on the number of port facilities in each county.

The 2002 VISTAS commercial marine inventory is based on the USEPA's 1999 NEI Version 2.0, projected to 2002 using appropriate growth factors. The 1999 NEI estimated emissions for these categories according to the following SCCs:

SCC	Descriptor 1	Descriptor 3	Descriptor 6	Descriptor 8
2280002100	Mobile Sources	Marine Vessels, Commercial	Diesel	Port emissions
2280002200	Mobile Sources	Marine Vessels, Commercial	Diesel	Underway emissions
2280003100	Mobile Sources	Marine Vessels, Commercial	Residual	Port emissions
2280003200	Mobile Sources	Marine Vessels, Commercial	Residual	Underway emissions

For the 1999 NEI, commercial marine diesel emissions were developed by obtaining 2000 emission estimates for all pollutants except SO_2 from the USEPA's Office of Transportation and Air Quality (OTAQ) marine diesel regulatory background documentation (*Draft Regulatory Impact Analysis - Control of Emissions from Compression-Ignition Marine Engines*). To estimate emissions for 1999, 2000 estimates were backcast using growth factors obtained from the draft Regulatory Impact Analysis (RIA) cited above. Steam-powered residual CMV emission estimates were developed by obtaining fuel usage data from OTAQ and applying fuel-based emission factors. A similar method was used for diesel SO_2 emissions. National diesel usage was estimated assuming a sulfur content of 0.25 percent and USEPA emission factors.

In apportioning, distillate and residual fuels are considered separately. National diesel emissions were disaggregated into port and underway emissions estimates based on the assumption that 75 percent of distillate fuel is consumed within the port, while the remaining fuel is consumed while underway, consistent with USEPA guidance. National residual emissions were disaggregated into port and underway emissions estimates based on the assumption that 25 percent of residual fuel is consumed within the port, while the remaining fuel is consumed while underway.

To allocate to counties, port emissions were assigned to the 150 largest U.S. ports based on activity obtained from the U.S. Army Corps of Engineers (USACE). The percentage of total traffic for each port was calculated by dividing the port-level traffic by the total traffic. Emissions for each port were then assigned to a single county.

Underway emissions are assigned to counties based on a county's shipping lane traffic. The Bureau of Transportation Statistics' (BTS) *National Transportation Atlas Databases-1999* contains data on the thousand tons per mile traveled for each shipping lane link in the United States (BTS-CD26). Where navigable rivers form a county or State boundary, the shipping lane traffic is proportioned to individual counties based on the length of shoreline that is shared. For example, if two counties share a navigable river, and both counties have the same length of shoreline, the shipping traffic is split evenly between the two counties. Shipping lanes that are not within counties, for example in the ocean, are associated to States based on BTS assignments. These waterway weights are then evenly distributed among the counties within these States that have navigable waterways. All shipping activity is summed at the county-level and compared with national shipping activity to determine what portion of activity can be attributed to individual counties. These proportions were used in disaggregating the national CMV emission estimates to the county level.

States that share borders with non-VISTAS States along the Mississippi and Ohio Rivers have expressed concern about the representativeness of port emission estimates at a county-level. Revising the county-level emissions estimates would allow more accurate modeling of emissions in the VISTAS states.

For underway emissions, Pechan believes that the allocation procedure results in a reasonable distribution of county-level emissions. However, the methodology to allocate port emissions results in all the emissions being assigned to a single county.

Port areas encompass multiple States and counties and in some cases, multiple waterways. Therefore, the emissions allocation process must incorporate all counties in the vicinity of the port where activity is occurring. This is especially true for inland rivers where activity takes place on both riverbanks and for ten river miles or more outside the port city. The revised methodology allocates port emissions based on a surrogate for port-related activity in each county, rather than using a single county to define the port.

The report, Waterborne Commerce of the United States, Calendar Year 1999, hereafter referred to as Waterborne Commerce, presents the cargo tonnage and number of vessel trips in major waterways of the United States. The report defines port areas, which USACE uses to develop the Top 150 Ports in the United States by amount of cargo tonnage. As discussed previously, the 1999 NEI allocates all the port emissions to these 150 ports based on the cargo tonnage handled by the port. Pechan uses this allocation of emissions to each port area as the starting point of its revised allocation process. Morehead City Harbor and the Port of Wilmington are the two main ports in North Carolina.

The next step was to develop a list of counties that make up the port area. Port area definitions were obtained from *Waterborne Commerce*. The port area definition for Morehead City Harbor port was "Morehead City Harbor, NC". The port area definition for Wilmington City port was "Both banks of the Cape Fear River extending from a point about 18 miles below the foot of Castle St. in Wilmington to a point about 2 miles above the Railroad Bridge at Navassa, and both banks of Northeast (Cape Fear) River from its mouth to a point about 1.67 miles above the Hilton Railroad Bridge". Using the port definitions by river mile, Pechan established which counties are included in each port area. The Port of Wilmington is included in the counties of Hanover and New Brunswick. The Morehead City Harbor is included in Carteret county.

The next step in allocating emissions is to develop a surrogate for the amount of CMV activity in each county of the port area. Pechan assumed that the activity of vessels in each county is related to the number of port facilities operating in a given county. Port facilities include terminals, piers, wharves, and docks that are involved in all types of commercial activity and support services. Pechan obtained the number of port facilities in each county from USACE reports, The Port Series Reports. The USACE periodically surveys the commercial marine industry to obtain information on port facilities and publishes it in The Port Series Reports. The reports give the name, location, operations, and describe the physical and inter-modal characteristics of the facilities. The data includes the location of the facility by river mile, State, and county.

For each port area, Pechan calculated the ratio between the number of port facilities in each county to the total number of facilities in all counties that make up the port area. This ratio was used to allocate emissions for each port area to the county-level. The ratio for Morehead City Harbor was 1.0 in Carteret county and the ratios for the Port of Wilmington were 0.8974 in New Hanover county and 0.1026 in Brunswick county. Pechan was directed to perform the reallocation for all VISTAS ports.

There are no commercial marine emissions in the Hickory or Triad areas.

7. 2009 NONROAD MOBILE SOURCE EMISSION INVENTORY DEVELOPMENT

The subsections that follow describe the projection process used to develop 2009 nonroad mobile source projection estimates for sources found in the NONROAD model and those sources estimated outside of the model (locomotives, airplanes, and commercial marine vessels).

7.1 Projection of NONROAD Mobile Sources

NONROAD model input files were prepared based on the 2002 base year inventory input files with appropriate updates for the projection years. Other specific updates for the projection years for NONROAD model sources consist of:

1. Revise the emission inventory year in the model (as well as various output file naming commands) to be reflective of the projection year.

2. Revise the fuel sulfur content for gasoline and diesel powered equipment.

3. Implement a limited number of local control program changes (national control program changes are handled internally within the NONROAD model, so explicit input file changes are not required).

All equipment population growth and fleet turnover impacts are handled internally within the NONROAD model, so that explicit input file changes are not required.

The final NONROAD2005c that was used for inventory development is capable of handling separate diesel fuel sulfur inputs for land-based and marine-based nonroad mobile source equipment in a single model execution. The following diesel fuel sulfur values were used:

Diesel S (ppm)	**2002**	**2009**
Land-Based	2500	348
Marine-Based	2638	408

7.2 Projection of Non-NONROAD Model Sources

Using the 2002 base year emissions inventory for aircraft, locomotives, and CMV prepared as described earlier in this document, corresponding emission projections for 2009 were developed. The following description is largely taken from the MACTEC document titled *Documentation of* *the Base G 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS*. Briefly, the methodology relies on growth and control factors developed from inventories used in support of recent USEPA rulemakings, and consists of the following steps:

(a) Begin with the 2002 base year emission estimates for aircraft, locomotive, and CMV.

(b) Detailed inventory data (both before and after controls) for these same emission sources for 1996, 2010, 2015, and 2020 were obtained from the USEPA's CAIR Technical Support Document. Using these data, combined growth and control factors for the period 2002-2009 were estimated using straight line interpolation between 1996 and 2010 (for 2009). This is done at the State-county-SCC-pollutant level of detail.

(c) The USEPA growth and control data are matched against the 2002 VISTAS base year data using State-county-SCC-pollutant as the match key. Ideally, there would be a one-to-one match and the process would end at this point. Unfortunately, actual match results were not always ideal, so additional matching criteria were required. For subsequent reference, this initial (highest resolution) matching criterion is denoted as the "CAIR-Primary" criterion.

(d) A second matching criterion is applied that utilizes a similar, but higher-level SCC (lower resolution) matching approach. For example, SCC 2275020000 (commercial aircraft) in the 2002 base year inventory data would be matched with SCC 2275000000 (all aircraft) in the CAIR data. This criterion is applied to records in the 2002 base year emissions file that are not matched using the "CAIR-Primary" criterion, and is also performed at the State-county-SCC-pollutant level of detail. For subsequent reference, this is denoted as the "CAIR-Secondary" criterion. At the end of this process, a number of unmatched records continued to remain, so a third level matching criterion was required.

(e) In the third matching step, the most frequently used SCC in the USEPA CAIR files for each of the aircraft, locomotive, and commercial marine sectors is averaged at the State level to produce a "default" State and pollutant-specific growth and control factor for the sector. The resulting factor is used as a "default" growth factor for all unmatched county-SCC-pollutant level data in each State. In effect, State-specific growth data are applied to county level data for which an explicit match between the VISTAS 2002 base year data and the USEPA CAIR data could not be developed. The default growth and control SCCs are 2275020000 (commercial aircraft) for the aircraft sector, 2280002000 (commercial marine diesel total) for the CMV sector, and 2285002000 (railroad equipment diesel total) for the locomotive sector. Matches made using this criterion are denoted as "CAIR-Tertiary" matches.

(f) According to USEPA documentation, the CAIR baseline emissions include the impacts of the (then proposed) Tier 4 (T4) nonroad mobile diesel rulemaking, which implements a low sulfur fuel requirement that affects both future CMV and locomotive emissions. However, the impacts of this rule were originally intended to be excluded from the initial VISTAS 2018 forecast, which was to include only "on-the-books" controls. (The T4 rule was finalized subsequent to the development of the preliminary 2018 inventory in March of 2004.) Given its final status, T4 impacts have now been moved into the "on the books" inventory for nonroad mobile source equipment. In addition, since there are no other proposed rules affecting the nonroad mobile source sector between 2002 and 2018, there is no difference between the 2018 "on the books" and 2018 "on the way" inventories for the sector; so that only a single forecast inventory (for each evaluation year) was developed. Nevertheless, since the algorithms developed to produce the VISTAS forecasts were developed when there was a distinction between the "on the books" and "on the way" inventories, the distinct algorithms used to produce the two inventories have been maintained even though the conceptual distinctions have been lost. This approach was taken for two reasons. First, it allowed the previously developed algorithms to be utilized without change. Second, it allowed for separate treatment of the T4 emissions impact which was important as those impacts have changed between the proposed and final T4 rules. Thus, previous USEPA inventories that include the proposed T4 impacts would not be accurate. Therefore, the procedural discussion continues to reflect the distinctions between non-T4 and T4 emissions, as these distinctions continue to be intrinsically important to the forecasting process. Therefore, a second set of USEPA CAIR files that excluded the Tier 4 diesel impacts was obtained and the same matching exercise described above in steps (b) through (e) was performed using these "No T4" files. It is important to note that the matching exercise described in steps (b) through (e) cannot simply be replaced because the "No T4" files obtained from the USEPA include only those SCCs specifically affected by the T4 rule (i.e., diesel CMV and locomotives). So in effect, the matching exercise was augmented (rather than replaced) with an additional three criteria analogous to those described in steps (c) through (e), and these are denoted as the "No T4-Primary," "No T4-Secondary," and "No T4-Tertiary" criteria. Because they exclude the impacts of the proposed T4 rule, matches using the "No T4" criteria supersede matches made using the basic CAIR criteria (as described in steps (c) through (e) above).

(g) The CAIR matching criteria were overridden for any record for which States provided local growth data. Only North Carolina provided these forecasts, as North Carolina has provided specific growth factors for airport emissions in four counties. Because the provided data were based on forecasted changes in landings and takeoffs at major North Carolina airports, the factors were applied only to commercial (SCC 2275020000) and air taxi (SCC 2275060000) emissions. Emissions forecasts for military and general aviation aircraft operations, as well as all aircraft operations in counties other than the four identified in the North Carolina growth factor submission, continued to utilize the growth factors developed according to steps (b) through (f) above. The locally generated growth factor (2002 to 2009) applied in Guilford County was 0.97.

(h) Using this approach, each State-county-SCC-pollutant was assigned a combined growth and control factor using the USEPA CAIR forecast or locally provided data. The 22,838 data records for aircraft, locomotives, and CMV in the 2002 base year emissions file were assigned growth factors in accordance with the following breakdown:

48 records matched State-provided growth factors,
4,179 records matched using the CAIR-Primary criterion,
240 records matched using the CAIR-Secondary criterion,
7,463 records matched using the CAIR-Tertiary criterion,
720 records matched using the No T4-Primary criterion,
3,858 records matched using the No T4-Secondary criterion, and
6,330 records matched using the No T4-Tertiary criterion.

(i) Finally, the impacts of the T4 rule as adopted were applied to the grown "non T4" emission estimates. The actual T4 emission standards do not affect aircraft, locomotive, or CMV directly, but associated diesel fuel sulfur requirements do affect locomotives and CMV. Lower fuel sulfur content affects both SO_2 and PM emissions. Expected fuel sulfur content was obtained for 2009 from the USEPA technical support document for the final T4 rule (*Final Regulatory Analysis: Control of Emissions from Nonroad Diesel Engines*, EPA420-R-04-007, May 2004). According to that document, the average diesel fuel sulfur content for locomotives and CMV is expected to be 408 parts per million by weight (ppmW) in 2009. This compares to expected non-T4 fuel sulfur levels of 2599 ppmW in 2009. Table 7.2-1 uses calculated emissions estimates for base and T4 control scenarios to estimate emission reduction impacts.

Table 7.2-1 Estimated Emission Reduction Impacts based on T-4 Rule

				2009
CMV SO_2	=	Non-T4 SO_2	×	0.1569
Locomotive SO_2	=	Non-T4 SO_2	×	0.1569
CMV PM	=	Non-T4 PM	×	0.8962
Locomotive PM	=	Non-T4 PM	×	0.8117

However, since the diesel fuel sulfur content assumed for the 2002 VISTAS base year inventory, upon which the 2009 inventory was based, is 2500 ppmW, a small adjustment to the emission reduction multiplier calculated from the T4 rule is appropriate since they are measured relative to modestly different sulfur contents (2599 ppmW for 2009). Correcting for these modest differences produces the emission reduction impact estimates relative to forecasts based on the VISTAS 2002 inventory shown in Table 7.2-2.

Table 7.2-2 Estimated Emission Reduction Impacts Relative to VISTAS 2002 Base Year Values

				2009
CMV SO_2	=	Non-T4 SO_2	×	0.1632
Locomotive SO_2	=	Non-T4 SO_2	×	0.1632
CMV PM	=	Non-T4 PM	×	0.9004
Locomotive PM	=	Non-T4 PM	×	0.8187

These factors were applied directly to the non-T4 emission forecasts to produce the final VISTAS 2009 emissions inventories for aircraft, locomotive, and CMV.

During the development of the preliminary 2018 VISTAS inventory in March 2004, this process yielded reasonable results and exhibited no particular systematic concerns. However, when the 2009 Base F inventory was developed, significant concerns related to SO_2 and PM were encountered. Essentially, what was revealed by the Base F 2009 forecast was a series of apparent inconsistencies in the CAIR 2010 and 2015 emission inventories (as compared to the 1996 and 2020 CAIR inventories) that were masked during the construction of the "longer-term" 2018 inventory.

For the most part, the issue seems to be centered on SO_2 and PM records, which are those records primarily affected by the T4 rule. But, as noted above, there does not seem to be any pattern of consistency that would indicate that either inclusion or exclusion of T4 rule impacts is the underlying cause. Moreover, where they occur, the observed growth extremes generally affect both SO_2 and PM equally, while one would expect PM effects to be buffered if the T4 rule was the underlying cause, since changes in diesel fuel sulfur content will only affect a fraction of PM (i.e., sulfate), while directly reducing SO_2.

While forecast inventories for aircraft, locomotives, and CMV were developed for 2009 and 2018 using both growth methods, it was ultimately decided to utilize the 1996-2020 growth basis since it provided more reasonable growth rates for 2009.

8. QUALITY ASSURANCE OF EMISSIONS INVENTORY

8.1 2002 Area and Nonroad Mobile

Many emission estimation methods are based on AP-42 factors located on the USEPA website at http://www.epa.gov/ttn/chief/ap42/, factors given in the Procedures document, and factors given in the documents of the Emission Inventory Improvement Program website located at http://www.epa.gov/ttn/chief/eiip/. Sources of error would primarily be associated with multiplier values, data entry errors, and the accuracy of formulas.

For the portion of the 2002 inventory developed by North Carolina, specific quality assurance (QA) procedures were followed. Under the direction of the Quality Assurance Coordinator, emission sources whose contribution were either at the high or low end of the range of estimates were scrutinized more closely to ensure that the emission estimates were estimated correctly. In addition, the raw data used in the calculations were verified to make sure transference to the spreadsheets was accomplished accurately. Furthermore, the formulas used to calculate the emissions were reviewed and checked for correctness. Random independent checks of the calculations were also performed to ensure the accuracy of the inventory.

For the portion of the 2002 inventory developed by VISTAS and MACTEC, specific QA procedures were followed. These procedures are outlined in the document titled *Documentation of the Base G 2002 Base Year, 2009, and 2018, Emission Inventories for VISTAS* prepared for VISTAS by MACTEC, Inc. Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for VISTAS. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the area source component of the 2002 inventory:

1. All CERR and NIF format State supplied data submittals were run through the USEPA's Format and Content checking software.

2. SCC level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.

3. Fields were either added or used within each NIF data table to track the sources of data for each emission record.

4. Data product summaries were provided to both the VISTAS Emission Inventory Technical Advisor and to Area Source and Fires SIWG representatives for review and comment. Changes based on these comments were implemented in the files.

5. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from 1.0 to 2.0. A minor change would cause a version number to go from 1.0 to 1.1. Minor changes resulting from largely editorial changes would result in a change from 1.00 to 1.01.

6. All final NIF files were checked using the USEPA Format and Content checking software and summary information by State and pollutant were prepared comparing the previous versions of the inventory to the latest.

For the fires inventory, data related to fuel loading and fuel consumption was reviewed and approved by the VISTAS Fire SIWG to ensure that values used for each type of fire and each individual fire were appropriate. Members of the VISTAS Fire SIWG included representatives from most State Divisions of Forestry (or equivalent) as well as U.S. Forest Service and National Park Service personnel.

In addition, for the nonroad portion of the inventory prepared by VISTAS, tier comparisons (by pollutant) were developed between the revised 2002 base year inventory and the initial base year inventory.

8.2 2009 Area and Nonroad Mobile

For the portion of the 2009 inventory developed by North Carolina, specific QA procedures were followed. Under the direction of the Quality Assurance Coordinator, emission sources whose contribution were either at the high or low end of the range of estimates were scrutinized more closely to ensure that the emission estimates were estimated correctly. In addition, the raw data used in the calculations were verified to make sure transference to the spreadsheets was accomplished accurately. Furthermore, the formulas used to calculate the daily emissions were reviewed and checked for correctness. Random independent checks of the calculations were also performed to ensure the accuracy of the inventory.

For the portion of the 2009 inventory developed by VISTAS and MACTEC, Inc., specific QA procedures were followed. These procedures are outlined in the document titled *Documentation of the Base G 2002 Base Year, 2009, and 2018, Emission Inventories for VISTAS* prepared for VISTAS by MACTEC, Inc. Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, to ensure that a full and complete inventory was developed for VISTAS, and to make sure that projection calculations were working correctly. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the area source and the nonroad mobile source components of the 2009 inventory:

1. All final files were run through EPA's Format and Content checking software.

2. SCC level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.

3. Tier comparisons (by pollutant) were developed between the 2002 base year inventory and the 2009 projection inventory. In addition, total VISTAS pollutant summaries were prepared to compare total emissions by pollutant between earlier and later versions of the inventory.

4. Data product summaries were provided to both the VISTAS Emission Inventory Technical Advisor and to the SIWG representatives for review and comment. Changes based on these comments were implemented in the files.

5. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from 1.0 to 2.0. A minor change would cause a version number to go from 1.0 to 1.1. Minor changes resulting from largely editorial changes would result in a change from 1.00 to 1.01.

9. ADDITIONAL DATA

9.1 SIC TO NAICS CROSSWALK

U.S. Census Bureau

1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 24: Lumber and wood products - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	24	Lumber and wood products	36,735	111,930,684	757,267	18,668,558
	241	Logging	13,533	13,625,734	83,212	2,014,254
	242	Sawmills and planing mills	6,270	32,750,181	178,575	4,477,618
	243	Millwork, plywood, and structural members	9,373	33,200,977	260,726	6,599,370
	244	Wood containers	2,922	4,332,491	49,580	936,731
	245	Wood buildings and mobile homes	1,028	13,179,370	91,234	2,362,873
	249	Miscellaneous wood products	3,609	14,841,931	93,940	2,277,712

N=Comparable data not available D=Withheld to avoid disclosure

SIC 24: Lumber and wood products - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
241	97/92		**Logging**	**13,533**	**13,625,734**	**83,212**	**2,014,254**
2411			Logging	13,533	13,625,734	83,212	2,014,254
	0% of 113310	10	Logging	13,533	13,625,734	83,212	2,014,254

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
242	97/92		**Sawmills and planing mills**	**6,270**	**32,750,181**	**178,575**	**4,477,618**
2421							

			Sawmills & planing mills, general	5,176	29,414,116	143,292	3,741,583
	100% of 321113	10	Sawmills (pt)	4,334	24,743,160	119,456	3,191,780
	74% of 321912	10	Cut stock, resawing lumber, & planing (pt)	761	4,447,045	22,105	515,145
	0% of 321918	10	Other millwork (including flooring) (pt)	5	19,285	91	2,695
	5% of 321999	10	All other miscellaneous wood product mfg (pt)	76	204,626	1,640	31,963
2426			Hardwood dimension & flooring mills	992	3,206,954	33,940	708,100
	24% of 321912	20	Cut stock, resawing lumber, & planing (pt)	619	1,455,914	17,109	357,168
	30% of 321918	20	Other millwork (including flooring) (pt)	127	1,368,123	10,521	235,924
	5% of 337215	10	Showcase, partition, shelving, & locker mfg (pt)	246	382,917	6,310	115,008
2429			Special product sawmills, n.e.c.	102	129,111	1,343	27,935
	0% of 321113	20	Sawmills (pt)	70	26,457	304	5,750
	2% of 321920	10	Wood container & pallet mfg (pt)	24	68,695	684	14,493
	1% of 321999	20	All other miscellaneous wood product mfg (pt)	8	33,959	355	7,692

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
243	97/92		**Millwork, plywood, and structural members**	**9,373**	**33,200,977**	**260,726**	**6,599,370**
2431			Millwork	2,745	12,013,383	92,259	2,344,586
	321911		Wood window & door mfg	1,409	8,896,734	64,771	1,714,686
	69% of 321918	30	Other millwork (including flooring) (pt)	1,336	3,116,649	27,488	629,900
2434			Wood kitchen cabinets	5,096	7,483,209	79,579	1,866,940
	82% of 337110	10	Wood kitchen cabinet & counter top mfg (pt)	5,096	7,483,209	79,579	1,866,940
2435			Hardwood veneer & plywood	332	2,856,487	22,151	525,887
	321211		Hardwood veneer & plywood mfg	332	2,856,487	22,151	525,887
2436			Softwood veneer & plywood	155	5,762,664	28,843	912,613
	321212		Softwood veneer & plywood mfg	155	5,762,664	28,843	912,613
2439			Structural wood members, n.e.c.	1,045	5,085,234	37,894	949,344
	0% of 321113	30	Sawmills (pt)	0	0	0	0
	321213		Engineered wood member (except truss) mfg	53	1,431,123	5,372	154,564
	321214		Truss mfg	992	3,654,111	32,522	794,780
	0% of 321912	30	Cut stock, resawing lumber, & planing (pt)	0	0	0	0
SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
244	97/92		**Wood containers**	**2,922**	**4,332,491**	**49,580**	**936,731**
2441			Nailed wood boxes & shook	318	405,966	4,885	108,629
	9% of 321920	20	Wood container & pallet mfg (pt)	318	405,966	4,885	108,629
2448			Wood pallets & skids	2,347	3,449,491	38,994	717,863
	77% of 321920	30	Wood container & pallet mfg (pt)	2,347	3,449,491	38,994	717,863
2449			Wood containers, n.e.c.	257	477,034	5,701	110,239
	11% of 321920	40	Wood container & pallet mfg (pt)	257	477,034	5,701	110,239
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
245	97/92		**Wood buildings and mobile homes**	**1,028**	**13,179,370**	**91,234**	**2,362,873**
2451			Mobile homes	319	10,167,746	68,269	1,788,646
	321991		Manufactured home (mobile home) mfg	319	10,167,746	68,269	1,788,646
2452			Prefabricated wood buildings	709	3,011,624	22,965	574,227
	321992		Prefabricated wood building mfg	709	3,011,624	22,965	574,227
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
249	97/92		**Miscellaneous wood products**	**3,609**	**14,841,931**	**93,940**	**2,277,712**
2491			Wood preserving	451	4,461,521	11,668	298,123
	321114		Wood preservation	451	4,461,521	11,668	298,123
2493			Reconstituted wood products	316	5,273,794	25,269	797,838
	321219		Reconstituted wood product mfg	316	5,273,794	25,269	797,838
2499			Wood products, n.e.c.	2,842	5,106,616	57,003	1,181,751
	1% of 321912	40	Cut stock, resawing lumber, & planing (pt)	20	73,251	549	12,847
	2% of 321920	50	Wood container & pallet mfg (pt)	49	65,184	870	18,727
	94% of 321999	30	All other miscellaneous wood product mfg (pt)	2,324	3,740,920	41,844	879,178
	0% of 332321	10	Metal window & door mfg (pt)	0	0	0	0
	15% of 339999	10	All other miscellaneous mfg (pt)	449	1,227,261	13,740	270,999

N=Comparable data not available D=Withheld to avoid disclosure

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.) Comparable SIC derivable from NAICS data.

(Drawbridge slightly open.) Almost comparable Sales or receipts from NAICS are within 3% of SIC sales or receipts.

(Drawbridge open.) Not comparable SIC sales or receipts cannot be estimated within 3% from NAICS data.

All-sector menu | Menu of all 2-digit SICs | Data in formats for downloading | PDF report

U.S. Census Bureau

1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 25: Furniture and fixtures - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	25	Furniture and fixtures	12,095	61,527,902	523,872	13,344,344
	251	Household furniture	5,609	26,334,791	265,115	5,861,109
	252	Office furniture	1,036	11,340,955	74,863	2,402,387
	253	Public building and related furniture	468	7,869,175	36,979	1,022,978
	254	Partitions and fixtures	3,751	10,637,959	101,925	2,899,667
	259	Miscellaneous furniture and fixtures	1,231	5,345,022	44,990	1,158,203

N=Comparable data not available D=Withheld to avoid disclosure

SIC 25: Furniture and fixtures - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
251	97/92		**Household furniture**	**5,609**	**26,334,791**	**265,115**	**5,861,109**
2511			Wood household furniture	3,035	10,940,684	123,368	2,587,446
	97% of 337122	10	Nonupholstered wood household furniture mfg (pt)	3,035	10,940,684	123,368	2,587,446
2512			Upholstered household furniture	1,095	8,034,017	85,258	1,930,167
	96% of 337121	10	Upholstered household furniture mfg (pt)	1,095	8,034,017	85,258	1,930,167
2514			Metal household furniture	420	2,422,853	22,835	503,957
	337124		Metal household furniture mfg	420	2,422,853	22,835	503,957

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
2515			Mattresses & bedsprings	742	4,067,225	24,673	643,390
	2% of 337121	20	Upholstered household furniture mfg (pt)	35	159,199	1,601	31,760
	337910		Mattress mfg	707	3,908,026	23,072	611,630
2517			Wood TV & radio cabinets	100	320,714	4,273	84,391
	337129		Wood television, radio, & sewing machine cabinet mfg	100	320,714	4,273	84,391
2519			Household furniture, n.e.c.	217	549,298	4,708	111,758
	337125		Household furniture (except wood & metal) mfg	217	549,298	4,708	111,758
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
252	97/92		**Office furniture**	**1,036**	**11,340,955**	**74,863**	**2,402,387**
2521			Wood office furniture	677	3,110,020	30,641	781,220
	337211		Wood office furniture mfg	677	3,110,020	30,641	781,220
2522			Office furniture, except wood	359	8,230,935	44,222	1,621,167
	337214		Office furniture (except wood) mfg	359	8,230,935	44,222	1,621,167
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
253	97/92		**Public building and related furniture**	**468**	**7,869,175**	**36,979**	**1,022,978**
2531			Public building & related furniture	468	7,869,175	36,979	1,022,978
	57% of 336360	30	Motor vehicle seating & interior trim mfg (pt)	184	6,060,320	20,784	610,043
	42% of 337127	10	Institutional furniture mfg (pt)	267	1,697,870	15,254	385,680
	9% of 339942	10	Lead pencil & art good mfg (pt)	17	110,985	941	27,255
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
254	97/92		**Partitions and fixtures**	**3,751**	**10,637,959**	**101,925**	**2,899,667**
2541			Wood partitions & fixtures	2,825	5,388,485	57,453	1,624,792
	10% of 337110	20	Wood kitchen cabinet & counter top mfg (pt)	812	938,353	9,785	254,585
	337212		Custom architectural woodwork & millwork mfg	1,105	2,197,493	24,363	715,011
	28% of 337215	20	Showcase, partition, shelving, & locker mfg (pt)	908	2,252,639	23,305	655,196
2542			Partitions & fixtures, except wood	926	5,249,474	44,472	1,274,875
	66% of 337215	30	Showcase, partition, shelving, & locker mfg (pt)	926	5,249,474	44,472	1,274,875
SIC	**NAICS**	**Pt**	**Description**	**Establish-**	**Value of Shipments**	**Paid**	**Annual payroll**

			ments	($1,000)	employees	($1,000)
259	97/92	**Miscellaneous furniture and fixtures**	**1,231**	**5,345,022**	**44,990**	**1,158,203**
2591		Drapery hardware, blinds, & shades	488	2,393,564	19,617	436,757
337920		Blind & shade mfg	488	2,393,564	19,617	436,757
2599		Furniture & fixtures, n.e.c.	743	2,951,458	25,373	721,446
57% of 337127 20		Institutional furniture mfg (pt)	727	2,305,770	22,448	605,971
4% of 339113 10		Surgical appliance & supplies mfg (pt)	16	645,688	2,925	115,475

N=Comparable data not available D=Withheld to avoid disclosure

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.) Comparable SIC derivable from NAICS data.

(Drawbridge slightly open.) Almost comparable Sales or receipts from NAICS are within 3% of SIC sales or receipts.

(Drawbridge open.) Not comparable SIC sales or receipts cannot be estimated within 3% from NAICS data.

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1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 33: Primary metal industries - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	33	Primary metal industries	6,275	188,774,795	692,175	26,829,622
	331	Blast furnace and basic steel products	954	77,532,783	217,679	10,059,589
	332	Iron and steel foundries	1,144	17,533,215	132,853	4,666,674
	333	Primary nonferrous metals	179	16,320,560	33,255	1,404,870
	334	Secondary nonferrous metals	256	6,977,168	13,479	468,021
	335	Nonferrous rolling and drawing	1,011	52,863,733	166,344	6,093,518
	336	Nonferrous foundries (castings)	1,676	11,598,177	94,496	2,897,629
	339	Miscellaneous primary metal products	1,055	5,949,159	34,069	1,239,321

N=Comparable data not available D=Withheld to avoid disclosure

SIC 33: Primary metal industries - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
331	97/92		**Blast furnace and basic steel products**	**954**	**77,532,783**	**217,679**	**10,059,589**
3312			Blast furnaces & steel mills	201	56,796,871	145,805	7,446,304
	25% of 324199	20	All other petroleum & coal products mfg (pt)	8	438,107	1,731	74,553
	99% of 331111	10	Iron & steel mills (pt)	193	56,358,764	144,074	7,371,751
3313			Electrometallurgical products	28	1,535,779	4,035	168,728

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	331112		Electrometallurgical ferroalloy product mfg	24	1,409,834	3,724	156,946
	3% of 331492	10	Other nonferrous metal secondary smelting, refining, & alloying (	4	125,945	311	11,782
3315			Steel wire & related products	304	5,291,290	25,754	799,508
	331222		Steel wire drawing	273	4,920,798	23,489	733,281
	7% of 332618	10	Other fabricated wire product mfg (pt)	31	370,492	2,265	66,227
3316			Cold finishing of steel shapes	186	6,343,466	14,362	639,349
	331221		Cold-rolled steel shape mfg	186	6,343,466	14,362	639,349
3317			Steel pipe & tubes	235	7,565,377	27,723	1,005,700
	331210		Iron & steel pipes & tubes mfg from purchased steel	235	7,565,377	27,723	1,005,700
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
332	97/92		**Iron and steel foundries**	**1,144**	**17,533,215**	**132,853**	**4,666,674**
3321			Gray iron foundries	669	11,911,623	83,570	3,120,450
	97% of 331511	10	Iron foundries (pt)	669	11,911,623	83,570	3,120,450
3322			Malleable iron foundries	28	352,615	2,628	113,937
	3% of 331511	20	Iron foundries (pt)	28	352,615	2,628	113,937
3324			Steel investment foundries	159	2,341,737	22,673	669,452
	331512		Steel investment foundries	159	2,341,737	22,673	669,452
3325			Steel foundries, n.e.c.	288	2,927,240	23,982	762,835
	331513		Steel foundries (except investment)	288	2,927,240	23,982	762,835
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
333	97/92		**Primary nonferrous metals**	**179**	**16,320,560**	**33,255**	**1,404,870**
3331			Primary copper	16	6,540,441	7,360	287,382
	331411		Primary smelting & refining of copper	16	6,540,441	7,360	287,382
3334			Primary aluminum	21	6,224,610	15,763	707,402
	331312		Primary aluminum production	21	6,224,610	15,763	707,402
3339			Primary nonferrous metals, n.e.c.	142	3,555,509	10,132	410,086
	331419		Other nonferrous metal primary smelting & refining	142	3,555,509	10,132	410,086
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
334	97/92		**Secondary nonferrous metals**	**256**	**6,977,168**	**13,479**	**468,021**
3341			Secondary nonferrous metals	256	6,977,168	13,479	468,021

	95% of 331314	10	Secondary smelting & alloying of aluminum (pt)	101	3,478,625	6,226	210,318
	85% of 331423	10	Secondary smelting, refining, & alloying of copper (pt)	24	1,082,052	1,768	69,988
	64% of 331492	20	Other nonferrous metal secondary smelting, refining, & alloying (	131	2,416,491	5,485	187,715

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
335	97/92		**Nonferrous rolling and drawing**	**1,011**	**52,863,733**	**166,344**	**6,093,518**
3351			Copper rolling & drawing	129	7,679,080	21,150	786,621
	331421		Copper rolling, drawing, & extruding	129	7,679,080	21,150	786,621
3353			Aluminum sheet, plate, & foil	70	13,755,566	25,111	1,199,382
	331315		Aluminum sheet, plate, & foil mfg	70	13,755,566	25,111	1,199,382
	0% of 332996	10	Fabricated pipe & pipe fitting mfg (pt)	0	0	0	0
3354			Aluminum extruded products	160	6,177,701	30,357	944,829
	331316		Aluminum extruded product mfg	160	6,177,701	30,357	944,829
3355			Aluminum rolling & drawing, n.e.c.	20	1,295,284	2,657	97,537
	78% of 331319	10	Other aluminum rolling & drawing (pt)	20	1,295,284	2,657	97,537
3356			Nonferrous rolling & drawing, n.e.c.	184	4,839,547	17,237	709,102
	66% of 331491	10	Other nonferrous metal rolling, drawing, & extruding (pt)	184	4,839,547	17,237	709,102
3357			Nonferrous wire drawing & insulating	448	19,116,555	69,832	2,356,047
	22% of 331319	20	Other aluminum rolling & drawing (pt)	16	361,323	1,649	46,377
	331422		Copper wire (except mechanical) drawing	36	1,029,653	4,692	131,549
	34% of 331491	20	Other nonferrous metal rolling, drawing, & extruding (pt)	83	2,475,702	8,635	280,606
	335921		Fiber optic cable mfg	38	2,767,017	8,589	364,654
	335929		Other communication & energy wire mfg	275	12,482,860	46,267	1,532,861

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
336	97/92		**Nonferrous foundries (castings)**	**1,676**	**11,598,177**	**94,496**	**2,897,629**
3363			Aluminum die-castings	318	3,791,717	27,717	906,108
	331521		Aluminum die-casting foundries	318	3,791,717	27,717	906,108
3364			Nonferrous die-casting, except aluminum	279	2,055,264	17,243	502,552
	331522		Nonferrous (except aluminum) die-casting foundries	279	2,055,264	17,243	502,552
3365			Aluminum foundries	626	3,937,406	34,098	1,013,843
	331524		Aluminum foundries (except die-casting)	626	3,937,406	34,098	1,013,843

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
3366			Copper foundries	312	854,704	8,909	260,340
	331525		Copper foundries (except die-casting)	312	854,704	8,909	260,340
3369			Nonferrous foundries, n.e.c.	141	959,086	6,529	214,786
	331528		Other nonferrous foundries (except die-casting)	141	959,086	6,529	214,786
339	97/92		**Miscellaneous primary metal products**	**1,055**	**5,949,159**	**34,069**	**1,239,321**
3398			Metal heat treating	808	3,485,459	22,674	802,930
	332811		Metal heat treating	808	3,485,459	22,674	802,930
3399			Primary metal products, n.e.c.	247	2,463,700	11,395	436,391
	1% of 331111	20	Iron & steel mills (pt)	82	596,791	2,440	95,739
	5% of 331314	20	Secondary smelting & alloying of aluminum (pt)	10	172,555	488	18,975
	15% of 331423	20	Secondary smelting, refining, & alloying of copper (pt)	11	187,036	565	21,117
	32% of 331492	30	Other nonferrous metal secondary smelting, refining, & alloying (	117	1,207,951	5,814	225,722
	6% of 332618	20	Other fabricated wire product mfg (pt)	27	299,367	2,088	74,838

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(Bridge complete.)	Comparable	SIC derivable from NAICS data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from NAICS are within 3% of SIC sales or receipts.
(Drawbridge open.)	Not comparable	SIC sales or receipts cannot be estimated within 3% from NAICS data.

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1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 34: Fabricated metal products - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	34	Fabricated metal products	37,985	231,704,012	1,549,494	50,904,372
	341	Metal cans and shipping containers	425	13,352,606	33,634	1,377,932
	342	Cutlery, handtools, and hardware	2,494	D	(100,000+)	D
	343	Plumbing and heating, except electric	662	8,671,083	49,165	1,501,147
	344	Fabricated structural metal products	13,959	65,206,295	459,789	14,111,998
	345	Screw machine products, bolts, etc.	3,785	16,460,738	133,399	4,573,452
	346	Metal forgings and stampings	3,625	44,832,778	267,958	10,486,353
	347	Metal services, n.e.c.	5,610	14,454,652	130,755	3,722,220
	348	Ordnance and accessories, n.e.c.	434	5,438,140	38,482	1,489,257
	349	Miscellaneous fabricated metal products	6,991	D	(100,000+)	D

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SIC 34: Fabricated metal products - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
341	97/92		**Metal cans and shipping containers**	**425**	**13,352,606**	**33,634**	**1,377,932**
3411			Metal cans	274	12,042,011	27,316	1,185,705

	332431		Metal can mfg	274	12,042,011	27,316	1,185,705
3412			Metal barrels, drums, & pails	151	1,310,595	6,318	192,227
	58% of 332439	10	Other metal container mfg (pt)	151	1,310,595	6,318	192,227
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
342	9⁄32		**Cutlery, handtools, and hardware**	**2,494**	**D**	**(100,000+)**	**D**
3421			Cutlery	164	2,198,365	11,129	357,283
	100% of 332211	10	Cutlery & flatware (except precious) mfg (pt)	164	2,198,365	11,129	357,283
3423			Hand & edge tools, n.e.c.	1,069	5,677,903	42,947	1,329,593
	86% of 332212	10	Hand & edge tool mfg (pt)	1,069	5,677,903	42,947	1,329,593
3425			Hand saws & saw blades	176	1,452,540	9,149	300,538
	332213		Saw blade & handsaw mfg	176	1,452,540	9,149	300,538
3429			Hardware, n.e.c.	1,085	D	(50k-99999)	D
	18% of 332439	20	Other metal container mfg (pt)	117	402,378	4,135	116,588
	96% of 332510	10	Hardware mfg (pt)	952	10,359,952	70,884	2,186,800
	D 332919	10	Other metal valve & pipe fitting mfg (pt)	16	D	(500-999)	D
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
343	9⁄32		**Plumbing and heating, except electric**	**662**	**8,671,083**	**49,165**	**1,501,147**
3431			Metal sanitary ware	88	1,575,505	9,994	280,462
	332998		Enameled iron & metal sanitary ware mfg	88	1,575,505	9,994	280,462
3432			Plumbing fittings & brass goods	121	3,708,187	16,676	510,498
	332913		Plumbing fixture fitting & trim mfg	116	3,590,128	16,202	499,675
	1% of 332999	20	All other miscellaneous fabricated metal product mfg (pt)	5	118,059	474	10,823
3433			Heating equipment, except electric	453	3,387,391	22,495	710,187
	91% of 333414	10	Heating equipment (except warm air furnaces) mfg (pt)	453	3,387,391	22,495	710,187
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
344	9⁄32		**Fabricated structural metal products**	**13,959**	**65,206,295**	**459,789**	**14,111,998**
3441			Fabricated structural metal	2,900	14,200,270	84,704	2,672,087
	87% of 332312	10	Fabricated structural metal mfg (pt)	2,900	14,200,270	84,704	2,672,087
3442			Metal doors, sash, & trim	1,384	9,876,049	72,970	1,896,135

	96% of 332321	20	Metal window & door mfg (pt)	1,384	9,876,049	72,970	1,896,135
3443			Fabricated plate work, boiler shops	2,130	11,463,395	87,038	2,886,191
	332313		Plate work mfg	1,035	2,806,913	25,453	797,131
	332410		Power boiler & heat exchanger mfg	472	3,849,100	27,542	946,401
	332420		Metal tank (heavy gauge) mfg	614	4,764,118	33,704	1,134,441
	0% of 333415	10	AC & warm air heating & commercial/industrial refrig equip mfg (p	9	43,264	339	8,218
3444			Sheet metal work	4,605	16,233,432	131,900	4,128,514
	332322		Sheet metal work mfg	4,479	15,957,992	129,826	4,068,484
	12% of 332439	30	Other metal container mfg (pt)	126	275,440	2,074	60,030
3446			Architectural metal work	1,744	3,536,413	30,960	875,174
	88% of 332323	10	Ornamental & architectural metal work mfg (pt)	1,744	3,536,413	30,960	875,174
3448			Prefabricated metal buildings	604	4,199,550	25,946	776,575
	332311		Prefabricated metal building & component mfg	604	4,199,550	25,946	776,575
3449			Miscellaneous metal work	592	5,697,186	26,271	877,322
	332114		Custom roll forming	401	3,074,662	15,219	500,899
	13% of 332312	20	Fabricated structural metal mfg (pt)	152	2,166,021	8,729	302,853
	4% of 332321	30	Metal window & door mfg (pt)	33	364,564	1,974	64,115
	2% of 332323	20	Ornamental & architectural metal work mfg (pt)	6	91,939	349	9,455
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
345	9/32		**Screw machine products, bolts, etc.**	**3,785**	**16,460,738**	**133,399**	**4,573,452**
3451			Screw machine products	2,745	8,326,077	80,404	2,634,075
	332721		Precision turned product mfg	2,745	8,326,077	80,404	2,634,075
3452			Bolts, nuts, rivets, & washers	1,040	8,134,661	52,995	1,939,377
	332722		Bolt, nut, screw, rivet, & washer mfg	1,040	8,134,661	52,995	1,939,377
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
346	9/32		**Metal forgings and stampings**	**3,625**	**44,832,778**	**267,958**	**10,486,353**
3462			Iron & steel forgings	421	4,924,426	26,432	1,035,345
	332111		Iron & steel forging	421	4,924,426	26,432	1,035,345
3463			Nonferrous forgings	84	1,858,708	9,129	366,879
	332112		Nonferrous forging	84	1,858,708	9,129	366,879
3465			Automotive stampings	810	23,668,110	126,905	5,647,964

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	336370		Motor vehicle metal stamping	810	23,668,110	126,905	5,647,964
3466			Crowns & closures	67	969,982	4,682	167,443
	332115		Crown & closure mfg	67	969,982	4,682	167,443
3469			Metal stampings, n.e.c.	2,243	13,411,552	100,810	3,268,722
	332116		Metal stamping	2,166	12,041,638	93,086	3,039,459
	332214		Kitchen utensil, pot, & pan mfg	77	1,369,914	7,724	229,263
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
347		97/92	**Metal services, n.e.c.**	**5,610**	**14,454,652**	**130,755**	**3,722,220**
3471			Plating & polishing	3,404	5,979,405	74,640	2,089,261
	332813		Electroplating, plating, polishing, anodizing, & coloring	3,404	5,979,405	74,640	2,089,261
3479			Metal coating & allied services	2,206	8,475,247	56,115	1,632,959
	332812		Metal coating/engraving (exc jewelry/silverware)/allied services	2,156	8,460,896	55,904	1,628,585
0% of	339911	10	Jewelry (except costume) mfg (pt)	22	5,798	79	1,620
1% of	339912	10	Silverware & plated ware mfg (pt)	12	6,296	103	2,091
0% of	339914	10	Costume jewelry & novelty mfg (pt)	16	2,257	29	663
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
348		97/92	**Ordnance and accessories, n.e.c.**	**434**	**5,438,140**	**38,482**	**1,489,257**
3482			Small arms ammunition	113	938,818	6,863	242,068
	332992		Small arms ammunition mfg	113	938,818	6,863	242,068
3483			Ammunition, except small arms, n.e.c.	53	1,497,045	9,427	379,450
	332993		Ammunition (except small arms) mfg	53	1,497,045	9,427	379,450
3484			Small arms	198	1,251,792	9,907	320,614
	332994		Small arms mfg	198	1,251,792	9,907	320,614
3489			Ordnance & accessories, n.e.c.	70	1,750,485	12,285	547,125
	332995		Other ordnance & accessories mfg	70	1,750,485	12,285	547,125
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
349		97/92	**Miscellaneous fabricated metal products**	**6,991**	**D**	**(100,000+)**	**D**
3491			Industrial valves	538	8,699,300	53,459	1,904,134
	332911		Industrial valve mfg	538	8,699,300	53,459	1,904,134

3492		Fluid power valves & hose fittings	424	6,602,909	37,132	1,324,392
	100% of 332912 10	Fluid power valve & hose fitting mfg (pt)	424	6,602,909	37,132	1,324,392
3493		Steel springs, except wire	129	761,711	5,381	174,467
	332611	Spring (heavy gauge) mfg	129	761,711	5,381	174,467
3494		Valves & pipe fittings, n.e.c.	245	2,827,380	18,216	576,136
	94% of 332919 20	Other metal valve & pipe fitting mfg (pt)	222	2,753,397	17,652	558,712
	1% of 332999 30	All other miscellaneous fabricated metal product mfg (pt)	23	73,983	564	17,424
3495		Wire springs	396	D	(10k-24999)	D
	332612	Spring (light gauge) mfg	394	2,481,151	18,798	564,372
	D 334518 10	Watch, clock, & part mfg (pt)	2	D	(100-249)	D
3496		Miscellaneous fabricated wire products	1,253	4,587,656	41,821	1,025,279
	87% of 332618 30	Other fabricated wire product mfg (pt)	1,253	4,587,656	41,821	1,025,279
3497		Metal foil & leaf	107	3,257,743	10,615	418,574
	322225	Laminated aluminum foil mfg for flexible packaging uses	43	1,546,143	4,967	211,497
	16% of 332999 40	All other miscellaneous fabricated metal product mfg (pt)	64	1,711,600	5,648	207,077
3498		Fabricated pipe & fittings	856	4,024,999	29,364	870,291
	100% of 332996 20	Fabricated pipe & pipe fitting mfg (pt)	856	4,024,999	29,364	870,291
3499		Fabricated metal products, n.e.c.	3,043	D	(50k-99999)	D
	332117	Powder metallurgy part mfg	128	1,317,301	10,760	367,623
	12% of 332439 40	Other metal container mfg (pt)	98	273,541	2,331	70,293
	4% of 332510 20	Hardware mfg (pt)	58	435,815	3,401	93,516
	D 332919 30	Other metal valve & pipe fitting mfg (pt)	7	D	(250-499)	D
	72% of 332999 50	All other miscellaneous fabricated metal product mfg (pt)	2,592	7,558,137	63,736	1,870,813
	2% of 337215 40	Showcase, partition, shelving, & locker mfg (pt)	78	123,057	1,295	35,369
	4% of 339914 20	Costume jewelry & novelty mfg (pt)	82	49,953	568	10,912

N=Comparable data not available D=Withheld to avoid disclosure

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.) Comparable SIC derivable from NAICS data.

(Drawbridge slightly open.) Almost comparable Sales or receipts from NAICS are within 3% of SIC sales or receipts.

(Drawbridge open.) Not comparable SIC sales or receipts cannot be estimated within 3% from NAICS data.

All-sector menu | Menu of all 2-digit SICs | Data in formats for downloading | PDF report

Source: 1997 Economic Census, Comparative Statistics

U.S. Census Bureau

1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 35: Industrial machinery and equipment - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	35	Industrial machinery and equipment	56,383	407,393,276	1,978,226	74,550,422
	351	Engines and turbines	390	D	(50k-99999)	D
	352	Farm and garden machinery	1,656	D	(50k-99999)	D
	353	Construction and related machinery	3,523	47,935,156	213,334	8,081,030
	354	Metalworking machinery	11,706	39,692,950	296,489	11,812,262
	355	Special industry machinery	4,781	D	(100,000+)	D
	356	General industrial machinery	4,479	44,080,890	265,359	9,752,818
	357	Computer and office equipment	2,181	D	(100,000+)	D
	358	Refrigeration and service machinery	2,277	39,317,539	204,675	6,800,658
	359	Industrial machinery, n.e.c.	25,390	38,647,841	368,481	12,360,014

N=Comparable data not available D=Withheld to avoid disclosure

SIC 35: Industrial machinery and equipment - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
351	97/92		**Engines and turbines**	**390**	**D**	**(50k-99999)**	**D**
3511			Turbines & turbine generator sets	86	5,783,057	19,529	910,316

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	333611		Turbine & turbine generator set unit mfg	86	5,783,057	19,529	910,316
3519			Internal combustion engines, n.e.c.	304	D	(50k-99999)	D
	D 333618	10	Other engine equipment mfg (pt)	297	D	(50k-99999)	D
	0% of 336399	10	All other motor vehicle parts mfg (pt)	7	123,954	896	24,247
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
352			**Farm and garden machinery**	**1,656**	**D**	**(50k-99999)**	**D**
3523			Farm machinery & equipment	1,508	D	(50k-99999)	D
	D 332212	20	Hand & edge tool mfg (pt)	1	D	(20-99)	D
	10% of 332323	30	Ornamental & architectural metal work mfg (pt)	140	380,152	3,082	86,294
	333111		Farm machinery & equipment mfg	1,339	15,921,455	66,370	2,370,599
	1% of 333922	10	Conveyor & conveying equipment mfg (pt)	28	33,377	320	6,663
3524			Lawn & garden equipment	148	D	(25k-49999)	D
	D 332212	30	Hand & edge tool mfg (pt)	3	D	(20-99)	D
	333112		Lawn & garden tractor & home lawn & garden equipment mfg	145	7,454,511	28,617	739,727
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
353			**Construction and related machinery**	**3,523**	**47,935,156**	**213,334**	**8,081,030**
3531			Construction machinery	897	24,117,413	87,607	3,374,527
	333120		Construction machinery mfg	785	21,965,455	74,965	2,998,967
	57% of 333923	10	Overhead traveling crane, hoist, & monorail system mfg (pt)	87	1,805,198	10,263	290,989
	4% of 336510	10	Railroad rolling stock mfg (pt)	25	346,760	2,379	84,571
3532			Mining machinery	292	2,710,923	13,547	486,496
	333131		Mining machinery & equipment mfg	292	2,710,923	13,547	486,496
3533			Oil field machinery	563	6,240,079	29,451	1,166,759
	333132		Oil & gas field machinery & equipment mfg	563	6,240,079	29,451	1,166,759
3534			Elevators & moving stairways	196	1,607,066	9,442	340,525
	333921		Elevator & moving stairway mfg	196	1,607,066	9,442	340,525
3535			Conveyors & conveying equipment	871	6,346,525	39,279	1,531,625
	100% of 333922	20	Conveyor & conveying equipment mfg (pt)	871	6,346,525	39,279	1,531,625
3536			Hoists, cranes, & monorails	220	1,340,561	7,751	278,899

	43% of 333923	20	Overhead traveling crane, hoist, & monorail system mfg (pt)	220	1,340,561	7,751	278,899
3537			Industrial trucks & tractors	484	5,572,589	26,257	902,199
	0% of 332439	50	Other metal container mfg (pt)	4	6,775	64	1,492
	0% of 332999	60	All other miscellaneous fabricated metal product mfg (pt)	19	27,488	240	6,939
	333924		Industrial truck, tractor, trailer, & stacker machinery mfg	461	5,538,326	25,953	893,768
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
354	9/32		**Metalworking machinery**	**11,706**	**39,692,950**	**296,489**	**11,812,262**
3541			Machine tools, metal cutting types	393	5,183,521	28,849	1,241,372
	97% of 333512	10	Machine tool (metal cutting types) mfg (pt)	393	5,183,521	28,849	1,241,372
3542			Machine tools, metal forming types	225	2,255,011	14,185	598,606
	333513		Machine tool (metal forming types) mfg	225	2,255,011	14,185	598,606
3543			Industrial patterns	673	623,927	7,959	285,038
	332997		Industrial pattern mfg	673	623,927	7,959	285,038
3544			Special dies, tools, jigs, & fixtures	7,275	13,361,490	128,770	5,318,715
	333511		Industrial mold mfg	2,529	5,116,635	48,657	2,088,950
	333514		Special die & tool, die set, jig, & fixture mfg	4,746	8,244,855	80,113	3,229,765
3545			Machine tool accessories	2,105	6,061,450	54,304	1,897,399
	11% of 332212	40	Hand & edge tool mfg (pt)	185	714,277	6,379	254,257
	333515		Cutting tool & machine tool accessory mfg	1,920	5,347,173	47,925	1,643,142
3546			Power-driven handtools	217	3,609,779	16,816	531,378
	333991		Power-driven handtool mfg	217	3,609,779	16,816	531,378
3547			Rolling mill machinery	100	700,084	4,149	167,312
	333516		Rolling mill machinery & equipment mfg	100	700,084	4,149	167,312
3548			Welding apparatus	244	4,433,877	22,434	915,152
	100% of 333992	10	Welding & soldering equipment mfg (pt)	244	4,433,877	22,434	915,152
	0% of 335311	10	Power, distribution, & specialty transformer mfg (pt)	0	0	0	0
3549			Metalworking machinery, n.e.c.	474	3,463,811	19,023	857,290
	333518		Other metalworking machinery mfg	474	3,463,811	19,023	857,290
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments**	**Paid employees**	**Annual payroll**

					($1,000)		($1,000)
355		9/32	**Special industry machinery**	**4,781**	**D**	**(100,000+)**	**D**
3552			Textile machinery	478	1,779,034	13,600	449,014
	100% of 333292	10	Textile machinery mfg (pt)	478	1,779,034	13,600	449,014
3553			Woodworking machinery	327	1,321,752	9,117	302,233
	333210		Sawmill & woodworking machinery mfg	327	1,321,752	9,117	302,233
3554			Paper industries machinery	366	3,438,235	18,594	772,659
	333291		Paper industry machinery mfg	366	3,438,235	18,594	772,659
3555			Printing trades machinery	546	D	(10k-24999)	D
	D 333293	10	Printing machinery & equipment mfg (pt)	546	D	(10k-24999)	D
3556			Food products machinery	597	2,877,841	19,026	715,068
	333294		Food product machinery mfg	597	2,877,841	19,026	715,068
3559			Special industry machinery, n.e.c.	2,467	D	(100,000+)	D
	333220		Plastics & rubber industry machinery mfg	455	3,584,992	18,574	743,901
	333295		Semiconductor machinery mfg	257	11,158,627	40,087	1,701,669
	D 333298	10	All other industrial machinery mfg (pt)	1,677	D	(50k-99999)	D
	7% of 333319	10	Other commercial & service industry machinery mfg (pt)	78	644,019	2,890	96,069
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
356		9/32	**General industrial machinery**	**4,479**	**44,080,890**	**265,359**	**9,752,818**
3561			Pumps & pumping equipment	489	6,826,043	36,552	1,422,919
	100% of 333911	10	Pump & pumping equipment mfg (pt)	489	6,826,043	36,552	1,422,919
3562			Ball & roller bearings	185	6,120,940	36,991	1,386,126
	332991		Ball & roller bearing mfg	185	6,120,940	36,991	1,386,126
3563			Air & gas compressors	314	5,633,008	24,821	940,349
	333912		Air & gas compressor mfg	314	5,633,008	24,821	940,349
3564			Blowers & fans	574	4,075,925	29,906	902,298
	333411		Air purification equipment mfg	370	2,174,729	16,183	470,103
	333412		Industrial & commercial fan & blower mfg	204	1,901,196	13,723	432,195
3565			Packaging machinery	689	4,858,270	31,581	1,255,960
	333993		Packaging machinery mfg	689	4,858,270	31,581	1,255,960
3566			Speed changers, drives, & gears	268	2,402,392	16,231	597,248

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	333612		Speed changer, industrial high-speed drive, & gear mfg	268	2,402,392	16,231	597,248
3567			Industrial furnaces & ovens	404	2,871,475	17,585	657,191
	333994		Industrial process furnace & oven mfg	404	2,871,475	17,585	657,191
3568			Power transmission equipment, n.e.c.	299	3,301,091	21,604	770,962
	333613		Mechanical power transmission equipment mfg	299	3,301,091	21,604	770,962
3569			General industrial machinery, n.e.c.	1,257	7,991,746	50,088	1,819,765
	88% of 333999	10	All other miscellaneous general-purpose machinery mfg (pt)	1,257	7,991,746	50,088	1,819,765
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
357	9/32		**Computer and office equipment**	**2,181**	**D**	**(100,000+)**	**D**
3571			Electronic computers	563	66,331,909	100,115	4,282,451
	334111		Electronic computer mfg	563	66,331,909	100,115	4,282,451
3572			Computer storage devices	211	13,907,367	42,364	1,950,230
	334112		Computer storage device mfg	211	13,907,367	42,364	1,950,230
3575			Computer terminals	142	1,483,460	5,764	253,087
	334113		Computer terminal mfg	142	1,483,460	5,764	253,087
3577			Computer peripheral equipment, n.e.c.	1,006	25,130,308	87,253	4,337,970
	93% of 334119	10	Other computer peripheral equipment mfg (pt)	1,006	25,130,308	87,253	4,337,970
3578			Calculating & accounting equipment	96	2,014,806	7,683	275,962
	5% of 333313	10	Office machinery mfg (pt)	35	144,380	966	30,889
	7% of 334119	20	Other computer peripheral equipment mfg (pt)	61	1,870,426	6,717	245,073
3579			Office machines, n.e.c.	163	D	(10k-24999)	D
	96% of 333313	20	Office machinery mfg (pt)	134	3,047,549	13,865	427,315
	D 334518	20	Watch, clock, & part mfg (pt)	16	D	(500-999)	D
	21% of 339942	20	Lead pencil & art good mfg (pt)	13	257,020	1,234	30,572
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
358	9/32		**Refrigeration and service machinery**	**2,277**	**39,317,539**	**204,675**	**6,800,658**
3581			Automatic merchandising machines	121	1,325,960	8,178	215,627
	333311		Automatic vending machine mfg	121	1,325,960	8,178	215,627
3582							

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
			Commercial laundry equipment	68	604,966	4,523	136,783
	333312		Commercial laundry, drycleaning, & pressing machine mfg	68	604,966	4,523	136,783
3585			Refrigeration & heating equipment	852	28,473,461	140,978	4,736,239
	100% of 333415	20	AC & warm air heating & commercial/industrial refrig equip mfg (p	792	22,846,865	119,456	3,682,296
	336391		Motor vehicle air-conditioning mfg	60	5,626,596	21,522	1,053,943
3586			Measuring & dispensing pumps	71	1,316,899	6,824	251,438
	333913		Measuring & dispensing pump mfg	71	1,316,899	6,824	251,438
3589			Service industry machinery, n.e.c.	1,165	7,596,253	44,172	1,460,571
	81% of 333319	20	Other commercial & service industry machinery mfg (pt)	1,165	7,596,253	44,172	1,460,571
359	97/92		**Industrial machinery, n.e.c.**	**25,390**	**38,647,841**	**368,481**	**12,360,014**
3592			Carburetors, pistons, rings, & valves	141	2,755,311	17,518	672,786
	336311		Carburetor, piston, piston ring, & valve mfg	141	2,755,311	17,518	672,786
3593			Fluid power cylinders & actuators	320	3,528,906	23,062	900,438
	100% of 333995	10	Fluid power cylinder & actuator mfg (pt)	320	3,528,906	23,062	900,438
3594			Fluid power pumps & motors	170	2,712,058	15,482	605,485
	100% of 333996	10	Fluid power pump & motor mfg (pt)	170	2,712,058	15,482	605,485
3596			Scales & balances, except laboratory	122	682,940	4,871	148,755
	333997		Scale & balance (except laboratory) mfg	122	682,940	4,871	148,755
3599			Industrial machinery, n.e.c.	24,637	28,968,626	307,548	10,032,550
	332710		Machine shops	23,619	27,143,131	290,951	9,497,047
	5% of 332999	70	All other miscellaneous fabricated metal product mfg (pt)	132	506,611	4,199	136,429
	2% of 333319	30	Other commercial & service industry machinery mfg (pt)	50	172,536	1,335	35,719
	13% of 333999	20	All other miscellaneous general-purpose machinery mfg (pt)	836	1,146,348	11,063	363,355

N=Comparable data not available D=Withheld to avoid disclosure

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.) Comparable SIC derivable from NAICS data.

(Drawbridge slightly open.) Almost comparable Sales or receipts from NAICS are within 3% of SIC sales or receipts.

(Drawbridge open.) Not comparable SIC sales or receipts cannot be estimated within 3% from NAICS data.

SIC 36: Electronic and other electric equipment - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	36	Electronic and other electric equipment	17,104	348,559,508	1,582,348	58,256,420
	361	Electric distribution equipment	901	12,325,326	67,929	2,276,264
	362	Electrical industrial apparatus	2,388	28,643,846	169,046	5,474,383
	363	Household appliances	356	D	(100,000+)	D
	364	Electric lighting and wiring equipment	2,106	26,197,139	158,615	4,888,856
	365	Household audio and video equipment	834	10,699,568	48,325	1,438,451
	366	Communications equipment	2,213	80,949,148	283,751	13,272,409
	367	Electronic components and accessories	6,605	141,997,578	611,693	22,958,642
	369	Miscellaneous electrical equipment and supplies	1,701	D	(100,000+)	D

N=Comparable data not available D=Withheld to avoid disclosure

SIC 36: Electronic and other electric equipment - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
361		9⁄32	**Electric distribution equipment**	**901**	**12,325,326**	**67,929**	**2,276,264**
3612			Transformers	318	4,716,162	26,638	822,096
	100% of 335311	20	Power, distribution, & specialty transformer mfg (pt)	318	4,716,162	26,638	822,096
3613			Switchgear & switchboard apparatus	583	7,609,164	41,291	1,454,168
	335313		Switchgear & switchboard apparatus mfg	583	7,609,164	41,291	1,454,168
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
362		9⁄32	**Electrical industrial apparatus**	**2,388**	**28,643,846**	**169,046**	**5,474,383**
3621			Motors & generators	528	11,788,281	71,112	2,072,046
	96% of 335312	10	Motor & generator mfg (pt)	528	11,788,281	71,112	2,072,046
3624			Carbon & graphite products	126	2,254,410	10,887	407,987
	335991		Carbon & graphite product mfg	126	2,254,410	10,887	407,987
3625			Relays & industrial controls	1,321	11,762,789	68,365	2,429,039
	335314		Relay & industrial control mfg	1,321	11,762,789	68,365	2,429,039
3629			Electrical industrial apparatus, n.e.c.	413	2,838,366	18,682	565,311
	41% of 335999	10	All other miscellaneous electrical equipment & component mfg (pt)	413	2,838,366	18,682	565,311
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
363		9⁄32	**Household appliances**	**356**	**D**	**(100,000+)**	**D**
3631			Household cooking equipment	84	3,543,231	17,543	480,836
	335221		Household cooking appliance mfg	84	3,543,231	17,543	480,836
3632			Household refrigerators & freezers	27	4,887,364	24,597	801,717
	335222		Household refrigerator & home freezer mfg	27	4,887,364	24,597	801,717
3633			Household laundry equipment	17	3,723,375	14,801	480,076
	335224		Household laundry equipment mfg	17	3,723,375	14,801	480,076
3634			Electric housewares & fans	154	3,817,521	19,229	458,176
	9% of 333414	20	Heating equipment (except warm air furnaces) mfg (pt)	16	329,270	2,171	46,787
	335211		Electric housewares & household fan mfg	138	3,488,251	17,058	411,389
3635			Household vacuum cleaners	34	2,399,206	10,537	340,498
	100% of 335212	10	Household vacuum cleaner mfg (pt)	34	2,399,206	10,537	340,498
3639			Household appliances, n.e.c.	40	D	(10k-	D

						24999)	
D	333298	20	All other industrial machinery mfg (pt)	4	D	(20-99)	D
0% of	335212	20	Household vacuum cleaner mfg (pt)	0	0	0	0
	335228		Other major household appliance mfg	36	3,300,662	13,309	425,991

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
364	97/92		**Electric lighting and wiring equipment**	**2,106**	**26,197,139**	**158,615**	**4,888,856**
3641			Electric lamps	82	3,306,009	15,903	574,696
	335110		Electric lamp bulb & part mfg	82	3,306,009	15,903	574,696
3643			Current-carrying wiring devices	519	5,877,522	44,907	1,293,583
	335931		Current-carrying wiring device mfg	519	5,877,522	44,907	1,293,583
3644			Noncurrent-carrying wiring devices	219	4,451,186	23,540	787,075
	335932		Noncurrent-carrying wiring device mfg	219	4,451,186	23,540	787,075
3645			Residential lighting fixtures	497	2,177,355	16,395	406,444
97% of	335121	20	Residential electric lighting fixture mfg (pt)	497	2,177,355	16,395	406,444
3646			Commercial lighting fixtures	356	4,047,437	23,090	657,341
	335122		Commercial/industrial/institutional electric lighting fixture mfg	356	4,047,437	23,090	657,341
3647			Vehicular lighting equipment	106	3,282,824	16,506	628,534
	336321		Vehicular lighting equipment mfg	106	3,282,824	16,506	628,534
3648			Lighting equipment, n.e.c.	327	3,054,806	18,274	541,183
100% of	335129	10	Other lighting equipment mfg (pt)	327	3,054,806	18,274	541,183

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
365	97/92		**Household audio and video equipment**	**834**	**10,699,568**	**48,325**	**1,438,451**
3651			Household audio & video equipment	554	8,454,194	31,727	944,647
	334310		Audio & video equipment mfg	554	8,454,194	31,727	944,647
3652			Prerecorded records & tapes	280	2,245,374	16,598	493,804
58% of	334612	10	Prerecorded CD (except software), tape, & record reproducing (pt)	280	2,245,374	16,598	493,804

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
366	97/92		**Communications equipment**	**2,213**	**80,949,148**	**283,751**	**13,272,409**
3661			Telephone & telegraph apparatus	625	39,673,619	110,408	5,591,933

	334210		Telephone apparatus mfg	598	38,300,044	104,262	5,329,203
	1% of 334416	10	Electronic coil, transformer, & other inductor mfg (pt)	7	8,904	63	1,836
	5% of 334418	10	Printed circuit assembly (electronic assembly) mfg (pt)	20	1,364,671	6,083	260,894
3663			Radio & TV communications equipment	1,091	37,042,241	148,156	6,765,352
	94% of 334220	10	Radio & TV broadcasting & wireless communications equipment mfg (	1,091	37,042,241	148,156	6,765,352
3669			Communications equipment, n.e.c.	497	4,233,288	25,187	915,124
	334290		Other communications equipment mfg	497	4,233,288	25,187	915,124
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
367	9/32		**Electronic components and accessories**	**6,605**	**141,997,578**	**611,693**	**22,958,642**
3671			Electron tubes	159	3,858,499	21,976	742,074
	334411		Electron tube mfg	159	3,858,499	21,976	742,074
3672			Printed circuit boards	1,401	9,787,576	76,702	2,313,578
	334412		Bare printed circuit board mfg	1,401	9,787,576	76,702	2,313,578
3674			Semiconductors & related devices	1,099	78,539,562	199,497	10,112,757
	334413		Semiconductor & related device mfg	1,099	78,539,562	199,497	10,112,757
3675			Electronic capacitors	129	2,482,163	18,882	531,259
	334414		Electronic capacitor mfg	129	2,482,163	18,882	531,259
3676			Electronic resistors	119	1,280,527	11,964	314,045
	334415		Electronic resistor mfg	119	1,280,527	11,964	314,045
3677			Electronic coils & transformers	426	1,512,232	19,178	450,160
	98% of 334416	20	Electronic coil, transformer, & other inductor mfg (pt)	426	1,512,232	19,178	450,160
3678			Electronic connectors	347	5,598,906	37,232	1,172,969
	334417		Electronic connector mfg	347	5,598,906	37,232	1,172,969
3679			Electronic components, n.e.c.	2,925	38,938,113	226,262	7,321,800
	6% of 334220	20	Radio & TV broadcasting & wireless communications equipment mfg (	126	2,265,873	16,305	606,528
	95% of 334418	20	Printed circuit assembly (electronic assembly) mfg (pt)	695	24,704,154	104,971	3,582,172
	334419		Other electronic component mfg	1,851	10,547,090	92,200	2,769,216
	8% of 336322	10	Other motor vehicle electrical & electronic equipment mfg (pt)	253	1,420,996	12,786	363,884
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**

SIC	NAICS	Industry	Establishments	Sales	Employees	Payroll
369	97/92	**Miscellaneous electrical equipment and supplies**	1,701	D	(100,000+)	D
3691		Storage batteries	137	4,432,112	23,288	789,579
	335911	Storage battery mfg	137	4,432,112	23,288	789,579
3692		Primary batteries, dry & wet	45	2,322,896	8,917	281,467
	335912	Primary battery mfg	45	2,322,896	8,917	281,467
3694		Engine electrical equipment	569	9,074,335	52,216	1,642,014
	54% of 336322 20	Other motor vehicle electrical & electronic equipment mfg (pt)	569	9,074,335	52,216	1,642,014
3695		Magnetic & optical recording media	259	4,726,363	21,345	815,970
	334613	Magnetic & optical recording media mfg	259	4,726,363	21,345	815,970
3699		Electrical equipment & supplies, n.e.c.	691	D	(25k-49999)	D
	2% of 332212 50	Hand & edge tool mfg (pt)	4	140,811	424	32,361
	0% of 333292 20	Textile machinery mfg (pt)	0	0	0	0
	D 333293 20	Printing machinery & equipment mfg (pt)	5	D	(100-249)	D
	0% of 333314 10	Optical instrument & lens mfg (pt)	5	7,320	56	1,871
	0% of 333315 10	Photographic & photocopying equipment mfg (pt)	0	0	0	0
	10% of 333319 40	Other commercial & service industry machinery mfg (pt)	57	934,728	8,513	382,013
	3% of 333512 20	Machine tool (metal cutting types) mfg (pt)	8	151,363	522	27,050
	D 333618 20	Other engine equipment mfg (pt)	2	D	(1-19)	D
	0% of 333992 20	Welding & soldering equipment mfg (pt)	6	11,101	71	3,028
	0% of 334119 30	Other computer peripheral equipment mfg (pt)	0	0	0	0
	1% of 334510 10	Electromedical & electrotherapeutic apparatus mfg (pt)	11	52,855	542	20,770
	0% of 334511 10	Search, detection, navigation, & guidance instrument mfg (pt)	7	77,832	604	24,725
	1% of 334516 10	Analytical laboratory instrument mfg (pt)	10	36,473	159	7,518
	0% of 334519 10	Other measuring & controlling device mfg (pt)	5	6,174	29	1,621
	0% of 335129 20	Other lighting equipment mfg (pt)	4	859	8	180
	59% of 335999 20	All other miscellaneous electrical equipment & component mfg (pt)	567	4,051,267	26,072	923,183
	0% of 339114 10	Dental equipment & supplies mfg (pt)	0	0	0	0

N=Comparable data not available D=Withheld to avoid disclosure

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.)	Comparable	SIC derivable from NAICS data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from NAICS are within 3% of SIC sales or receipts.
(Drawbridge open.)	Not comparable	SIC sales or receipts cannot be estimated within 3% from NAICS data.

Data in formats for

U.S. Census Bureau

1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 37: Transportation equipment - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	37	Transportation equipment	12,387	515,881,602	1,561,662	68,298,623
	371	Motor vehicles and equipment	5,274	D	(100,000+)	D
	372	Aircraft and parts	1,711	98,963,996	411,247	20,703,396
	373	Ship and boat building and repairing	3,482	17,015,123	148,261	4,641,293
	374	Railroad equipment	207	7,916,635	31,633	1,234,564
	375	Motorcycles, bicycles, and parts	385	D	(10k-24999)	D
	376	Guided missiles, space vehicles, parts	99	18,929,257	76,808	4,500,660
	379	Miscellaneous transportation equipment	1,229	D	(50k-99999)	D

N=Comparable data not available D=Withheld to avoid disclosure

SIC 37: Transportation equipment - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
371		97/92	**Motor vehicles and equipment**	**5,274**	**D**	**(100,000+)**	**D**
3711			Motor vehicles & car bodies	472	D	(100,000+)	D
	336111		Automobile mfg	194	95,385,563	114,060	6,411,952
	336112		Light truck & utility vehicle mfg	112	110,400,169	94,033	5,361,980
	336120		Heavy duty truck mfg	84	14,490,344	28,214	1,212,651

1% of	336211	10	Motor vehicle body mfg (pt)	76	82,633	404	10,503
D	336992	10	Military armored vehicle, tank, & tank component mfg (pt)	6	D	(250-499)	D
3713			Truck & bus bodies	715	8,719,326	41,779	1,189,519
96% of	336211	20	Motor vehicle body mfg (pt)	715	8,719,326	41,779	1,189,519
3714			Motor vehicle parts & accessories	3,609	120,951,593	490,657	19,565,925
3% of	336211	30	Motor vehicle body mfg (pt)	23	265,552	1,201	40,558
	336312		Gasoline engine & engine parts mfg	881	25,974,369	81,368	3,555,964
38% of	336322	30	Other motor vehicle electrical & electronic equipment mfg (pt)	193	6,446,681	30,489	1,054,750
	336330		Motor vehicle steering & suspension component (except spring) mfg	212	10,750,312	48,944	2,336,212
100% of	336340	20	Motor vehicle brake system mfg (pt)	269	10,033,288	43,132	1,486,119
	336350		Motor vehicle transmission & power train parts mfg	523	33,288,093	111,954	5,564,722
100% of	336399	20	All other motor vehicle parts mfg (pt)	1,508	34,193,298	173,569	5,527,600
3715			Truck trailers	390	5,507,768	30,678	836,590
	336212		Truck trailer mfg	390	5,507,768	30,678	836,590
3716			Motor homes	88	3,943,709	18,086	507,700
	336213		Motor home mfg	88	3,943,709	18,086	507,700

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
372	9/32		**Aircraft and parts**	**1,711**	**98,963,996**	**411,247**	**20,703,396**
3721			Aircraft	204	56,273,651	200,961	10,733,030
	336411		Aircraft mfg	204	56,273,651	200,961	10,733,030
3724			Aircraft engines & engine parts	369	22,617,284	82,557	4,223,020
	336412		Aircraft engine & engine parts mfg	369	22,617,284	82,557	4,223,020
3728			Aircraft parts & equipment, n.e.c.	1,138	20,073,061	127,729	5,747,346
0% of	332912	20	Fluid power valve & hose fitting mfg (pt)	0	0	0	0
0% of	333995	20	Fluid power cylinder & actuator mfg (pt)	0	0	0	0
0% of	333996	20	Fluid power pump & motor mfg (pt)	0	0	0	0
	336413		Other aircraft part & auxiliary equipment mfg	1,138	20,073,061	127,729	5,747,346

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
373	9/32		**Ship and boat building and repairing**	**3,482**	**17,015,123**	**148,261**	**4,641,293**
3731			Ship building & repairing	700	10,571,810	97,385	3,366,404
	336611		Ship building & repairing	700	10,571,810	97,385	3,366,404

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
3732			Boat building & repairing	2,782	6,443,313	50,876	1,274,889
	336612		Boat building	1,043	5,622,040	41,422	1,033,974
	18% of 811490	20	Boat repair	1,739	821,273	9,454	240,915
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
374	97/92		**Railroad equipment**	**207**	**7,916,635**	**31,633**	**1,234,564**
3743			Railroad equipment	207	7,916,635	31,633	1,234,564
	0% of 333911	20	Pump & pumping equipment mfg (pt)	0	0	0	0
	96% of 336510	20	Railroad rolling stock mfg (pt)	207	7,916,635	31,633	1,234,564
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
375	97/92		**Motorcycles, bicycles, and parts**	**385**	**D**	**(10k-24999)**	**D**
3751			Motorcycles, bicycles, & parts	385	D	(10k-24999)	D
	D 336991	10	Motorcycle, bicycle, & parts mfg (pt)	385	D	(10k-24999)	D
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
376	97/92		**Guided missiles, space vehicles, parts**	**99**	**18,929,257**	**76,808**	**4,500,660**
3761			Guided missiles & space vehicles	22	14,791,466	52,158	3,156,221
	336414		Guided missile & space vehicle mfg	22	14,791,466	52,158	3,156,221
3764			Space propulsion units & parts	28	3,239,033	18,540	1,066,084
	336415		Guided missile & space vehicle propulsion unit & parts mfg	28	3,239,033	18,540	1,066,084
3769			Space vehicle equipment, n.e.c.	49	898,758	6,110	278,355
	336419		Other guided missile & space vehicle parts & auxiliary equip mfg	49	898,758	6,110	278,355
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
379	97/92		**Miscellaneous transportation equipment**	**1,229**	**D**	**(50k-99999)**	**D**
3792			Travel trailer & campers	315	3,076,049	20,112	506,058
	67% of 336214	10	Travel trailer & camper mfg (pt)	315	3,076,049	20,112	506,058
3795			Tanks & tank components	37	D	(5000-9999)	D
	D 336992	20	Military armored vehicle, tank, & tank component mfg (pt)	37	D	(5000-9999)	D
3799			Transportation equipment, n.e.c.	877	D	(25k-49999)	D

D 332212 60	Hand & edge tool mfg (pt)	1	D	(20-99)	D
33% of 336214 20	Travel trailer & camper mfg (pt)	498	1,485,367	13,240	299,845
336999	All other transportation equipment mfg	378	4,557,989	19,466	512,362

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Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.)	Comparable	SIC derivable from NAICS data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from NAICS are within 3% of SIC sales or receipts.
(Drawbridge open.)	Not comparable	SIC sales or receipts cannot be estimated within 3% from NAICS data.

All-sector menu   Menu of all 2-digit SICs   Data in formats for downloading   PDF report

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1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 38: Instruments and related products - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	38	Instruments and related products	11,727	D	(100,000+)	D
	381	Search and navigation equipment	680	32,497,776	187,557	9,958,084
	382	Measuring and controlling devices	4,787	46,449,122	263,237	11,037,829
	384	Medical instruments and supplies	4,818	D	(100,000+)	D
	385	Ophthalmic goods	575	3,607,813	26,366	814,242
	386	Photographic equipment and supplies	739	21,305,761	63,642	2,928,089
	387	Watches, clocks, watchcases, and parts	128	718,191	5,646	155,180

N=Comparable data not available D=Withheld to avoid disclosure

SIC 38: Instruments and related products - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
381	97/92		**Search and navigation equipment**	**680**	**32,497,776**	**187,557**	**9,958,084**
3812			Search & navigation equipment	680	32,497,776	187,557	9,958,084
	100% of 334511	20	Search, detection, navigation, & guidance instrument mfg (pt)	680	32,497,776	187,557	9,958,084

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
382	97/92		**Measuring and controlling devices**	**4,787**	**46,449,122**	**263,237**	**11,037,829**
3821							

			Laboratory apparatus & furniture	385	2,471,153	18,253	686,742
	339111		Laboratory apparatus & furniture mfg	385	2,471,153	18,253	686,742
3822			Environmental controls	317	2,935,692	21,450	664,820
	334512		Automatic environmental control mfg	317	2,935,692	21,450	664,820
3823			Process control instruments	1,002	7,890,923	49,196	2,004,259
	334513		Industrial process control instrument mfg	1,002	7,890,923	49,196	2,004,259
3824			Fluid meters & counting devices	222	3,765,769	17,390	683,294
	334514		Totalizing fluid meter & counting device mfg	222	3,765,769	17,390	683,294
3825			Instruments to measure electricity	843	13,877,200	63,522	3,008,675
	2% of 334416	30	Electronic coil, transformer, & other inductor mfg (pt)	17	24,303	190	6,985
	334515		Electricity measuring & testing instrument mfg	826	13,852,897	63,332	3,001,690
3826			Analytical instruments	664	7,157,038	38,200	1,782,600
	100% of 334516	20	Analytical laboratory instrument mfg (pt)	664	7,157,038	38,200	1,782,600
3827			Optical instruments & lenses	495	3,174,652	20,801	833,784
	100% of 333314	20	Optical instrument & lens mfg (pt)	495	3,174,652	20,801	833,784
3829			Measuring & controlling devices, n.e.c.	859	5,176,695	34,425	1,373,655
	100% of 334519	20	Other measuring & controlling device mfg (pt)	853	5,114,547	33,904	1,356,368
	0% of 339112	10	Surgical & medical instrument mfg (pt)	6	62,148	521	17,287

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
384	9/32		**Medical instruments and supplies**	**4,818**	**D**	**(100,000+)**	**D**
3841			Surgical & medical instruments	1,598	18,450,024	107,298	4,139,100
	100% of 339112	20	Surgical & medical instrument mfg (pt)	1,598	18,450,024	107,298	4,139,100
3842			Surgical appliances & supplies	1,728	D	(50k-99999)	D
	D 322121	30	Paper (except newsprint) mills (pt)	2	D	(250-499)	D
	7% of 322291	20	Sanitary paper product mfg (pt)	16	651,398	2,236	68,411
	7% of 334510	20	Electromedical & electrotherapeutic apparatus mfg (pt)	74	807,427	6,722	224,883
	96% of 339113	20	Surgical appliance & supplies mfg (pt)	1,636	14,743,779	82,390	2,865,055
3843			Dental equipment & supplies	877	2,699,867	18,072	613,286
	100% of 339114	20	Dental equipment & supplies mfg (pt)	877	2,699,867	18,072	613,286
3844			X-ray apparatus & tubes	155	3,942,256	14,276	664,233
	334517		Irradiation apparatus mfg	155	3,942,256	14,276	664,233

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
3845			Electromedical equipment	460	10,567,566	47,121	2,372,703
92% of	334510	30	Electromedical & electrotherapeutic apparatus mfg (pt)	460	10,567,566	47,121	2,372,703
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
385	97/92		**Ophthalmic goods**	**575**	**3,607,813**	**26,366**	**814,242**
3851			Ophthalmic goods	575	3,607,813	26,366	814,242
	339115		Ophthalmic goods mfg	575	3,607,813	26,366	814,242
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
386	97/92		**Photographic equipment and supplies**	**739**	**21,305,761**	**63,642**	**2,928,089**
3861			Photographic equipment & supplies	739	21,305,761	63,642	2,928,089
	325992		Photographic film, paper, plate, & chemical mfg	311	12,895,637	38,935	1,828,139
100% of	333315	20	Photographic & photocopying equipment mfg (pt)	428	8,410,124	24,707	1,099,950
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
387	97/92		**Watches, clocks, watchcases, and parts**	**128**	**718,191**	**5,646**	**155,180**
3873			Watches, clocks, & watchcases	128	718,191	5,646	155,180
78% of	334518	30	Watch, clock, & part mfg (pt)	128	718,191	5,646	155,180

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(Bridge complete.)	Comparable	SIC derivable from NAICS data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from NAICS are within 3% of SIC sales or receipts.
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All-sector menu   Menu of all 2-digit SICs   Data in formats for downloading   PDF report

Source: 1997 Economic Census, Comparative Statistics

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1997 Economic Census: Bridge Between SIC and NAICS

SIC: Manufacturing

SIC 39: Miscellaneous manufacturing industries - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
	39	Miscellaneous manufacturing industries	18,043	50,997,838	393,972	10,563,481
	391	Jewelry, silverware, and plated ware	2,828	7,243,618	46,547	1,208,070
	393	Musical instruments	576	1,356,651	13,411	363,022
	394	Toys and sporting goods	3,600	D	(100,000+)	D
	395	Pens, pencils, office, and art supplies	1,017	3,987,200	28,150	738,265
	396	Costume jewelry and notions	1,075	D	(10k-24999)	D
	399	Miscellaneous manufactures	8,947	D	(100,000+)	D

N=Comparable data not available D=Withheld to avoid disclosure

SIC 39: Miscellaneous manufacturing industries - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
391	97/92		**Jewelry, silverware, and plated ware**	**2,828**	**7,243,618**	**46,547**	**1,208,070**
3911			Jewelry, precious metal	2,272	5,416,836	34,694	884,942
	100% of 339911	20	Jewelry (except costume) mfg (pt)	2,272	5,416,836	34,694	884,942
3914			Silverware & plated ware	162	907,716	6,457	187,774
	0% of 332211	20	Cutlery & flatware (except precious) mfg (pt)	11	8,032	101	2,699
	99% of 339912	20	Silverware & plated ware mfg (pt)	151	899,684	6,356	185,075

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
3915			Jewelers' materials & lapidary work	394	919,066	5,396	135,354
	339913		Jewelers' material & lapidary work mfg	394	919,066	5,396	135,354
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
393		9/32	**Musical instruments**	**576**	**1,356,651**	**13,411**	**363,022**
3931			Musical instruments	576	1,356,651	13,411	363,022
	339992		Musical instrument mfg	576	1,356,651	13,411	363,022
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
394		9/32	**Toys and sporting goods**	**3,600**	**D**	**(100,000+)**	**D**
3942			Dolls	240	299,821	3,393	63,722
	339931		Doll & stuffed toy mfg	240	299,821	3,393	63,722
3944			Games, toys, & children's vehicles	789	D	(25k-49999)	D
	D 336991	20	Motorcycle, bicycle, & parts mfg (pt)	4	D	(20-99)	D
	339932		Game, toy, & children's vehicle mfg	785	4,534,497	29,622	773,459
3949			Sporting & athletic goods, n.e.c.	2,571	10,591,160	69,664	1,831,218
	339920		Sporting & athletic goods mfg	2,571	10,591,160	69,664	1,831,218
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
395		9/32	**Pens, pencils, office, and art supplies**	**1,017**	**3,987,200**	**28,150**	**738,265**
3951			Pens & mechanical pencils	112	1,590,770	8,394	261,580
	339941		Pen & mechanical pencil mfg	112	1,590,770	8,394	261,580
3952			Lead pencils & art goods	152	883,200	6,002	143,660
	0% of 325998	30	All other miscellaneous chemical product & preparation mfg (pt)	0	0	0	0
	0% of 337127	30	Institutional furniture mfg (pt)	9	16,749	187	5,901
	70% of 339942	30	Lead pencil & art good mfg (pt)	143	866,451	5,815	137,759
3953			Marking devices	634	643,007	7,831	185,316
	339943		Marking device mfg	634	643,007	7,831	185,316
3955			Carbon paper & inked ribbons	119	870,223	5,923	147,709
	339944		Carbon paper & inked ribbon mfg	119	870,223	5,923	147,709
SIC	**NAICS**	**Pt**	**Description**	**Establish-ments**	**Value of Shipments ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
396		9/32	**Costume jewelry and notions**	**1,075**	**D**	**(10k-24999)**	**D**
3961			Costume jewelry	826	1,223,475	13,976	314,581

SIC	NAICS	Pt	Description	Establish-ments	Value of Shipments ($1,000)	Paid employees	Annual payroll ($1,000)
96% of	339914	30	Costume jewelry & novelty mfg (pt)	826	1,223,475	13,976	314,581
3965			Fasteners, buttons, needles, & pins	249	D	(5000-9999)	D
D	339993	20	Fastener, button, needle, & pin mfg (pt)	249	D	(5000-9999)	D
399	97/92		**Miscellaneous manufactures**	**8,947**	**D**	**(100,000+)**	**D**
3991			Brooms & brushes	274	1,703,139	13,882	372,010
84% of	339994	20	Broom, brush, & mop mfg (pt)	274	1,703,139	13,882	372,010
3993			Signs & advertising displays	5,709	7,910,809	82,956	2,382,461
	339950		Sign mfg	5,709	7,910,809	82,956	2,382,461
3995			Burial caskets	177	1,271,184	6,962	212,491
	339995		Burial casket mfg	177	1,271,184	6,962	212,491
3996			Hard surface floor coverings	26	1,819,931	5,614	255,635
97% of	326192	20	Resilient floor covering mfg (pt)	26	1,819,931	5,614	255,635
3999			Mfg industries, n.e.c.	2,761	D	(50k-99999)	D
3% of	314999	50	All other miscellaneous textile product mills (pt)	52	173,353	2,167	42,673
1% of	316110	20	Leather & hide tanning & finishing (pt)	26	24,625	329	7,616
0% of	321999	50	All other miscellaneous wood product mfg (pt)	0	0	0	0
0% of	322299	30	All other converted paper product mfg (pt)	0	0	0	0
0% of	323110	30	Commercial lithographic printing (pt)	0	0	0	0
0% of	323111	30	Commercial gravure printing (pt)	0	0	0	0
0% of	323112	30	Commercial flexographic printing (pt)	0	0	0	0
0% of	323113	40	Commercial screen printing (pt)	0	0	0	0
0% of	323119	30	Other commercial printing (pt)	0	0	0	0
1% of	325998	40	All other miscellaneous chemical product & preparation mfg (pt)	9	80,624	572	18,596
1% of	326199	20	All other plastics product mfg (pt)	140	319,241	3,141	77,397
D	332212	70	Hand & edge tool mfg (pt)	7	D	(500-999)	D
3% of	332999	80	All other miscellaneous fabricated metal product mfg (pt)	185	285,362	3,231	85,799
3% of	335121	30	Residential electric lighting fixture mfg (pt)	53	69,864	1,216	22,121
1% of	337127	40	Institutional furniture mfg (pt)	5	28,296	329	8,183
85% of	339999	20	All other miscellaneous mfg (pt)	2,284	7,183,815	60,397	1,563,790

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(Bridge complete.) Comparable SIC derivable from NAICS data.

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1997 Economic Census: Bridge Between SIC and NAICS SIC: Transportation, communications, and utilities %% **

SIC 41: Local and interurban passenger transportation - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
	41	Local and interurban passenger transportation	19,621	D	(100,000+)	D
	411	Local and suburban passenger transportation	10,147	D	(100,000+)	D
	412	Taxi service	3,184	1,280,597	27,850	392,759
	413	Interurban and rural bus transportation	407	1,147,432	19,900	549,727
	414	Charter bus service	1,531	1,768,199	31,483	548,026
	415	School bus service	4,326	4,233,836	147,441	1,810,695
	417	Bus terminal and service facilities	26	15,253	220	5,190

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%% Data do not include large certificated passenger carriers that report to the Office of Airline Statistics, U.S. Department of Transportation

** Railroad transportation and U.S. Postal Service industries are out of scope for the 1997 Economic Ce

SIC 41: Local and interurban passenger transportation - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
411	97/92		**Local and suburban passenger transportation**	**10,147**	**D**	**(100,000+)**	**D**
4111			Local & suburban transit	1,152	D	(25k-49999)	D
	485111		Mixed mode transit systems	28	51,567	759	24,112
	485112		Commuter rail systems	16	D	(2500-	D

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
						4999)	
	485113		Bus & motor vehicle transit systems	542	1,152,525	27,448	744,397
	485119		Other urban transit systems	32	D	(500-999)	D
	90% of 485999	10	Scheduled airport shuttle service	534	601,988	13,435	217,633
4119			Other local passenger transportation	8,995	8,147,039	179,736	3,183,251
	485320		Limousine service	3,234	1,873,924	29,432	487,867
	4% of 485410	20	Employee bus service	158	158,947	4,223	67,261
	485991		Special needs transportation	1,789	1,141,413	31,791	486,676
	10% of 485999	20	All other passenger transportation	232	67,395	1,078	15,557
	83% of 487110	10	Sightseeing buses	307	462,186	6,858	145,734
	88% of 621910	90	Ambulance or rescue service (except by air)	3,275	4,443,174	106,354	1,980,156

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
412	97/92		**Taxi service**	**3,184**	**1,280,597**	**27,850**	**392,759**
4121			Taxi service	3,184	1,280,597	27,850	392,759
	485310		Taxi service	3,184	1,280,597	27,850	392,759

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
413	97/92		**Interurban and rural bus transportation**	**407**	**1,147,432**	**19,900**	**549,727**
4131			Interurban & rural bus transportation	407	1,147,432	19,900	549,727
	485210		Interurban & rural bus transportation	407	1,147,432	19,900	549,727

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
414	97/92		**Charter bus service**	**1,531**	**1,768,199**	**31,483**	**548,026**
4141			Charter bus service, local	482	459,953	8,694	143,572
	26% of 485510	10	Charter bus service, local	482	459,953	8,694	143,572
4142			Charter bus service, interstate/interurban	1,049	1,308,246	22,789	404,454
	74% of 485510	20	Charter bus service, interstate/interurban	1,049	1,308,246	22,789	404,454

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
415	97/92		**School bus service**	**4,326**	**4,233,836**	**147,441**	**1,810,695**
4151			School bus service	4,326	4,233,836	147,441	1,810,695
	96% of 485410	10	School bus service	4,326	4,233,836	147,441	1,810,695

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
417	97/92		**Bus terminal and service facilities**	**26**	**15,253**	**220**	**5,190**
4173			Bus terminal & service facilities	26	15,253	220	5,190

4% of 488490	10	Terminal or maintenance facilities for motor vehicle pass trans	26	15,253	220	5,190

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** Railroad transportation and U.S. Postal Service industries are out of scope for the 1997 Economic Ce

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All-sector menu   Menu of all 2-digit SICs   Data in formats for downloading   PDF report

Source: 1997 Economic Census, Comparative Statistics

Last modified: 6/27/00

1997 Economic Census: Bridge Between SIC and NAICS SIC: Transportation, communications, and utilities %% **

SIC 42: Motor freight transportation and warehousing - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
	42	Motor freight transportation and warehousing	133,373	197,375,341	1,960,130	55,739,452
	421	Trucking and courier services, except air	119,868	184,178,773	1,831,577	52,513,343
	422	Public warehousing and storage	13,491	13,183,579	128,433	3,222,154
	423	Trucking terminal facilities	14	12,989	120	3,955

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** Railroad transportation and U.S. Postal Service industries are out of scope for the 1997 Economic Ce

SIC 42: Motor freight transportation and warehousing - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
421	97/92		**Trucking and courier services, except air**	**119,868**	**184,178,773**	**1,831,577**	**52,513,343**
4212			Local trucking without storage	61,063	51,384,852	473,694	12,642,812
90% of	484110	Σ	General freight trucking, local	14,545	11,108,345	73,967	3,166,529
	484110	10	General freight trucking without storage, local, truckload	10,296	7,783,545	73,967	1,934,702
	484110	20	General freight trucking w/o storage, local, less than truckload	4,249	3,324,800	47,246	1,231,827
10% of	484210	10	Used household & office goods moving, local, without storage	3,259	1,198,983	20,858	395,383
96% of	484220	Σ	Specialized freight (except used goods) trucking, local	34,935	18,932,851	10,951	4,514,945

	484220	10	Hazardous materials trucking (except waste), local	1,434	1,267,441	10,951	366,278
	484220	20	Agricultural products trucking without storage, local	8,065	2,785,495	29,925	629,234
	484220	30	Dump trucking	17,440	9,748,351	81,553	2,083,930
	484220	40	Specialized trucking without storage, local	7,996	5,131,564	56,450	1,435,503
	562111		Solid waste collection	7,083	18,211,495	137,049	4,048,032
	562112		Hazardous waste collection	414	1,095,553	8,468	317,464
	562119		Other waste collection	827	837,625	7,227	200,459
4213			Trucking, except local	47,315	105,764,108	915,091	28,992,807
	484121		General freight trucking, long-distance, truckload	23,111	51,142,148	425,758	12,690,093
	484122		General freight trucking, long-distance, less than truckload	6,210	25,010,091	258,972	9,509,916
72% of	484210	20	Used household & office goods moving, long-distance	3,555	9,111,477	65,734	1,741,891
100% of	484230	Σ	Specialized freight (except used goods) trucking, long-distance	14,439	20,500,392	28,396	5,050,907
	484230	10	Hazardous materials trucking (except waste), long-distance	2,043	3,840,724	28,396	918,360
	484230	20	Agricultural products trucking, long-distance	5,389	3,693,332	32,371	789,921
	484230	30	Other specialized trucking, long-distance	7,007	12,966,336	103,860	3,342,626
4214			Local trucking with storage	3,744	4,221,111	57,749	1,401,608
10% of	484110	Σ	General freight trucking, local	915	1,164,931	7,468	355,591
	484110	30	General freight trucking with storage, local, truckload	542	678,272	7,468	199,953
	484110	40	General freight trucking with storage, local, less than truckload	373	486,659	6,096	155,638
18% of	484210	30	Used household & office goods moving, local, with storage	2,286	2,273,241	34,958	806,674
4% of	484220	50	Specialized trucking with storage, local	543	782,939	9,227	239,343
4215			Courier services, except by air	7,746	22,808,702	385,043	9,476,116
53% of	492110	10	Courier services (except by air)	2,362	19,289,602	317,630	8,234,379
	492210		Local messengers & local delivery	5,384	3,519,100	67,413	1,241,737

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
422		97/92	**Public warehousing and storage**	**13,491**	**13,183,579**	**128,433**	**3,222,154**
4221			Farm product warehousing & storage facilities	486	673,198	5,280	118,542
	493130		Farm product warehousing & storage	486	673,198	5,280	118,542
4222			Refrigerated products warehousing	872	2,268,823	22,109	609,335
100% of	493120	10	Refrigerated products warehousing	872	2,268,823	22,109	609,335

SIC	NAICS	Pt	Description	Establish-ments	Revenue ($1,000)	Paid employees	Annual payroll ($1,000)
4225			General warehousing & storage	10,912	7,846,325	81,450	1,918,952
	100% of 493110	10	General warehousing & storage (except in foreign trade zones)	3,918	5,320,671	62,777	1,622,917
	531130		Lessors of miniwarehouses & self storage units	6,994	2,525,654	18,673	296,035
4226			Other special warehousing & storage	1,221	2,395,233	19,594	575,325
	0% of 493110	20	General warehousing & storage in foreign trade zones	3	718	7	111
	0% of 493120	20	Fur storage	5	1,504	12	249
	100% of 493190	Σ	Other warehousing & storage	1,213	2,393,011	6,158	574,965
	493190	10	Household goods warehousing & storage	317	451,574	6,158	141,630
	493190	20	Specialized goods warehousing & storage	896	1,941,437	13,417	433,335
423	97/92		**Trucking terminal facilities**	**14**	**12,989**	**120**	**3,955**
4231			Trucking terminal facilities	14	12,989	120	3,955
	3% of 488490	20	Motor freight terminal & joint terminal maint facility trans	14	12,989	120	3,955

N=Comparable data not available D=Withheld to avoid disclosure
%% Data do not include large certificated passenger carriers that report to the Office of Airline Statistics, U.S. Department of Transportation
** Railroad transportation and U.S. Postal Service industries are out of scope for the 1997 Economic Ce

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.)	Comparable	SIC derivable from NAICS data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from NAICS are within 3% of SIC sales or receipts.
(Drawbridge open.)	Not comparable	SIC sales or receipts cannot be estimated within 3% from NAICS data.

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1997 Economic Census: Bridge Between SIC and NAICS

SIC: Retail trade

SIC 55: Automotive dealers and gasoline service stations - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
	55	Automotive dealers and gasoline service stations	202,237	788,231,182	2,283,756	55,502,391
	551	Motor vehicle dealers (new and used)	25,897	518,971,824	1,046,243	35,202,751
	552	Motor vehicle dealers (used only)	23,340	34,680,468	92,752	2,197,396
	553	Auto and home supply stores	40,565	35,028,316	300,953	6,044,147
	554	Gasoline service stations	98,846	170,660,068	741,040	9,488,181
	555	Boat dealers	5,262	8,934,230	35,134	839,296
	556	Recreational vehicle dealers	3,014	10,069,749	29,463	813,962
	557	Motorcycle dealers	3,635	7,369,260	29,026	712,065
	559	Automotive dealers, not elsewhere classified	1,678	2,517,267	9,145	204,593

N=Comparable data not available D=Withheld to avoid disclosure

SIC 55: Automotive dealers and gasoline service stations - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
551		97/92	**Motor vehicle dealers (new and used)**	**25,897**	**518,971,824**	**1,046,243**	**35,202,751**
5511			Motor vehicle dealers (new & used)	25,897	518,971,824	1,046,243	35,202,751
	441110		New car dealers	25,897	518,971,824	1,046,243	35,202,751

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
552	97/92		**Motor vehicle dealers (used only)**	**23,340**	**34,680,468**	**92,752**	**2,197,396**
5521			Motor vehicle dealers (used only)	23,340	34,680,468	92,752	2,197,396
	441120		Used car dealers	23,340	34,680,468	92,752	2,197,396

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
553	97/92		**Auto and home supply stores**	**40,565**	**35,028,316**	**300,953**	**6,044,147**
5531			Auto & home supply stores	40,565	35,028,316	300,953	6,044,147
	47% of 441310	10	Auto supplies stores	24,508	20,143,722	175,587	3,096,231
	68% of 441320	10	New tire dealers	14,814	13,312,367	113,807	2,761,880
	6% of 452990	32	Other auto & home supplies stores	1,243	1,572,227	11,559	186,036

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
554	97/92		**Gasoline service stations**	**98,846**	**170,660,068**	**741,040**	**9,488,181**
5541			Gasoline service stations	98,846	170,660,068	741,040	9,488,181
	78% of 447110	20	Gasoline stations with convenience stores	53,641	100,103,399	432,935	5,234,676
	100% of 447190	Σ	Other gasoline stations	45,205	70,556,669	238,465	4,253,505
	447190	10	Gasoline stations with no convenience stores	42,270	55,523,140	238,465	3,338,637
	447190	20	Truck stops	2,935	15,033,529	69,640	914,868

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
555	97/92		**Boat dealers**	**5,262**	**8,934,230**	**35,134**	**839,296**
5551			Boat dealers	5,262	8,934,230	35,134	839,296
	441222		Boat dealers	5,262	8,934,230	35,134	839,296

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
556	97/92		**Recreational vehicle dealers**	**3,014**	**10,069,749**	**29,463**	**813,962**
5561			Recreational vehicle dealers	3,014	10,069,749	29,463	813,962
	441210		Recreational vehicle dealers	3,014	10,069,749	29,463	813,962

SIC	NAICS	Pt	Description	Establish-ments	Sales ($1,000)	Paid employees	Annual payroll ($1,000)
557	97/92		**Motorcycle dealers**	**3,635**	**7,369,260**	**29,026**	**712,065**
5571			Motorcycle dealers	3,635	7,369,260	29,026	712,065
	441221		Motorcycle dealers	3,635	7,369,260	29,026	712,065

SIC	NAICS	Pt	Description	Establish-	Sales	Paid	Annual payroll

			ments	($1,000)	employees	($1,000)
559	97/92	**Automotive dealers, not elsewhere classified**	**1,678**	**2,517,267**	**9,145**	**204,593**
5599	(Bridge complete)	Automotive dealers, not elsewhere classified	1,678	2,517,267	9,145	204,593
441229		All other motor vehicle dealers	1,678	2,517,267	9,145	204,593

N=Comparable data not available D=Withheld to avoid disclosure

$$ 1992 sales data include sales from catalog order desks. 1997 sales data exclude sales from catalog order des

Σ=sum of NAICS parts listed below the symbol 97/92 links to Comparative Statistics for 1992 and 1997

(Bridge complete.)	Comparable	SIC derivable from NAICS data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from NAICS are within 3% of SIC sales or receipts.
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1997 Economic Census: Bridge Between SIC and NAICS

SIC: Service industries

SIC 75: Truck rental services, without drivers - Finder by 3-digit SIC

Includes only establishments with payroll. Introductory text includes scope and methodology.

Go to bridge	SIC	Description		Establish-ments	Receipts ($1,000)	Paid employees	Annual payroll ($1,000)
	75	Automotive repair, services, and parking	Taxable	191,907	99,574,966	1,094,161	22,643,253
	751	Automotive rental and leasing, without drivers	Taxable	10,542	28,921,850	158,062	3,870,601
	752	Automobile parking	Taxable	10,358	5,174,724	76,166	967,701
	753	Automotive repair shops	Taxable	142,372	55,685,916	630,614	14,808,177
	754	Automotive services, except repair	Taxable	28,635	9,792,476	229,319	2,996,774

N=Comparable data not available D=Withheld to avoid disclosure

SIC 75: Truck rental services, without drivers - 4-digit SIC to 6-digit NAICS

Includes only establishments with payroll. Introductory text includes scope and methodology. Figures to the left of NAICS codes indicate the percent of NAICS receipts represented by this part; and link to Table 1 where other parts of the NAICS are shown. 97/92 links to 1997 and 1992 Comparative Statistics for whole SICs.

SIC	NAICS	Pt	Description		Establish-ments	Receipts ($1,000)	Paid employees	Annual payroll ($1,000)
751	97/92		**Automotive rental and leasing, without drivers**	Taxable	**10,542**	**28,921,850**	**158,062**	**3,870,601**
7513			Truck rental services, without drivers	Taxable	4,936	10,081,603	45,224	1,377,581
98% of	532120	Σ	Truck, utility trailer, & RV rental & leasing	Taxable	4,936	10,081,603	13,138	1,377,581
	532120	10	Truck rental	Taxable	2,498	2,420,548	13,138	296,754
	532120	20	Truck leasing	Taxable	2,438	7,661,055	32,086	1,080,827
7514			Passenger car rental	Taxable	4,367	14,783,704	102,623	2,129,602

SIC	NAICS	Pt	Description		Establish-ments	Receipts ($1,000)	Paid employees	Annual payroll ($1,000)
	532111		Passenger car rental	Taxable	4,367	14,783,704	102,623	2,129,602
7515			Passenger car leasing	Taxable	879	3,800,424	8,325	315,960
	532112		Passenger car leasing	Taxable	879	3,800,424	8,325	315,960
7519			Utility trailer & recreational vehicle rental	Taxable	360	256,119	1,890	47,458
3% of	532120	90	Utility trailer & RV (recreational vehicle) rental & leasing	Taxable	360	256,119	1,890	47,458
SIC	**NAICS**	**Pt**	**Description**		**Establish-ments**	**Receipts ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
752	9/32		**Automobile parking**	Taxable	**10,358**	**5,174,724**	**76,166**	**967,701**
7521			Automobile parking	Taxable	10,358	5,174,724	76,166	967,701
	812930		Parking lots & garages	Taxable	10,358	5,174,724	76,166	967,701
SIC	**NAICS**	**Pt**	**Description**		**Establish-ments**	**Receipts ($1,000)**	**Paid employees**	**Annual payroll ($1,000)**
753	9/32		**Automotive repair shops**	Taxable	**142,372**	**55,685,916**	**630,614**	**14,808,177**
7532			Top, body, & upholstery repair shops & paint shops	Taxable	35,569	17,755,296	205,172	5,172,206
100% of	811121	Σ	Automotive body, paint, & interior repair & maintenance	Taxable	35,569	17,755,296	192,853	5,172,206
	811121	10	Paint or body repair shops	Taxable	33,144	16,645,229	192,853	4,899,276
	811121	20	Van conversion services	Taxable	639	723,189	6,507	156,778
	811121	30	Upholstery & interior repair shops	Taxable	1,786	386,878	5,812	116,152
7533			Automotive exhaust system repair shops	Taxable	5,251	1,985,377	23,015	524,940
	811112		Automotive exhaust system repair	Taxable	5,251	1,985,377	23,015	524,940
7534			Tire retreading & repair shops	Taxable	1,760	1,270,577	10,930	248,727
	326212		Tire retreading	Taxable	754	982,607	7,939	192,387
27% of	811198	10	Tire repair shops	Taxable	1,006	287,970	2,991	56,340
7536			Automotive glass replacement shops	Taxable	5,599	3,149,984	29,187	753,574
	811122		Automotive glass replacement shops	Taxable	5,599	3,149,984	29,187	753,574
7537			Automotive transmission repair shops	Taxable	6,768	2,431,584	29,442	709,254
	811113		Automotive transmission repair	Taxable	6,768	2,431,584	29,442	709,254
7538			General automotive repair shops	Taxable	77,751	25,598,455	290,634	6,438,842
	811111		General automotive repair	Taxable	77,751	25,598,455	290,634	6,438,842
7539			Automotive repair shops, n.e.c.	Taxable	9,674	3,494,643	42,234	960,634
100% of	811118	Σ	Other automotive mechanical & electrical repair & maintenance	Taxable	9,674	3,494,643	4,802	960,634
	811118	10	Carburetor repair shops	Taxable	1,091	363,763	4,802	106,409

	811118	20	Brake, front end, & wheel alignment	Taxable	3,741	1,553,732	18,216	449,563
	811118	30	Electrical repair shops, motor vehicle	Taxable	1,679	494,744	6,890	135,846
	811118	40	Radiator repair	Taxable	2,295	728,297	8,372	174,076
	811118	90	All other motor vehicle repair shops	Taxable	868	354,107	3,954	94,740

SIC	NAICS	Pt	Description		Establish-ments	Receipts ($1,000)	Paid employees	Annual payroll ($1,000)
754		97/92	**Automotive services, except repair**	Taxable	**28,635**	**9,792,476**	**229,319**	**2,996,774**
7542			Carwashes	Taxable	13,683	3,911,344	123,602	1,252,587
	811192		Carwashes	Taxable	13,683	3,911,344	123,602	1,252,587
7549			Automotive services, except repair & carwashes	Taxable	14,952	5,881,132	105,717	1,744,187
	488410		Motor vehicle towing	Taxable	5,893	2,295,188	36,845	747,355
	811191		Automotive oil change & lubrication shops	Taxable	7,413	2,787,318	57,083	778,632
74% of	811198	20	All other motor vehicle services (except repair & carwashes)	Taxable	1,646	798,626	11,789	218,200

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% Comparability may be limited because of changes in assignment of tax status by industry.

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9.2 FRACTION OF NAICS CODE EMPLOYMENT USED TO CREATE SIC EMPLOYMENT

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
Factory Finished Wood Surface Coating					
2426	321918	10521	38100	0.276	Other millwork (including flooring)
2426	337215	6310	75382	0.084	Showcase, partition, shelving, & locker mfg
2426	321912	17109	39763	0.430	Cut stock, resawing lumber, & planing
2429	321113	304	119760	0.003	Sawmills
2429	321920	684	51134	0.013	Wood container & pallet mfg
2429	321999	355	43839	0.008	All other miscellaneous wood product mfg
2431	321911	64771	64771	1.000	Wood window & door mfg
2431	321918	27488	38100	0.721	Other millwork (including flooring)
2434	337110	79579	99257	0.802	Wood kitchen cabinet & counter top mfg
2435	321211	22151	22151	1.000	Hardwood veneer & plywood mfg
2436	321212	28843	28843	1.000	Softwood veneer & plywood mfg
2439	321912	0	39763	0.000	Cut stock, resawing lumber, & planing
2439	321214	32522	32522	1.000	Truss mfg
2439	321113	0	119760	0.000	Sawmills
2439	321213	5372	5372	1.000	Engineered wood member (except truss) mfg
2441	321920	4885	51134	0.096	Wood container & pallet mfg
2448	321920	38994	51134	0.763	Wood container & pallet mfg
2449	321920	5701	51134	0.111	Wood container & pallet mfg
2451	321991	68269	68269	1.000	Manufactured home (mobile home) mfg
2452	321992	22965	22965	1.000	Prefabricated wood building mfg
2493	321219	25269	25269	1.000	Reconstituted wood product mfg
2499	339999	13740	74137	0.185	All other miscellaneous mfg
2499	332321	0	74944	0.000	Metal window & door mfg
2499	321920	870	51134	0.017	Wood container & pallet mfg
2499	321912	549	39763	0.014	Cut stock, resawing lumber, & planing
2499	321999	41844	43839	0.954	All other miscellaneous wood product mfg
Furniture & Fixtures Surface Coating and Part of Miscellaneous Degreasing					
2511	337122	123368	128248	0.962	Nonupholstered wood household furniture mfg
2512	337121	85258	90009	0.947	Upholstered household furniture mfg
2514	337124	22835	22835	1.000	Metal household furniture mfg
2515	337121	1601	90009	0.018	Upholstered household furniture mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees ‘1997	Employee Fraction	NAICS description
2515	337910	23072	23072	1.000	Mattress mfg
2517	337129	4273	4273	1.000	Wood television, radio, & sewing machine cabinet mfg
2519	337125	4708	4708	1.000	Household furniture (except wood & metal) mfg
2521	337211	30641	30641	1.000	Wood office furniture mfg
2522	337214	44222	44222	1.000	Office furniture (except wood) mfg
2531	336360	20784	45600	0.456	Motor vehicle seating & interior trim mfg
2531	337127	15254	38218	0.399	Institutional furniture mfg
2531	339942	941	7990	0.118	Lead pencil & art good mfg
2541	337110	9785	99257	0.099	Wood kitchen cabinet & counter top mfg
2541	337212	24363	24363	1.000	Custom architectural woodwork & millwork mfg
2541	337215	23305	75382	0.309	Showcase, partition, shelving, & locker mfg
2542	337215	44472	75382	0.590	Showcase, partition, shelving, & locker mfg
2591	337920	19617	19617	1.000	Blind & shade mfg
2599	337127	22448	38218	0.587	Institutional furniture mfg
2599	339113	2925	85315	0.034	Surgical appliance & supplies mfg
Part of Misc. Degreasing					
3312	324199	1731	3671	0.472	All other petroleum & coal products mfg
3312	331111	144074	146514	0.983	Iron & steel mills
3313	331112	3724	3724	1.000	Electrometallurgical ferroalloy product mfg
3313	331492	311	11610	0.027	Other nonferrous metal secondary smelting, refining, & alloying
3315	331222	23489	23489	1.000	Steel wire drawing
3315	332618	2265	46174	0.049	Other fabricated wire product mfg
3316	331221	14362	14362	1.000	Cold-rolled steel shape mfg
3317	331210	27723	27723	1.000	Iron & steel pipes & tubes mfg from purchased steel
3321	331511	83570	86198	0.970	Iron foundries
3322	331511	2628	86198	0.030	Iron foundries
3324	331512	22673	22673	1.000	Steel investment foundries
3325	331513	23982	23982	1.000	Steel foundries (except investment)
3331	331411	7360	7360	1.000	Primary smelting & refining of copper
3334	331312	15763	15763	1.000	Primary aluminum production
3339	331419	10132	10132	1.000	Other nonferrous metal primary smelting & refining

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3341	331423	1768	2333	0.758	Secondary smelting, refining, & alloying of copper
3341	331492	5485	11610	0.472	Other nonferrous metal secondary smelting, refining, & alloying
3341	331314	6226	6714	0.927	Secondary smelting & alloying of aluminum
3351	331421	21150	21150	1.000	Copper rolling, drawing, & extruding
3353	331315	25111	25111	1.000	Aluminum sheet, plate, & foil mfg
3353	332996	0	29364	0.000	Fabricated pipe & pipe fitting mfg
3354	331316	30357	30357	1.000	Aluminum extruded product mfg
3355	331319	2657	4306	0.617	Other aluminum rolling & drawing
3356	331491	17237	25872	0.666	Other nonferrous metal rolling, drawing, & extruding
Part of Misc. Degreasing and Part of Electrical Insulation Surface Coating					
3357	331319	1649	4306	0.383	Other aluminum rolling & drawing
3357	331422	4692	4692	1.000	Copper wire (except mechanical) drawing
3357	331491	8635	25872	0.334	Other nonferrous metal rolling, drawing, & extruding
3357	335921	8589	8589	1.000	Fiber optic cable mfg
3357	335929	46267	46267	1.000	Other communication & energy wire mfg
Part of Misc. Degreasing					
3363	331521	27717	27717	1.000	Aluminum die-casting foundries
3364	331522	17243	17243	1.000	Nonferrous (except aluminum) die-casting foundries
3365	331524	34098	34098	1.000	Aluminum foundries (except die-casting)
3366	331525	8909	8909	1.000	Copper foundries (except die-casting)
3369	331528	6529	6529	1.000	Other nonferrous foundries (except die-casting)
3398	332811	22674	22674	1.000	Metal heat treating
3399	331111	2440	146514	0.017	Iron & steel mills
3399	331314	488	6714	0.073	Secondary smelting & alloying of aluminum
3399	331423	565	2333	0.242	Secondary smelting, refining, & alloying of copper
3399	331492	5814	11610	0.501	Other nonferrous metal secondary smelting, refining, & alloying
3399	332618	2088	46174	0.045	Other fabricated wire product mfg
Part of Misc. Degreasing and Metal Containers Surface Coating					
3411	332431	27316	27316	1.000	Metal can mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3412	332439	6318	14922	0.423	Other metal container mfg
Part of Misc. Degreasing					
3421	332211	11129	11230	0.991	Cutlery & flatware (except precious) mfg
3423	332212	42947	50388	0.852	Hand & edge tool mfg
3425	332213	9149	9149	1.000	Saw blade & handsaw mfg
3429	332439	4135	14922	0.277	Other metal container mfg
3429	332510	70884	74285	0.954	Hardware mfg
3429	332919	750	18739	0.040	Other metal valve & pipe fitting mfg
3431	332998	9994	9994	1.000	Enameled iron & metal sanitary ware mfg
3432	332913	16202	16202	1.000	Plumbing fixture fitting & trim mfg
3432	332999	474	79070	0.006	All other miscellaneous fabricated metal product mfg
3433	333414	22495	24666	0.912	Heating equipment (except warm air furnaces) mfg
3441	332312	84704	93433	0.907	Fabricated structural metal mfg
3442	332321	72970	74944	0.974	Metal window & door mfg
3443	333415	339	119795	0.003	AC & warm air heating & commercial/industrial refrig equip mfg
3443	332420	33704	33704	1.000	Metal tank (heavy gauge) mfg
3443	332313	25453	25453	1.000	Plate work mfg
3443	332410	27542	27542	1.000	Power boiler & heat exchanger mfg
3444	332322	129826	129826	1.000	Sheet metal work mfg
3444	332439	2074	14922	0.139	Other metal container mfg
3446	332323	30960	34391	0.900	Ornamental & architectural metal work mfg
3448	332311	25946	25946	1.000	Prefabricated metal building & component mfg
3449	332114	15219	15219	1.000	Custom roll forming
3449	332312	8729	93433	0.093	Fabricated structural metal mfg
3449	332321	1974	74944	0.026	Metal window & door mfg
3449	332323	349	34391	0.010	Ornamental & architectural metal work mfg
3451	332721	80404	80404	1.000	Precision turned product mfg
3452	332722	52995	52995	1.000	Bolt, nut, screw, rivet, & washer mfg
3462	332111	26432	26432	1.000	Iron & steel forging
3463	332112	9129	9129	1.000	Nonferrous forging
3465	336370	126905	126905	1.000	Motor vehicle metal stamping
3466	332115	4682	4682	1.000	Crown & closure mfg
3469	332116	93086	93086	1.000	Metal stamping

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3469	332214	7724	7724	1.000	Kitchen utensil, pot, & pan mfg
3471	332813	74640	74640	1.000	Electroplating, plating, polishing, anodizing, & coloring

Part of Misc. Degreasing and Sheet, Strip & Coil Surface Coating					
3479	332812	55904	55904	1.000	Metal coating/engraving (exc jewelry/silverware)/allied services
3479	339911	79	34773	0.002	Jewelry (except costume) mfg
3479	339912	103	6459	0.016	Silverware & plated ware mfg
3479	339914	29	14573	0.002	Costume jewelry & novelty mfg
Part of Misc. Degreasing					
3482	332992	6863	6863	1.000	Small arms ammunition mfg
3483	332993	9427	9427	1.000	Ammunition (except small arms) mfg
3484	332994	9907	9907	1.000	Small arms mfg
3489	332995	12285	12285	1.000	Other ordnance & accessories mfg
3491	332911	53459	53459	1.000	Industrial valve mfg
3492	332912	37132	37132	1.000	Fluid power valve & hose fitting mfg
3493	332611	5381	5381	1.000	Spring (heavy gauge) mfg
3494	332919	17652	18739	0.942	Other metal valve & pipe fitting mfg
3494	332999	564	79070	0.007	All other miscellaneous fabricated metal product mfg
3495	332612	18798	18798	1.000	Spring (light gauge) mfg
3495	334518	175	6333	0.028	Watch, clock, & part mfg
3496	332618	41821	46174	0.906	Other fabricated wire product mfg
3497	332999	5648	79070	0.071	All other miscellaneous fabricated metal product mfg
3497	322225	4967	4967	1.000	Laminated aluminum foil mfg for flexible packaging uses
3498	332996	29364	29364	1.000	Fabricated pipe & pipe fitting mfg
3499	332439	2331	14922	0.156	Other metal container mfg
3499	332510	3401	74285	0.046	Hardware mfg
3499	332919	375	18739	0.020	Other metal valve & pipe fitting mfg
3499	332999	63736	79070	0.806	All other miscellaneous fabricated metal product mfg
3499	337215	1295	75382	0.017	Showcase, partition, shelving, & locker mfg
3499	339914	568	14573	0.039	Costume jewelry & novelty mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3499	332117	10760	10760	1.000	Powder metallurgy part mfg
Part of Misc. Degreasing and Machinery & Equipment Surface Coating					
3511	333611	19529	19529	1.000	Turbine & turbine generator set unit mfg
3519	333618	56338	56348	1.000	Other engine equipment mfg
3519	336399	896	174465	0.005	All other motor vehicle parts mfg
3523	332212	60	50388	0.001	Hand & edge tool mfg
3523	333922	320	39599	0.008	Conveyor & conveying equipment mfg
3523	333111	66370	66370	1.000	Farm machinery & equipment mfg
3523	332323	3082	34391	0.090	Ornamental & architectural metal work mfg
3524	332212	60	50388	0.001	Hand & edge tool mfg
3524	333112	28617	28617	1.000	Lawn & garden tractor & home lawn & garden equipment mfg
3531	333120	74965	74965	1.000	Construction machinery mfg
3531	333923	10263	18014	0.570	Overhead traveling crane, hoist, & monorail system mfg
3531	336510	2379	34012	0.070	Railroad rolling stock mfg
3532	333131	13547	13547	1.000	Mining machinery & equipment mfg
3533	333132	29451	29451	1.000	Oil & gas field machinery & equipment mfg
3534	333921	9442	9442	1.000	Elevator & moving stairway mfg
3535	333922	39279	39599	0.992	Conveyor & conveying equipment mfg
3536	333923	7751	18014	0.430	Overhead traveling crane, hoist, & monorail system mfg
3537	333924	25953	25953	1.000	Industrial truck, tractor, trailer, & stacker machinery mfg
3537	332439	64	14922	0.004	Other metal container mfg
3537	332999	240	79070	0.003	All other miscellaneous fabricated metal product mfg
3541	333512	28849	29371	0.982	Machine tool (metal cutting types) mfg
3542	333513	14185	14185	1.000	Machine tool (metal forming types) mfg
3543	332997	7959	7959	1.000	Industrial pattern mfg
3544	333511	48657	48657	1.000	Industrial mold mfg
3544	333514	80113	80113	1.000	Special die & tool, die set, jig, & fixture mfg
3545	332212	6379	50388	0.127	Hand & edge tool mfg
3545	333515	47925	47925	1.000	Cutting tool & machine tool accessory mfg
3546	333991	16816	16816	1.000	Power-driven handtool mfg
3547	333516	4149	4149	1.000	Rolling mill machinery & equipment mfg
3548	335311	0	26638	0.000	Power, distribution, & specialty transformer

SIC	NAICS	SIC Employees 1997	NAICS Employees ‘1997	Employee Fraction	NAICS description
					mfg
3548	333992	22434	22505	0.997	Welding & soldering equipment mfg
3549	333518	19023	19023	1.000	Other metalworking machinery mfg
3552	333292	13600	13600	1.000	Textile machinery mfg
3553	333210	9117	9117	1.000	Sawmill & woodworking machinery mfg
3554	333291	18594	18594	1.000	Paper industry machinery mfg
3555	333293	17500	21000	0.833	Printing machinery & equipment mfg
3556	333294	19026	19026	1.000	Food product machinery mfg
3559	333319	2890	56910	0.051	Other commercial & service industry machinery mfg
3559	333220	18574	18574	1.000	Plastics & rubber industry machinery mfg
3559	333295	40087	40087	1.000	Semiconductor machinery mfg
3559	333298	53046	53106	0.999	All other industrial machinery mfg
3561	333911	36552	36552	1.000	Pump & pumping equipment mfg
3562	332991	36991	36991	1.000	Ball & roller bearing mfg
3563	333912	24821	24821	1.000	Air & gas compressor mfg
3564	333411	16183	16183	1.000	Air purification equipment mfg
3564	333412	13723	13723	1.000	Industrial & commercial fan & blower mfg
3565	333993	31581	31581	1.000	Packaging machinery mfg
3566	333612	16231	16231	1.000	Speed changer, industrial high-speed drive, & gear mfg
3567	333994	17585	17585	1.000	Industrial process furnace & oven mfg
3568	333613	21604	21604	1.000	Mechanical power transmission equipment mfg
3569	333999	50088	61151	0.819	All other miscellaneous general-purpose machinery mfg
3571	334111	100115	100115	1.000	Electronic computer mfg
3572	334112	42364	42364	1.000	Computer storage device mfg
3575	334113	5764	5764	1.000	Computer terminal mfg
3577	334119	87253	93970	0.929	Other computer peripheral equipment mfg
3578	333313	966	14831	0.065	Office machinery mfg
3578	334119	6717	93970	0.071	Other computer peripheral equipment mfg
3579	333313	13865	14831	0.935	Office machinery mfg
3579	334518	750	6333	0.118	Watch, clock, & part mfg
3579	339942	1234	7990	0.154	Lead pencil & art good mfg
3581	333311	8178	8178	1.000	Automatic vending machine mfg
3582	333312	4523	4523	1.000	Commercial laundry, drycleaning, & pressing

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
					machine mfg
3585	333415	119456	119795	0.997	AC & warm air heating & commercial/industrial refrig equip mfg
3585	336391	21522	21522	1.000	Motor vehicle air-conditioning mfg
3586	333913	6824	6824	1.000	Measuring & dispensing pump mfg
3589	333319	44172	56910	0.776	Other commercial & service industry machinery mfg
3592	336311	17518	17518	1.000	Carburetor, piston, piston ring, & valve mfg
3593	333995	23062	23062	1.000	Fluid power cylinder & actuator mfg
3594	333996	15482	15482	1.000	Fluid power pump & motor mfg
3596	333997	4871	4871	1.000	Scale & balance (except laboratory) mfg
3599	332710	290951	290951	1.000	Machine shops
3599	332999	4199	79070	0.053	All other miscellaneous fabricated metal product mfg
3599	333319	1335	56910	0.023	Other commercial & service industry machinery mfg
3599	333999	11063	61151	0.181	All other miscellaneous general-purpose machinery mfg
Part of Misc. & Electronic Degreasing and Part of Electrical Insulation Surface Coating					
3612	335311	26638	26638	1.000	Power, distribution, & specialty transformer mfg
Part of Misc. & Electronic Degreasing					
3613	335313	41291	41291	1.000	Switchgear & switchboard apparatus mfg
3621	335312	71112	74666	0.952	Motor & generator mfg
3624	335991	10887	10887	1.000	Carbon & graphite product mfg
3625	335314	68365	68365	1.000	Relay & industrial control mfg
3629	335999	18682	44754	0.417	All other miscellaneous electrical equipment & component mfg
Part of Misc. & Electronic Degreasing and Appliance Surface Coating					
3631	335221	17543	17543	1.000	Household cooking appliance mfg
3632	335222	24597	24597	1.000	Household refrigerator & home freezer mfg
3633	335224	14801	14801	1.000	Household laundry equipment mfg
3634	333414	2171	24666	0.088	Heating equipment (except warm air furnaces) mfg
3634	335211	17058	17058	1.000	Electric housewares & household fan mfg
3635	335212	10537	10537	1.000	Household vacuum cleaner mfg
3639	333298	60	53106	0.001	All other industrial machinery mfg
3639	335212	0	10537	0.000	Household vacuum cleaner mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3639	335228	13309	13309	1.000	Other major household appliance mfg
Part of Misc. & Electronic Degreasing					
3641	335110	15903	15903	1.000	Electric lamp bulb & part mfg
3643	335931	44907	44907	1.000	Current-carrying wiring device mfg
3644	335932	23540	23540	1.000	Noncurrent-carrying wiring device mfg
3645	335121	16395	17685	0.927	Residential electric lighting fixture mfg
3646	335122	23090	23090	1.000	Commercial/industrial/institutional electric lighting fixture mfg
3647	336321	16506	16506	1.000	Vehicular lighting equipment mfg
3648	335129	18274	18282	1.000	Other lighting equipment mfg
3651	334310	31727	31727	1.000	Audio & video equipment mfg
3652	334612	16598	25554	0.650	Prerecorded CD (except software), tape, & record reproducing
3661	334210	104262	104262	1.000	Telephone apparatus mfg
3661	334416	63	19431	0.003	Electronic coil, transformer, & other inductor mfg
3661	334418	6083	111054	0.055	Printed circuit assembly (electronic assembly) mfg
3663	334220	148156	164461	0.901	Radio & TV broadcasting & wireless communications equipment mfg
3669	334290	25187	25187	1.000	Other communications equipment mfg
3671	334411	21976	21976	1.000	Electron tube mfg
3672	334412	76702	76702	1.000	Bare printed circuit board mfg
3674	334413	199497	199497	1.000	Semiconductor & related device mfg
3675	334414	18882	18882	1.000	Electronic capacitor mfg
3676	334415	11964	11964	1.000	Electronic resistor mfg
3677	334416	19178	19431	0.987	Electronic coil, transformer, & other inductor mfg
3678	334417	37232	37232	1.000	Electronic connector mfg
3679	336322	12786	95491	0.134	Other motor vehicle electrical & electronic equipment mfg
3679	334220	16305	164461	0.099	Radio & TV broadcasting & wireless communications equipment mfg
3679	334418	104971	111054	0.945	Printed circuit assembly (electronic assembly) mfg
3679	334419	92200	92200	1.000	Other electronic component mfg
3691	335911	23288	23288	1.000	Storage battery mfg
3692	335912	8917	8917	1.000	Primary battery mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3694	336322	52216	95491	0.547	Other motor vehicle electrical & electronic equipment mfg
3695	334613	21345	21345	1.000	Magnetic & optical recording media mfg
3699	333992	71	22505	0.003	Welding & soldering equipment mfg
3699	335999	26072	44754	0.583	All other miscellaneous electrical equipment & component mfg
3699	335129	8	18282	0.000	Other lighting equipment mfg
3699	334519	29	33933	0.001	Other measuring & controlling device mfg
3699	334516	159	38359	0.004	Analytical laboratory instrument mfg
3699	334119	0	93970	0.000	Other computer peripheral equipment mfg
3699	334510	542	54385	0.010	Electromedical & electrotherapeutic apparatus mfg
3699	339114	0	18072	0.000	Dental equipment & supplies mfg
3699	333512	522	29371	0.018	Machine tool (metal cutting types) mfg
3699	333319	8513	56910	0.150	Other commercial & service industry machinery mfg
3699	333315	0	24707	0.000	Photographic & photocopying equipment mfg
3699	333314	56	20857	0.003	Optical instrument & lens mfg
3699	333293	175	21000	0.008	Printing machinery & equipment mfg
3699	333292	0	13600	0.000	Textile machinery mfg
3699	332212	424	50388	0.008	Hand & edge tool mfg
3699	334511	604	188161	0.003	Search, detection, navigation, & guidance instrument mfg
3699	333618	10	56348	0.000	Other engine equipment mfg
Part of Misc. Degreasing and New Automobile Surface Coating					
3711	336992	375	5788	0.065	Military armored vehicle, tank, & tank component mfg
3711	336111	114060	114060	1.000	Automobile mfg
3711	336112	94033	94033	1.000	Light truck & utility vehicle mfg
3711	336120	28214	28214	1.000	Heavy duty truck mfg
3711	336211	404	43384	0.009	Motor vehicle body mfg
Part of Misc. Degreasing and Part of Other Transportation Equipment Surface Coating					
3713	336211	41779	43384	0.963	Motor vehicle body mfg
3714	336312	81368	81368	1.000	Gasoline engine & engine parts mfg
3714	336322	30489	95491	0.319	Other motor vehicle electrical & electronic equipment mfg
3714	336330	48944	48944	1.000	Motor vehicle steering & suspension component (except spring) mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3714	336340	43132	43132	1.000	Motor vehicle brake system mfg
3714	336350	111954	111954	1.000	Motor vehicle transmission & power train parts mfg
3714	336399	173569	174465	0.995	All other motor vehicle parts mfg
3714	336211	1201	43384	0.028	Motor vehicle body mfg
3715	336212	30678	30678	1.000	Truck trailer mfg
3716	336213	18086	18086	1.000	Motor home mfg
3721	336411	200961	200961	1.000	Aircraft mfg
3724	336412	82557	82557	1.000	Aircraft engine & engine parts mfg
3728	332912	0	37132	0.000	Fluid power valve & hose fitting mfg
3728	336413	127729	127729	1.000	Other aircraft part & auxiliary equipment mfg
3728	333995	0	23062	0.000	Fluid power cylinder & actuator mfg
3728	333996	0	15482	0.000	Fluid power pump & motor mfg
Part of Misc. Degreasing and Marine Surface Coating					
3731	336611	97385	97385	1.000	Ship building & repairing
3732	336612	41422	41422	1.000	Boat building
3732	811490	9454	65213	0.145	Other personal & household goods repair & maintenance
Part of Misc. Degreasing and Part of Other Transportation Equipment Surface Coating					
3743	333911	0	36552	0.000	Pump & pumping equipment mfg
3743	336510	31633	34012	0.930	Railroad rolling stock mfg
3751	336991	17158	17218	0.997	Motorcycle, bicycle, & parts mfg
3761	336414	52158	52158	1.000	Guided missile & space vehicle mfg
3764	336415	18540	18540	1.000	Guided missile & space vehicle propulsion unit & parts mfg
3769	336419	6110	6110	1.000	Other guided missile & space vehicle parts & auxiliary equip mfg
3792	336214	20112	33352	0.603	Travel trailer & camper mfg
3795	336992	5415	5788	0.936	Military armored vehicle, tank, & tank component mfg
3799	336214	13240	33352	0.397	Travel trailer & camper mfg
3799	336999	19466	19466	1.000	All other transportation equipment mfg
3799	332212	60	50388	0.001	Hand & edge tool mfg
Part of Misc. Degreasing					
3812	334511	187557	188161	0.997	Search, detection, navigation, & guidance instrument mfg
3821	339111	18253	18253	1.000	Laboratory apparatus & furniture mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees ‘1997	Employee Fraction	NAICS description
3822	334512	21450	21450	1.000	Automatic environmental control mfg
3823	334513	49196	49196	1.000	Industrial process control instrument mfg
3824	334514	17390	17390	1.000	Totalizing fluid meter & counting device mfg
3825	334416	190	19431	0.010	Electronic coil, transformer, & other inductor mfg
3825	334515	63332	63332	1.000	Electricity measuring & testing instrument mfg
3826	334516	38200	38359	0.996	Analytical laboratory instrument mfg
3827	333314	20801	20857	0.997	Optical instrument & lens mfg
3829	339112	521	107819	0.005	Surgical & medical instrument mfg
3829	334519	33904	33933	0.999	Other measuring & controlling device mfg
3841	339112	107298	107819	0.995	Surgical & medical instrument mfg
3842	322121	375	120176	0.003	Paper (except newsprint) mills
3842	322291	2236	21791	0.103	Sanitary paper product mfg
3842	334510	6722	54385	0.124	Electromedical & electrotherapeutic apparatus mfg
3842	339113	82390	85315	0.966	Surgical appliance & supplies mfg
3843	339114	18072	18072	1.000	Dental equipment & supplies mfg
3844	334517	14276	14276	1.000	Irradiation apparatus mfg
3845	334510	47121	54385	0.866	Electromedical & electrotherapeutic apparatus mfg
3851	339115	26366	26366	1.000	Ophthalmic goods mfg
3861	325992	38935	38935	1.000	Photographic film, paper, plate, & chemical mfg
3861	333315	24707	24707	1.000	Photographic & photocopying equipment mfg
3873	334518	5646	6333	0.892	Watch, clock, & part mfg
3911	339911	34694	34773	0.998	Jewelry (except costume) mfg
3914	332211	101	11230	0.009	Cutlery & flatware (except precious) mfg
3914	339912	6356	6459	0.984	Silverware & plated ware mfg
3915	339913	5396	5396	1.000	Jewelers' material & lapidary work mfg
3931	339992	13411	13411	1.000	Musical instrument mfg
3942	339931	3393	3393	1.000	Doll & stuffed toy mfg
3944	336991	60	17218	0.003	Motorcycle, bicycle, & parts mfg
3944	339932	29622	29622	1.000	Game, toy, & children's vehicle mfg
3949	339920	69664	69664	1.000	Sporting & athletic goods mfg
3951	339941	8394	8394	1.000	Pen & mechanical pencil mfg
3952	339942	5815	7990	0.728	Lead pencil & art good mfg

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
3952	337127	187	38218	0.005	Institutional furniture mfg
3952	325998	0	35915	0.000	All other miscellaneous chemical product & preparation mfg
3953	339943	7831	7831	1.000	Marking device mfg
3955	339944	5923	5923	1.000	Carbon paper & inked ribbon mfg
3961	339914	13976	14573	0.959	Costume jewelry & novelty mfg
3965	339993	7500	7842	0.956	Fastener, button, needle, & pin mfg
3991	339994	13882	16826	0.825	Broom, brush, & mop mfg
3993	339950	82956	82956	1.000	Sign mfg
3995	339995	6962	6962	1.000	Burial casket mfg
3996	326192	5614	6070	0.925	Resilient floor covering mfg
3999	323119	0	33016	0.000	Other commercial printing
3999	337127	329	38218	0.009	Institutional furniture mfg
3999	335121	1216	17685	0.069	Residential electric lighting fixture mfg
3999	332999	3231	79070	0.041	All other miscellaneous fabricated metal product mfg
3999	332212	750	50388	0.015	Hand & edge tool mfg
3999	326199	3141	526382	0.006	All other plastics product mfg
3999	325998	572	35915	0.016	All other miscellaneous chemical product & preparation mfg
3999	314999	2167	64480	0.034	All other miscellaneous textile product mills
3999	323113	0	72221	0.000	Commercial screen printing
3999	339999	60397	74137	0.815	All other miscellaneous mfg
3999	316110	329	15317	0.021	Leather & hide tanning & finishing
3999	321999	0	43839	0.000	All other miscellaneous wood product mfg
3999	322299	0	24302	0.000	All other converted paper product mfg
3999	323110	0	415117	0.000	Commercial lithographic printing
3999	323111	0	23260	0.000	Commercial gravure printing
3999	323112	0	30588	0.000	Commercial flexographic printing
Part of Misc. Open Top Degreasing & Auto Repair Cold Cleaning					
4173	488490	220	7480	0.029	Other support activities for road transportation
4231	488490	120	7480	0.016	Other support activities for road transportation
5511	441110	1046243	1046243	1.000	New car dealers
5521	441120	92752	92752	1.000	Used car dealers
5541	447190	69640	308105	0.226	Other gasoline stations

SIC	NAICS	SIC Employees 1997	NAICS Employees '1997	Employee Fraction	NAICS description
5541	447110	432935	613957	0.705	Gasoline stations with convenience stores
5541	447190	238465	308105	0.774	Other gasoline stations
5551	441222	35134	35134	1.000	Boat dealers
5561	441210	29463	29463	1.000	Recreational vehicle dealers
7532	811121	192853	205172	0.940	Automotive body, paint, & interior repair & maintenance
7532	811121	6507	205172	0.032	Automotive body, paint, & interior repair & maintenance
7532	811121	5812	205172	0.028	Automotive body, paint, & interior repair & maintenance
7533	811112	23015	23015	1.000	Automotive exhaust system repair
7534	811198	2991	14780	0.202	All other automotive repair & maintenance
7534	326212	7939	7939	1.000	Tire retreading
7536	811122	29187	29187	1.000	Automotive glass replacement shops
7537	811113	29442	29442	1.000	Automotive transmission repair
7538	811111	290634	290634	1.000	General automotive repair
7539	811118	3954	42234	0.094	Other automotive mechanical & electrical repair & maintenance
7539	811118	4802	42234	0.114	Other automotive mechanical & electrical repair & maintenance
7539	811118	18216	42234	0.431	Other automotive mechanical & electrical repair & maintenance
7539	811118	6890	42234	0.163	Other automotive mechanical & electrical repair & maintenance
7539	811118	8372	42234	0.198	Other automotive mechanical & electrical repair & maintenance
Dry Cleaning					
7215	812310	53023	53023	1.000	Dry cleaning, coin operated
7216	812320	166208	203777	0.816	Dry cleaning, commercial

Appendix F.3
On-Road Mobile Source
Emissions Inventory Documentation

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1. INTRODUCTION

The attainment modeling for the Hickory (Catawba County) and the Triad (Davidson and Guilford Counties) fine particulate matter ($PM_{2.5}$) nonattainment areas were performed in conjunction with the regional haze modeling being done by the Southeast Regional Planning Organization, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the fine particulate matter and particulate modeling being done by the Association of Southeastern Integrated Planning (ASIP). VISTAS and ASIP are run by the ten southeast states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia). The North Carolina Division of Air Quality (NCDAQ) decided to use this modeling for its attainment demonstration since the modeling uses annual simulations and includes the intermediate year 2009, which is the attainment year for $PM_{2.5}$.

On-road mobile sources are those vehicles that travel on the highways and the roadways. On-road mobile sources emissions comprise a small percentage of the total particulate for all of North Carolina. Particulate emissions from motor vehicles only occur while the vehicle is moving or idling. These emissions are direct tailpipe (both gas and diesel), sulfate, tire wear, and brake wear. Only direct particulate emissions processes will be estimated in order to properly reflect the total particulate emissions from this source category. In its simplest terms, emissions from on-road mobile sources are calculated by multiplying an activity level, in this case daily vehicle miles traveled (VMT) as provided by the North Carolina Department of Transportation (NCDOT) and Metropolitan Planning Organization (MPOs), by an emission factor.

The US Environmental Protection Agency (USEPA) developed the MOBILE model to estimate emission factors based on information on the way vehicles are driven in a particular area. The newest version of the MOBILE model, MOBILE6.2, was used. In 2004, MOBILE6.2 was incorporated into SMOKEv2.1, which was used in the VISTAS/ASIP modeling. Key inputs for MOBILE6.2 include information on the age of vehicles on the roads, the average speed of those vehicles, what types of roads those vehicles are traveling on, any control technologies in place in an area that reduce emissions for motor vehicles (e.g., emissions inspection programs), and ambient temperature and humidity.

MOBILE6.2 particulate outputs contain both primary particulates (soot from tailpipes, tire, and brake wear) and secondary (particulate precursors). Secondary particulate matter is formed by chemical reactions of gas-phase precursors in the atmosphere (FR Vol.70, No. 210, p65992). The specific primary outputs are GASPM, i.e. particles directly emitted from all gasoline vehicles, OCARBON (organic carbon) and ECARBON (elemental carbon) from diesel engines, (sulfate) SO_4 from both fuels, and tire and brake dust from all vehicles.

A very important component of the on-road mobile emissions estimation process is interagency consultation. The transportation partners involved in this State Implementation Plan (SIP) and development of the motor vehicle emissions budgets (MVEBs) included: USEPA, NCDOT, Federal Highway Administration (FHWA), Greater Hickory (MPO), Unifour Rural Planning Organization (RPO), Piedmont Triad RPO, Greensboro MPO, High Point MPO, and the Burlington-Graham MPO. Specifically, the NCDOT and the MPOs were consulted on input data such as speeds and VMT derived from the travel demand model (TDM).

The documentation for the on-road mobile sources is broken out into two components:

1) how the inventory was developed for the particulate matter emissions modeling used for the attainment demonstration and,

2) how the motor vehicle emissions budgets were developed for the three North Carolina counties that comprise the $PM_{2.5}$ nonattainment areas.

2. MOBILE6.2 INPUT ASSUMPTIONS FOR EMISSIONS MODELING

The MOBILE6.2 module of SMOKE was used to develop the 2009 on-road mobile source emissions estimates for fine particulate matter. The MOBILE6.2 parameters, vehicle fleet descriptions, and VMT estimates were combined with gridded, episode-specific temperature data to calculate the gridded, temporalized emission estimates. Of note, whereas the on-network emissions estimates are spatially allocated based on link location and subsequently summed to the grid cell level, the off-network emissions estimates are spatially allocated based on a combination of the FHWA Version 2.0 highway networks and population. For the VISTAS/ASIP 36/12 km modeling, no link based data was used. The MOBILE6.2 emission factors are based on episode-specific temperatures predicted by the meteorological model. Furthermore, the MOBILE6.2 emission factor model accounts for the following:

- Daily minimum/maximum or 24 hourly temperatures;
- Facility speeds;
- Locale-specific inspection/maintenance (I/M) control programs, if any;
- VMT, fleet turnover, and changes in fuel composition and Reid Vapor Pressure (RVP).

2.1 Speed Assumptions

Emissions from motor vehicles vary with the manner in which the vehicle is operated. Vehicles traveling at 65 miles per hour (mph) emit a very different mix and concentrations of pollutants than the car that is idling at a stoplight. In order to estimate emissions from vehicles for a typical day, NCDOT and the MPOs provided speeds for their respective counties.

The speeds for several urban counties covered by the MPOs were generated from their latest travel demand models (TDMs) at the time emissions modeling began. NCDOT recommended using Wake County off-peak speeds for all remaining counties in North Carolina not covered by TDMs.

Interstates are modeled as "non-ramp" instead of "freeways" because both speed and VMT for ramps are included in the functional classification for the major facility it is connected to in the TDM. This is consistent with the USEPA guidance.

2.2 Vehicle Age Distribution

The vehicle age distribution is based on annual registration data for North Carolina and is provided by NCDOT. For this analysis the age distribution was generated based on 2005 data, representing the latest quality assured information available. The NCDOT provided vehicle count data for each vehicle classification from years 1974 and prior through 2005. Vehicles greater than 25 years old were combined and included as the 25^{th} model year. The vehicle count information is provided for nine vehicle types; light duty gas vehicles (LDGV), light duty diesel vehicles (LDDV), light duty gas trucks 1 (LDGT1), light duty gas trucks 2 (LDGT2), light duty diesel trucks 1 (LDDT1), light duty diesel trucks 2 (LDDT2), heavy duty gas vehicles (HDGV), heavy duty diesel vehicles (HDDV) and motorcycles (MC). LDDT1 and LDDT2 are combined and labeled as light duty diesel trucks (LDDT). This vehicle distribution convention corresponds to the old MOBILE5 format and does not correlate to the USEPA MOBILE6.2 model vehicle types. In order to convert the data provided by the NCDOT into the MOBILE6.2 model format, the NCDAQ used a utility developed by the USEPA that disaggregates the 8 MOBILE5 model vehicle types into the 16 MOBILE6.2 vehicle types. The count data provided by the NCDOT is converted into fractions by dividing each count per vehicle type per year by the total number of vehicles in that classification for all years. For example, the number of 2005 light duty vehicles divided by the total number of light duty vehicles for all years. The fractions are arranged into MOBILE5 format for conversion to the 16 vehicle types required by the MOBILE6.2 model using the USEPA conversion utility.

2.3 Vehicle Mix Assumptions

2.3.1 North Carolina Statewide Vehicle Mix Development

The vehicle mix refers to the percentage of different vehicle types on each of the 12 FHWA road types. These road types are listed below in Table 2.3.1-1. It is critical when estimating mobile emissions in an area to use data that accurately reflects the vehicle types traveling on each of these different road types.

Table 2. 3. 1 – 1. 1999-2001 Percent Vehicles by FHWA Vehicle Class by Functional Classification

	PASS CARS	PICK UPS	BUS	2-A TRK	3-A TRK	4-A TRK	4-A TTST	5-A TTST	6-A TTST	5-A TWIN	6-A TWIN	7-A TWIN	MC
Rural													
Interstate	56.93	10.80	1.06	2.50	1.56	1.09	4.79	19.23	0.48	0.73	0.24	0.11	0.49
Other Prin Art	69.34	15.79	0.71	2.80	1.48	0.25	2.07	6.67	0.26	0.16	0.05	0.04	0.40
Minor Art	70.58	17.23	0.59	3.19	1.87	0.27	1.79	3.69	0.21	0.05	0.01	0.02	0.49
Major Col	73.21	17.52	0.51	3.01	1.45	0.24	1.63	1.84	0.18	0.02	0.01	0.02	0.36
Minor Col	74.00	16.50	0.65	3.00	1.55	0.17	1.75	1.50	0.30	0.05	0.02	0.06	0.45
Local	71.93	18.66	0.51	4.09	1.06	0.02	1.54	1.60	0.05	0.00	0.00	0.00	0.55
Urban													
Interstate	68.68	12.84	0.89	2.12	1.68	0.42	2.70	9.29	0.45	0.36	0.09	0.10	0.36
Oth Freeway	74.79	13.97	0.57	2.48	1.17	0.42	2.56	3.42	0.17	0.07	0.01	0.03	0.33
Oth Prin Art	76.64	14.84	0.46	2.20	1.30	0.13	1.66	2.12	0.21	0.04	0.01	0.04	0.32
Minor Art	79.35	14.43	0.47	2.16	1.08	0.10	1.26	0.66	0.11	0.00	0.00	0.02	0.36
Collectors	81.15	13.42	0.43	2.02	1.12	0.07	0.99	0.40	0.05	0.00	0.00	0.01	0.34
Local	75.56	16.59	0.82	2.57	1.73	0.03	0.95	1.05	0.10	0.00	0.00	0.00	0.59

The NCDAQ created a statewide mix based on the methodology outlined in the August 2004 USEPA guidance document EPA420-R-04-013, *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation*. Below is the methodology used to convert the 13 Highway Performance Monitoring System (HPMS) vehicle types count data reported to FHWA to generate a state specific vehicle mix.

The North Carolina HPMS data that was used to generate the statewide vehicle mix was based on 1999 through 2001 data counts. This was the latest available statewide count information at the time of the emissions modeling. Table 2.3.1-1 shows the percent of vehicles per vehicle type for each of the 12 road classes.

Disaggregating State Specific Information

The *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation*, Section 4.1.5, illustrates how to map the HPMS statewide vehicle data to general vehicle categories. This mapping is outlined below:

HPMS Category	**General Category**
Motorcycle	Motorcycle (MC)
Passenger Car	Passenger Car (LDV)
Other 2-Axel, 4-Tire Vehicles	Light Truck (LDT)
Buses	Bus (HDB)
All Other Trucks: Single unit, 2-axel, 6-tire Single unit, 3-axel Single unit, 4 or more axel Single trailer, 4 or fewer axel Single trailer, 5-axel Single trailer, 6 or more axel Multi-trailer, 5 or fewer axel Multi-trailer, 6-axel Multi-trailer, 7 or more axel	Heavy Duty Truck (HDV)

The HPMS data in Table 2.3.1-1 was grouped into these five general categories for each road type. In order to expand the five general categories to the 16 vehicle types used in MOBILE6.2, the national average VMT fractions by each vehicle class were used. The 2000 fractions were used since the state specific data is from 1999 through 2001. The national average data was obtained from Table 4.1.2 in _Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation_. An example for rural interstates is illustrated below:

From Table 2.3.1-1 above:

Passenger Cars	=	56.93%	5 axel Trailer	=	19.23%
Pickup Trucks	=	10.80%	6 axel Trailer	=	0.48%
Buses	=	1.06%	5 axel Multi Trailer	=	0.73%
2 axel Trucks	=	2.50%	6 axel Multi Trailer	=	0.24%
3 axel Trucks	=	1.56%	7 axel Multi Trailer	=	0.11%
4 axel Trucks	=	1.09%	Motorcycles	=	0.49%
4 axel Trailer	=	4.79%			

Therefore, the five general categories are:

Motorcycles	=	0.49%
Light Duty Vehicles	=	56.93%
Light Duty Trucks	=	10.80%
Heavy Duty Buses	=	1.06%
Heavy Duty Vehicles	=	30.73%

From Table 4.1.2 in _Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation_, the 2000 national average vehicle mix for light duty trucks, buses and heavy duty trucks are:

Light Duty Trucks

LDT1	=	0.0655
LDT2	=	0.2179
LDT3	=	0.0672
LDT4	=	0.0309
Total	**=**	**0.3815**

Buses

HDBS	=	0.0019
HDBT	=	0.0009
Total	**=**	**0.0028**

Heavy Duty Trucks

HDV2B	=	0.0380
HDV3	=	0.0038
HDV4	=	0.0029
HDV5	=	0.0022
HDV6	=	0.0082
HDV7	=	0.0098
HDV8A	=	0.0108
HDV8B	=	0.0386
Total	**=**	**0.1143**

Using the methodology described in *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation*, Section 4.1.5, the 2000 North Carolina statewide mix was developed. The basic formula for developing the mix is shown below,

$$\text{Vehicle Type} = (\text{2000 M6.2 fraction for vehicle}) \times \frac{(\text{99-01 State total for group})}{(\text{2000 M6.2 total for subcategory})}$$

Table 2.3.1-2 displays the calculation for each vehicle type for the 2000 rural interstate vehicle mix.

Table 2.3.1-2. Calculation of New 2000 Statewide Rural Interstate Vehicle Mix

Vehicle Type		Calculation		New 2000 Mix
LDV	=	LDV	=	0.5693
MC	=	MC	=	0.0049
Light Duty Trucks				
LDT1	=	0.0655 x (0.1080/0.3815)	=	0.0185
LDT2	=	0.2179 x (0.1080/0.3815)	=	0.0617
LDT3	=	0.0672 x (0.1080/0.3815)	=	0.0190
LDT4	=	0.0309 x (0.1080/0.3815)	=	0.0087
Total Light Duty Vehicles				0.6822
Heavy Duty Vehicles				
HDV2B	=	0.0380 x (0.3073/0.1143)	=	0.1022
HDV3	=	0.0038 x (0.3073/0.1143)	=	0.0102
HDV4	=	0.0029 x (0.3073/0.1143)	=	0.0078
HDV5	=	0.0022 x (0.3073/0.1143)	=	0.0059
HDV6	=	0.0082 x (0.3073/0.1143)	=	0.0220
HDV7	=	0.0098 x (0.3073/0.1143)	=	0.0263
HDV8A	=	0.0108 x (0.3073/0.1143)	=	0.0290
HDV8B	=	0.0386 x (0.3073/0.1143)	=	0.1038
Buses				
HDBS	=	0.0019 x (0.0106/0.0028)	=	0.0072
HDBT	=	0.0009 x (0.0106/0.0028)	=	0.0034
Total Heavy Duty Vehicles				0.3178

2009 Statewide Vehicle Mix

Once the 2000 vehicle mix was generated, the other years were created using the methodology described in *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation*, Section 4.1.4. This method grouped light duty vehicles(light duty trucks and motorcycles) together and heavy duty vehicles (heavy duty buses and heavy duty trucks) together. The combined percentages for these groupings are listed below.

Light Duty Vehicles	=	68.22%
Heavy Duty Vehicles	=	31.78%

The MOBILE6.2 vehicle mix fractions for the year being developed were obtained from Table 4.1.2 in *Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation*. The MOBILE6.2 vehicle fractions for 2009 are listed below.

Light Duty Vehicles

LDV	=	0.3669
LDT1	=	0.0869
LDT2	=	0.2894
LDT3	=	0.0892
LDT4	=	0.0410
MC	=	0.0054
Total	**=**	**0.8788**

Heavy Duty Vehicles

HDV2B	=	0.0389
HDV3	=	0.0038
HDV4	=	0.0032
HDV5	=	0.0024
HDV6	=	0.0087
HDV7	=	0.0103
HDV8A	=	0.0112
HDV8B	=	0.0398
HDBS	=	0.0020
HDBT	=	0.0010
Total	**=**	**0.1213**

The North Carolina 2009 vehicle mix was normalized to the MOBILE6.2 fractions using the following formula:

$$\text{Vehicle Type} = (\text{2009 M6 fraction for vehicle}) \times \frac{(\text{2000 State total for group})}{(\text{2009 M6 total for group})}$$

Table 2.3.1-3 below displays the calculations used to generate the 2009 North Carolina vehicle mix for rural interstate.

Table 2.3.1-3. Calculation of 2009 NC Statewide Rural Interstate Vehicle Mix

Vehicle Type		Calculation		2009 State Mix
Light Duty Vehicles				
LDV	=	0.3669 x (0.6822/0.8788)	=	0.2848
LDT1	=	0.0869 x (0.6822/0.8788)	=	0.0675
LDT2	=	0.2894 x (0.6822/0.8788)	=	0.2247
LDT3	=	0.0892 x (0.6822/0.8788)	=	0.0692
LDT4	=	0.0410 x (0.6822/0.8788)	=	0.0318
MC	=	0.0054 x (0.6822/0.8788)		0.0042
Heavy Duty Vehicles				
HDV2B	=	0.0389 x (0.3178/0.1213)	=	0.1019
HDV3	=	0.0038 x (0.3178/0.1213)	=	0.0100
HDV4	=	0.0032 x (0.3178/0.1213)	=	0.0084
HDV5	=	0.0024 x (0.3178/0.1213)	=	0.0063
HDV6	=	0.0087 x (0.3178/0.1213)	=	0.0228
HDV7	=	0.0103 x (0.3178/0.1213)	=	0.0270
HDV8A	=	0.0112 x (0.3178/0.1213)	=	0.0293
HDV8B	=	0.0398 x (0.3178/0.1213)	=	0.1043
HDBS	=	0.0020 x (0.3178/0.1213)	=	0.0052
HDBT	=	0.0010 x (0.3178/0.1213)	=	0.0026

2.4 Temperature, Relative Humidity and Barometric Pressure Assumptions

Although, MOBILE6.2 $PM_{2.5}$ emission factors used by SMOKE are not significantly influenced by temperature and humidity, the other pollutants that are needed for one atmosphere modeling, such as nitrogen oxides and volatile organic compounds, are influenced by temperature and humidity. Therefore, the most desirable approach is to model on-road mobile emissions using gridded, temporalized data from the meteorological model. The VISTAS on-road mobile inventories were developed using this approach.

2.5 Vehicle Inspection and Maintenance Program Assumptions

In the early 1990's, North Carolina adopted emissions inspection requirements for vehicles in 9 urban counties. This program tested emissions at idle for 1975 and newer gasoline powered light duty vehicles. This "idle test" was assumed to have a compliance rate of 95 percent and covered

Gaston, Mecklenburg, Union, Cabarrus, Forsyth, Guilford, Orange, Durham and Wake Counties. In addition, the inspection stations are required to administer an anti-tampering check to ensure that emissions control equipment installed originally are on the vehicle and that the equipment has not been altered.

In 2002, North Carolina implemented a new vehicle emissions inspection program referred to as onboard diagnostics (OBD-II). This program covers all light duty gasoline powered vehicles that are model year 1996 and newer. The program was initially implemented in the 9 counties that originally had the "idle test" and was expanded to include a total of 48 counties between July 2002 and January 2006. Because the OBD-II program did not begin until midway through 2002, the 2002 annual on-road mobile inventory to support VISTAS/ASIP modeling was developed with the "idle test" only in the 9 counties listed above in addition to the anti-tampering in all counties. By 2009 the OBD-II program will be fully implemented resulting in all three nonattainment counties, Catawba, Davidson, and Guilford, to be subject to the OBD-II I/M program. In addition, the inspection stations are required to administer an anti-tampering check to ensure that emissions control equipment on any vehicle 35 model years old and newer has not been altered.

2.6 Reid Vapor Pressure Assumptions

The RVP is a measure of gasoline's volatility. An RVP of 7.8 pounds per square inch (psi) is required during May through September in the former 1-hour ozone nonattainment areas, which includes Guilford and Davidson Counties. The remainder of North Carolina is required to have an RVP of 9.0 psi, used in Catawba County, during May through September. For the months of October, November, February, March and April, the RVP is 13.5 psi. The RVP in January and December is 15.0 psi.

2.7 Vehicle Miles Traveled Assumptions

In order to calculate emissions from on-road mobile sources, emission factors are developed as discussed throughout this document. The emission factors are then multiplied by an activity level, which for on-road mobile sources is VMT.

For most counties in North Carolina, the 2002 VMT was derived from the 2002 Highway Performance Maintenance System (HPMS) data provided by NCDOT and the 2009 was grown based on a linear interpolation of the most recent 10 years (1995-2004) of HPMS data. Similar to the speed data explained above, VMT from several urban counties TDMs were used instead of

HPMS VMT. Where travel demand model data was available, it was the recommendation of the North Carolina transportation partners to use it instead of the HPMS data.

In situations where certain North Carolina counties are partially covered by a travel demand model, and the North Carolina transportation partners anticipate future versions of the travel models to cover the entire county, an adjusted HPMS VMT number was used. This upward adjustment (30%) of the countywide HPMS VMT data is based on an analysis by NCDAQ that shows that travel demand model VMT can be as much as 30% higher than the HPMS VMT.

2.8 Diesel Fuel Sulfur Content Assumptions

The diesel fuel sulfur content is required in MOBILE6.2 to generate $PM_{2.5}$ emission factors because the amount of sulfur in diesel fuel directly correlates to sulfate particulate emissions. For the emissions modeling, the diesel sulfur content is 500 parts per million (ppm) in 2002 and 43 ppm in 2009. The same diesel sulfur content is used for all of the nonattainment counties. These values come from Section 5.5 in Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation. Office of Transportation and Air Quality (OTAQ) was contacted prior to this submission to verify that there was no update to this guidance.

3. QUALITY ASSURANCE MEASURES

The Quality Assurance (QA) of the data is one of the most important steps in performing an air quality modeling study. Because emissions inventory development is tedious, time consuming and involves complex manipulation of many different types of large data sets, errors are frequently made and, if rigorous QA measures are not in place, these errors may remain undetected. For the on-road mobile source category, QA can be broken into two components: 1) input files/data, and 2) SMOKE outputs/summaries. On-road mobile input data QA is summarized below. SMOKE output QA is summarized in Appendix H.1 of this document for all source categories.

On-road mobile input data was collected from the NCDOT and specific MPOs throughout North Carolina. The NCDAQ checked the speed information for reasonableness against previous sets of speeds for that specific area. Additionally, the following data elements are checked for accuracy in the input files prior to use in the modeling: pollutants, fuel RVP, I/M program settings, anti-tampering program settings, calendar year, evaluation month. All input files are printed and checked by hand against a “key” with the original source of the information. This QA step is always performed by a person other than the one who generated the files. If any discrepancies are found, they are marked on the hard copy supplied by to the person who generated the input files for correction. Vehicle age distribution is another input referenced in the actual MOBILE6.2 input file. This file is checked against the original spreadsheet from which it is generated. Again, if any discrepancies are found, they are noted and returned to the person responsible for generating those files. VMT and vehicle mix (also referred to as VMT mix) are additional data elements that are checked after they are formatted for SMOKE. This file is checked against the original source of the VMT and VMT mix data.

4. MOBILE6.2 INPUTS FOR MOTOR VEHICLE EMISSIONS BUDGETS

The purpose of transportation conformity is to ensure that Federal transportation actions occurring in a nonattainment areas does not hinder the area from maintaining the annual $PM_{2.5}$ standard. This means that the level of emissions estimated by the NCDOT or the MPOs for the Transportation Implementation Plan and Long Range Transportation Plan must not exceed the motor vehicle emissions budgets (MVEBs) as defined in this attainment demonstration SIP.

The sections below describe the MOBILE6.2 input assumptions used to calculate the MVEBs. The MOBILE6.2 input files and output files used in the development of the on-road mobile source emissions for the attainment demonstration are compiled in Section 6.

MOBILE6.2 is insensitive to temperatures, RVP, and inspection and maintenance commands when calculating $PM_{2.5}$ emission factors. The NCDAQ has decided to model a typical summer day for the MVEBs and multiply the resulting emissions by 365 to get annual $PM_{2.5}$ emissions.

In our coordinated planning phase for the PM 2.5 SIP, all of the partners came forward with their individual planning data/assumptions to be used in the development of the SIP. These data were the most current data at that time and included road types, speeds, VMT, I&M data, meteorological data, etc. These data were to be used in Mobile6.2 by NCDAQ to obtain emission factors and to set budgets if required.

Since the SIP submittal deadline in April 2008, the vehicle age distribution has a 2007 update that is now available. 2007 accident data has become available to update the I/M fraction for 2009. Additionally, 2007 counts used for the vehicle-mix have become available. The NCDAQ consulted with partners as to the use of the new data, which does not significantly change from that used in the SIP modeling.

The NCDAQ used quarterly NOx emission estimates based on the relative data pertinent to each quarter. Mobile6.2 is limited to two months, January and July 2002. The first quarter was designated 1 for January. The second and third quarters will be designated 7 for July. The forth

quarter was designated as 1 for January of the following year as recommended by the USEPA guidance document Technical Guidance on the Use of MOBILE6.2 for Emission Inventory Preparation (USEPA, August 2004).
Meteorological data is from the Triad Regional Airport for Davidson and Guilford counties. Data for Catawba County is from the Hickory airport. Averages are determined for RVP for each quarter per county. I&M fraction is calculated from annual accident data used as a surrogate for the percentage of cars on the road in each county during the year with and without I&M. Our most current accident data was from 2007.

4.1 Speed Assumptions

The MOBILE6.2 command "AVEAGE SPEED" was used to enter the daily speeds. This command requires the average speed on a given roadway scenario.

In order to estimate emissions from vehicles for a typical day, NCDOT and the MPOs provided speeds for their respective counties. The speeds were generated from their latest travel demand model. The speeds provided are based on a daily average.

Updated speed data was available at the time the MVEBs were developed. Although this updated data may be different from what was modeled in the attainment demonstration, the differences were not significant and will not result in different attainment test results.

Table 4.1-1 below provides a summary of the updated speeds used for the development of the MVEBs. The column headings in Table 4.1-1 represent the 12 FHWA road types used in the modeling and are listed below. The 12 FHWA road types are:

RI	Rural Interstate	UI	Urban Interstate
RPA	Rural Other Principle Arterial	UF	Urban Freeway & Expressway
RMA	Rural Minor Arterial	UPA	Urban Other Principal Arterial
RMjC	Rural Major Collector	UMiA	Urban Minor Arterial
RMiC	Rural Minor Collector	UC	Urban Collector
RL	Rural Local	UL	Urban Local

Table 4.1-1. 2009 Daily Speeds Used to Calculate the MVEBs

County	RI	RPA	RMA	RMjC	RMiC	RL	UI	UF	UPA	UMiA	UC	UL
Catawba TDM	0	0	0	0	0	0	60	57	27	29	33	29
Catawba Non-TDM	66	47	44	43	42	42	63	56	29	32	31	31

Davidson TDM	68	60	44	44	48	46	66	52	40	40	37	43
Davidson Non-TDM	65	44	43	43	42	42	62	56	28	32	31	32
Guilford TDM	59	57	45	47	46	44	60	54	40	38	38	37

4.2 Vehicle Age Distribution

The vehicle age distribution used in developing the MVEBs is not the same as what was used in the VISTAS/ASIP modeling. The NCDOT supplied updated vehicle age distribution based on 2005 vehicle count data on May 1, 2007, after the emissions modeling was completed. The vehicle age distribution used in the emissions modeling was based on 2004 vehicle count data. A MOBILE6.2 run was performed to determine if there is any difference between the two data sets. There was minimal difference in the emission factors, therefore, the NCDAQ utilized the 2005 vehicle age distribution to establish the MVEBs for PM2.5 because it was the most up-to-date data available at the time of PM2.5 emission modeling.

For NOx budgets developed in fall 2008, NCDAQ calculated a vehicle age distribution based on the most current 2007 count data supplied by NCDOT in June 2008. This newer age distribution was not seen to vary much from the 2005 distribution.

4.3 Development of Vehicle Mix

The vehicle mix used to project the MVEBs for PM2.5 is developed from 2006 vehicle counts data provided by the NCDOT Division of Motor Vehicles on May 1, 2007. The MVEBs are calculated using the updated vehicle mix since it is the most up-to-date data available and sensitivity runs performed using MOBILE6.2 show very little difference between the vehicle mix used in the emissions modeling, which is based on 1999-2001 vehicle count data, and the updated data provided for 2006.

The same methodology used to derive the vehicle mix as described in Section 2.3 was employed to derive the vehicle mix based on the 2006 vehicle count data. The updated vehicle counts data can be found in Table 4.3-1.

For NOx budgets developed in fall 2008, NCDAQ calculated a vehicle mix based on 2007 count data supplied by NCDOT in June 2008. This newer age distribution was not seen to vary much from the 2006 count data.

Table 4.3-1. 2006 Percent Vehicles by FHWA Vehicle Class by Functional Classification

	PASS CARS	PICK UPS	BUS	2-A TRK	3-A TRK	4-A TRK	4-A TTST	5-A TTST	6-A TTST	5-A TWIN	6-A TWIN	7-A TWIN	MC
Rural													
Interstate	59.2	12.9	1.1	2.7	0.8	0.0	1.9	19.2	0.7	0.6	0.3	0.2	0.4
Prin Art	66.9	18.4	0.8	3.4	1.2	0.1	1.4	6.5	0.3	0.2	0.1	0.0	0.8
Minor Art	67.7	19.6	0.8	3.8	1.2	0.1	1.3	4.6	0.2	0.0	0.0	0.0	0.6
Major Col	71.3	19.8	0.5	3.3	1.0	0.1	0.9	2.3	0.1	0.0	0.0	0.0	0.6
Minor Col	70.6	20.4	0.7	4.0	1.1	0.1	0.9	1.5	0.1	0.0	0.0	0.0	0.8
Local	71.93	18.66	0.51	4.09	1.06	0.02	1.54	1.6	0.05	0.0	0.0	0.0	0.55
Urban													
Interstate	67.9	14.0	0.8	2.7	1.0	0.1	1.3	11.0	0.3	0.3	0.1	0.0	0.5
Oth Freeway	72.5	15.7	0.7	2.7	1.0	0.1	1.1	5.4	0.3	0.1	0.0	0.0	0.45
Prin Art	74.6	16.7	0.5	2.8	0.8	0.1	0.9	2.7	0.2	0.0	0.0	0.0	0.6
Minor Art	77.1	16.2	0.6	2.8	0.7	0.1	0.7	0.8	0.2	0.0	0.0	0.0	0.6
Collectors	77.3	17.0	0.5	2.7	0.8	0.0	0.5	0.4	0.0	0.0	0.0	0.0	0.7
Local	75.56	16.59	0.82	2.57	1.73	0.03	0.95	1.05	0.1	0.0	0.0	0.0	0.59

4.4 Temperature Assumptions

Since the $PM_{2.5}$ emission factors are not sensitive to temperature, the MOBILE6.2 command "MIN MAX TEMPERATURES" was used to enter temperatures to estimate mobile source emissions for particulate matter. For the nonattainment area, the NCDAQ used the 2002 annual minimum/maximum temperature profile from the Triad Airport Meteorological Station for Guilford and Davidson Counties. The Hickory Airport 2002 data was used for Catawba County.

Table 4.4-1. 2002 Catawba County Temperatures

Annual average MIN/MAX Temperatures	
49 ^{o}F	70 ^{o}F

Table 4.4-2. 2002 Davidson and Guilford Counties Temperatures

Annual average MIN/MAX Temperatures	
50 ^{o}F	70 ^{o}F

NOx emission factors are sensitive to temperature and relative humidity. Hourly average for temperature and relative humidity were calculated for each of the four quarters. Meteorological data is from the Hickory Airport for Catawba County. Data for Davidson and Guilford counties is from the Triad Regional airport.

Temperatures

Catawba County

First Q	37.8 36.8 37.2 40.6 44.1 47.8 50.3 52.6 53.8 54.7 54.8 54.0
	51.5 49.3 47.8 46.4 44.8 44.1 42.8 41.5 40.5 40.2 39.6 38.6
Second Q	58.3 60.5 63.7 67.1 69.6 72.3 73.7 75.6 75.8 76.6 76.6 75.7
	74.3 72.0 69.6 67.6 65.7 64.5 63.8 62.2 61.2 60.4 59.4 58.5
Third Q	66.8 67.9 70.5 73.7 76.6 78.7 80.9 81.2 82.1 82.5 82.3 81.3
	79.9 77.8 73.6 73.1 71.8 71.1 70.3 69.6 69.0 68.0 67.5 66.9
Fourth Q	43.3 43.3 43.5 46.3 49.2 51.6 53.5 54.7 55.6 56.0 54.0 55.8
	51.7 50.5 49.1 47.8 47.3 46.2 45.7 45.7 44.9 44.6 44.0 43.7

Davidson County & Guilford County

First Q	37.5 37.1 37.9 41.5 44.8 47.5 49.7 51.4 52.7 53.6 53.6 52.4
	50.3 48.2 46.3 45.0 43.9 42.9 42.3 41.3 40.4 39.7 39.1 38.1
Second Q	58.6 61.1 64.5 67.6 70.1 72.8 74.6 75.7 76.5 77.1 76.8 75.9
	74.2 71.6 69.2 67.5 65.8 64.7 63.7 62.2 61.2 60.2 59.3 58.5
Third Q	68.2 69.7 72.3 75.0 77.5 79.6 81.2 82.2 83.0 83.1 82.6 81.6
	79.9 77.2 74.7 73.3 72.2 72.3 71.2 70.8 70.1 69.4 68.7 68.3
Fourth Q	44.1 44.0 44.7 47.5 50.0 52.2 53.8 55.0 55.6 55.9 55.2 53.7
	51.5 50.6 48.7 48.3 47.7 47.4 46.3 46.0 45.6 45.2 44.9 44.5

Relative Humidity
Catawba County

First Q	74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
	50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5
Second Q	86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
	51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4
Third Q	87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
	60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2
Fourth Q	85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
	67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

Davidson County & Guilford County

First Q	74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
	51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4
Second Q	82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
	49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7
Third Q	86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
	63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6
Fourth Q	85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
	70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

4.5 Vehicle Inspection and Maintenance Program Assumptions

The ODB-II program is administered in all of the counties in the $PM_{2.5}$ nonattainment area. All counties in North Carolina have a vehicle safety inspection program. Inspection stations are required to administer an anti-tampering check to ensure that emissions control equipment on any vehicle, less than 35 model years old, has not been altered. $PM_{2.5}$ sensitivity runs demonstrate that the inspection and maintenance program does not have an effect on direct $PM_{2.5}$ emission factors. Therefore, for purposes of the PM2.5 MVEBs, the I/M program was assumed to be 100% penetration.

NOx emission factors were determined for 2009 for both I/M and non I/M fractions using 2007 accident data supplied be NCDOT in August 2008. The table below shows the calculated I/M fractions used to set the NOx MVEBs.

Table 4.5. 2009 County-level I/M Fractions

County	2009 I/M Fraction
Catawba	91%
Davidson	94%
Guilford	94%

4.6 Reid Vapor Pressure Assumptions

Per North Carolina's Rules in Section 15A NCAC 2D.1300 the RVP is required to be 7.8 psi June through September in areas that were nonattainment for the 1-hour ozone standard, which includes Davidson and Guilford Counties. Catawba County follows the rest of State RVP of 9.0 psi for the summer. RVP was determined to have no effect on $PM_{2.5}$ emission factors. For the development of the PM2.5 MVEBs, a typical summer day is modeled using an RVP of 7.8 psi for Guilford and Davidson Counties and 9.0 psi for Catawba County.

For NOx MVEBs quarterly average RVPs per county were calculated. Table 4.6 lists the RVP for each county used for the Mobile6 runs to calculate NOx emission factors.

Table 4.6. Quarterly RVP Used to Calculate NOx MVEBs

County	Q1 - Jan, Feb, Mar	Q2 – Apr, May, June	Q3- July, Aug, Sept	Q4 – Oct, Nov, Dec
Catawba	14.0	10.5	9.0	14.0
Davidson	14.0	10.1	7.8	14.0
Guilford	14.0	10.1	7.8	14.0

4.7 Vehicle Miles Traveled Assumptions

In order to calculate emissions from on-road mobile sources, emission factors are developed as discussed throughout this document. The emission factors are then multiplied by an activity level, which for on-road mobile sources is daily VMT.

The daily VMT for the nonattainment area was provided by NCDOT. Table 4.7-1 lists the VMT used in the MVEBs calculations.

Table 4.7-1. 2009 Daily VMT Used to Calculate the MVEBs

Road Type	Catawba TDM	Catawba non-TDM	Davidson TDM	Davidson non-TDM	Guilford TDM
Urban					
Interstate	1,068,778	165,606	333,251	371,816	4,925,953
Freeways	318,096	39,019	676,186	199,204	2,341,290
Other Prin. Arterial	762,827	167,088	448,118	372,564	2,405,901
Minor Arterial	1,132,744	152,147	293,172	298,549	2,698,219
Collector	261,444	26,271	192,524	57,169	1,143,015
Local	514,186	123,328	242,868	131,653	1,884,921
Rural					
Interstate	0	56,490	306,105	443,207	992,132
Other Prin. Arterial	0	75,274	249,163	287,385	587,329
Minor Arterial	0	73,290	269,215	301,987	198,365
Major Collector	0	56,815	172,846	427,935	688,901
Minor Collector	0	90,945	156,314	215,492	289,515
Local	0	68,347	301,453	157,910	440,324
Total VMT	**4,058,075**	**1,094,620**	**3,641,215**	**3,264,870**	**18,595,865**

4.8 Diesel Fuel Sulfur Content Assumptions

The diesel fuel sulfur content is required in MOBILE6.2 to generate $PM_{2.5}$ emission factors because the amount of sulfur in diesel fuel directly correlates to sulfate particulate emissions. For the MVEBs calculation, the diesel fuel sulfur content is 43 parts per million (ppm) for all of the nonattainment counties. This is the same value used in the 2009 emissions modeling.

5. MOTOR VEHICLE EMISSIONS BUDGETS FOR CONFORMITY

5.1 Transportation Conformity

The purpose of transportation conformity is to ensure that Federal transportation actions occurring in a nonattainment areas does not hinder the area from attaining and/or maintaining the annual $PM_{2.5}$ standard. This means that the level of emissions estimated by the NCDOT or the MPOs for the Transportation Implementation Plan and Long Range Transportation Plan must not exceed the MVEBs as defined in this attainment demonstration SIP.

The NCDAQ consults with the transportation partners as one of the requirements in developing the attainment demonstration SIP and setting MVEBs. The NCDAQ sent out a request for comments on setting the geographic extent of the MVEBs to all of the transportation partners. A copy of the letter and responses from the transportation partners can be found in Appendix B. In the letter, NCDAQ expressed its preference for setting county level budgets and some of the reasons why NCDAQ believed county level budgets were appropriate. Additionally, the NCDAQ consulted the partners for the data used in the development of the MVEBs, as well as the data used in the VISTAS/ASIP modeling. The consultation plan can also be found Appendix B along with the responses from the transportation partners.

With respect to the $PM_{2.5}$ nonattainment areas, the NCDAQ received comments from the Greensboro MPO regarding the geographic extent of the MVEBs. The Greensboro MPO agreed with the NCDAQ that MVEBs should be set at the county level. Copies of the letters received can be found in Appendix B. Therefore, if MVEBs are established, they will be set at the county level.

5.2 Pollutants to be Considered

40 CFR 93.119(f)(7) through (10) identifies the pollutants for $PM_{2.5}$ for which regional emissions analysis needs to be performed for transportation conformity purposes. These parts of the rule are listed below:

§119(f)(7) – $PM_{2.5}$ in $PM_{2.5}$ areas;

§119(f)(8) – Reentrained road dust in $PM_{2.5}$ areas only if the EPA [Environmental Protection Agency] Regional Administrator or the director of the State air agency has made a finding that emissions from reentrained road dust within the area are a significant contributor to the $PM_{2.5}$ nonattainment problem and has so notified the MPO and DOT [Department of Transportation];

§119(f)(9) – NOX [nitrogen oxides] in $PM_{2.5}$ areas, unless the EPA Regional Administrator and the director of the State air agency have made a finding that emissions of NOX from within the area are not a significant contributor to the $PM_{2.5}$ nonattainment problem and has so notified the MPO and DOT; and

§119(f)(10) – VOC [volatile organic compounds], SO2 [sulfur dioxide] and/or ammonia in $PM_{2.5}$ areas if the EPA Regional Administrator or the director of the State air agency has made a finding that any of such precursor emissions from within the area are a significant contributor to the $PM_{2.5}$ nonattainment problem and has so notified the MPO and DOT.

Only primary, or direct, $PM_{2.5}$ tailpipe emissions must be considered for transportation conformity regional emissions analysis. The other precursor pollutants and reentrained road dust only need to be considered if the State air agency and/or the USEPA has deemed the pollutant as a significant contributor to the $PM_{2.5}$ nonattainment problem. The following sections discuss the significance of the precursor pollutants and reentrained road dust to the $PM_{2.5}$ nonattainment problem.

5.2.1 Precursor Pollutants NOx, VOC and Ammonia

The $PM_{2.5}$ precursor NO_x is presumed to be a significant contributor to the $PM_{2.5}$ nonattainment problem by the USEPA. The NCDAQ has determined that NOx is a relatively minor contributor to the $PM_{2.5}$ concentrations in North Carolina. However, the NCDAQ is not asserting that NOx is an insignificant precursor for the 1997 or 2006 revisions of the $PM_{2.5}$ standard. Therefore, the NCDAQ will establishe county level MVEBs for NOx for all three $PM_{2.5}$ nonattainment counties.

For the purpose of this attainment demonstration, VOC and ammonia are presumed to be insignificant contributors to the $PM_{2.5}$ nonattainment problem by the USEPA. The NCDAQ agrees with the USEPA that both VOC and ammonia are insignificant contributors to the $PM_{2.5}$ nonattainment problem in North Carolina. The discussion of the insignificance of these precursors is presented in Apendix O. Since these precursors have been deemed insignificant, no MVEBs are being established for VOC or ammonia.

5.2.2 Reentrained Road Dust

The majority of the roads in North Carolina are paved so there is minimum road dust due to the paved roads. The factor to calculate reentrained road dust on paved roads is very small. What dust is generated, has been shown in the literature, *Methodology to Estimate the Transportable Fraction (TF) of Fugitive Dust Emissions for Regional and Urban Scale Air Quality Analyses, US EPA, August 3, 2005*, to be inconsequential.

This fact is affirmed by the small crustal component in the $PM_{2.5}$ speciated data which measures only 3% at Hickory monitoring site (Catawba County) in 2002 and only 2% at Lexington monitoring site (Davidson County) in 2004 (see Figure 5.2.2-1 below).

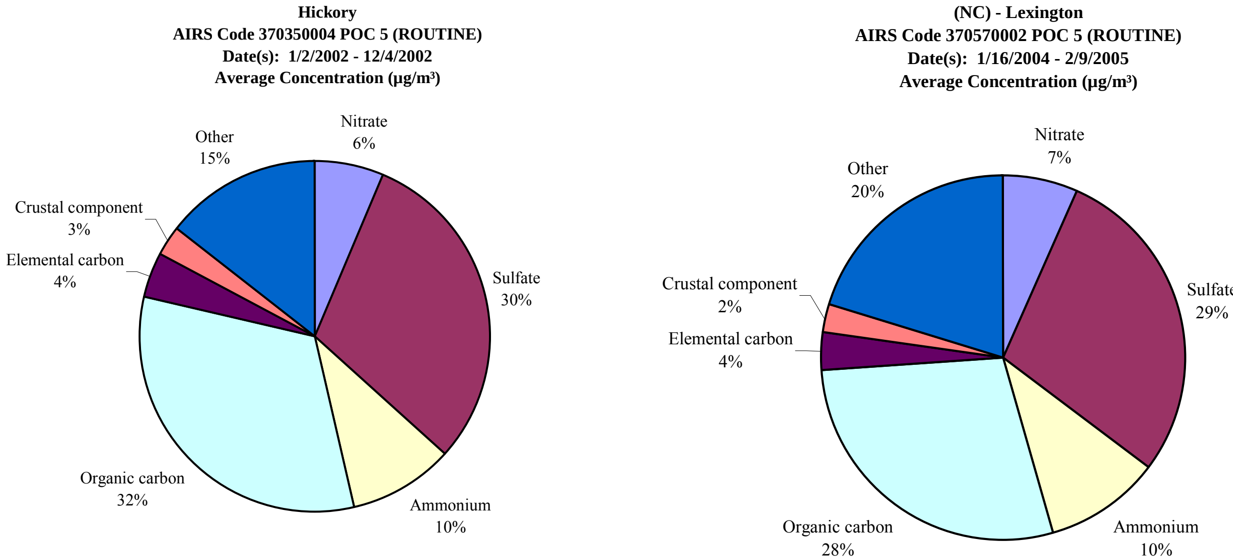

Figure 5.2.2-1. Speciated Data for the Hickory area (left) and the Triad area (right)

Since the reentrained road dust is not a significant contributor to the $PM_{2.5}$ nonattainment problem, the NCDAQ will not be establishing MVEBs for this source category. An affirmative insignificance finding from the USEPA only relieves the transportation partners from a regional emissions analysis for reentrained road dust emissions for these areas and does not relieve them of the other transportation conformity requirements. The transportation partners will need to note the reentrained road dust insignificance finding (if found adequate and approved by the USEPA) in future conformity determinations.

5.2.3 Precursor Pollutant SO_2

The $PM_{2.5}$ precursor SO_2 could not be deemed insignificant to the $PM_{2.5}$ nonattainment problem. However, the NCDAQ has determined that SO_2 emitted by the mobile source sector is insignificant. The USEPA in its Federal Register notice for $PM_{2.5}$ does not address the mobile sector in its listing of significant emissions. North Carolina agrees with the following statements addressing SO_2 from on-road mobile emissions as published in the May 6, 2005 Federal Register, 70 FR 24283:

"While speciated air quality data show that sulfate is a relatively significant component (e.g., ranging from nine to 40 percent) of $PM_{2.5}$ mass in all regions of the country, emissions inventory data and projections show that on-road emissions of SOx constitute a ''de minimis'' (i.e., extremely small) portion of total SOx emissions. Emissions inventory data for 1999 for the 372 potential $PM_{2.5}$ nonattainment counties for $PM_{2.5}$ (based on 1999–2001 air quality data) show that on-road sources were responsible for only two percent of total SOx emissions.

Furthermore, EPA has already adopted two regulations that will greatly reduce emissions of SOx from on-road sources by the time such regulations are both in full effect in 2009. First, in 2004 the low sulfur gasoline program began to be phased in and will be fully effective in 2007 (February 10, 2000, 65 FR 6697). This regulation will reduce the sulfur content of gasoline by approximately 90 percent when fully effective. Second, in 2006 the low sulfur diesel program will begin to be phased in and will be fully effective by 2009 (January 18, 2001, 66 FR 5001). This regulation will reduce the sulfur content of diesel fuel by approximately 97 percent nationally when fully effective.

Projections of on-road emissions of SO_2 in 2020 indicate that on-road sources will be responsible for less than one percent of the total SO_2 emissions in 2020 in the 372 potential $PM_{2.5}$ nonattainment counties (based on 1999– 2001 air quality data). These projections confirm that the implementation of the fuel regulations discussed above will ensure that as a general matter of SO_2 emissions from on-road sources remain at insignificant levels in all areas."

Although sulfate is a significant component to the $PM_{2.5}$ nonattainment problem in North Carolina, the majority of the SO2 emissions in 2009 come from the stationary point source sector (see Figure 5.2.3-1). The mobile source sector only contributes one half of one percent (0.05 %) of the 2009 statewide SO_2 emissions. This is consistent with what the USEPA stated above.

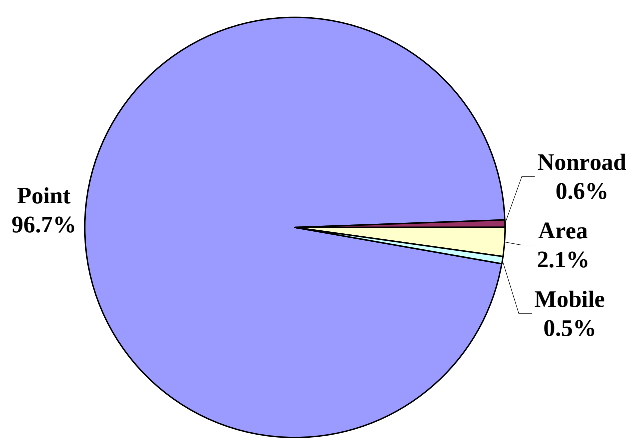

Figure 5.2.3-1. North Carolina's 2009 Statewide SO_2 Emissions

Since the mobile source SO_2 contribution is insignificant, the NCDAQ is not establishing MVEBs for this precursor. An affirmative insignificance finding from the USEPA only relieves the transportation partners from a regional emissions analysis for SO_2 emissions for these areas and does not relieve them of the other transportation conformity requirements. The transportation partners will need to note the SO_2 insignificance finding (if found adequate and approved by the USEPA) in future conformity determinations.

5.3 Highway Mobile Source Direct $PM_{2.5}$ Emssions

The mobile source pollutants to be addressed for transportation conformity purposes are direct $PM_{2.5}$ emissions for the Triad and NOx for both Hickory and the Triad. 40 CFR 93.109(k) in the Transportation Conformity Rule Amendments for the new 8-hour ozone and fine particulate matter National Ambient Air Quality Standards (NAAQSs) addresses areas with insignificant motor vehicle emissions as follows,

> *"Notwithstanding the other paragraphs in this section, an area is not required to satisfy a regional emissions analysis for §93.118 and/or §93.119 for a given pollutant/precursor and NAAQS, if EPA finds through the adequacy or approval process that a SIP demonstrates that regional motor vehicle emissions are an insignificant contributor to the air quality problem for that pollutant/precursor and NAAQS. The SIP would have to demonstrate that it would be unreasonable to expect that such an area would experience enough motor vehicle emissions growth in that pollutant/precursor for a NAAQS violation to occur."*

The rule suggests that such a finding would be based on a number of factors, including the percentage of motor vehicle emissions in the context of the total SIP inventory, the current state of air quality as determined by monitoring data for that NAAQS, the absence of SIP motor vehicle control measures, and historical trends and future projections of the growth of motor vehicle emissions. Although there is an inspection and maintenance program in the nonattainment areas, this control measure does not control primary $PM_{2.5}$, but rather is in place to reduce the ozone precursors.

The NCDAQ believes strongly that the primary $PM_{2.5}$ emissions from mobile sources do not contribute significantly to the $PM_{2.5}$ nonattainment problem. However, USEPA has indicated they will not approve a SIP that does not set MVEBs for primary $PM_{2.5}$ for the Triad. Therefore, the NCDAQ will establishe county level MVEBs for primary $PM_{2.5}$ for the Triad. The sections that follow discuss the insignificance of PM2.5 emissions.

5.3.1 Insignificance of Primary $PM_{2.5}$ Emissions

The NCDAQ has examined the sources of $PM_{2.5}$ emissions and their contribution to $PM_{2.5}$ formation in the nonattainment counties. This was accomplished using the 2009 emissions inventories developed for the VISTAS/ASIP modeling. Figure 5.3.1-1 and 5.3.1-2 provides the percent contributions from point, area, nonroad mobile and on-road mobile source sectors for the Hickory and Triad nonattainment areas, respectively.

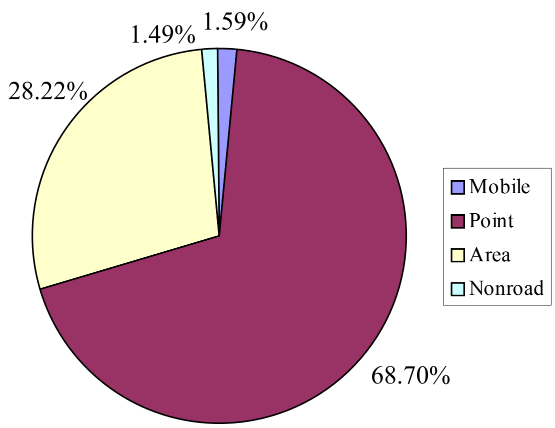

Figure 5.3.1-1. Hickory Area 2009 Primary $PM_{2.5}$ Emissions

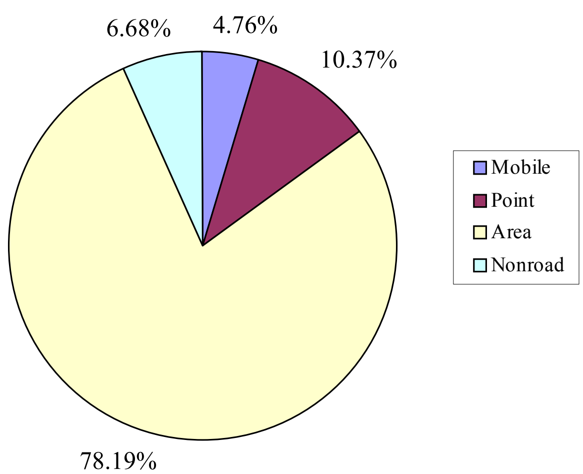

Figure 5.3.1-2. Triad Area 2009 Primary $PM_{2.5}$ Emissions

The 2009 on-road mobile $PM_{2.5}$ emissions contributed only 1.6% of the total $PM_{2.5}$ emissions for the Hickory area. In the Triad area, the 2009 mobile $PM_{2.5}$ emissions were 4.8% of the total $PM_{2.5}$ emissions. Therefore, in both areas it is demonstrated, in the opinion of NCDAQ, that the $PM_{2.5}$ emissions compared to the total $PM_{2.5}$ emissions are insignificant. However, USEPA has indicated that they only agree with the insignificance finding for on-road direct PM2.5 for Hickory. It should be noted that the mobile source $PM_{2.5}$ emissions slightly decrease from 2002 to 2009 despite an increase in VMT. The Hickory $PM_{2.5}$ emissions go from 100 tons/year in 2002 to 75 tons/year in 2009 and the Triad area goes from 319 tons/year to 245 tons/year. Meanwhile, we see an increase in VMT in the Hickory area from 4,444,280 miles/day in 2002 to 5,081,590 miles/day in 2009. For the Triad, the VMT grows from 15,000,150 miles/day in 2002 to 16,399,220 miles/day in 2009. Further justification for the case insignificance of direct PM2.5 emission follows.

The NCDAQ performed sensitivity modeling using 2008 emissions modeling in order to address the challenge of Section 93.109(k) in the Transportation Conformity Rule Amendments, *"The SIP would have to demonstrate that it would be unreasonable to expect enough motor vehicle emissions growth in that pollutant/precursor for a NAAQS violation to occur"*. The modeling system used was the same as the VISTAS/ASIP modeling and consisted of three components: 1) the Penn State University/National Center for Atmospheric Research Mesoscale Model (MM5 version 3.6.1+), 2) the Sparse Matrix Operator Kernel Emissions Modeling System (SMOKE version 2.1), and 3) the Community Multiscale Air Quality (CMAQ version 4.4) model. Model configurations, input data, and modeling methods are consistent with those suggested by the USEPA in *Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-hour Ozone NAAQS*.

The primary $PM_{2.5}$ emissions from on-road mobile sources were doubled in Catawba, Davidson and Guilford Counties, therefore, simulating a doubling of the VMT during a 7-day summer time simulation. The results of the emissions sensitivities showed such similar results that looking at just the difference between two air quality model simulations, one with base case emissions and another with reduced emissions inputs, showed no change. To show what the differences were between the two runs, line graphs of the hourly emissions for the time period modeled for all three counties are displayed in Figures 5.3.1-3 through 5.3.1-5 below**.** The sensitivity modeling design value (DV) increased by 0.04 $\mu g/m^3$ in Catawba County. In the Triad nonattainment area, the sensitivity modeling DV increased by 0.05 $\mu g/m^3$ and 0.07 $\mu g/m^3$ in Davidson and Guilford Counties, respectively. In both nonattainment areas, the modeling DV increased by less than one-tenth $\mu g/m^3$. These differences are barely visible as seen in the figures below.

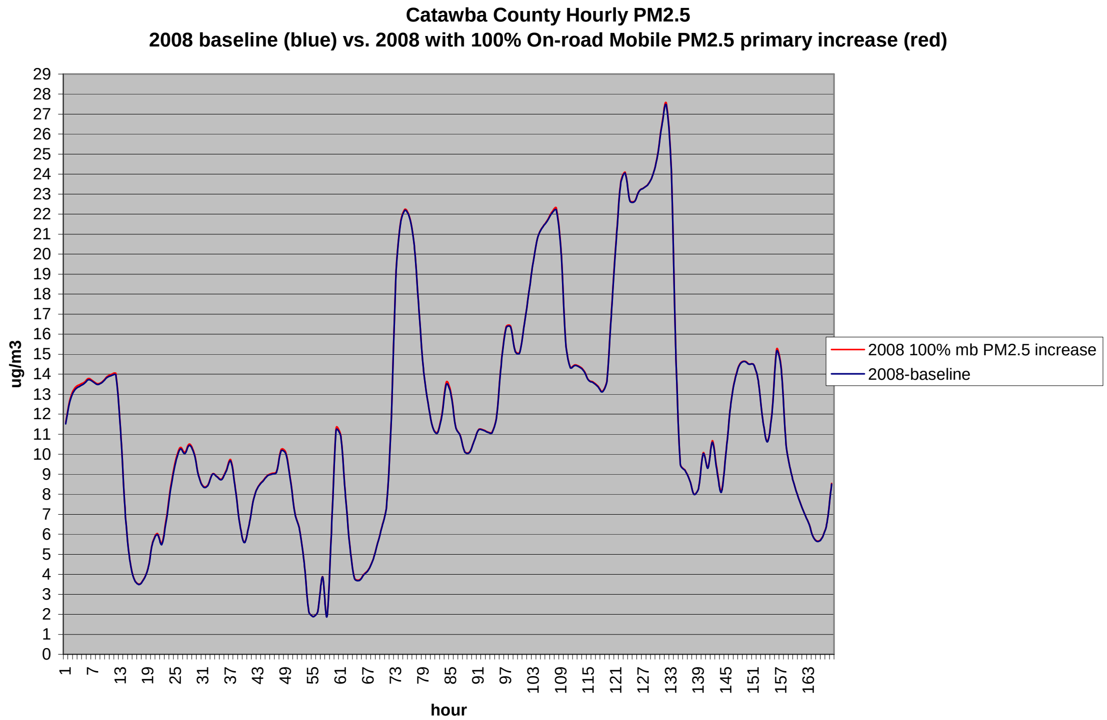

Figure 5.3.1-3. Catawba County Hourly PM25 Emissions

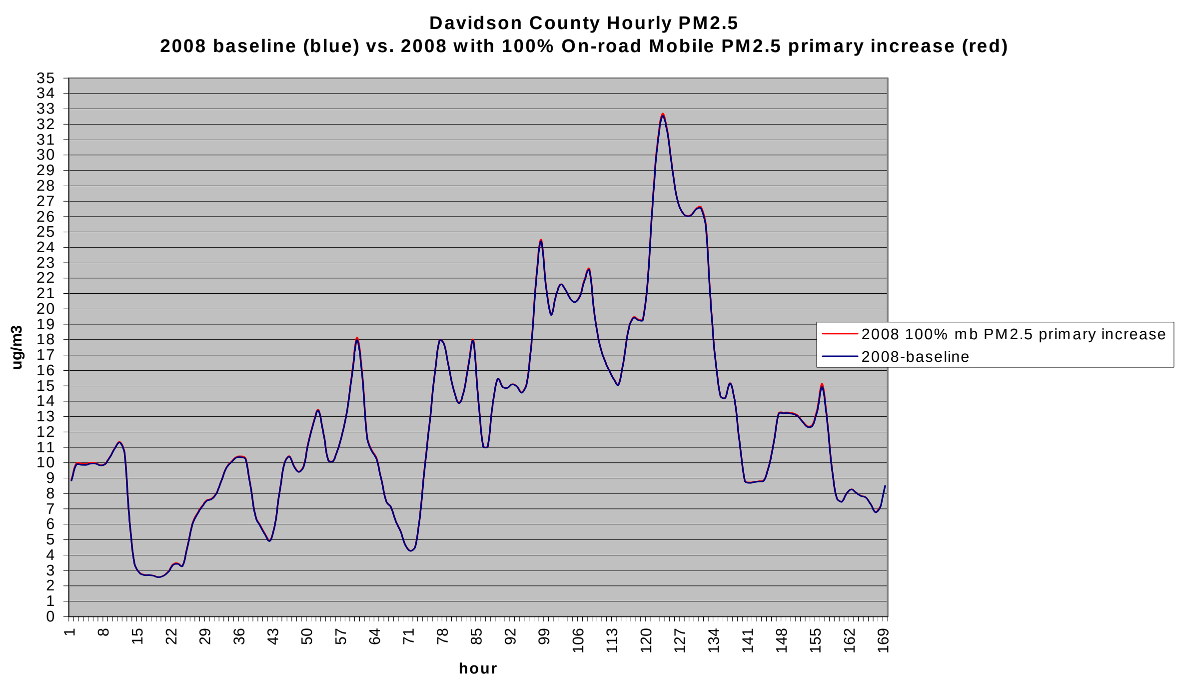

Figure 5.3.1-4. Davidson County Hourly PM25 Emissions

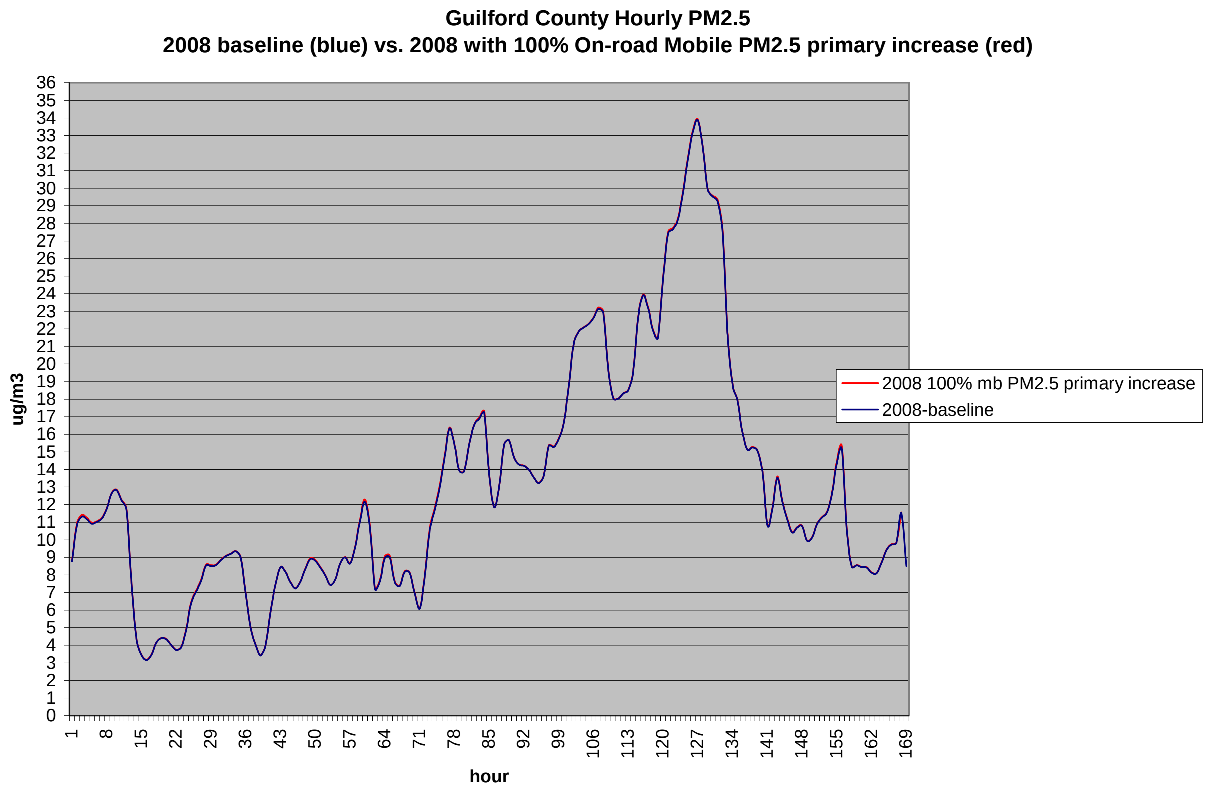

Figure 5.3.1-5. Guilford County Hourly PM_{25} Emissions

Based on the information discussed above, the NCDAQ steadfastly believes that the on-road mobile $PM_{2.5}$ emissions are insignificant contributors to the $PM_{2.5}$ nonattainment problem. Emission estimates indicate that the on-road mobile $PM_{2.5}$ emissions are a small percentage of the total $PM_{2.5}$ emissions in the nonattainment areas. On-road mobile $PM_{2.5}$ emissions are projected to decrease into the future notwithstanding VMT increases. Air quality modeling sensitivities show that doubling the mobile source $PM_{2.5}$ emissions has very little effect on the future design values. Furthermore, both nonattainment areas are modeled to be well below the annual $PM_{2.5}$ NAAQS by 2009 as discussed in the attainment demonstration SIP narrative and the NCDAQ considers it unreasonable to expect that the $PM_{2.5}$ nonattainment areas will experience enough motor vehicle $PM_{2.5}$ emissions growth for a future $PM_{2.5}$ violation to occur due to mobile sources.

Due to above analysis and agreement from EPA, budgets for direct PM2.5 will not be set for the Hickory nonattainment area. An affirmative insignificance finding from the USEPA only relieves the transportation partners from a regional emissions analysis for $PM_{2.5}$ emissions for this area and does not relieve them of the other transportation conformity requirements. The transportation partners will need to note the $PM_{2.5}$ insignificance finding (if found adequate and approved by the USEPA) in future conformity determinations.

5.3.2 PM_{25} and NOx Motor Vehicle Emissions Budgets

As part of the consultation process on setting MVEBs, the NCDAQ sent out a request for comment on setting the geographic extent of the MVEBs to all of the transportation partners. A copy of the letter can be found in Appendix B. In the letter, the NCDAQ expressed its preference for setting county level budgets and some of the reasons why the NCDAQ believed county level budgets were appropriate. With respect to the $PM_{2.5}$ nonattainment areas, the NCDAQ received comments from the Greensboro MPO regarding the geographic extent of the MVEBs. The Greensboro MPO agreed with the NCDAQ that MVEBs should be set at the county level. Copies of the letters received that relate to the $PM_{2.5}$ nonattainment areas can be found in Appendix B. Therefore MVEBs will be set at the county level.

MVEBs will be set for the attainment year 2009. By the time the MVEBs are found adequate or approved by the USEPA, the next transportation conformity regional emissions analysis should be for years 2009 and beyond. Therefore, MVEBs will not be set for the baseline year 2002.

Although the emissions are usually expressed in terms of tons, the MVEBs will be set in terms of kilograms (kg). The reason for this assertion is because the MOBILE model generates the emissions factors in grams per mile. In past conformity exercises, there have been some issues with conversion to tons, as well as concerns with how the MVEBs were rounded. Setting MVEBs in kilograms will avoid these issues in future conformity determinations.

Tables 5.3.2-1 and 5.3.2-2 below display the Triad highway mobile $PM_{2.5}$ and the Triad and Hickory highway mobile NO_X emissions expressed in tons per year and the corresponding kilograms per year values for 2009. These two tables are for reference purposes only and are not the tables presenting the 2009 MVEBs, which is discussed next.

Table 5.3.2-1. County Level $PM_{2.5}$ Highway Mobile Emissions for 2009

County	MVEB (Tons/year)	MVEB (Kilograms/year)
Davidson	78.4	71,152
Guilford	181.1	164,286

Table 5.3.2-2. County Level NO_X Highway Mobile Emissions for 2009

County	MVEB (Tons/year)	MVEB (Kilograms/year)
Catawba	3183.4	2,887,955
Davidson	4780.2	4,336,567
Guilford	11,034.9	10,010,856

The NCDAQ will set MVEBs, for transportation conformity purposes, as county budgets for 2009. Tables 5.3.2-3 and 5.3.2-4 below present the Triad $PM_{2.5}$ and the Triad and Hickory NOx MVEBs in kilograms per year, by county. Upon the USEPA's affirmative adequacy finding for these county level sub-area MVEBs, these MVEBs will become the applicable MVEBs for each county.

Table 5.3.2-3. County Level PM_{25} MVEBs for 2009

County	MVEB (Kg/year)
Davidson	71,152
Guilford	164,286

Table 5.3.2-4. County Level NOx MVEBs for 2009

County	MVEB (Kg/year)
Catawba	2,887,955
Davidson	4,336,567
Guilford	10,010,856

6. MOBILE6.2 DATA USED IN SETTING MVEBs

6.1 MOBILE6.2 Input Files for PM2.5 and NOx

6.1.1 Input Files for PM2.5

6.1.1.1 Catawba County 2009 MOBILE6.2 Input File for PM2.5

```
POLLUTANTS         :
PARTICULATES       :
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 9.0

REG DIST           : ncage05.prn

MIN/MAX TEMP       : 50.0 70.0

> OBDII

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3442  0.0815  0.2714  0.0836  0.0384  0.0564  0.0055  0.0046
0.0035  0.0126  0.0149  0.0162  0.0577  0.0029  0.0015  0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3699  0.0876  0.2918  0.0899  0.0413  0.0366  0.0036  0.0030
0.0023  0.0082  0.0097  0.0105  0.0374  0.0019  0.0009  0.0054
```

```
AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3930  0.0931  0.3100  0.0956  0.0439  0.0188  0.0018  0.0015
0.0012  0.0042  0.0050  0.0054  0.0192  0.0010  0.0005  0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3967  0.0939  0.3127  0.0964  0.0443  0.0161  0.0016  0.0013
0.0010  0.0036  0.0043  0.0046  0.0165  0.0008  0.0004  0.0058

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban local mix and speeds

VMT FRACTIONS      :
0.3872  0.0917  0.3054  0.0941  0.0433  0.0233  0.0023  0.0019
0.0014  0.0052  0.0062  0.0067  0.0238  0.0012  0.0006  0.0057

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
```

```
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3030 0.0718 0.2389 0.0736 0.0339 0.0880 0.0086 0.0072
0.0054 0.0197 0.0233 0.0253 0.0900 0.0045 0.0023 0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3591 0.0851 0.2833 0.0873 0.0401 0.0448 0.0044 0.0037
0.0028 0.0100 0.0119 0.0129 0.0458 0.0023 0.0012 0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3668 0.0869 0.2894 0.0892 0.0410 0.0389 0.0038 0.0032
0.0024 0.0087 0.0103 0.0112 0.0398 0.0020 0.0010 0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3827 0.0906 0.3018 0.0930 0.0428 0.0267 0.0026 0.0022
0.0017 0.0060 0.0071 0.0077 0.0274 0.0014 0.0007 0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Rural minor collector mix and speeds

VMT FRACTIONS      :
```

```
0.3821  0.0905  0.3014  0.0929  0.0427  0.0272  0.0027  0.0022
0.0017  0.0061  0.0072  0.0078  0.0278  0.0014  0.0007  0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Rural local mix and speeds

VMT FRACTIONS      :
0.3805  0.0901  0.3001  0.0925  0.0425  0.0284  0.0028  0.0023
0.0018  0.0064  0.0075  0.0082  0.0291  0.0015  0.0007  0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3442  0.0815  0.2714  0.0836  0.0384  0.0564  0.0055  0.0046
0.0035  0.0126  0.0149  0.0162  0.0577  0.0029  0.0015  0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3699  0.0876  0.2918  0.0899  0.0413  0.0366  0.0036  0.0030
0.0023  0.0082  0.0097  0.0105  0.0374  0.0019  0.0009  0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q
```

```
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3930 0.0931 0.3100 0.0956 0.0439 0.0188 0.0018 0.0015
0.0012 0.0042 0.0050 0.0054 0.0192 0.0010 0.0005 0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3967 0.0939 0.3127 0.0964 0.0443 0.0161 0.0016 0.0013
0.0010 0.0036 0.0043 0.0046 0.0165 0.0008 0.0004 0.0058

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.0

> Urban local mix and speeds

VMT FRACTIONS      :
0.3872 0.0917 0.3054 0.0941 0.0433 0.0233 0.0023 0.0019
0.0014 0.0052 0.0062 0.0067 0.0238 0.0012 0.0006 0.0057

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

END OF RUN         :
```

6.1.1.2 Davidson County 2009 MOBILE6.2 Input File for PM2.5

```
POLLUTANTS         :
PARTICULATES       :
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 7.8

MIN/MAX TEMP       : 49.0 70.0

REG DIST           : NCage05.prn

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22121111
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3030 0.0718 0.2389 0.0736 0.0339 0.0880 0.0086 0.0072
0.0054 0.0197 0.0233 0.0253 0.0900 0.0045 0.0023 0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3591 0.0851 0.2833 0.0873 0.0401 0.0448 0.0044 0.0037
0.0028 0.0100 0.0119 0.0129 0.0458 0.0023 0.0012 0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00
```

```
> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3668 0.0869 0.2894 0.0892 0.0410 0.0389 0.0038 0.0032
0.0024 0.0087 0.0103 0.0112 0.0398 0.0020 0.0010 0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

**********  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3827 0.0906 0.3018 0.0930 0.0428 0.0267 0.0026 0.0022
0.0017 0.0060 0.0071 0.0077 0.0274 0.0014 0.0007 0.0056

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3821 0.0905 0.3014 0.0929 0.0427 0.0272 0.0027 0.0022
0.0017 0.0061 0.0072 0.0078 0.0278 0.0014 0.0007 0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural local mix and speeds

VMT FRACTIONS      :
0.3805 0.0901 0.3001 0.0925 0.0425 0.0284 0.0028 0.0023
0.0018 0.0064 0.0075 0.0082 0.0291 0.0015 0.0007 0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3442 0.0815 0.2714 0.0836 0.0384 0.0564 0.0055 0.0046
0.0035 0.0126 0.0149 0.0162 0.0577 0.0029 0.0015 0.0051

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0
```

```
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3699 0.0876 0.2918 0.0899 0.0413 0.0366 0.0036 0.0030
0.0023 0.0082 0.0097 0.0105 0.0374 0.0019 0.0009 0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3930 0.0931 0.3100 0.0956 0.0439 0.0188 0.0018 0.0015
0.0012 0.0042 0.0050 0.0054 0.0192 0.0010 0.0005 0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3967 0.0939 0.3127 0.0964 0.0443 0.0161 0.0016 0.0013
0.0010 0.0036 0.0043 0.0046 0.0165 0.0008 0.0004 0.0058

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
```

```
DIESEL SULFUR      : 43.00

> Urban local mix and speeds

VMT FRACTIONS      :
0.3872  0.0917  0.3054  0.0941  0.0433  0.0233  0.0023  0.0019
0.0014  0.0052  0.0062  0.0067  0.0238  0.0012  0.0006  0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********

SCENARIO RECORD    : Rural interstate - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

VMT FRACTIONS      :
0.3030  0.0718  0.2389  0.0736  0.0339  0.0880  0.0086  0.0072
0.0054  0.0197  0.0233  0.0253  0.0900  0.0045  0.0023  0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3591  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0458  0.0023  0.0012  0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3668  0.0869  0.2894  0.0892  0.0410  0.0389  0.0038  0.0032
0.0024  0.0087  0.0103  0.0112  0.0398  0.0020  0.0010  0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

**********  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3827  0.0906  0.3018  0.0930  0.0428  0.0267  0.0026  0.0022
0.0017  0.0060  0.0071  0.0077  0.0274  0.0014  0.0007  0.0056
```

```
AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3821 0.0905 0.3014 0.0929 0.0427 0.0272 0.0027 0.0022
0.0017 0.0061 0.0072 0.0078 0.0278 0.0014 0.0007 0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural local mix and speeds

VMT FRACTIONS      :
0.3805 0.0901 0.3001 0.0925 0.0425 0.0284 0.0028 0.0023
0.0018 0.0064 0.0075 0.0082 0.0291 0.0015 0.0007 0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3442 0.0815 0.2714 0.0836 0.0384 0.0564 0.0055 0.0046
0.0035 0.0126 0.0149 0.0162 0.0577 0.0029 0.0015 0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3699 0.0876 0.2918 0.0899 0.0413 0.0366 0.0036 0.0030
0.0023 0.0082 0.0097 0.0105 0.0374 0.0019 0.0009 0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
```

```
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

************ SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3930 0.0931 0.3100 0.0956 0.0439 0.0188 0.0018 0.0015
0.0012 0.0042 0.0050 0.0054 0.0192 0.0010 0.0005 0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

************ SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3967 0.0939 0.3127 0.0964 0.0443 0.0161 0.0016 0.0013
0.0010 0.0036 0.0043 0.0046 0.0165 0.0008 0.0004 0.0058

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

************ SCENARIO SECTION ********
SCENARIO RECORD    : Urban local - Non Modeled
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban local mix and speeds

VMT FRACTIONS      :
0.3872 0.0917 0.3054 0.0941 0.0433 0.0233 0.0023 0.0019
0.0014 0.0052 0.0062 0.0067 0.0238 0.0012 0.0006 0.0057

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

END OF RUN         :
```

6.1.1.3 Guilford County 2009 MOBILE6.2 Input File for PM2.5

```
POLLUTANTS          :
PARTICULATES        :
SPREADSHEET         : Guilford County
RUN DATA            :
***************** RUN SECTION  **********
FUEL RVP            : 7.8

MIN/MAX TEMP        : 49.0 70.0

REG DIST            : trdage05.prn

I/M PROGRAM         : 1 2003 2050 1 TRC OBD I/M
I/M MODEL YEARS     : 1 1996 2050
I/M VEHICLES        : 1 22222 11111111 1
I/M STRINGENCY      : 1 10.0
I/M COMPLIANCE      : 1 95.0
I/M WAIVER RATES    : 1 5.0 5.0

I/M PROGRAM         : 2 2003 2050 1 TRC EVAP OBD
I/M MODEL YEARS     : 2 1996 2050
I/M VEHICLES        : 2 22222 11111111 1
I/M STRINGENCY      : 2 10.0
I/M COMPLIANCE      : 2 95.0
I/M WAIVER RATES    : 2 5.0 5.0

ANTI-TAMP PROG      :
91 75 50 22222 22222222 2 11 095. 22121111
************  SCENARIO SECTION ********
SCENARIO RECORD     : Rural interstate - TDM
CALENDAR YEAR       : 2009
EVALUATION MONTH    : 7
PARTICULATE EF      : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE       : 2.50
DIESEL SULFUR       : 43.00

> Rural interstate mix and speeds

VMT FRACTIONS       :
0.3030  0.0718  0.2389  0.0736  0.0339  0.0880  0.0086  0.0072
0.0054  0.0197  0.0233  0.0253  0.0900  0.0045  0.0023  0.0045

AVERAGE SPEED       : 59 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD     : Rural principle arterial - TDM
CALENDAR YEAR       : 2009
EVALUATION MONTH    : 7
PARTICULATE EF      : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE       : 2.50
DIESEL SULFUR       : 43.00

> Rural other principle arterial mix and speeds

VMT FRACTIONS       :
0.3591  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0458  0.0023  0.0012  0.0053

AVERAGE SPEED       : 57 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD     : Rural minor arterial - TDM
CALENDAR YEAR       : 2009
EVALUATION MONTH    : 7
PARTICULATE EF      : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE       : 2.50
DIESEL SULFUR       : 43.00
```

```
> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3668 0.0869 0.2894 0.0892 0.0410 0.0389 0.0038 0.0032
0.0024 0.0087 0.0103 0.0112 0.0398 0.0020 0.0010 0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3827 0.0906 0.3018 0.0930 0.0428 0.0267 0.0026 0.0022
0.0017 0.0060 0.0071 0.0077 0.0274 0.0014 0.0007 0.0056

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3821 0.0905 0.3014 0.0929 0.0427 0.0272 0.0027 0.0022
0.0017 0.0061 0.0072 0.0078 0.0278 0.0014 0.0007 0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Rural local mix and speeds

VMT FRACTIONS      :
0.3805 0.0901 0.3001 0.0925 0.0425 0.0284 0.0028 0.0023
0.0018 0.0064 0.0075 0.0082 0.0291 0.0015 0.0007 0.0056

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3442 0.0815 0.2714 0.0836 0.0384 0.0564 0.0055 0.0046
0.0035 0.0126 0.0149 0.0162 0.0577 0.0029 0.0015 0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0
```

```
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3699 0.0876 0.2918 0.0899 0.0413 0.0366 0.0036 0.0030
0.0023 0.0082 0.0097 0.0105 0.0374 0.0019 0.0009 0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3930 0.0931 0.3100 0.0956 0.0439 0.0188 0.0018 0.0015
0.0012 0.0042 0.0050 0.0054 0.0192 0.0010 0.0005 0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
DIESEL SULFUR      : 43.00

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3967 0.0939 0.3127 0.0964 0.0443 0.0161 0.0016 0.0013
0.0010 0.0036 0.0043 0.0046 0.0165 0.0008 0.0004 0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local - TDM
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 2.50
```

```
DIESEL SULFUR      : 43.00

> Urban local mix and speeds

VMT FRACTIONS      :
0.3872  0.0917  0.3054  0.0941  0.0433  0.0233  0.0023  0.0019
0.0014  0.0052  0.0062  0.0067  0.0238  0.0012  0.0006  0.0057

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

END OF RUN         :
```

6.1.2 2009 MOBILE6.2 Input Files for NOx

6.1.2.1 Catawba County 2009 MOBILE6.2 Input Files for NOx

MOBILE6 INPUT FILE :

```
> Catawba County 2009   IM,TDM/Rural, PM SIP Winter Q1
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 37.8 36.8 37.2 40.6 44.1 47.8 50.3 52.6 53.8 54.7 54.8 54.0
                     51.5 49.3 47.8 46.4 44.8 44.1 42.8 41.5 40.5 40.2 39.6 38.6

> OBDII

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
```

```
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1
```

```
> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds
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VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5
BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054
```

```
AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
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                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009   Non IM,TDM/Rural, PM SIP Winter Q1
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 37.8 36.8 37.2 40.6 44.1 47.8 50.3 52.6 53.8 54.7 54.8 54.0
                     51.5 49.3 47.8 46.4 44.8 44.1 42.8 41.5 40.5 40.2 39.6 38.6

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0
```

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RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5
BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
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EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds
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VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.2 76.0 76.1 70.5 63.2 59.5 54.6 53.1 51.6 47.5 47.4 48.6
                     50.1 55.4 57.8 58.6 61.9 64.5 67.0 68.1 70.5 70.1 72.0 73.5

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009   IM,TDM/Rural, PM SIP Spring Q2
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  *********
FUEL RVP           : 10.5

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 58.3 60.5 63.7 67.1 69.6 72.3 73.7 75.6 75.8 76.6 76.6 75.7
                     74.3 72.0 69.6 67.6 65.7 64.5 63.8 62.2 61.2 60.4 59.4 58.5

> OBDII

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
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I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058
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AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056


AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
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SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009   NON IM,TDM/Rural, PM SIP Spring Q2
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 10.5

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 58.3 60.5 63.7 67.1 69.6 72.3 73.7 75.6 75.8 76.6 76.6 75.7
                     74.3 72.0 69.6 67.6 65.7 64.5 63.8 62.2 61.2 60.4 59.4 58.5

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
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SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
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> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds
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VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054
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AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056


AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0
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RELATIVE HUMIDITY  : 86.3 82.7 74.8 66.5 60.0 55.2 52.3 49.1 48.5 47.6 48.3 49.2
                     51.0 55.6 60.5 64.7 68.4 71.9 74.7 76.4 79.5 81.8 83.4 84.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009  IM,TDM/Rural, PM SIP Spring Q3
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
****************** RUN SECTION  **********
FUEL RVP           : 9.0

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 66.8 67.9 70.5 73.7 76.6 78.7 80.9 81.2 82.1 82.5 82.3 81.3
                     79.9 77.8 73.6 73.1 71.8 71.1 70.3 69.6 69.0 68.0 67.5 66.9

> OBDII

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q3
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
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> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056


AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2
BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009   NON IM,TDM/Rural, PM SIP Spring Q3
> Updated with new vehicle-mix and vehicle-age Sept '08
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POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 9.0

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 66.8 67.9 70.5 73.7 76.6 78.7 80.9 81.2 82.1 82.5 82.3 81.3
                     79.9 77.8 73.6 73.1 71.8 71.1 70.3 69.6 69.0 68.0 67.5 66.9


ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds
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VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053
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AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0
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RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056


AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 87.9 85.2 80.3 73.1 67.6 63.0 58.3 58.5 56.6 56.6 56.5 58.6
                     60.3 63.3 73.1 74.3 78.8 81.0 82.0 83.6 84.7 86.8 87.2 88.2

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009   IM,TDM/Rural, PM SIP Fall Q4
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 43.3 43.3 43.5 46.3 49.2 51.6 53.5 54.7 55.6 56.0 54.0 55.8
                     51.7 50.5 49.1 47.8 47.3 46.2 45.7 45.7 44.9 44.6 44.0 43.7

> OBDII

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
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91 75 50 22222 22222222 2 11 095. 22212222

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
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SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1
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> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4
BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
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0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059
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AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Catawba County 2009   Non IM,TDM/Rural, PM SIP Fall Q4
> Updated with new vehicle-mix and vehicle-age Sept '08

POLLUTANTS         : NOX
SPREADSHEET        : Catawba County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14

REG DIST           : ncage07.prn

HOURLY TEMPERATURES: 43.3 43.3 43.5 46.3 49.2 51.6 53.5 54.7 55.6 56.0 54.0 55.8
                     51.7 50.5 49.1 47.8 47.3 46.2 45.7 45.7 44.9 44.6 44.0 43.7

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-TDM-Q4
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-TDM-Q4
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
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0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial-Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 27 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 33 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-TDM-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056
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AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 47 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
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                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4
BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 63 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
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```
SCENARIO RECORD    : Urban principle arterial-Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056

AVERAGE SPEED      : 29 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local- Catawba County-Rural-Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056


AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.7 86.0 85.4 79.8 73.6 67.7 63.8 61.5 59.4 57.9 58.8 62.2
                     67.1 70.6 73.1 74.2 76.9 80.8 81.7 82.3 83.4 84.4 84.9 85.4

BAROMETRIC PRES    : 30
END OF RUN         :
```

6.1.2.2 Davidson County 2009 MOBILE6.2 Input Files for NOx

MOBILE6 INPUT FILE :

```
> Davidson County 2009 I&M PM SIP Winter(Q1)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14

HOURLY TEMPERATURES: 37.5 37.1 37.9 41.5 44.8 47.5 49.7 51.4 52.7 53.6 53.6 52.4
                     50.3 48.2 46.3 45.0 43.9 42.9 42.3 41.3 40.4 39.7 39.1 38.1

REG DIST           : ncage07.prn

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q1
```

```
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1
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> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
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0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054
```

```
AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Davidson County 2009 NON I&M PM SIP Winter(Q1)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14

HOURLY TEMPERATURES: 37.5 37.1 37.9 41.5 44.8 47.5 49.7 51.4 52.7 53.6 53.6 52.4
                     50.3 48.2 46.3 45.0 43.9 42.9 42.3 41.3 40.4 39.7 39.1 38.1

REG DIST           : ncage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q1
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1
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> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds
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VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059
```

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AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Davidson County 2009 I&M PM SIP Spring(Q2)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 10.1

HOURLY TEMPERATURES: 58.6 61.1 64.5 67.6 70.1 72.8 74.6 75.7 76.5 77.1 76.8 75.9
                     74.2 71.6 69.2 67.5 65.8 64.7 63.7 62.2 61.2 60.2 59.3 58.5

REG DIST           : ncage07.prn

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054
AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q2
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
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> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds
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VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058
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AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059
AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Davidson County 2009 NON I&M PM SIP Spring(Q2)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 10.1

HOURLY TEMPERATURES: 58.6 61.1 64.5 67.6 70.1 72.8 74.6 75.7 76.5 77.1 76.8 75.9
                     74.2 71.6 69.2 67.5 65.8 64.7 63.7 62.2 61.2 60.2 59.3 58.5

REG DIST           : ncage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
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0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054
AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0
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RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
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SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
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> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds
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VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059
AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Davidson County 2009 I&M PM SIP Summer(Q3)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 7.8

HOURLY TEMPERATURES: 68.2 69.7 72.3 75.0 77.5 79.6 81.2 82.2 83.0 83.1 82.6 81.6
                     79.9 77.2 74.7 73.3 72.2 72.3 71.2 70.8 70.1 69.4 68.7 68.3

REG DIST           : ncage07.prn

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
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I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0
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RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
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************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
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> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.00544

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
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0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Davidson County 2009 NON I&M PM SIP Summer(Q3)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
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***************** RUN SECTION  **********
FUEL RVP          : 7.8

HOURLY TEMPERATURES: 68.2 69.7 72.3 75.0 77.5 79.6 81.2 82.2 83.0 83.1 82.6 81.6
                     79.9 77.2 74.7 73.3 72.2 72.3 71.2 70.8 70.1 69.4 68.7 68.3

REG DIST           : ncage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057
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AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
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                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
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************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7
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> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Davidson County Year+1 - 2010 I&M PM SIP Fall(Q4)
> 2007 Veh Age Dist.
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POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14.0

HOURLY TEMPERATURES: 44.1 44.0 44.7 47.5 50.0 52.2 53.8 55.0 55.6 55.9 55.2 53.7
                     51.5 50.6 48.7 48.3 47.7 47.4 46.3 46.0 45.6 45.2 44.9 44.5

REG DIST           : ncage07.prn

I/M PROGRAM        : 1 2004 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2004 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054
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AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054
AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
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************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
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CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1
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> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
```

```
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
END OF RUN         :
```

MOBILE6 INPUT FILE :

```
> Davidson County Year+1 - 2010 NON I&M PM SIP Fall(Q4)
> 2007 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Davidson County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14.0

HOURLY TEMPERATURES: 44.1 44.0 44.7 47.5 50.0 52.2 53.8 55.0 55.6 55.9 55.2 53.7
                     51.5 50.6 48.7 48.3 47.7 47.4 46.3 46.0 45.6 45.2 44.9 44.5

REG DIST           : ncage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 68 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds
```

```
VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 48 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
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AVERAGE SPEED      : 66 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054
AVERAGE SPEED      : 52 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
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                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039    0.0719    0.2396    0.0738    0.0339    0.0874    0.0085    0.0072
0.0054    0.0195    0.0231    0.0252    0.0894    0.0045    0.0022    0.0045

AVERAGE SPEED      : 65 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590    0.0851    0.2833    0.0873    0.0401    0.0448    0.0044    0.0037
0.0028    0.0100    0.0119    0.0129    0.0459    0.0023    0.0012    0.0053

AVERAGE SPEED      : 44 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656    0.0866    0.2884    0.0889    0.0409    0.0398    0.0039    0.0033
0.0025    0.0089    0.0105    0.0115    0.0408    0.0020    0.0010    0.0054

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6
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BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057

AVERAGE SPEED      : 43 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

AVERAGE SPEED      : 42 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051

AVERAGE SPEED      : 62 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway Rural
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```
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054

AVERAGE SPEED      : 56 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 28 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059

AVERAGE SPEED      : 31 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local Rural
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1
```

```
> Urban local mix and speeds

VMT FRACTIONS      :
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056

AVERAGE SPEED      : 32 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
END OF RUN         :
```

6.1.2.3 Guilford County 2009 MOBILE6.2 Input File for Nox

MOBILE6 INPUT FILE :

```
> Guilford County 2009 I&M PM SIP Winter(Q1)
> Guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14.0

HOURLY TEMPERATURES: 37.5 37.1 37.9 41.5 44.8 47.5 49.7 51.4 52.7 53.6 53.6 52.4
                     50.3 48.2 46.3 45.0 43.9 42.9 42.3 41.3 40.4 39.7 39.1 38.1

REG DIST           : guiage07.prn

I/M PROGRAM        : 1 2003 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2003 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1
```

```
> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053


AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054


AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859  0.0914  0.3043  0.0938  0.0431  0.0243  0.0024  0.0020
0.0015  0.0054  0.0064  0.0070  0.0249  0.0013  0.0006  0.0057


AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838  0.0909  0.3027  0.0933  0.0429  0.0259  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0265  0.0013  0.0007  0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1
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> Rural local mix and speeds

VMT FRACTIONS      :
0.3713  0.0880  0.2930  0.0903  0.0415  0.0354  0.0035  0.0029
0.0022  0.0079  0.0094  0.0102  0.0362  0.0018  0.0009  0.0055


AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439  0.0815  0.2713  0.0836  0.0384  0.0565  0.0055  0.0046
0.0035  0.0126  0.0150  0.0163  0.0578  0.0029  0.0015  0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673  0.0870  0.2899  0.0894  0.0411  0.0384  0.0037  0.0032
0.0024  0.0086  0.0102  0.0111  0.0393  0.0020  0.0010  0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds
```

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VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056


AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Guilford County 2009 Non-IM PM SIP Winter(Q1)
> Guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14.0

HOURLY TEMPERATURES: 37.5 37.1 37.9 41.5 44.8 47.5 49.7 51.4 52.7 53.6 53.6 52.4
                     50.3 48.2 46.3 45.0 43.9 42.9 42.3 41.3 40.4 39.7 39.1 38.1

REG DIST           : guiage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q1
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039 0.0719 0.2396 0.0738 0.0339 0.0874 0.0085 0.0072
0.0054 0.0195 0.0231 0.0252 0.0894 0.0045 0.0022 0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590 0.0851 0.2833 0.0873 0.0401 0.0448 0.0044 0.0037
0.0028 0.0100 0.0119 0.0129 0.0459 0.0023 0.0012 0.0053


AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656 0.0866 0.2884 0.0889 0.0409 0.0398 0.0039 0.0033
0.0025 0.0089 0.0105 0.0115 0.0408 0.0020 0.0010 0.0054


AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859 0.0914 0.3043 0.0938 0.0431 0.0243 0.0024 0.0020
0.0015 0.0054 0.0064 0.0070 0.0249 0.0013 0.0006 0.0057


AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q1
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```
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838  0.0909  0.3027  0.0933  0.0429  0.0259  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0265  0.0013  0.0007  0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713  0.0880  0.2930  0.0903  0.0415  0.0354  0.0035  0.0029
0.0022  0.0079  0.0094  0.0102  0.0362  0.0018  0.0009  0.0055


AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439  0.0815  0.2713  0.0836  0.0384  0.0565  0.0055  0.0046
0.0035  0.0126  0.0150  0.0163  0.0578  0.0029  0.0015  0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673  0.0870  0.2899  0.0894  0.0411  0.0384  0.0037  0.0032
0.0024  0.0086  0.0102  0.0111  0.0393  0.0020  0.0010  0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1
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> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q1
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056


AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 74.5 75.1 74.9 67.8 59.9 55.7 52.1 49.5 47.7 46.6 45.8 48.0
                     51.9 56.6 58.6 61.2 63.4 65.0 66.0 67.0 68.0 68.8 70.3 72.4

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Guilford County 2009 I&M PM SIP Spring(Q2)
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> Guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 10.1

HOURLY TEMPERATURES: 58.6 61.1 64.5 67.6 70.1 72.8 74.6 75.7 76.5 77.1 76.8 75.9
                     74.2 71.6 69.2 67.5 65.8 64.7 63.7 62.2 61.2 60.2 59.3 58.5

REG DIST           : guiage07.prn

I/M PROGRAM        : 1 2003 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2003 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7


BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds
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VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859  0.0914  0.3043  0.0938  0.0431  0.0243  0.0024  0.0020
0.0015  0.0054  0.0064  0.0070  0.0249  0.0013  0.0006  0.0057

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838  0.0909  0.3027  0.0933  0.0429  0.0259  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0265  0.0013  0.0007  0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713  0.0880  0.2930  0.0903  0.0415  0.0354  0.0035  0.0029
0.0022  0.0079  0.0094  0.0102  0.0362  0.0018  0.0009  0.0055

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439  0.0815  0.2713  0.0836  0.0384  0.0565  0.0055  0.0046
0.0035  0.0126  0.0150  0.0163  0.0578  0.0029  0.0015  0.0051
```

```
AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673  0.0870  0.2899  0.0894  0.0411  0.0384  0.0037  0.0032
0.0024  0.0086  0.0102  0.0111  0.0393  0.0020  0.0010  0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0
```

```
RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

```
> Guilford County 2009 Non-IM PM SIP Spring(Q2)
> Guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 10.1

HOURLY TEMPERATURES: 58.6 61.1 64.5 67.6 70.1 72.8 74.6 75.7 76.5 77.1 76.8 75.9
                     74.2 71.6 69.2 67.5 65.8 64.7 63.7 62.2 61.2 60.2 59.3 58.5

REG DIST           : guiage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7


BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053
```

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AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859  0.0914  0.3043  0.0938  0.0431  0.0243  0.0024  0.0020
0.0015  0.0054  0.0064  0.0070  0.0249  0.0013  0.0006  0.0057

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838  0.0909  0.3027  0.0933  0.0429  0.0259  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0265  0.0013  0.0007  0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713  0.0880  0.2930  0.0903  0.0415  0.0354  0.0035  0.0029
0.0022  0.0079  0.0094  0.0102  0.0362  0.0018  0.0009  0.0055

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
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                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439  0.0815  0.2713  0.0836  0.0384  0.0565  0.0055  0.0046
0.0035  0.0126  0.0150  0.0163  0.0578  0.0029  0.0015  0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673  0.0870  0.2899  0.0894  0.0411  0.0384  0.0037  0.0032
0.0024  0.0086  0.0102  0.0111  0.0393  0.0020  0.0010  0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
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************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q2
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 82.0 79.1 71.1 63.6 58.4 53.0 49.5 46.8 45.3 44.3 45.4 46.5
                     49.5 54.7 59.4 62.9 66.8 69.6 70.3 72.7 75.5 77.9 80.4 81.7

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Guilford County 2009 I&M PM SIP Summer(Q3)
> Guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 7.8

HOURLY TEMPERATURES: 68.2 69.7 72.3 75.0 77.5 79.6 81.2 82.2 83.0 83.1 82.6 81.6
                     79.9 77.2 74.7 73.3 72.2 72.3 71.2 70.8 70.1 69.4 68.7 68.3

REG DIST           : guiage07.prn

I/M PROGRAM        : 1 2003 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2003 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q3
CALENDAR YEAR      : 2009
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EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859  0.0914  0.3043  0.0938  0.0431  0.0243  0.0024  0.0020
0.0015  0.0054  0.0064  0.0070  0.0249  0.0013  0.0006  0.0057

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q3
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CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838 0.0909 0.3027 0.0933 0.0429 0.0259 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0265 0.0013 0.0007 0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713 0.0880 0.2930 0.0903 0.0415 0.0354 0.0035 0.0029
0.0022 0.0079 0.0094 0.0102 0.0362 0.0018 0.0009 0.0055

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439 0.0815 0.2713 0.0836 0.0384 0.0565 0.0055 0.0046
0.0035 0.0126 0.0150 0.0163 0.0578 0.0029 0.0015 0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673 0.0870 0.2899 0.0894 0.0411 0.0384 0.0037 0.0032
0.0024 0.0086 0.0102 0.0111 0.0393 0.0020 0.0010 0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
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```
SCENARIO RECORD    : Urban principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Guilford County 2009 Non-IM PM SIP Summer(Q3)
> Guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 7.8

HOURLY TEMPERATURES: 68.2 69.7 72.3 75.0 77.5 79.6 81.2 82.2 83.0 83.1 82.6 81.6
                     79.9 77.2 74.7 73.3 72.2 72.3 71.2 70.8 70.1 69.4 68.7 68.3

REG DIST           : guiage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222
************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6
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BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859 0.0914 0.3043 0.0938 0.0431 0.0243 0.0024 0.0020
0.0015 0.0054 0.0064 0.0070 0.0249 0.0013 0.0006 0.0057

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838 0.0909 0.3027 0.0933 0.0429 0.0259 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0265 0.0013 0.0007 0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713 0.0880 0.2930 0.0903 0.0415 0.0354 0.0035 0.0029
0.0022 0.0079 0.0094 0.0102 0.0362 0.0018 0.0009 0.0055

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439 0.0815 0.2713 0.0836 0.0384 0.0565 0.0055 0.0046
0.0035 0.0126 0.0150 0.0163 0.0578 0.0029 0.0015 0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
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                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673  0.0870  0.2899  0.0894  0.0411  0.0384  0.0037  0.0032
0.0024  0.0086  0.0102  0.0111  0.0393  0.0020  0.0010  0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0
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RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q3
CALENDAR YEAR      : 2009
EVALUATION MONTH   : 7

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 86.8 84.8 79.3 73.9 68.3 64.3 60.7 59.3 57.6 56.8 57.6 59.5
                     63.2 69.1 73.6 76.4 77.6 78.6 80.1 81.4 82.3 83.5 84.9 86.6

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Guilford County IM PMSIP (Run Yr + 1) 2010 Fall(Q4)
> guiage07 Veh Age Dist.

POLLUTANTS         : NOX
SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14.0


HOURLY TEMPERATURES: 44.1 44.0 44.7 47.5 50.0 52.2 53.8 55.0 55.6 55.9 55.2 53.7
                     51.5 50.6 48.7 48.3 47.7 47.4 46.3 46.0 45.6 45.2 44.9 44.5

REG DIST           : guiage07.prn

I/M PROGRAM        : 1 2003 2050 1 TRC OBD I/M
I/M MODEL YEARS    : 1 1996 2050
I/M VEHICLES       : 1 22222 11111111 1
I/M STRINGENCY     : 1 10.0
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 5.0 5.0

I/M PROGRAM        : 2 2003 2050 1 TRC EVAP OBD
I/M MODEL YEARS    : 2 1996 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 10.0
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 5.0 5.0

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0
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RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859  0.0914  0.3043  0.0938  0.0431  0.0243  0.0024  0.0020
0.0015  0.0054  0.0064  0.0070  0.0249  0.0013  0.0006  0.0057

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838  0.0909  0.3027  0.0933  0.0429  0.0259  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0265  0.0013  0.0007  0.0056
```

```
AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713  0.0880  0.2930  0.0903  0.0415  0.0354  0.0035  0.0029
0.0022  0.0079  0.0094  0.0102  0.0362  0.0018  0.0009  0.0055

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439  0.0815  0.2713  0.0836  0.0384  0.0565  0.0055  0.0046
0.0035  0.0126  0.0150  0.0163  0.0578  0.0029  0.0015  0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673  0.0870  0.2899  0.0894  0.0411  0.0384  0.0037  0.0032
0.0024  0.0086  0.0102  0.0111  0.0393  0.0020  0.0010  0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837  0.0909  0.3026  0.0933  0.0429  0.0260  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0266  0.0013  0.0007  0.0056
```

```
AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943  0.0934  0.3112  0.0959  0.0441  0.0177  0.0017  0.0015
0.0011  0.0040  0.0047  0.0051  0.0181  0.0009  0.0005  0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977  0.0942  0.3138  0.0967  0.0445  0.0151  0.0015  0.0012
0.0009  0.0034  0.0040  0.0044  0.0155  0.0008  0.0004  0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838  0.0908  0.3025  0.0932  0.0429  0.0261  0.0025  0.0021
0.0016  0.0058  0.0069  0.0075  0.0267  0.0013  0.0007  0.0056

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
END OF RUN         :
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MOBILE6 INPUT FILE :

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> Guilford County Non-IM PM SIP (Run Yr + 1) 2010 Fall(Q4)
> guiage07 Veh Age Dist.

POLLUTANTS         : NOX
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SPREADSHEET        : Guilford County
RUN DATA           :
***************** RUN SECTION  **********
FUEL RVP           : 14.0


HOURLY TEMPERATURES: 44.1 44.0 44.7 47.5 50.0 52.2 53.8 55.0 55.6 55.9 55.2 53.7
                     51.5 50.6 48.7 48.3 47.7 47.4 46.3 46.0 45.6 45.2 44.9 44.5

REG DIST           : guiage07.prn

ANTI-TAMP PROG     :
91 75 50 22222 22222222 2 11 095. 22212222

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural interstate mix and speeds

VMT FRACTIONS      :
0.3039  0.0719  0.2396  0.0738  0.0339  0.0874  0.0085  0.0072
0.0054  0.0195  0.0231  0.0252  0.0894  0.0045  0.0022  0.0045

AVERAGE SPEED      : 59 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural other principle arterial mix and speeds

VMT FRACTIONS      :
0.3590  0.0851  0.2833  0.0873  0.0401  0.0448  0.0044  0.0037
0.0028  0.0100  0.0119  0.0129  0.0459  0.0023  0.0012  0.0053

AVERAGE SPEED      : 57 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor arterial mix and speeds

VMT FRACTIONS      :
0.3656  0.0866  0.2884  0.0889  0.0409  0.0398  0.0039  0.0033
0.0025  0.0089  0.0105  0.0115  0.0408  0.0020  0.0010  0.0054

AVERAGE SPEED      : 45 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural major collector TDM Q4
CALENDAR YEAR      : 2010
```

```
EVALUATION MONTH   : 1

> Rural major collector mix and speeds

VMT FRACTIONS      :
0.3859 0.0914 0.3043 0.0938 0.0431 0.0243 0.0024 0.0020
0.0015 0.0054 0.0064 0.0070 0.0249 0.0013 0.0006 0.0057

AVERAGE SPEED      : 47 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural minor collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural minor collector mix and speeds

VMT FRACTIONS      :
0.3838 0.0909 0.3027 0.0933 0.0429 0.0259 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0265 0.0013 0.0007 0.0056

AVERAGE SPEED      : 46 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Rural local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Rural local mix and speeds

VMT FRACTIONS      :
0.3713 0.0880 0.2930 0.0903 0.0415 0.0354 0.0035 0.0029
0.0022 0.0079 0.0094 0.0102 0.0362 0.0018 0.0009 0.0055

AVERAGE SPEED      : 44 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban interstate TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban interstate mix and speeds

VMT FRACTIONS      :
0.3439 0.0815 0.2713 0.0836 0.0384 0.0565 0.0055 0.0046
0.0035 0.0126 0.0150 0.0163 0.0578 0.0029 0.0015 0.0051

AVERAGE SPEED      : 60 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban freeway TDM Q4
```

```
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban freeway mix and speeds

VMT FRACTIONS      :
0.3673 0.0870 0.2899 0.0894 0.0411 0.0384 0.0037 0.0032
0.0024 0.0086 0.0102 0.0111 0.0393 0.0020 0.0010 0.0054

AVERAGE SPEED      : 54 Non-Ramp 100.0 0.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban principle arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban principle arterial mix and speeds

VMT FRACTIONS      :
0.3837 0.0909 0.3026 0.0933 0.0429 0.0260 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0266 0.0013 0.0007 0.0056

AVERAGE SPEED      : 40 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban minor arterial TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban minor arterial mix and speeds

VMT FRACTIONS      :
0.3943 0.0934 0.3112 0.0959 0.0441 0.0177 0.0017 0.0015
0.0011 0.0040 0.0047 0.0051 0.0181 0.0009 0.0005 0.0058

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
SCENARIO RECORD    : Urban collector TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban collector mix and speeds

VMT FRACTIONS      :
0.3977 0.0942 0.3138 0.0967 0.0445 0.0151 0.0015 0.0012
0.0009 0.0034 0.0040 0.0044 0.0155 0.0008 0.0004 0.0059

AVERAGE SPEED      : 38 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30

************  SCENARIO SECTION ********
```

```
SCENARIO RECORD    : Urban local TDM Q4
CALENDAR YEAR      : 2010
EVALUATION MONTH   : 1

> Urban local mix and speeds

VMT FRACTIONS      :
0.3838 0.0908 0.3025 0.0932 0.0429 0.0261 0.0025 0.0021
0.0016 0.0058 0.0069 0.0075 0.0267 0.0013 0.0007 0.0056

AVERAGE SPEED      : 37 Arterial 0.0 100.0 0.0 0.0

RELATIVE HUMIDITY  : 85.1 84.6 84.1 79.4 73.9 69.0 64.8 62.9 62.0 61.6 63.0 66.3
                     70.8 74.4 76.1 78.0 78.6 80.5 80.7 81.2 82.1 82.3 82.7 83.6

BAROMETRIC PRES    : 30
END OF RUN         :
```

6.2 MOBILE6.2 Output Files

6.2.1 2009 Mobile6.2 Output Files for PM2.5

6.2.1.1 Catawba County 2009 MOBILE6.2 Output File for PM2.5

```
***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT09P.IN (file 1, run 1).                                  *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3439    0.3529    0.1202              0.0519    0.0003    0.0018
0.1239    0.0051    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0054
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0143
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0073
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0007
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0278
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0026
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0357
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0124
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0882
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3695    0.3794    0.1293              0.0337    0.0004    0.0019
0.0804    0.0054    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0049
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0093
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0048
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0196
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0273
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0110
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0924
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
```

```
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0037    0.0040    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0046
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0066
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0034
                SO4:    0.0004    0.0005    0.0006    0.0005    0.0013    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0424    0.0743    0.0675
0.1758    0.0143    0.0153
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
           Total PM:    0.0114    0.0119    0.0121    0.0120    0.0499    0.0817    0.0748
0.1876    0.0206    0.0229
                SO2:    0.0068    0.0087    0.0114    0.0094    0.0168    0.0086    0.0160
0.0380    0.0033    0.0102
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0947
 ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3926    0.4031    0.1375              0.0173    0.0004    0.0020
0.0413    0.0058    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0037    0.0040    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0045
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1148    ------    0.0048
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0588    ------    0.0025
                SO4:    0.0003    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1762    0.0143    0.0124
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
```

```
          Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1881    0.0206    0.0199
               SO2:    0.0068    0.0087    0.0114    0.0094    0.0168    0.0086    0.0160
0.0380    0.0033    0.0097
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0962
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3963    0.4066    0.1387              0.0148    0.0004    0.0021
0.0354    0.0058    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0044
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0041
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0585    ------    0.0022
               SO4:    0.0003    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1756    0.0143    0.0112
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
          Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1874    0.0206    0.0187
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0168    0.0086    0.0160
0.0379    0.0033    0.0095
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0968
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3868    0.3971    0.1354              0.0214    0.0004    0.0020
0.0512    0.0057    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0037    0.0040    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0046
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0059
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0031
                SO4:    0.0003    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1759    0.0143    0.0142
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
           Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1877    0.0206    0.0217
                SO2:    0.0068    0.0087    0.0114    0.0094    0.0168    0.0086    0.0160
0.0379    0.0033    0.0100
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0952
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3027    0.3107    0.1060              0.0810    0.0003    0.0016
0.1933    0.0045    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0062
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0222
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0114
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0009
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0408
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0029
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0490
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0147
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0816
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0004    0.0019
0.0985    0.0053    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0051
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0114
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0059
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0230
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0308
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0116
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0907
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3664    0.3763    0.1283              0.0358    0.0004    0.0019
0.0855    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0050
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0099
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0051
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0206
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0283
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0112
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0919
 -------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
              Gasoline Fuel Sulfur Content:   30. ppm
                Diesel Fuel Sulfur Content:   43. ppm
                      Particle Size Cutoff:  2.50 Microns
                          Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3823    0.3924    0.1338              0.0246    0.0004    0.0020
0.0589    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1147    ------    0.0068
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0587    ------    0.0035
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1760    0.0143    0.0156
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0232
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0103
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0945
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3817    0.3919    0.1336              0.0251    0.0004    0.0020
0.0597    0.0056    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0069
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0036
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0158
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0234
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0103
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0944
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3801    0.3902    0.1331              0.0262    0.0004    0.0020
0.0625    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1147    ------    0.0072
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0587    ------    0.0038
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1760    0.0143    0.0163
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0239
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0104
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0942
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
              Gasoline Fuel Sulfur Content:   30. ppm
                Diesel Fuel Sulfur Content:   43. ppm
                      Particle Size Cutoff:  2.50 Microns
                          Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3439    0.3529    0.1202              0.0519    0.0003    0.0018
0.1239    0.0051    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0054
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0143
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0073
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0007
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0278
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0026
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0357
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0124
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0882
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3695    0.3794    0.1293              0.0337    0.0004    0.0019
0.0804    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0049
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0093
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0048
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
  Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0196
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0273
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0110
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0924
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
```

```
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:   0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:   0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:   0.0037    0.0040    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0046
            ECARBON:   ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0066
            OCARBON:   ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0034
                SO4:   0.0003    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:   0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1758    0.0143    0.0153
              Brake:   0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:   0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
           Total PM:   0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1876    0.0206    0.0229
                SO2:   0.0068    0.0087    0.0114    0.0094    0.0168    0.0086    0.0160
0.0380    0.0033    0.0102
                NH3:   0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0947
 ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q
* File 1, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:   0.3926    0.4031    0.1375              0.0173    0.0004    0.0020
0.0413    0.0058    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:   0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:   0.0038    0.0041    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0045
            ECARBON:   ------    ------    ------    ------    ------    0.0576    0.0273
0.1148    ------    0.0048
            OCARBON:   ------    ------    ------    ------    ------    0.0163    0.0393
0.0588    ------    0.0025
                SO4:   0.0003    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:   0.0040    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1762    0.0143    0.0123
              Brake:   0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:   0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
```

```
          Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1881    0.0206    0.0199
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0168    0.0086    0.0160
0.0380    0.0033    0.0097
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0962
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3963    0.4066    0.1387              0.0148    0.0004    0.0021
0.0354    0.0058    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0037    0.0040    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0044
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0041
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0585    ------    0.0022
               SO4:    0.0003    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1756    0.0143    0.0112
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
          Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1874    0.0206    0.0187
               SO2:    0.0068    0.0088    0.0114    0.0094    0.0168    0.0086    0.0160
0.0379    0.0033    0.0095
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0968
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q
* File 1, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3868    0.3971    0.1354              0.0214    0.0004    0.0020
0.0512    0.0057    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0037    0.0040    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0046
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0059
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0031
                SO4:    0.0003    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1759    0.0143    0.0142
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
           Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1877    0.0206    0.0217
                SO2:    0.0068    0.0088    0.0114    0.0094    0.0168    0.0086    0.0160
0.0379    0.0033    0.0100
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0952
 -------------------------------------------------------------------------------------------------
-----------------------
```

6.2.1.2 Davidson County 2009 MOBILE6.2 Output File for PM2.5

```
****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: DV09P.IN (file 1, run 1).                                    *
****************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate - TDM
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3027    0.3107    0.1060              0.0810    0.0003    0.0016
0.1933    0.0045    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0062
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0222
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0114
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0009
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0408
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0029
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0490
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0147
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0816
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial - TDM
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0004    0.0019
0.0985    0.0053    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0051
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0114
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0059
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0230
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0308
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0116
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0907
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial - TDM
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3664    0.3763    0.1283              0.0358    0.0004    0.0019
0.0855    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0050
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0099
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0051
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0206
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0283
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0112
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0919
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector - TDM
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3823    0.3924    0.1338              0.0246    0.0004    0.0020
0.0589    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1147    ------    0.0068
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0587    ------    0.0035
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
  Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1760    0.0143    0.0156
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0232
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0103
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0945
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector - TDM
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3817    0.3919    0.1336              0.0251    0.0004    0.0020
0.0597    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0069
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0036
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0158
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0234
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0103
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0944
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local - TDM
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
              Gasoline Fuel Sulfur Content:   30. ppm
                Diesel Fuel Sulfur Content:   43. ppm
                      Particle Size Cutoff:  2.50 Microns
                          Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3801    0.3902    0.1331              0.0262    0.0004    0.0020
0.0625    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1147    ------    0.0072
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0587    ------    0.0038
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1760    0.0143    0.0163
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0239
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0104
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0942
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate - TDM
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3439    0.3529    0.1202              0.0519    0.0003    0.0018
0.1239    0.0051    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0054
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0143
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0073
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0007
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0278
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0026
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0357
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0124
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0882
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway - TDM
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3695    0.3794    0.1293              0.0337    0.0004    0.0019
0.0804    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0049
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0093
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0048
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0196
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0273
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0110
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0924
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial - TDM
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
              Gasoline Fuel Sulfur Content:   30. ppm
                Diesel Fuel Sulfur Content:   43. ppm
                      Particle Size Cutoff:  2.50 Microns
                          Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0066
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0034
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0153
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0228
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0102
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0947
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial - TDM
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3926    0.4031    0.1375              0.0173    0.0004    0.0020
0.0413    0.0058    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0045
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1148    ------    0.0048
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0588    ------    0.0025
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1762    0.0143    0.0123
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1881    0.0206    0.0198
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0097
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0962
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector - TDM
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---   ------    ------
   VMT Distribution:    0.3963    0.4066    0.1387              0.0148    0.0004    0.0021
0.0354    0.0058    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0044
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0041
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0585    ------    0.0022
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1756    0.0143    0.0112
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1874    0.0206    0.0187
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0095
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0968
 -------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local - TDM
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---   ------    ------
   VMT Distribution:    0.3868    0.3971    0.1354              0.0214    0.0004    0.0020
0.0512    0.0057    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0046
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0059
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0031
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0142
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0217
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0100
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0952
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate - Non Modeled
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3027    0.3107    0.1060              0.0810    0.0003    0.0016
0.1933    0.0045    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0062
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0222
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0114
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0009
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0408
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0029
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0490
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0147
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0816
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial - Non Modeled
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0004    0.0019
0.0985    0.0053    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0051
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0114
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0059
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0230
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0308
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0116
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0907
 ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial - Non Modeled
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3664    0.3763    0.1283              0.0358    0.0004    0.0019
0.0855    0.0054    1.0000
 ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0050
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0099
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0051
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0206
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1877    0.0206    0.0283
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0112
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0919
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector - Non Modeled
* File 1, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3823    0.3924    0.1338              0.0246    0.0004    0.0020
0.0589    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1147    ------    0.0068
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0587    ------    0.0035
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1760    0.0143    0.0156
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0232
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0103
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0945
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector - Non Modeled
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3817    0.3919    0.1336              0.0251    0.0004    0.0020
0.0597    0.0056    1.0000
 ---------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0069
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0036
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0158
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0234
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0103
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0944
 ---------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local - Non Modeled
* File 1, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3801    0.3902    0.1331              0.0262    0.0004    0.0020
0.0625    0.0056    1.0000
 ---------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0047
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1147    ------    0.0072
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0587    ------    0.0038
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1760    0.0143    0.0163
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
          Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0239
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0104
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0942
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate - Non Modeled
* File 1, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3439    0.3529    0.1202              0.0519    0.0003    0.0018
0.1239    0.0051    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0054
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0143
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0073
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0007
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1759    0.0143    0.0278
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0026
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1878    0.0206    0.0357
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0380    0.0033    0.0124
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0882
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway - Non Modeled
* File 1, Run 1, Scenario 20.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3695    0.3794    0.1293              0.0337    0.0004    0.0019
0.0804    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0049
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0093
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0048
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0047    0.0046    0.0426    0.0743    0.0675
0.1758    0.0143    0.0196
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
           Total PM:    0.0114    0.0119    0.0120    0.0119    0.0501    0.0817    0.0748
0.1876    0.0206    0.0273
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0167    0.0086    0.0160
0.0379    0.0033    0.0110
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0924
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial - Non Modeled
* File 1, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0037    0.0040    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0046
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0066
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0034
                SO4:    0.0004    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0006
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1758    0.0143    0.0153
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
          Total PM:    0.0114    0.0119    0.0121    0.0120    0.0500    0.0817    0.0748
0.1876    0.0206    0.0229
               SO2:    0.0068    0.0087    0.0114    0.0094    0.0168    0.0086    0.0160
0.0380    0.0033    0.0102
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0947
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial - Non Modeled
* File 1, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3926    0.4031    0.1375              0.0173    0.0004    0.0020
0.0413    0.0058    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0041    0.0042    0.0041    0.0411    ------    ------    ---
---    0.0142    0.0045
            ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1148    ------    0.0048
            OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0588    ------    0.0025
                SO4:    0.0003    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1762    0.0143    0.0123
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
           Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1881    0.0206    0.0199
                SO2:    0.0068    0.0088    0.0115    0.0094    0.0168    0.0086    0.0160
0.0380    0.0033    0.0097
                NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0962
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector - Non Modeled
* File 1, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3963    0.4066    0.1387              0.0148    0.0004    0.0021
0.0354    0.0058    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0037    0.0040    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0044
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1145    ------    0.0041
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0585    ------    0.0022
               SO4:    0.0003    0.0005    0.0005    0.0005    0.0014    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0041    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1756    0.0143    0.0112
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
          Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1874    0.0206    0.0187
               SO2:    0.0068    0.0088    0.0114    0.0094    0.0168    0.0086    0.0160
0.0379    0.0033    0.0095
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0968
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local - Non Modeled
* File 1, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3868    0.3971    0.1354              0.0214    0.0004    0.0020
0.0512    0.0057    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0041    0.0042    0.0041    0.0410    ------    ------    ---
---    0.0142    0.0046
           ECARBON:    ------    ------    ------    ------    ------    0.0576    0.0273
0.1146    ------    0.0059
           OCARBON:    ------    ------    ------    ------    ------    0.0163    0.0393
0.0586    ------    0.0031
               SO4:    0.0003    0.0005    0.0005    0.0005    0.0015    0.0004    0.0008
0.0027    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0046    0.0047    0.0046    0.0425    0.0743    0.0675
0.1759    0.0143    0.0142
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
```

```
          Total PM:    0.0114    0.0119    0.0121    0.0119    0.0500    0.0817    0.0748
0.1877    0.0206    0.0217
               SO2:    0.0068    0.0088    0.0115    0.0094    0.0168    0.0086    0.0160
0.0379    0.0033    0.0100
               NH3:    0.1017    0.1005    0.1000    0.1004    0.0451    0.0068    0.0068
0.0270    0.0113    0.0952
 -----------------------------------------------------------------------------------------------
----------------------
```

6.2.1.3 Guilford County 2009 MOBILE6.2 Output Files for PM2.5

```
***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: GU09P.IN (file 1, run 1).                                   *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate - TDM
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3027    0.3107    0.1059              0.0802    0.0003    0.0016
0.1941    0.0045    1.0000
 -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0057
            ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0172
            OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0452    ------    0.0088
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0009
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0374    0.0676    0.0581
0.1360    0.0143    0.0327
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0029
           Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0409
                SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0147
                NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0816
 -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial - TDM
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3588    0.3684    0.1255              0.0409    0.0003    0.0019
0.0989    0.0053    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0049
           ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0088
           OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0453    ------    0.0045
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1360    0.0143    0.0188
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0266
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0116
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0908
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial - TDM
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
              Gasoline Fuel Sulfur Content:   30. ppm
                Diesel Fuel Sulfur Content:   43. ppm
                      Particle Size Cutoff:  2.50 Microns
                          Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3664    0.3763    0.1283              0.0355    0.0004    0.0019
0.0858    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0048
           ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0076
           OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0452    ------    0.0040
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1360    0.0143    0.0169
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
```

```
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0247
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0112
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0920
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector - TDM
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3823    0.3924    0.1338              0.0244    0.0004    0.0020
0.0591    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0045
            ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0882    ------    0.0053
            OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0453    ------    0.0028
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1361    0.0143    0.0131
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
           Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1479    0.0206    0.0207
                SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0103
                NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0946
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector - TDM
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3817    0.3919    0.1336              0.0248    0.0004    0.0020
0.0600    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0045
           ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0054
           OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0452    ------    0.0028
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0374    0.0676    0.0581
0.1360    0.0143    0.0132
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0208
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0103
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0945
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local - TDM
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3801    0.3902    0.1330              0.0259    0.0004    0.0020
0.0628    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0045
           ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0882    ------    0.0056
           OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0453    ------    0.0029
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1361    0.0143    0.0136
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0450    0.0750    0.0654
0.1479    0.0206    0.0212
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0104
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0943
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate - TDM
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3439    0.3529    0.1202              0.0514    0.0003    0.0018
0.1244    0.0051    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0051
            ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0882    ------    0.0110
            OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0453    ------    0.0057
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0007
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1361    0.0143    0.0226
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0026
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1479    0.0206    0.0304
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0124
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0883
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway - TDM
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3695    0.3794    0.1293              0.0334    0.0004    0.0019
0.0807    0.0054    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0047
            ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0072
            OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0452    ------    0.0037
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0006
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1360    0.0143    0.0162
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0024
           Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0239
                SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0110
                NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0925
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial - TDM
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0237    0.0004    0.0020
0.0573    0.0056    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0045
            ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0882    ------    0.0051
            OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0452    ------    0.0027
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0374    0.0676    0.0581
0.1360    0.0143    0.0128
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0023
```

```
           Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0204
                SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0102
                NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0948
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial - TDM
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3926    0.4031    0.1375              0.0171    0.0004    0.0021
0.0415    0.0058    1.0000
 -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
               Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
              GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0043
            ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0883    ------    0.0037
            OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0454    ------    0.0020
                SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1363    0.0143    0.0105
              Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
               Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
           Total PM:    0.0113    0.0118    0.0117    0.0118    0.0450    0.0750    0.0654
0.1481    0.0206    0.0180
                SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0097
                NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0963
 -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector - TDM
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
               Gasoline Fuel Sulfur Content:   30. ppm
                 Diesel Fuel Sulfur Content:   43. ppm
                       Particle Size Cutoff:  2.50 Microns
                           Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3963    0.4066    0.1387              0.0147    0.0004    0.0021
0.0355    0.0058    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0043
           ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0032
           OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0451    ------    0.0017
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0374    0.0676    0.0581
0.1358    0.0143    0.0096
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1476    0.0206    0.0171
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0095
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0969
 -------------------------------------------------------------------------------------------------
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* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local - TDM
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                              Calendar Year:  2009
                                      Month:  July
              Gasoline Fuel Sulfur Content:   30. ppm
                Diesel Fuel Sulfur Content:   43. ppm
                      Particle Size Cutoff:  2.50 Microns
                          Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3868    0.3971    0.1354              0.0212    0.0004    0.0020
0.0514    0.0057    1.0000
 -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
              Lead:    0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ---
---    0.0000    0.0000
             GASPM:    0.0038    0.0040    0.0040    0.0040    0.0358    ------    ------    ---
---    0.0142    0.0044
           ECARBON:    ------    ------    ------    ------    ------    0.0524    0.0235
0.0881    ------    0.0046
           OCARBON:    ------    ------    ------    ------    ------    0.0148    0.0338
0.0453    ------    0.0024
               SO4:    0.0002    0.0005    0.0005    0.0005    0.0017    0.0004    0.0008
0.0026    0.0001    0.0005
   Total Exhaust PM:    0.0040    0.0045    0.0044    0.0045    0.0375    0.0676    0.0581
0.1360    0.0143    0.0119
             Brake:    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053    0.0053
0.0053    0.0053    0.0053
              Tire:    0.0020    0.0020    0.0020    0.0020    0.0022    0.0020    0.0020
0.0065    0.0010    0.0022
```

```
          Total PM:    0.0113    0.0118    0.0117    0.0118    0.0449    0.0750    0.0654
0.1478    0.0206    0.0195
               SO2:    0.0068    0.0088    0.0115    0.0095    0.0166    0.0085    0.0160
0.0378    0.0033    0.0100
               NH3:    0.1017    0.1006    0.1008    0.1006    0.0451    0.0068    0.0068
0.0270    0.0113    0.0954
 -----------------------------------------------------------------------------------------------
----------------------
```

6.2.2 2009 MOBILE6.2 Output Files for NOx

6.2.2.1 Catawba County 2009 MOBILE6.2 Output Files for NOx

```
***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT091.IN (file 1, run 1).                                  *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q1
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.780     1.328     1.410     1.349     3.678    0.889     1.160
11.477      2.37     2.536
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q1
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.771     1.315     1.397     1.336     3.610    0.812     1.059
10.547      2.25     1.991
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q1
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.732     1.265     1.354     1.288     2.892    0.578     0.751
6.892      1.67     1.434
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q1
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.722     1.250     1.337     1.272     2.940    0.568     0.739
6.774      1.70     1.298
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q1
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.711     1.234     1.319     1.255     3.036    0.561     0.729
6.693      1.76     1.246
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q1
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
```

```
              Maximum Rel. Hum.:  76.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.722     1.250     1.337     1.272     2.938    0.568     0.739
6.780      1.70     1.417
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate mix and speeds
                  Calendar Year:  2009
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  36.8 (F)
            Maximum Temperature:  54.8 (F)
              Minimum Rel. Hum.:  47.4 (%)
              Maximum Rel. Hum.:  76.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0806    0.0003    0.0016
0.1918    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.796     1.350     1.432     1.371     3.798    1.083     1.414
13.806      2.57     3.783
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  36.8 (F)
```

```
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                Reformulated Gas:   No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.740     1.272     1.355     1.293     3.370    0.633     0.823
8.381      1.90     1.881
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                Reformulated Gas:   No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.731     1.260     1.343     1.281     3.297    0.601     0.782
7.170      1.85     1.671
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
```

```
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.728     1.256     1.339     1.277     3.275    0.595     0.773
7.094      1.85     1.423
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0239    0.0004    0.0020
0.0569    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.725     1.252     1.336     1.273     3.250    0.588     0.764
7.015      1.84     1.439
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
```

```
                    Altitude:  Low
         Minimum Temperature:  36.8 (F)
         Maximum Temperature:  54.8 (F)
           Minimum Rel. Hum.:  47.4 (%)
           Maximum Rel. Hum.:  76.1 (%)
        Barometric Pressure: 30.00 (inches Hg)
            Nominal Fuel RVP:  14.0 psi
               Weathered RVP:  14.0 psi
         Fuel Sulfur Content:   30. ppm

         Exhaust I/M Program:  Yes
            Evap I/M Program:  Yes
                 ATP Program:  Yes
            Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0327    0.0004    0.0019
0.0777    0.0055    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.725     1.252     1.336     1.273     3.250    0.588     0.764
7.008      1.84     1.582
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #
               Calendar Year:  2009
                       Month:  Jan.
                    Altitude:  Low
         Minimum Temperature:  36.8 (F)
         Maximum Temperature:  54.8 (F)
           Minimum Rel. Hum.:  47.4 (%)
           Maximum Rel. Hum.:  76.1 (%)
        Barometric Pressure: 30.00 (inches Hg)
            Nominal Fuel RVP:  14.0 psi
               Weathered RVP:  14.0 psi
         Fuel Sulfur Content:   30. ppm

         Exhaust I/M Program:  Yes
            Evap I/M Program:  Yes
                 ATP Program:  Yes
            Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.790     1.341     1.424     1.362     3.752    1.009     1.317
12.923      2.49     2.731
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
               Calendar Year:  2009
```

```
                        Month:  Jan.
                     Altitude:  Low
          Minimum Temperature:  36.8 (F)
          Maximum Temperature:  54.8 (F)
            Minimum Rel. Hum.:  47.4 (%)
            Maximum Rel. Hum.:  76.1 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  14.0 psi
                Weathered RVP:  14.0 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  Yes
             Evap I/M Program:  Yes
                  ATP Program:  Yes
             Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.768     1.310     1.392     1.331     3.585    0.785     1.023
10.216      2.21     1.959
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q1
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                Calendar Year:  2009
                        Month:  Jan.
                     Altitude:  Low
          Minimum Temperature:  36.8 (F)
          Maximum Temperature:  54.8 (F)
            Minimum Rel. Hum.:  47.4 (%)
            Maximum Rel. Hum.:  76.1 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  14.0 psi
                Weathered RVP:  14.0 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  Yes
             Evap I/M Program:  Yes
                  ATP Program:  Yes
             Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.722     1.250     1.337     1.272     2.938    0.568     0.739
6.779      1.70     1.417
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.713     1.237     1.323     1.258     3.013    0.562     0.730
6.698      1.74     1.286
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.716     1.240     1.326     1.262     2.987    0.563     0.732
6.717      1.73     1.252
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q1
* File 1, Run 1, Scenario 18.
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.716     1.240     1.326     1.262     2.985     0.563     0.732
6.716      1.73     1.407
  --------------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT091N.IN (file 2, run 1).                                 *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q1
* File 2, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
    Composite NOX :      0.898     1.495     1.580     1.517     3.678    0.889     1.160
11.477      2.37     2.656
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q1
* File 2, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.888     1.482     1.567     1.503     3.610    0.812     1.059
10.547      2.25     2.119
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q1
* File 2, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial mix and speeds
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
```

```
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.849     1.435     1.530     1.459     2.892    0.578     0.751
6.892      1.67     1.569
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q1
* File 2, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.838     1.418     1.512     1.442     2.940    0.568     0.739
6.774      1.70     1.436
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q1
* File 2, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.825     1.399     1.492     1.423     3.036    0.561     0.729
6.693      1.76     1.383
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q1
* File 2, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.838     1.418     1.512     1.442     2.938    0.568     0.739
6.780      1.70     1.551
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0806    0.0003    0.0016
0.1918    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.915     1.519     1.604     1.540     3.798    1.083     1.414
13.806      2.57     3.890
  ---------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.855     1.438     1.525     1.460     3.370    0.633     0.823
8.381      1.90     2.005
  ---------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.845     1.425     1.514     1.448     3.297    0.601     0.782
7.170      1.85     1.797
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.842     1.421     1.510     1.444     3.275    0.595     0.773
7.094      1.85     1.555
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0239    0.0004    0.0020
0.0569    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.839     1.417     1.506     1.440     3.250    0.588     0.764
7.015      1.84     1.571
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0327    0.0004    0.0019
0.0777    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.839     1.417     1.506     1.440     3.250    0.588     0.764
7.008      1.84     1.710
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
           GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.909     1.510     1.595     1.531     3.752    1.009     1.317
12.923      2.49     2.851
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
           GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.885     1.477     1.562     1.499     3.585    0.785     1.023
10.216      2.21     2.086
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q1
* File 2, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
```

```
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.838     1.418     1.512     1.442     2.938    0.568     0.739
6.779      1.70     1.550
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  36.8 (F)
             Maximum Temperature:  54.8 (F)
               Minimum Rel. Hum.:  47.4 (%)
               Maximum Rel. Hum.:  76.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.827     1.403     1.495     1.426     3.013    0.562     0.730
6.698      1.74     1.422
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  36.8 (F)
             Maximum Temperature:  54.8 (F)
               Minimum Rel. Hum.:  47.4 (%)
               Maximum Rel. Hum.:  76.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
```

```
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.830     1.406     1.499     1.430     2.987    0.563     0.732
6.717      1.73     1.389
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q1
* File 2, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  36.8 (F)
              Maximum Temperature:  54.8 (F)
                Minimum Rel. Hum.:  47.4 (%)
                Maximum Rel. Hum.:  76.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.830     1.406     1.499     1.430     2.985    0.563     0.732
6.716      1.73     1.539
  ---------------------------------------------------------------------------------------------
----------------------


****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: CAT092.IN (file 1, run 1).                                   *
****************************************************************************


* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
```

```
              Minimum Rel. Hum.:  47.6 (%)
              Maximum Rel. Hum.:  86.3 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.5 psi
                  Weathered RVP:  10.5 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                      ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.614     1.025     1.059     1.034     3.111    0.854     1.084
10.542      1.82     2.182
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  58.3 (F)
            Maximum Temperature:  76.6 (F)
              Minimum Rel. Hum.:  47.6 (%)
              Maximum Rel. Hum.:  86.3 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.5 psi
                  Weathered RVP:  10.5 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                      ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.607     1.015     1.049     1.024     3.053    0.780     0.990
9.683      1.73     1.678
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q2
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  58.3 (F)
```

```
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.586     0.978     1.018     0.988     2.446    0.555     0.702
6.350      1.28     1.176
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.966     1.004     0.975     2.486    0.546     0.691
6.242      1.31     1.050
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
```

```
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.565     0.952     0.989     0.961     2.568    0.539     0.682
6.166      1.35     1.001
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.966     1.004     0.975     2.485    0.546     0.691
6.247      1.31     1.161
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
```

```
                     Altitude:  Low
          Minimum Temperature:  58.3 (F)
          Maximum Temperature:  76.6 (F)
            Minimum Rel. Hum.:  47.6 (%)
            Maximum Rel. Hum.:  86.3 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  10.5 psi
                Weathered RVP:  10.5 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  Yes
             Evap I/M Program:  Yes
                  ATP Program:  Yes
             Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:             <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.625     1.043     1.076     1.051     3.212     1.039     1.321
12.694      1.97     3.335
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                Calendar Year:  2009
                        Month:  July
                     Altitude:  Low
          Minimum Temperature:  58.3 (F)
          Maximum Temperature:  76.6 (F)
            Minimum Rel. Hum.:  47.6 (%)
            Maximum Rel. Hum.:  86.3 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  10.5 psi
                Weathered RVP:  10.5 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  Yes
             Evap I/M Program:  Yes
                  ATP Program:  Yes
             Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:             <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.584     0.981     1.017     0.990     2.851     0.608     0.770
7.682      1.46     1.583
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                Calendar Year:  2009
```

```
                         Month:  July
                      Altitude:  Low
           Minimum Temperature:  58.3 (F)
           Maximum Temperature:  76.6 (F)
             Minimum Rel. Hum.:  47.6 (%)
             Maximum Rel. Hum.:  86.3 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  10.5 psi
                 Weathered RVP:  10.5 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  Yes
              Evap I/M Program:  Yes
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.007     0.981     2.789    0.578     0.732
6.607      1.42     1.394
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  July
                      Altitude:  Low
           Minimum Temperature:  58.3 (F)
           Maximum Temperature:  76.6 (F)
             Minimum Rel. Hum.:  47.6 (%)
             Maximum Rel. Hum.:  86.3 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  10.5 psi
                 Weathered RVP:  10.5 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  Yes
              Evap I/M Program:  Yes
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.575     0.969     1.004     0.978     2.771    0.571     0.724
6.537      1.42     1.162
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.573     0.965     1.001     0.975     2.749    0.565     0.715
6.464      1.41     1.177
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.573     0.965     1.001     0.974     2.749    0.565     0.715
6.457      1.41     1.312
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q2
```

```
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.036     1.070     1.045     3.174    0.969     1.231
11.878      1.91     2.360
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.604     1.012     1.046     1.020     3.032    0.754     0.956
9.377      1.70     1.649
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
* Urban principle arterial-Catawba County-Rural-Q2
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  --------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.966     1.004     0.975     2.485    0.546     0.691
6.246      1.31     1.161
  --------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  --------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.567     0.954     0.992     0.964     2.548    0.540     0.683
6.171      1.34     1.038
  --------------------------------------------------------------------------------------------------
-----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.570     0.957     0.995     0.967     2.527    0.541     0.685
6.189      1.33     1.006
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q2
* File 1, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.570     0.957     0.995     0.967     2.525    0.541     0.685
6.188      1.33     1.152
  -------------------------------------------------------------------------------------------
----------------------
```

```
****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: CAT092N.IN (file 4, run 1).                                  *
****************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q2
* File 4, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.705     1.173     1.188     1.177     3.111    0.854     1.084
10.542      1.82     2.282
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q2
* File 4, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
```

```
  ----------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.698     1.163     1.178     1.166     3.053    0.780     0.990
9.683      1.73     1.784
  ----------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q2
* File 4, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ----------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.679     1.127     1.150     1.133     2.446    0.555     0.702
6.350      1.28     1.288
  ----------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q2
* File 4, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.668     1.113     1.135     1.119     2.486    0.546     0.691
6.242      1.31     1.163
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q2
* File 4, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.655     1.097     1.119     1.103     2.568    0.539     0.682
6.166      1.35     1.114
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q2
* File 4, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.668     1.113     1.135     1.119     2.485    0.546     0.691
6.247      1.31     1.272
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.718     1.192     1.206     1.196     3.212    1.039     1.321
12.694      1.97     3.424
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.674     1.127     1.145     1.132     2.851    0.608     0.770
7.682      1.46     1.686
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.668     1.117     1.136     1.122     2.789    0.578     0.732
6.607      1.42     1.498
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.665     1.114     1.133     1.119     2.771    0.571     0.724
6.537      1.42     1.271
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.663     1.111     1.130     1.115     2.749    0.565     0.715
6.464      1.41     1.286
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.663     1.111     1.130     1.115     2.749    0.565     0.715
6.457      1.41     1.417
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.713     1.185     1.199     1.189     3.174    0.969     1.231
11.878      1.91     2.460
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.696     1.159     1.174     1.163     3.032    0.754     0.956
9.377      1.70     1.754
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q2
* File 4, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.668     1.113     1.135     1.118     2.485    0.546     0.691
6.246      1.31     1.271
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 16.
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.658     1.100     1.122     1.106     2.548    0.540     0.683
6.171      1.34     1.150
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.660     1.103     1.125     1.109     2.527    0.541     0.685
6.189      1.33     1.120
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q2
* File 4, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.3 (F)
              Maximum Temperature:  76.6 (F)
                Minimum Rel. Hum.:  47.6 (%)
                Maximum Rel. Hum.:  86.3 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.5 psi
                    Weathered RVP:  10.5 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
```

```
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.660     1.103     1.125     1.109     2.525    0.541     0.685
6.188      1.33     1.262
  --------------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT093.IN (file 1, run 1).                                  *
***************************************************************************

* Urban interstate- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.560     0.921     0.952     0.929     3.216    0.854     1.084
10.542      1.57     2.119
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.554     0.912     0.943     0.920     3.156    0.780     0.990
9.683      1.49     1.609
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q3
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.547     0.882     0.918     0.891     2.529    0.555     0.702
6.350      1.11     1.111
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.537     0.869     0.905     0.879     2.570    0.546     0.691
6.242      1.13     0.981
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.523     0.855     0.891     0.864     2.655    0.539     0.682
6.166      1.16     0.931
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
```

```
              Maximum Rel. Hum.:  88.2 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   9.0 psi
                  Weathered RVP:   8.8 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.537     0.869     0.905     0.879     2.569    0.546     0.691
6.247      1.13     1.096
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  66.8 (F)
            Maximum Temperature:  82.5 (F)
              Minimum Rel. Hum.:  56.5 (%)
              Maximum Rel. Hum.:  88.2 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   9.0 psi
                  Weathered RVP:   8.8 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.570     0.937     0.968     0.945     3.320    1.039     1.321
12.694      1.70     3.282
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  66.8 (F)
            Maximum Temperature:  82.5 (F)
```

```
              Minimum Rel. Hum.:  56.5 (%)
              Maximum Rel. Hum.:  88.2 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   9.0 psi
                  Weathered RVP:   8.8 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.536     0.882     0.914     0.890     2.947    0.608     0.770
7.682      1.26     1.519
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  66.8 (F)
            Maximum Temperature:  82.5 (F)
              Minimum Rel. Hum.:  56.5 (%)
              Maximum Rel. Hum.:  88.2 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   9.0 psi
                  Weathered RVP:   8.8 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.531     0.873     0.906     0.881     2.882    0.578     0.732
6.607      1.23     1.329
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  66.8 (F)
```

```
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.529     0.870     0.903     0.878     2.864    0.571     0.724
6.537      1.22     1.092
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.527     0.867     0.901     0.876     2.841    0.565     0.715
6.464      1.22     1.109
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
```

```
                  Altitude:  Low
       Minimum Temperature:  66.8 (F)
       Maximum Temperature:  82.5 (F)
         Minimum Rel. Hum.:  56.5 (%)
         Maximum Rel. Hum.:  88.2 (%)
       Barometric Pressure: 30.00 (inches Hg)
          Nominal Fuel RVP:   9.0 psi
             Weathered RVP:   8.8 psi
       Fuel Sulfur Content:   30. ppm

       Exhaust I/M Program:  Yes
          Evap I/M Program:  Yes
               ATP Program:  Yes
          Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.527     0.867     0.900     0.876     2.842    0.565     0.715
6.457      1.22     1.246
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #

             Calendar Year:  2009
                     Month:  July
                  Altitude:  Low
       Minimum Temperature:  66.8 (F)
       Maximum Temperature:  82.5 (F)
         Minimum Rel. Hum.:  56.5 (%)
         Maximum Rel. Hum.:  88.2 (%)
       Barometric Pressure: 30.00 (inches Hg)
          Nominal Fuel RVP:   9.0 psi
             Weathered RVP:   8.8 psi
       Fuel Sulfur Content:   30. ppm

       Exhaust I/M Program:  Yes
          Evap I/M Program:  Yes
               ATP Program:  Yes
          Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.566     0.931     0.962     0.939     3.281    0.969     1.231
11.878      1.65     2.295
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.552     0.909     0.940     0.917     3.134    0.754     0.956
9.377      1.46     1.580
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q3
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.537     0.869     0.905     0.879     2.569    0.546     0.691
6.246      1.13     1.095
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 16.
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  66.8 (F)
             Maximum Temperature:  82.5 (F)
               Minimum Rel. Hum.:  56.5 (%)
               Maximum Rel. Hum.:  88.2 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:   9.0 psi
                   Weathered RVP:   8.8 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.526     0.858     0.893     0.867     2.634    0.540     0.683
6.171      1.16     0.969
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  66.8 (F)
             Maximum Temperature:  82.5 (F)
               Minimum Rel. Hum.:  56.5 (%)
               Maximum Rel. Hum.:  88.2 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:   9.0 psi
                   Weathered RVP:   8.8 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.529     0.861     0.896     0.870     2.612    0.541     0.685
6.189      1.15     0.937
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q3
```

```
* File 1, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.529     0.861     0.896     0.870     2.610    0.541     0.685
6.188      1.15     1.086
  ---------------------------------------------------------------------------------------------
-----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT093N.IN (file 1, run 1).                                 *
***************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
```

```
    Composite NOX :      0.643     1.054     1.069     1.058     3.216    0.854     1.084
10.542      1.57     2.208
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q2
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.637     1.044     1.060     1.048     3.156    0.780     0.990
9.683      1.49     1.704
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q3
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
```

```
 Composite Emission Factors (g/mi):
     Composite NOX :      0.632     1.016     1.038     1.021     2.529    0.555     0.702
6.350      1.11     1.212
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.002     1.023     1.007     2.570    0.546     0.691
6.242      1.13     1.085
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
```

```
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.606     0.986     1.007     0.992     2.655    0.539     0.682
6.166      1.16     1.034
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q3
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.002     1.023     1.007     2.569    0.546     0.691
6.247      1.13     1.196
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.653     1.071     1.085     1.074     3.320    1.039     1.321
12.694      1.70     3.361
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.618     1.013     1.030     1.017     2.947    0.608     0.770
7.682      1.26     1.612
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.612     1.003     1.022     1.008     2.882    0.578     0.732
6.607      1.23     1.423
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.611     1.000     1.019     1.005     2.864    0.571     0.724
6.537      1.22     1.191
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.609     0.998     1.016     1.002     2.841    0.565     0.715
6.464      1.22     1.207
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.609     0.998     1.016     1.002     2.842    0.565     0.715
6.457      1.22     1.341
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:             <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.649     1.064     1.079     1.068     3.281    0.969     1.231
11.878      1.65     2.385
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:             <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.635     1.041     1.056     1.045     3.134    0.754     0.956
9.377      1.46     1.675
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q3
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.002     1.023     1.007     2.569    0.546     0.691
6.246      1.13     1.195
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.609     0.989     1.010     0.995     2.634    0.540     0.683
6.171      1.16     1.071
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
```

```
                    ATP Program:  Yes
               Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.612     0.992     1.013     0.998     2.612    0.541     0.685
6.189      1.15     1.040
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q3
* File 1, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  66.8 (F)
              Maximum Temperature:  82.5 (F)
                Minimum Rel. Hum.:  56.5 (%)
                Maximum Rel. Hum.:  88.2 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   9.0 psi
                    Weathered RVP:   8.8 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.612     0.992     1.013     0.998     2.610    0.541     0.685
6.188      1.15     1.186
  ---------------------------------------------------------------------------------------------------
----------------------

***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT094.IN (file 7, run 1).                                  *
***************************************************************************

* Urban interstate- Catawba County-TDM-Q4
* File 7, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
```

```
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.669     1.179     1.261     1.200     3.275    0.658     1.023
10.274      2.26     2.257
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q4
* File 7, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.660     1.167     1.250     1.188     3.214    0.601     0.934
9.429      2.14     1.767
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q4
* File 7, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.625     1.123     1.211     1.145     2.575    0.426     0.662
6.184      1.59     1.269
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q4
* File 7, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2010
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  43.3 (F)
             Maximum Temperature:  56.0 (F)
               Minimum Rel. Hum.:  57.9 (%)
               Maximum Rel. Hum.:  86.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.617     1.109     1.196     1.131     2.617    0.420     0.651
6.078      1.62     1.147
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q4
* File 7, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2010
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  43.3 (F)
             Maximum Temperature:  56.0 (F)
               Minimum Rel. Hum.:  57.9 (%)
               Maximum Rel. Hum.:  86.0 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.607     1.094     1.180     1.116     2.703    0.414     0.643
6.004      1.68     1.101
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q4
* File 7, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.617     1.109     1.196     1.131     2.616    0.420     0.651
6.083      1.62     1.254
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
```

```
              Maximum Rel. Hum.:  86.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.683     1.199     1.281     1.220     3.381    0.802     1.247
12.389      2.45     3.380
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2010
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  43.3 (F)
            Maximum Temperature:  56.0 (F)
              Minimum Rel. Hum.:  57.9 (%)
              Maximum Rel. Hum.:  86.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0003    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.633     1.129     1.212     1.150     3.001    0.467     0.726
7.462      1.81     1.666
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2010
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  43.3 (F)
            Maximum Temperature:  56.0 (F)
```

```
              Minimum Rel. Hum.:  57.9 (%)
              Maximum Rel. Hum.:  86.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0366    0.0003    0.0019
0.0876    0.0054    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.625     1.118     1.201     1.139     2.935    0.444     0.690
6.438      1.77     1.483
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2010
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  43.3 (F)
            Maximum Temperature:  56.0 (F)
              Minimum Rel. Hum.:  57.9 (%)
              Maximum Rel. Hum.:  86.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3856    0.3957    0.1349              0.0224    0.0003    0.0020
0.0534    0.0057    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.622     1.114     1.198     1.136     2.916    0.439     0.682
6.369      1.76     1.260
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2010
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  43.3 (F)
```

```
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0238    0.0003    0.0020
0.0570    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.619     1.111     1.195     1.132     2.894    0.434     0.674
6.296      1.75     1.274
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0326    0.0003    0.0019
0.0778    0.0055    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.619     1.111     1.195     1.132     2.894    0.434     0.674
6.290      1.75     1.403
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
```

```
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.678     1.191     1.274     1.212     3.341    0.747     1.162
11.587      2.37     2.434
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.658     1.163     1.245     1.184     3.192    0.580     0.902
9.129      2.10     1.738
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q4
* File 7, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
```

```
                   Altitude:  Low
       Minimum Temperature:  43.3 (F)
       Maximum Temperature:  56.0 (F)
         Minimum Rel. Hum.:  57.9 (%)
         Maximum Rel. Hum.:  86.0 (%)
      Barometric Pressure: 30.00 (inches Hg)
         Nominal Fuel RVP:  14.0 psi
             Weathered RVP:  14.0 psi
       Fuel Sulfur Content:   30. ppm

       Exhaust I/M Program:  Yes
          Evap I/M Program:  Yes
               ATP Program:  Yes
          Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.617     1.109     1.196     1.131     2.616    0.420     0.651
6.082      1.62     1.254
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
             Calendar Year:  2010
                     Month:  Jan.
                  Altitude:  Low
       Minimum Temperature:  43.3 (F)
       Maximum Temperature:  56.0 (F)
         Minimum Rel. Hum.:  57.9 (%)
         Maximum Rel. Hum.:  86.0 (%)
      Barometric Pressure: 30.00 (inches Hg)
         Nominal Fuel RVP:  14.0 psi
             Weathered RVP:  14.0 psi
       Fuel Sulfur Content:   30. ppm

       Exhaust I/M Program:  Yes
          Evap I/M Program:  Yes
               ATP Program:  Yes
          Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.609     1.097     1.183     1.119     2.682    0.415     0.644
6.009      1.66     1.136
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
             Calendar Year:  2010
```

```
                        Month:  Jan.
                     Altitude:  Low
          Minimum Temperature:  43.3 (F)
          Maximum Temperature:  56.0 (F)
            Minimum Rel. Hum.:  57.9 (%)
            Maximum Rel. Hum.:  86.0 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  14.0 psi
                Weathered RVP:  14.0 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  Yes
             Evap I/M Program:  Yes
                  ATP Program:  Yes
             Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.611     1.100     1.186     1.122     2.659    0.416     0.645
6.026      1.65     1.105
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q4
* File 7, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                Calendar Year:  2010
                        Month:  Jan.
                     Altitude:  Low
          Minimum Temperature:  43.3 (F)
          Maximum Temperature:  56.0 (F)
            Minimum Rel. Hum.:  57.9 (%)
            Maximum Rel. Hum.:  86.0 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  14.0 psi
                Weathered RVP:  14.0 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  Yes
             Evap I/M Program:  Yes
                  ATP Program:  Yes
             Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.611     1.100     1.186     1.122     2.658    0.416     0.645
6.025      1.65     1.245
  -----------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: CAT094N.IN (file 8, run 1).                                 *
```

```
****************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-TDM-Q4
* File 8, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.858     1.426     1.509     1.447     3.639    0.889     1.160
11.477      2.26     2.607
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-TDM-Q4
* File 8, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.849     1.413     1.496     1.434     3.571    0.812     1.059
10.547      2.14     2.068
```

```
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-TDM-Q4
* File 8, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.745     1.297     1.386     1.320     2.575    0.426     0.662
6.184      1.59     1.407
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-TDM-Q4
* File 8, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.735     1.281     1.370     1.304     2.617    0.420     0.651
6.078      1.62     1.288
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-TDM-Q4
* File 8, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.724     1.265     1.352     1.287     2.703    0.414     0.643
6.004      1.68     1.241
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-TDM-Q4
* File 8, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
```

```
 Composite Emission Factors (g/mi):
     Composite NOX :      0.735     1.281     1.370     1.304     2.616    0.420     0.651
6.083      1.62     1.391
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.805     1.374     1.453     1.394     3.381    0.802     1.247
12.389      2.45     3.490
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0003    0.0019
0.0986    0.0053    1.0000
```

```
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.751     1.300     1.382     1.321     3.001    0.467     0.726
7.462      1.81     1.793
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0366    0.0003    0.0019
0.0876    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.742     1.288     1.372     1.310     2.935    0.444     0.690
6.438      1.77     1.612
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3856    0.3957    0.1349              0.0224    0.0003    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.740     1.285     1.368     1.306     2.916    0.439     0.682
6.369      1.76     1.395
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0238    0.0003    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.737     1.281     1.365     1.302     2.894    0.434     0.674
6.296      1.75     1.409
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
```

```
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0326    0.0003    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.737     1.281     1.365     1.302     2.894    0.434     0.674
6.290      1.75     1.534
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.800     1.365     1.445     1.386     3.341    0.747     1.162
11.587      2.37     2.558
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway mix and speeds
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.778     1.336     1.416     1.356     3.192    0.580     0.902
9.129      2.10     1.869
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial-Catawba County-Rural-Q4
* File 8, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.735     1.281     1.370     1.304     2.616    0.420     0.651
6.082      1.62     1.390
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.726     1.268     1.355     1.290     2.682    0.415     0.644
6.009      1.66     1.275
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.728     1.271     1.359     1.293     2.659    0.416     0.645
6.026      1.65     1.246
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local- Catawba County-Rural-Q4
* File 8, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  43.3 (F)
              Maximum Temperature:  56.0 (F)
                Minimum Rel. Hum.:  57.9 (%)
                Maximum Rel. Hum.:  86.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.728     1.271     1.359     1.293     2.658    0.416     0.645
6.025      1.65     1.380
  -------------------------------------------------------------------------------------------------
----------------------
```

6.2.2.2 Davidson County 2009 MOBILE6.2 Output Files for NOx

```
****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: DV091.IN (file 1, run 1).                                    *
****************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q1
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0806    0.0003    0.0016
0.1918    0.0045    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.802     1.359     1.442     1.380     3.810    1.083     1.414
13.806      2.59     3.789
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q1
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.785     1.337     1.420     1.358     3.691    0.889     1.160
11.474      2.39     2.251
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q1
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.736     1.269     1.353     1.290     3.308    0.601     0.782
7.170      1.87     1.678
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q1
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
```

```
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  Yes
              Evap I/M Program:  Yes
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.736     1.269     1.352     1.290     3.309    0.601     0.782
7.173      1.87     1.438
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q1
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  37.1 (F)
             Maximum Temperature:  53.6 (F)
               Minimum Rel. Hum.:  45.8 (%)
               Maximum Rel. Hum.:  75.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0239    0.0004    0.0020
0.0569    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.748     1.285     1.368     1.306     3.404    0.644     0.838
7.696      1.94     1.508
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q1
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  37.1 (F)
             Maximum Temperature:  53.6 (F)
```

```
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0327    0.0004    0.0019
0.0777    0.0055    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.742     1.277     1.360     1.298     3.356    0.620     0.807
7.399      1.90     1.635
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q1
* File 1, Run 1, Scenario 7.
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.802     1.359     1.442     1.380     3.810    1.083     1.414
13.813      2.59     2.857
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q1
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
```

```
               Minimum Rel. Hum.:  45.8 (%)
               Maximum Rel. Hum.:  75.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.760     1.302     1.385     1.323     3.502    0.705     0.917
9.247      2.06     1.866
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q1
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  37.1 (F)
             Maximum Temperature:  53.6 (F)
               Minimum Rel. Hum.:  45.8 (%)
               Maximum Rel. Hum.:  75.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.723     1.252     1.337     1.273     3.209    0.573     0.745
6.838      1.84     1.428
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q1
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  37.1 (F)
```

```
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.723     1.252     1.337     1.273     3.210    0.573     0.745
6.834      1.84     1.307
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q1
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.717     1.244     1.329     1.265     3.142    0.565     0.735
6.745      1.81     1.258
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q1
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
```

```
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.733     1.265     1.349     1.286     3.284    0.595     0.773
7.101      1.86     1.456
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 1, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0806    0.0003    0.0016
0.1918    0.0045    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.802     1.359     1.442     1.380     3.810    1.083     1.414
13.806      2.59     3.789
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 1, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
```

```
                    Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  Yes
              Evap I/M Program:  Yes
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.736     1.269     1.352     1.290     3.309    0.601     0.782
8.004      1.87     1.838
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 1, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  Yes
              Evap I/M Program:  Yes
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.733     1.265     1.349     1.286     3.285    0.595     0.773
7.091      1.86     1.667
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 1, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
```

```
                    Month:  Jan.
                 Altitude:  Low
      Minimum Temperature:  37.1 (F)
      Maximum Temperature:  53.6 (F)
        Minimum Rel. Hum.:  45.8 (%)
        Maximum Rel. Hum.:  75.1 (%)
      Barometric Pressure: 30.00 (inches Hg)
         Nominal Fuel RVP:  14.0 psi
            Weathered RVP:  14.0 psi
      Fuel Sulfur Content:   30. ppm

      Exhaust I/M Program:  Yes
         Evap I/M Program:  Yes
              ATP Program:  Yes
         Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.733     1.265     1.349     1.286     3.286    0.595     0.773
7.094      1.86     1.430
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 1, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
            Calendar Year:  2009
                    Month:  Jan.
                 Altitude:  Low
      Minimum Temperature:  37.1 (F)
      Maximum Temperature:  53.6 (F)
        Minimum Rel. Hum.:  45.8 (%)
        Maximum Rel. Hum.:  75.1 (%)
      Barometric Pressure: 30.00 (inches Hg)
         Nominal Fuel RVP:  14.0 psi
            Weathered RVP:  14.0 psi
      Fuel Sulfur Content:   30. ppm

      Exhaust I/M Program:  Yes
         Evap I/M Program:  Yes
              ATP Program:  Yes
         Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0239    0.0004    0.0020
0.0569    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.730     1.261     1.345     1.282     3.261    0.588     0.764
7.015      1.85     1.446
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 1, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0327    0.0004    0.0019
0.0777    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.730     1.261     1.345     1.282     3.261    0.588     0.764
7.008      1.85     1.589
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 1, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.792     1.346     1.429     1.367     3.741    0.970     1.266
12.457      2.47     2.675
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 1, Run 1, Scenario 20.
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.773     1.319     1.402     1.340     3.597    0.785     1.023
10.216      2.23     1.966
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 1, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.732     1.267     1.355     1.289     2.926    0.573     0.745
6.833      1.70     1.432
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
```

```
* File 1, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.718     1.246     1.332     1.268     3.023    0.562     0.730
6.698      1.76     1.293
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 1, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.720     1.249     1.335     1.271     2.997    0.563     0.732
6.717      1.74     1.259
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
* Urban local Rural
* File 1, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.718     1.246     1.332     1.268     3.021    0.562     0.730
6.704      1.76     1.411
  ---------------------------------------------------------------------------------------------------
----------------------


****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: DV091N.IN (file 2, run 1).                                   *
****************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q1
* File 2, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0806    0.0003    0.0016
0.1918    0.0045    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.921     1.529     1.614     1.551     3.810    1.083     1.414
13.806      2.59     3.897
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q1
* File 2, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.904     1.506     1.591     1.527     3.691    0.889     1.160
11.474      2.39     2.377
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q1
* File 2, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
```

```
 Composite Emission Factors (g/mi):
     Composite NOX :      0.851     1.435     1.524     1.458     3.308    0.601     0.782
7.170      1.87     1.804
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q1
* File 2, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.851     1.435     1.524     1.458     3.309    0.601     0.782
7.173      1.87     1.571
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q1
* File 2, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0239    0.0004    0.0020
0.0569    0.0056    1.0000
```

```
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.864     1.452     1.539     1.474     3.404    0.644     0.838
7.696      1.94     1.641
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q1
* File 2, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0327    0.0004    0.0019
0.0777    0.0055    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.857     1.443     1.532     1.466     3.356    0.620     0.807
7.399      1.90     1.764
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q1
* File 2, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.921     1.529     1.614     1.551     3.810    1.083     1.414
13.813      2.59     2.979
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q1
* File 2, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.877     1.469     1.555     1.491     3.502    0.705     0.917
9.247      2.06     1.994
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q1
* File 2, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.838     1.418     1.509     1.441     3.209    0.573     0.745
6.838      1.84     1.561
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q1
* File 2, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.838     1.418     1.509     1.441     3.210    0.573     0.745
6.834      1.84     1.443
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q1
* File 2, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.831     1.410     1.501     1.433     3.142    0.565     0.735
6.745      1.81     1.395
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q1
* File 2, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.848     1.431     1.521     1.454     3.284    0.595     0.773
7.101      1.86     1.589
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 2, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0806    0.0003    0.0016
0.1918    0.0045    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.921     1.529     1.614     1.551     3.810    1.083     1.414
13.806      2.59     3.897
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 2, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.851     1.435     1.524     1.458     3.309    0.601     0.782
8.004      1.87     1.962
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 2, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.848     1.431     1.521     1.454     3.285    0.595     0.773
7.091      1.86     1.794
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 2, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.848     1.431     1.520     1.454     3.286    0.595     0.773
7.094      1.86     1.563
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 2, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
```

```
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0239    0.0004    0.0020
0.0569    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.845     1.427     1.517     1.450     3.261    0.588     0.764
7.015      1.85     1.578
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 2, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  37.1 (F)
            Maximum Temperature:  53.6 (F)
              Minimum Rel. Hum.:  45.8 (%)
              Maximum Rel. Hum.:  75.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0327    0.0004    0.0019
0.0777    0.0055    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.845     1.427     1.517     1.450     3.261    0.588     0.764
7.008      1.85     1.717
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 2, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  37.1 (F)
            Maximum Temperature:  53.6 (F)
              Minimum Rel. Hum.:  45.8 (%)
              Maximum Rel. Hum.:  75.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
```

```
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0521    0.0003    0.0018
0.1241    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.911     1.515     1.601     1.537     3.741    0.970     1.266
12.457      2.47     2.796
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 2, Run 1, Scenario 20.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.890     1.487     1.573     1.509     3.597    0.785     1.023
10.216      2.23     2.094
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 2, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm
```

```
              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0240    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.849     1.436     1.531     1.460     2.926    0.573     0.745
6.833      1.70     1.567
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
* File 2, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.833     1.413     1.506     1.436     3.023    0.562     0.730
6.698      1.76     1.430
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 2, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm
```

```
              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.835     1.416     1.510     1.440     2.997    0.563     0.732
6.717      1.74     1.397
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local Rural
* File 2, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.833     1.413     1.506     1.436     3.021    0.562     0.730
6.704      1.76     1.544
  ---------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: DV092.IN (file 3, run 1).                                   *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q2
* File 3, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
```

```
               Maximum Temperature:  77.1 (F)
                 Minimum Rel. Hum.:  44.3 (%)
                 Maximum Rel. Hum.:  82.0 (%)
               Barometric Pressure: 30.00 (inches Hg)
                  Nominal Fuel RVP:  10.1 psi
                     Weathered RVP:  10.1 psi
               Fuel Sulfur Content:   30. ppm

               Exhaust I/M Program:  Yes
                  Evap I/M Program:  Yes
                       ATP Program:  Yes
                  Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.627     1.046     1.079     1.055     3.243    1.039     1.321
12.694      1.98     3.340
  -----------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q2
* File 3, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                     Calendar Year:  2009
                             Month:  July
                          Altitude:  Low
               Minimum Temperature:  58.5 (F)
               Maximum Temperature:  77.1 (F)
                 Minimum Rel. Hum.:  44.3 (%)
                 Maximum Rel. Hum.:  82.0 (%)
               Barometric Pressure: 30.00 (inches Hg)
                  Nominal Fuel RVP:  10.1 psi
                     Weathered RVP:  10.1 psi
               Fuel Sulfur Content:   30. ppm

               Exhaust I/M Program:  Yes
                  Evap I/M Program:  Yes
                       ATP Program:  Yes
                  Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.615     1.028     1.062     1.037     3.141    0.854     1.084
10.539      1.83     1.914
  -----------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q2
* File 3, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                     Calendar Year:  2009
                             Month:  July
                          Altitude:  Low
```

```
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.579     0.975     1.011     0.984     2.815    0.578     0.732
6.607      1.43     1.397
  ---------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q2
* File 3, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector mix and speeds
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.579     0.975     1.011     0.984     2.816    0.578     0.732
6.610      1.43     1.171
  ---------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q2
* File 3, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
```

```
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  58.5 (F)
            Maximum Temperature:  77.1 (F)
              Minimum Rel. Hum.:  44.3 (%)
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.588     0.988     1.023     0.997     2.897    0.619     0.784
7.093      1.49     1.235
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q2
* File 3, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  58.5 (F)
            Maximum Temperature:  77.1 (F)
              Minimum Rel. Hum.:  44.3 (%)
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.584     0.981     1.017     0.990     2.856    0.596     0.755
6.819      1.45     1.356
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q2
* File 3, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.627     1.046     1.079     1.054     3.243    1.039     1.321
12.700      1.98     2.473
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q2
* File 3, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.597     1.001     1.036     1.010     2.980    0.677     0.858
8.482      1.58     1.562
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q2
* File 3, Run 1, Scenario 9.
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.571     0.962     0.998     0.971     2.731    0.551     0.697
6.301      1.41     1.166
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q2
* File 3, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.571     0.962     0.998     0.971     2.732    0.551     0.697
6.296      1.41     1.051
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q2
```

```
* File 3, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.566     0.955     0.992     0.965     2.674    0.543     0.687
6.214      1.39     1.007
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q2
* File 3, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.008     0.981     2.794    0.571     0.724
6.543      1.43     1.190
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
* Rural interstate Rural
* File 3, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  58.5 (F)
            Maximum Temperature:  77.1 (F)
              Minimum Rel. Hum.:  44.3 (%)
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.627     1.046     1.079     1.055     3.243    1.039     1.321
12.694      1.98     3.340
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 3, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  58.5 (F)
            Maximum Temperature:  77.1 (F)
              Minimum Rel. Hum.:  44.3 (%)
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.579     0.975     1.011     0.984     2.815    0.578     0.732
7.334      1.43     1.542
  -----------------------------------------------------------------------------------------------
----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 3, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.008     0.981     2.795    0.571     0.724
6.534      1.43     1.388
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 3, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.008     0.981     2.797    0.571     0.724
6.537      1.43     1.165
  ---------------------------------------------------------------------------------------------
----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 3, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.575     0.969     1.005     0.978     2.775    0.565     0.715
6.464      1.42     1.181
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 3, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.575     0.969     1.005     0.978     2.775    0.565     0.715
6.457      1.42     1.315
```

```
 ------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 3, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
 ------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.620     1.036     1.069     1.044     3.183    0.932     1.184
11.447      1.89     2.306
 ------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 3, Run 1, Scenario 20.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
 ------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.606     1.015     1.049     1.023     3.061    0.754     0.956
9.377      1.71     1.652
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 3, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.583     0.975     1.014     0.985     2.490    0.550     0.697
6.296      1.30     1.171
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
* File 3, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
```

```
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.569     0.958     0.995     0.967     2.572    0.540     0.683
6.171      1.35     1.041
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 3, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.572     0.960     0.998     0.970     2.551    0.541     0.685
6.189      1.34     1.009
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local Rural
* File 3, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.569     0.958     0.996     0.967     2.571    0.540     0.683
6.176      1.35     1.153
  -----------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: DV092.IN (file 3, run 1).                                   *
***************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q2
* File 3, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.627     1.046     1.079     1.055     3.243    1.039     1.321
12.694      1.98     3.340
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q2
* File 3, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
          Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                            ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.615     1.028     1.062     1.037     3.141    0.854     1.084
10.539      1.83     1.914
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q2
* File 3, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                            ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.579     0.975     1.011     0.984     2.815    0.578     0.732
6.607      1.43     1.397
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q2
* File 3, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.579     0.975     1.011     0.984     2.816    0.578     0.732
6.610      1.43     1.171
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q2
* File 3, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.588     0.988     1.023     0.997     2.897    0.619     0.784
7.093      1.49     1.235
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q2
* File 3, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
```

```
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.584     0.981     1.017     0.990     2.856    0.596     0.755
6.819      1.45     1.356
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q2
* File 3, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.627     1.046     1.079     1.054     3.243    1.039     1.321
12.700      1.98     2.473
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q2
* File 3, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm
```

```
               Exhaust I/M Program:  Yes
                  Evap I/M Program:  Yes
                       ATP Program:  Yes
                  Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.597     1.001     1.036     1.010     2.980    0.677     0.858
8.482      1.58     1.562
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q2
* File 3, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.571     0.962     0.998     0.971     2.731    0.551     0.697
6.301      1.41     1.166
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q2
* File 3, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm
```

```
              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.571     0.962     0.998     0.971     2.732    0.551     0.697
6.296      1.41     1.051
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q2
* File 3, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.566     0.955     0.992     0.965     2.674    0.543     0.687
6.214      1.39     1.007
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q2
* File 3, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
```

```
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.008     0.981     2.794    0.571     0.724
6.543      1.43     1.190
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 3, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.627     1.046     1.079     1.055     3.243    1.039     1.321
12.694      1.98     3.340
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 3, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
```

```
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.579     0.975     1.011     0.984     2.815    0.578     0.732
7.334      1.43     1.542
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 3, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.008     0.981     2.795    0.571     0.724
6.534      1.43     1.388
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 3, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.577     0.972     1.008     0.981     2.797    0.571     0.724
6.537      1.43     1.165
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 3, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  Yes
                Evap I/M Program:  Yes
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.575     0.969     1.005     0.978     2.775    0.565     0.715
6.464      1.42     1.181
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 3, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.575     0.969     1.005     0.978     2.775    0.565     0.715
6.457      1.42     1.315
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 3, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.620     1.036     1.069     1.044     3.183    0.932     1.184
11.447      1.89     2.306
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 3, Run 1, Scenario 20.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
```

```
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.606     1.015     1.049     1.023     3.061    0.754     0.956
9.377      1.71     1.652
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 3, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  58.5 (F)
            Maximum Temperature:  77.1 (F)
              Minimum Rel. Hum.:  44.3 (%)
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.583     0.975     1.014     0.985     2.490    0.550     0.697
6.296      1.30     1.171
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
* File 3, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  58.5 (F)
            Maximum Temperature:  77.1 (F)
```

```
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.569     0.958     0.995     0.967     2.572    0.540     0.683
6.171      1.35     1.041
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 3, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.572     0.960     0.998     0.970     2.551    0.541     0.685
6.189      1.34     1.009
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local Rural
* File 3, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
```

```
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.569     0.958     0.996     0.967     2.571    0.540     0.683
6.176      1.35     1.153
  ---------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: DV093.IN (file 5, run 1).                                   *
***************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q3
* File 5, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.559     0.918     0.947     0.925     3.365    1.039     1.321
12.694      1.66     3.273
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q3
```

```
* File 5, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -----------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.549     0.902     0.932     0.910     3.259    0.854     1.084
10.539      1.53     1.831
  -----------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q3
* File 5, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.521     0.855     0.887     0.863     2.921    0.578     0.732
6.607      1.20     1.318
  -----------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
* Rural major collector TDM Q3
* File 5, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.521     0.855     0.887     0.863     2.923    0.578     0.732
6.610      1.20     1.086
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q3
* File 5, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.528     0.866     0.898     0.874     3.007    0.619     0.784
7.093      1.25     1.148
  -----------------------------------------------------------------------------------------------
----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q3
* File 5, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.524     0.860     0.892     0.869     2.964    0.596     0.755
6.819      1.22     1.274
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q3
* File 5, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.559     0.918     0.947     0.925     3.365    1.039     1.321
12.700      1.66     2.393
  -----------------------------------------------------------------------------------------------
----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q3
* File 5, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.535     0.878     0.909     0.886     3.093    0.677     0.858
8.482      1.33     1.480
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q3
* File 5, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.514     0.843     0.876     0.851     2.834    0.551     0.697
6.301      1.18     1.082
```

```
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q3
* File 5, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.514     0.843     0.876     0.851     2.835    0.551     0.697
6.296      1.18     0.965
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q3
* File 5, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.511     0.837     0.871     0.846     2.775    0.543     0.687
6.214      1.17     0.920
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q3
* File 5, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.519     0.852     0.885     0.860     2.900    0.571     0.724
6.543      1.20     1.105
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 5, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
```

```
 Composite Emission Factors (g/mi):
     Composite NOX :      0.559     0.918     0.947     0.925     3.365    1.039     1.321
12.694      1.66     3.273
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 5, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.521     0.855     0.887     0.863     2.922    0.578     0.732
7.334      1.20     1.465
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 5, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
```

```
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.519     0.852     0.885     0.860     2.901    0.571     0.724
6.534      1.20     1.309
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 5, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.519     0.852     0.884     0.860     2.902    0.571     0.724
6.537      1.20     1.079
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 5, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :     0.518     0.849     0.882     0.857     2.880    0.565     0.715
6.464      1.19     1.096
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 5, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :     0.518     0.849     0.882     0.857     2.880    0.565     0.715
6.457      1.19     1.234
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 5, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.553     0.909     0.939     0.916     3.304    0.932     1.184
11.447      1.59     2.228
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 5, Run 1, Scenario 20.
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.542     0.890     0.921     0.898     3.177    0.754     0.956
9.377      1.43     1.568
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 5, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.533     0.858     0.893     0.867     2.584    0.550     0.697
6.296      1.09     1.091
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
* File 5, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.517     0.841     0.875     0.849     2.670    0.540     0.683
6.171      1.13     0.957
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 5, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.520     0.843     0.878     0.852     2.647    0.541     0.685
6.189      1.12     0.924
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local Rural
* File 5, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.517     0.841     0.875     0.849     2.668    0.540     0.683
6.176      1.13     1.071
  -----------------------------------------------------------------------------------------------
----------------------


*************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                            *
* Input file: DV093N.IN (file 6, run 1).                                *
*************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q3
* File 6, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
```

```
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.640     1.048     1.062     1.052     3.365    1.039     1.321
12.694      1.66     3.351
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q3
* File 6, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.630     1.032     1.047     1.036     3.259    0.854     1.084
10.539      1.53     1.922
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q3
* File 6, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm
```

```
              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.601     0.982     1.000     0.987     2.921    0.578     0.732
6.607      1.20     1.410
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q3
* File 6, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.601     0.982     1.000     0.987     2.923    0.578     0.732
6.610      1.20     1.183
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q3
* File 6, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm
```

```
              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.608     0.994     1.011     0.999     3.007    0.619     0.784
7.093      1.25     1.245
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q3
* File 6, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.605     0.988     1.006     0.993     2.964    0.596     0.755
6.819      1.22     1.367
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q3
* File 6, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
```

```
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                           ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.640     1.048     1.062     1.052     3.365    1.039     1.321
12.700      1.66     2.481
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q3
* File 6, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                           ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.615     1.007     1.022     1.011     3.093    0.677     0.858
8.482      1.33     1.572
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q3
* File 6, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
```

```
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.594     0.970     0.989     0.975     2.834    0.551     0.697
6.301      1.18     1.178
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q3
* File 6, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.594     0.971     0.989     0.975     2.835    0.551     0.697
6.296      1.18     1.064
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q3
* File 6, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.592     0.965     0.985     0.970     2.775    0.543     0.687
6.214      1.17     1.020
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q3
* File 6, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.600     0.980     0.998     0.984     2.900    0.571     0.724
6.543      1.20     1.201
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 6, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.640     1.048     1.062     1.052     3.365    1.039     1.321
12.694      1.66     3.351
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 6, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3586    0.3684    0.1256              0.0413    0.0004    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.601     0.982     1.000     0.987     2.922    0.578     0.732
7.334      1.20     1.555
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 6, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
```

```
              Maximum Rel. Hum.:  86.8 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   7.8 psi
                  Weathered RVP:   7.7 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0367    0.0004    0.0019
0.0875    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.600     0.980     0.998     0.984     2.901    0.571     0.724
6.534      1.20     1.400
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 6, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  68.2 (F)
            Maximum Temperature:  83.1 (F)
              Minimum Rel. Hum.:  56.8 (%)
              Maximum Rel. Hum.:  86.8 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   7.8 psi
                  Weathered RVP:   7.7 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0224    0.0004    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.600     0.980     0.998     0.984     2.902    0.571     0.724
6.537      1.20     1.176
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 6, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2009
                          Month:  July
                       Altitude:  Low
            Minimum Temperature:  68.2 (F)
            Maximum Temperature:  83.1 (F)
```

```
               Minimum Rel. Hum.:  56.8 (%)
               Maximum Rel. Hum.:  86.8 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:   7.8 psi
                   Weathered RVP:   7.7 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0238    0.0004    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.598     0.977     0.995     0.981     2.880    0.565     0.715
6.464      1.19     1.192
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 6, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
             Minimum Temperature:  68.2 (F)
             Maximum Temperature:  83.1 (F)
               Minimum Rel. Hum.:  56.8 (%)
               Maximum Rel. Hum.:  86.8 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:   7.8 psi
                   Weathered RVP:   7.7 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0326    0.0004    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.598     0.977     0.995     0.981     2.880    0.565     0.715
6.457      1.19     1.328
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 6, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
             Minimum Temperature:  68.2 (F)
```

```
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.634     1.039     1.053     1.042     3.304    0.932     1.184
11.447      1.59     2.315
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 6, Run 1, Scenario 20.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0354    0.0004    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.623     1.019     1.034     1.023     3.177    0.754     0.956
9.377      1.43     1.660
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 6, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
```

```
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0239    0.0004    0.0020
0.0571    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.616     0.988     1.009     0.993     2.584    0.550     0.697
6.296      1.09     1.189
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
* File 6, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0021
0.0390    0.0058    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.598     0.969     0.989     0.974     2.670    0.540     0.683
6.171      1.13     1.057
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 6, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
```

```
                    Altitude:  Low
           Minimum Temperature:  68.2 (F)
           Maximum Temperature:  83.1 (F)
             Minimum Rel. Hum.:  56.8 (%)
             Maximum Rel. Hum.:  86.8 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:   7.8 psi
                 Weathered RVP:   7.7 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.602     0.972     0.993     0.977     2.647    0.541     0.685
6.189      1.12     1.025
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local Rural
* File 6, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  July
                      Altitude:  Low
           Minimum Temperature:  68.2 (F)
           Maximum Temperature:  83.1 (F)
             Minimum Rel. Hum.:  56.8 (%)
             Maximum Rel. Hum.:  86.8 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:   7.8 psi
                 Weathered RVP:   7.7 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0240    0.0004    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.598     0.969     0.989     0.974     2.668    0.540     0.683
6.176      1.13     1.168
  -------------------------------------------------------------------------------------------------
----------------------


****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: DV094.IN (file 7, run 1).                                    *
****************************************************************************
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q4
* File 7, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.679     1.191     1.273     1.212     3.377    0.802     1.247
12.389      2.43     3.376
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q4
* File 7, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0003    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.665     1.171     1.253     1.192     3.271    0.658     1.023
10.271      2.24     1.989
  ---------------------------------------------------------------------------------------------
----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q4
* File 7, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0366    0.0003    0.0019
0.0876    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.111     1.194     1.132     2.932    0.444     0.690
6.438      1.75     1.478
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q4
* File 7, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3856    0.3957    0.1349              0.0224    0.0003    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.111     1.193     1.132     2.933    0.444     0.690
6.441      1.75     1.261
```

```
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q4
* File 7, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0238    0.0003    0.0020
0.0570    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.631     1.125     1.208     1.146     3.017    0.476     0.740
6.915      1.82     1.325
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q4
* File 7, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0326    0.0003    0.0019
0.0778    0.0055    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.626     1.118     1.200     1.139     2.974    0.458     0.712
6.645      1.78     1.439
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q4
* File 7, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.679     1.191     1.273     1.212     3.377    0.802     1.247
12.395      2.43     2.537
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q4
* File 7, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
```

```
 Composite Emission Factors (g/mi):
     Composite NOX :      0.642     1.140     1.222     1.161     3.104    0.521     0.809
8.248      1.94     1.642
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q4
* File 7, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.610     1.096     1.179     1.117     2.844    0.423     0.657
6.136      1.73     1.253
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q4
* File 7, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
```

```
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.610     1.096     1.179     1.117     2.846    0.423     0.657
6.132      1.73     1.143
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q4
* File 7, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.604     1.088     1.172     1.110     2.785    0.417     0.648
6.051      1.71     1.099
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q4
* File 7, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.618     1.107     1.190     1.128     2.911    0.439     0.682
6.374      1.75     1.278
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 7, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.679     1.191     1.273     1.212     3.377    0.802     1.247
12.389      2.43     3.376
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 7, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0003    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.111     1.193     1.132     2.932    0.444     0.690
7.120      1.75     1.616
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 7, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0366    0.0003    0.0019
0.0876    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.618     1.107     1.190     1.128     2.912    0.439     0.682
6.366      1.75     1.468
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 7, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3856    0.3957    0.1349              0.0224    0.0003    0.0020
0.0534    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.618     1.107     1.190     1.128     2.913    0.439     0.682
6.369      1.75     1.254
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 7, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0238    0.0003    0.0020
0.0570    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.616     1.103     1.187     1.125     2.890    0.434     0.674
6.296      1.74     1.268
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 7, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0326    0.0003    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.616     1.103     1.187     1.125     2.890    0.434     0.674
6.290      1.74     1.398
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 7, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.671     1.180     1.262     1.200     3.315    0.718     1.117
11.164      2.32     2.371
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 7, Run 1, Scenario 20.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.653     1.156     1.237     1.176     3.188    0.580     0.902
9.129      2.09     1.732
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 7, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.617     1.108     1.195     1.130     2.593    0.423     0.657
6.131      1.60     1.255
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
* File 7, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.605     1.090     1.175     1.111     2.679    0.415     0.644
6.009      1.65     1.130
  -------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 7, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.607     1.092     1.178     1.114     2.656    0.416     0.645
6.026      1.64     1.100
  -------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local Rural
* File 7, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
```

```
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  ------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.605     1.090     1.175     1.111     2.678    0.415     0.644
6.014      1.65     1.237
  ------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: DV094N.IN (file 8, run 1).                                  *
***************************************************************************
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q4
* File 8, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  ------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.801     1.365     1.444     1.385     3.377    0.802     1.247
12.389      2.43     3.485
  ------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q4
* File 8, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0003    0.0019
0.0986    0.0053    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.785     1.344     1.423     1.364     3.271    0.658     1.023
10.271      2.24     2.117
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q4
* File 8, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2010
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  44.0 (F)
             Maximum Temperature:  55.9 (F)
               Minimum Rel. Hum.:  61.6 (%)
               Maximum Rel. Hum.:  85.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0366    0.0003    0.0019
0.0876    0.0054    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.738     1.280     1.363     1.301     2.932    0.444     0.690
6.438      1.75     1.606
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q4
* File 8, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2010
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  44.0 (F)
             Maximum Temperature:  55.9 (F)
               Minimum Rel. Hum.:  61.6 (%)
               Maximum Rel. Hum.:  85.1 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3856    0.3957    0.1349              0.0224    0.0003    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.738     1.280     1.363     1.301     2.933    0.444     0.690
6.441      1.75     1.396
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q4
* File 8, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0238    0.0003    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.749     1.295     1.377     1.316     3.017    0.476     0.740
6.915      1.82     1.460
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q4
* File 8, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
```

```
              Maximum Rel. Hum.:  85.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0326    0.0003    0.0019
0.0778    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.743     1.287     1.370     1.308     2.974    0.458     0.712
6.645      1.78     1.570
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q4
* File 8, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
            Minimum Temperature:  44.0 (F)
            Maximum Temperature:  55.9 (F)
              Minimum Rel. Hum.:  61.6 (%)
              Maximum Rel. Hum.:  85.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.801     1.365     1.444     1.385     3.377    0.802     1.247
12.395      2.43     2.660
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q4
* File 8, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
            Minimum Temperature:  44.0 (F)
            Maximum Temperature:  55.9 (F)
```

```
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.761     1.311     1.391     1.331     3.104    0.521     0.809
8.248      1.94     1.771
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q4
* File 8, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.726     1.265     1.349     1.286     2.844    0.423     0.657
6.136      1.73     1.386
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q4
* File 8, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
```

```
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.726     1.265     1.349     1.286     2.846    0.423     0.657
6.132      1.73     1.281
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q4
* File 8, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.720     1.257     1.342     1.279     2.785    0.417     0.648
6.051      1.71     1.237
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q4
* File 8, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
```

```
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.735     1.276     1.360     1.298     2.911    0.439     0.682
6.374      1.75     1.412
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate Rural
* File 8, Run 1, Scenario 13.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0804    0.0003    0.0016
0.1920    0.0045    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.801     1.365     1.444     1.385     3.377    0.802     1.247
12.389      2.43     3.485
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial Rural
* File 8, Run 1, Scenario 14.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
```

```
                      Altitude:  Low
           Minimum Temperature:  44.0 (F)
           Maximum Temperature:  55.9 (F)
             Minimum Rel. Hum.:  61.6 (%)
             Maximum Rel. Hum.:  85.1 (%)
          Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1256              0.0413    0.0003    0.0019
0.0986    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.738     1.280     1.363     1.301     2.932    0.444     0.690
7.120      1.75     1.741
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial Rural
* File 8, Run 1, Scenario 15.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2010
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  44.0 (F)
           Maximum Temperature:  55.9 (F)
             Minimum Rel. Hum.:  61.6 (%)
             Maximum Rel. Hum.:  85.1 (%)
          Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0366    0.0003    0.0019
0.0876    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.735     1.276     1.360     1.298     2.912    0.439     0.682
6.366      1.75     1.596
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector Rural
* File 8, Run 1, Scenario 16.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2010
```

```
                        Month:  Jan.
                     Altitude:  Low
          Minimum Temperature:  44.0 (F)
          Maximum Temperature:  55.9 (F)
            Minimum Rel. Hum.:  61.6 (%)
            Maximum Rel. Hum.:  85.1 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  14.0 psi
                Weathered RVP:  14.0 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  No
             Evap I/M Program:  No
                  ATP Program:  Yes
             Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3856    0.3957    0.1349              0.0224    0.0003    0.0020
0.0534    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.735     1.276     1.360     1.298     2.913    0.439     0.682
6.369      1.75     1.389
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector Rural
* File 8, Run 1, Scenario 17.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                Calendar Year:  2010
                        Month:  Jan.
                     Altitude:  Low
          Minimum Temperature:  44.0 (F)
          Maximum Temperature:  55.9 (F)
            Minimum Rel. Hum.:  61.6 (%)
            Maximum Rel. Hum.:  85.1 (%)
          Barometric Pressure: 30.00 (inches Hg)
             Nominal Fuel RVP:  14.0 psi
                Weathered RVP:  14.0 psi
          Fuel Sulfur Content:   30. ppm

          Exhaust I/M Program:  No
             Evap I/M Program:  No
                  ATP Program:  Yes
             Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0238    0.0003    0.0020
0.0570    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.732     1.273     1.356     1.294     2.890    0.434     0.674
6.296      1.74     1.403
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local Rural
* File 8, Run 1, Scenario 18.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0326    0.0003    0.0019
0.0778    0.0055    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.732     1.273     1.356     1.294     2.890    0.434     0.674
6.290      1.74     1.527
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate Rural
* File 8, Run 1, Scenario 19.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0520    0.0003    0.0018
0.1242    0.0051    1.0000
  --------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.792     1.353     1.432     1.373     3.315    0.718     1.117
11.164      2.32     2.494
  --------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway Rural
* File 8, Run 1, Scenario 20.
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0354    0.0003    0.0019
0.0845    0.0054    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.773     1.327     1.407     1.347     3.188    0.580     0.902
9.129      2.09     1.862
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial Rural
* File 8, Run 1, Scenario 21.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0239    0.0003    0.0020
0.0571    0.0056    1.0000
  -------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.735     1.280     1.369     1.303     2.593    0.423     0.657
6.131      1.60     1.392
  -------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial Rural
```

```
* File 8, Run 1, Scenario 22.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0163    0.0004    0.0020
0.0390    0.0058    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.721     1.260     1.346     1.282     2.679    0.415     0.644
6.009      1.65     1.268
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector Rural
* File 8, Run 1, Scenario 23.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1392              0.0139    0.0004    0.0021
0.0333    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.723     1.263     1.350     1.285     2.656    0.416     0.645
6.026      1.64     1.239
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
* Urban local Rural
* File 8, Run 1, Scenario 24.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0240    0.0003    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.721     1.260     1.346     1.282     2.678    0.415     0.644
6.014      1.65     1.371
  ---------------------------------------------------------------------------------------------
-----------------------

P:\Planning\ATTAINMT\MOBILE\PM SIP\NOx\DAVGUINOx
```

6.2.2.3 Guilford County 2009 MOBILE6.2 Output Files for NOx

```
***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: GU091.IN (file 1, run 1).                                   *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q1
* File 1, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3036    0.3115    0.1061              0.0797    0.0003    0.0016
0.1927    0.0045    1.0000
  ---------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.734     1.298     1.225     1.280     3.001    0.785     0.982
9.546      2.35     2.849
  ---------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q1
* File 1, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0409    0.0003    0.0019
0.0990    0.0053    1.0000
  ---------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.728     1.290     1.216     1.271     2.963    0.738     0.922
8.999      2.27     1.915
  ---------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q1
* File 1, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0363    0.0004    0.0019
0.0879    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.691     1.238     1.170     1.221     2.724    0.552     0.688
6.229      1.88     1.525
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q1
* File 1, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0222    0.0004    0.0020
0.0536    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.698     1.247     1.177     1.229     2.767    0.574     0.716
6.496      1.92     1.344
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q1
* File 1, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0236    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.694     1.243     1.174     1.225     2.746    0.563     0.702
6.371      1.90     1.354
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q1
* File 1, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0323    0.0004    0.0020
0.0781    0.0055    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.689     1.235     1.166     1.217     2.707    0.546     0.681
6.163      1.87     1.458
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q1
* File 1, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0515    0.0003    0.0018
0.1247    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.737     1.302     1.228     1.284     3.019    0.808     1.010
9.812      2.39     2.254
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q1
* File 1, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0350    0.0004    0.0019
0.0849    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.719     1.276     1.204     1.258     2.904    0.672     0.839
8.233      2.15     1.713
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q1
* File 1, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0237    0.0004    0.0020
0.0573    0.0056    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.676     1.218     1.151     1.201     2.626    0.520     0.648
5.873      1.85     1.304
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q1
* File 1, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.672     1.213     1.147     1.196     2.590    0.516     0.642
5.815      1.83     1.195
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q1
* File 1, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0138    0.0004    0.0021
0.0334    0.0059    1.0000
  ---------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.672     1.213     1.147     1.196     2.590    0.516     0.642
5.821      1.83     1.164
  ---------------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q1
* File 1, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0238    0.0004    0.0020
0.0574    0.0056    1.0000
  ---------------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.670     1.210     1.144     1.193     2.570    0.513     0.639
5.790      1.82     1.291
  ---------------------------------------------------------------------------------------------------
-----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: GU091N.IN (file 2, run 1).                                  *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q1
* File 2, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
```

```
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0797    0.0003    0.0016
0.1927    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.853     1.469     1.393     1.450     3.001    0.785     0.982
9.546      2.35     2.955
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q1
* File 2, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  37.1 (F)
             Maximum Temperature:  53.6 (F)
               Minimum Rel. Hum.:  45.8 (%)
               Maximum Rel. Hum.:  75.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0409    0.0003    0.0019
0.0990    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.846     1.460     1.384     1.441     2.963    0.738     0.922
8.999      2.27     2.041
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q1
* File 2, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial mix and speeds
                   Calendar Year:  2009
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  37.1 (F)
             Maximum Temperature:  53.6 (F)
               Minimum Rel. Hum.:  45.8 (%)
```

```
              Maximum Rel. Hum.:  75.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3652    0.3750    0.1279              0.0363    0.0004    0.0019
0.0879    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.807     1.407     1.338     1.389     2.724    0.552     0.688
6.229      1.88     1.651
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q1
* File 2, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
            Minimum Temperature:  37.1 (F)
            Maximum Temperature:  53.6 (F)
              Minimum Rel. Hum.:  45.8 (%)
              Maximum Rel. Hum.:  75.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0222    0.0004    0.0020
0.0536    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.813     1.416     1.345     1.398     2.767    0.574     0.716
6.496      1.92     1.478
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q1
* File 2, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
            Minimum Temperature:  37.1 (F)
            Maximum Temperature:  53.6 (F)
```

```
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0236    0.0004    0.0020
0.0572    0.0056    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.810     1.411     1.342     1.394     2.746    0.563     0.702
6.371      1.90     1.488
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q1
* File 2, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0323    0.0004    0.0020
0.0781    0.0055    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.804     1.403     1.335     1.386     2.707    0.546     0.681
6.163      1.87     1.587
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q1
* File 2, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  37.1 (F)
```

```
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0515    0.0003    0.0018
0.1247    0.0051    1.0000
  -----------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.856     1.473     1.397     1.454     3.019    0.808     1.010
9.812      2.39     2.375
  -----------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q1
* File 2, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway mix and speeds
                    Calendar Year:  2009
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  37.1 (F)
              Maximum Temperature:  53.6 (F)
                Minimum Rel. Hum.:  45.8 (%)
                Maximum Rel. Hum.:  75.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0350    0.0004    0.0019
0.0849    0.0054    1.0000
  -----------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.836     1.446     1.372     1.427     2.904    0.672     0.839
8.233      2.15     1.842
  -----------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q1
* File 2, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  Jan.
```

```
                     Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0237    0.0004    0.0020
0.0573    0.0056    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.791     1.386     1.320     1.370     2.626    0.520     0.648
5.873      1.85     1.437
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q1
* File 2, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.787     1.381     1.316     1.364     2.590    0.516     0.642
5.815      1.83     1.332
  ----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q1
* File 2, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
```

```
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0138    0.0004    0.0021
0.0334    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.787     1.381     1.316     1.364     2.590    0.516     0.642
5.821      1.83     1.302
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q1
* File 2, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                 Calendar Year:  2009
                         Month:  Jan.
                      Altitude:  Low
           Minimum Temperature:  37.1 (F)
           Maximum Temperature:  53.6 (F)
             Minimum Rel. Hum.:  45.8 (%)
             Maximum Rel. Hum.:  75.1 (%)
           Barometric Pressure: 30.00 (inches Hg)
              Nominal Fuel RVP:  14.0 psi
                 Weathered RVP:  14.0 psi
           Fuel Sulfur Content:   30. ppm

           Exhaust I/M Program:  No
              Evap I/M Program:  No
                   ATP Program:  Yes
              Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0238    0.0004    0.0020
0.0574    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.784     1.378     1.313     1.362     2.570    0.513     0.639
5.790      1.82     1.424
  ---------------------------------------------------------------------------------------------
----------------------


*************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                            *
* Input file: GU092.IN (file 3, run 1).                                 *
```

```
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q2
* File 3, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0795    0.0003    0.0016
0.1929    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.572     0.996     0.913     0.975     2.440    0.746     0.911
8.580      1.81     2.440
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q2
* File 3, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0408    0.0003    0.0019
0.0991    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.567     0.989     0.907     0.968     2.409    0.701     0.855
8.085      1.75     1.592
```

```
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q2
* File 3, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0362    0.0003    0.0019
0.0880    0.0054    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.541     0.949     0.871     0.929     2.215    0.525     0.638
5.626      1.44     1.249
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q2
* File 3, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0221    0.0004    0.0020
0.0537    0.0057    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.545     0.956     0.877     0.936     2.250    0.546     0.665
5.867      1.48     1.081
  -----------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q2
* File 3, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0236    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
-----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.543     0.952     0.874     0.932     2.233    0.536     0.652
5.754      1.46     1.092
  -----------------------------------------------------------------------------------------------
-----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q2
* File 3, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0322    0.0004    0.0020
0.0782    0.0055    1.0000
  -----------------------------------------------------------------------------------------------
-----------------------
```

```
 Composite Emission Factors (g/mi):
     Composite NOX :      0.539     0.946     0.868     0.926     2.201    0.519     0.632
5.566      1.44     1.188
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q2
* File 3, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0514    0.0003    0.0018
0.1248    0.0051    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.574     0.999     0.916     0.978     2.455    0.768     0.937
8.821      1.84     1.898
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q2
* File 3, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0349    0.0004    0.0019
0.0850    0.0054    1.0000
```

```
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.560     0.979     0.898     0.958     2.361    0.639     0.778
7.391      1.65     1.411
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q2
* File 3, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0236    0.0004    0.0020
0.0574    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.530     0.933     0.857     0.914     2.135    0.495     0.602
5.303      1.42     1.049
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q2
* File 3, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.527     0.929     0.853     0.910     2.106    0.490     0.596
5.251      1.41     0.951
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q2
* File 3, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0137    0.0004    0.0021
0.0335    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.527     0.929     0.853     0.910     2.106    0.490     0.596
5.256      1.41     0.922
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q2
* File 3, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                    ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0237    0.0004    0.0020
0.0575    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.526     0.927     0.851     0.907     2.090    0.488     0.593
5.228      1.40     1.040
  -----------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: GU092N.IN (file 4, run 1).                                  *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q2
* File 4, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                    ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0795    0.0003    0.0016
0.1929    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.663     1.145     1.038     1.118     2.440    0.746     0.911
8.580      1.81     2.527
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q2
* File 4, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
```

```
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0408    0.0003    0.0019
0.0991    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.658     1.138     1.032     1.111     2.409    0.701     0.855
8.085      1.75     1.695
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q2
* File 4, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0362    0.0003    0.0019
0.0880    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.630     1.096     0.995     1.070     2.215    0.525     0.638
5.626      1.44     1.353
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q2
* File 4, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm
```

```
              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0221    0.0004    0.0020
0.0537    0.0057    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.635     1.103     1.001     1.077     2.250    0.546     0.665
5.867      1.48     1.191
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q2
* File 4, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0236    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.633     1.100     0.998     1.074     2.233    0.536     0.652
5.754      1.46     1.201
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q2
* File 4, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
```

```
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0322    0.0004    0.0020
0.0782    0.0055    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.628     1.093     0.993     1.068     2.201    0.519     0.632
5.566      1.44     1.294
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q2
* File 4, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  10.1 psi
                   Weathered RVP:  10.1 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0514    0.0003    0.0018
0.1248    0.0051    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.665     1.149     1.041     1.121     2.455    0.768     0.937
8.821      1.84     1.997
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q2
* File 4, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                   Calendar Year:  2009
                           Month:  July
                        Altitude:  Low
             Minimum Temperature:  58.5 (F)
             Maximum Temperature:  77.1 (F)
               Minimum Rel. Hum.:  44.3 (%)
               Maximum Rel. Hum.:  82.0 (%)
             Barometric Pressure: 30.00 (inches Hg)
```

```
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0349    0.0004    0.0019
0.0850    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.651     1.127     1.022     1.100     2.361    0.639     0.778
7.391      1.65     1.516
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q2
* File 4, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0236    0.0004    0.0020
0.0574    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.619     1.080     0.981     1.055     2.135    0.495     0.602
5.303      1.42     1.158
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q2
* File 4, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
```

```
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.616     1.076     0.978     1.051     2.106    0.490     0.596
5.251      1.41     1.062
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q2
* File 4, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
                Maximum Rel. Hum.:  82.0 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  10.1 psi
                    Weathered RVP:  10.1 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0137    0.0004    0.0021
0.0335    0.0059    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.616     1.075     0.978     1.051     2.106    0.490     0.596
5.256      1.41     1.034
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q2
* File 4, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  58.5 (F)
              Maximum Temperature:  77.1 (F)
                Minimum Rel. Hum.:  44.3 (%)
```

```
              Maximum Rel. Hum.:  82.0 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  10.1 psi
                  Weathered RVP:  10.1 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  No
               Evap I/M Program:  No
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0237    0.0004    0.0020
0.0575    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.615     1.073     0.976     1.049     2.090    0.488     0.593
5.228      1.40     1.148
  -----------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: GU093.IN (file 5, run 1).                                   *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q3
* File 5, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
            Minimum Temperature:  68.2 (F)
            Maximum Temperature:  83.1 (F)
              Minimum Rel. Hum.:  56.8 (%)
              Maximum Rel. Hum.:  86.8 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:   7.8 psi
                  Weathered RVP:   7.7 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0795    0.0003    0.0016
0.1929    0.0045    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.511     0.874     0.802     0.856     2.533    0.746     0.911
8.580      1.52     2.377
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q3
* File 5, Run 1, Scenario 2.
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0408    0.0003    0.0019
0.0991    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.508     0.868     0.796     0.850     2.500    0.701     0.855
8.085      1.46     1.515
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q3
* File 5, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0362    0.0003    0.0019
0.0880    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.486     0.832     0.765     0.815     2.299    0.525     0.638
5.626      1.21     1.174
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q3
```

```
* File 5, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0221    0.0004    0.0020
0.0537    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.490     0.838     0.770     0.821     2.335    0.546     0.665
5.867      1.24     1.000
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q3
* File 5, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0236    0.0004    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.488     0.835     0.767     0.818     2.317    0.536     0.652
5.754      1.23     1.011
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
* Rural local TDM Q3
* File 5, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0322    0.0004    0.0020
0.0782    0.0055    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.485     0.830     0.762     0.813     2.284    0.519     0.632
5.566      1.21     1.112
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q3
* File 5, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0514    0.0003    0.0018
0.1248    0.0051    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.513     0.877     0.804     0.858     2.548    0.768     0.937
8.821      1.54     1.824
  ------------------------------------------------------------------------------------------------
----------------------
```

```
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q3
* File 5, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
             Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0349    0.0004    0.0019
0.0850    0.0054    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.502     0.859     0.788     0.841     2.450    0.639     0.778
7.391      1.39     1.332
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q3
* File 5, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
             Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0236    0.0004    0.0020
0.0574    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
```

```
     Composite NOX :      0.478     0.818     0.752     0.801     2.216    0.495     0.602
5.303      1.19     0.971
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q3
* File 5, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  ---------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.476     0.814     0.749     0.798     2.186    0.490     0.596
5.251      1.18     0.870
  ---------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q3
* File 5, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0137    0.0004    0.0021
0.0335    0.0059    1.0000
```

```
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.476     0.814     0.749     0.798     2.186    0.490     0.596
5.256      1.18     0.840
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q3
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0237    0.0004    0.0020
0.0575    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.475     0.813     0.748     0.796     2.169    0.488     0.593
5.228      1.17     0.962
  ------------------------------------------------------------------------------------------------
----------------------


***************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                              *
* Input file: GU093N.IN (file 6, run 1).                                  *
***************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q3
* File 6, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0795    0.0003    0.0016
0.1929    0.0045    1.0000
  --------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.591     1.005     0.912     0.981     2.533    0.746     0.911
8.580      1.52     2.454
  --------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q3
* File 6, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0408    0.0003    0.0019
0.0991    0.0053    1.0000
  --------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.587     0.998     0.907     0.975     2.500    0.701     0.855
8.085      1.46     1.605
  --------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q3
* File 6, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0362    0.0003    0.0019
0.0880    0.0054    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.566     0.961     0.874     0.939     2.299    0.525     0.638
5.626      1.21     1.265
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q3
* File 6, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3855    0.3957    0.1349              0.0221    0.0004    0.0020
0.0537    0.0057    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.570     0.967     0.879     0.945     2.335    0.546     0.665
5.867      1.24     1.096
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q3
* File 6, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3936    0.1342              0.0236    0.0004    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.568     0.964     0.877     0.942     2.317    0.536     0.652
5.754      1.23     1.107
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q3
* File 6, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3709    0.3810    0.1299              0.0322    0.0004    0.0020
0.0782    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.564     0.959     0.872     0.937     2.284    0.519     0.632
5.566      1.21     1.205
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q3
* File 6, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0514    0.0003    0.0018
0.1248    0.0051    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.593     1.008     0.915     0.984     2.548    0.768     0.937
8.821      1.54     1.911
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q3
* File 6, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3669    0.3769    0.1286              0.0349    0.0004    0.0019
0.0850    0.0054    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.582     0.989     0.898     0.966     2.450    0.639     0.778
7.391      1.39     1.424
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q3
* File 6, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
```

```
                   ATP Program:  Yes
              Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3833    0.3935    0.1342              0.0236    0.0004    0.0020
0.0574    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.558     0.947     0.862     0.925     2.216    0.495     0.602
5.303      1.19     1.067
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q3
* File 6, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                         ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.556     0.943     0.859     0.922     2.186    0.490     0.596
5.251      1.18     0.968
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q3
* File 6, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
```

```
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0137    0.0004    0.0021
0.0335    0.0059    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.556     0.943     0.859     0.922     2.186    0.490     0.596
5.256      1.18     0.939
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q3
* File 6, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2009
                            Month:  July
                         Altitude:  Low
              Minimum Temperature:  68.2 (F)
              Maximum Temperature:  83.1 (F)
                Minimum Rel. Hum.:  56.8 (%)
                Maximum Rel. Hum.:  86.8 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:   7.8 psi
                    Weathered RVP:   7.7 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:                <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3933    0.1341              0.0237    0.0004    0.0020
0.0575    0.0056    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.555     0.941     0.857     0.920     2.169    0.488     0.593
5.228      1.17     1.058
  ------------------------------------------------------------------------------------------------
----------------------


****************************************************************************
* MOBILE6.2.03 (24-Sep-2003)                                               *
* Input file: GU094.IN (file 7, run 1).                                    *
****************************************************************************

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q4
* File 7, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
```

```
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0796    0.0003    0.0016
0.1928    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.618     1.132     1.064     1.115     2.606    0.590     0.859
8.393      2.21     2.491
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q4
* File 7, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                          ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0408    0.0003    0.0019
0.0991    0.0053    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.613     1.124     1.057     1.107     2.573    0.554     0.807
7.903      2.14     1.668
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q4
* File 7, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
```

```
              Minimum Rel. Hum.:  61.6 (%)
              Maximum Rel. Hum.:  85.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0363    0.0003    0.0019
0.0879    0.0054    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.580     1.079     1.016     1.063     2.366    0.414     0.602
5.491      1.77     1.326
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q4
* File 7, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
            Minimum Temperature:  44.0 (F)
            Maximum Temperature:  55.9 (F)
              Minimum Rel. Hum.:  61.6 (%)
              Maximum Rel. Hum.:  85.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3856    0.3957    0.1349              0.0221    0.0003    0.0020
0.0537    0.0057    1.0000
  -------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.586     1.087     1.023     1.070     2.403    0.431     0.627
5.731      1.81     1.166
  -------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q4
* File 7, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
            Minimum Temperature:  44.0 (F)
```

```
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0236    0.0003    0.0020
0.0572    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.583     1.083     1.020     1.067     2.384    0.423     0.615
5.618      1.79     1.176
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q4
* File 7, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0323    0.0003    0.0020
0.0781    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.578     1.076     1.013     1.060     2.350    0.410     0.595
5.432      1.76     1.267
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q4
* File 7, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
```

```
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0514    0.0003    0.0018
0.1248    0.0051    1.0000
  ------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.621     1.136     1.068     1.118     2.622    0.607     0.884
8.632      2.25     1.967
  ------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q4
* File 7, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0350    0.0003    0.0019
0.0849    0.0054    1.0000
  ------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.604     1.113     1.046     1.096     2.521    0.505     0.734
7.215      2.02     1.489
  ------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q4
* File 7, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
```

```
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  44.0 (F)
            Maximum Temperature:  55.9 (F)
              Minimum Rel. Hum.:  61.6 (%)
              Maximum Rel. Hum.:  85.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0237    0.0003    0.0020
0.0573    0.0056    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.567     1.061     1.000     1.045     2.280    0.390     0.567
5.172      1.73     1.131
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q4
* File 7, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                  Calendar Year:  2010
                          Month:  Jan.
                       Altitude:  Low
            Minimum Temperature:  44.0 (F)
            Maximum Temperature:  55.9 (F)
              Minimum Rel. Hum.:  61.6 (%)
              Maximum Rel. Hum.:  85.1 (%)
            Barometric Pressure: 30.00 (inches Hg)
               Nominal Fuel RVP:  14.0 psi
                  Weathered RVP:  14.0 psi
            Fuel Sulfur Content:   30. ppm

            Exhaust I/M Program:  Yes
               Evap I/M Program:  Yes
                    ATP Program:  Yes
               Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.563     1.056     0.996     1.041     2.250    0.387     0.562
5.120      1.72     1.035
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q4
* File 7, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
```

```
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0137    0.0004    0.0021
0.0335    0.0059    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.563     1.056     0.996     1.041     2.249    0.387     0.562
5.125      1.72     1.007
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q4
* File 7, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  Yes
                 Evap I/M Program:  Yes
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0237    0.0003    0.0020
0.0575    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.561     1.053     0.994     1.038     2.232    0.385     0.559
5.097      1.71     1.120
  -----------------------------------------------------------------------------------------------
----------------------


***************************************************************************
```

```
* MOBILE6.2.03 (24-Sep-2003)                                          *
* Input file: GU094N.IN (file 8, run 1).                              *
***********************************************************************

* Reading Registration Distributions from the following external
* data file: GUIAGE07.PRN

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural interstate TDM Q4
* File 8, Run 1, Scenario 1.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2010
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  44.0 (F)
             Maximum Temperature:  55.9 (F)
               Minimum Rel. Hum.:  61.6 (%)
               Maximum Rel. Hum.:  85.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3036    0.3115    0.1061              0.0796    0.0003    0.0016
0.1928    0.0045    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.738     1.305     1.229     1.285     2.606    0.590     0.859
8.393      2.21     2.598
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural principle arterial TDM Q4
* File 8, Run 1, Scenario 2.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                   Calendar Year:  2010
                           Month:  Jan.
                        Altitude:  Low
             Minimum Temperature:  44.0 (F)
             Maximum Temperature:  55.9 (F)
               Minimum Rel. Hum.:  61.6 (%)
               Maximum Rel. Hum.:  85.1 (%)
             Barometric Pressure: 30.00 (inches Hg)
                Nominal Fuel RVP:  14.0 psi
                   Weathered RVP:  14.0 psi
             Fuel Sulfur Content:   30. ppm

             Exhaust I/M Program:  No
                Evap I/M Program:  No
                     ATP Program:  Yes
                Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:               <6000     >6000     (All)
                       ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3587    0.3684    0.1255              0.0408    0.0003    0.0019
0.0991    0.0053    1.0000
```

```
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.732     1.296     1.221     1.277     2.573    0.554     0.807
7.903      2.14     1.794
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor arterial TDM Q4
* File 8, Run 1, Scenario 3.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3653    0.3750    0.1279              0.0363    0.0003    0.0019
0.0879    0.0054    1.0000
  ------------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
    Composite NOX :      0.697     1.249     1.180     1.231     2.366    0.414     0.602
5.491      1.77     1.453
  ------------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector TDM Q4
* File 8, Run 1, Scenario 4.
* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural major collector mix and speeds
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
```

```
   VMT Distribution:    0.3856    0.3957    0.1349              0.0221    0.0003    0.0020
0.0537    0.0057    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.703     1.257     1.186     1.239     2.403    0.431     0.627
5.731      1.81     1.301
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural minor collector TDM Q4
* File 8, Run 1, Scenario 5.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3936    0.1342              0.0236    0.0003    0.0020
0.0572    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.700     1.253     1.183     1.235     2.384    0.423     0.615
5.618      1.79     1.309
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Rural local TDM Q4
* File 8, Run 1, Scenario 6.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:               <6000     >6000     (All)
```

```
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3710    0.3810    0.1299              0.0323    0.0003    0.0020
0.0781    0.0055    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.694     1.246     1.177     1.228     2.350    0.410     0.595
5.432      1.76     1.396
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban interstate TDM Q4
* File 8, Run 1, Scenario 7.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
             GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3436    0.3528    0.1202              0.0514    0.0003    0.0018
0.1248    0.0051    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.740     1.309     1.232     1.289     2.622    0.607     0.884
8.632      2.25     2.089
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban freeway TDM Q4
* File 8, Run 1, Scenario 8.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
```

```
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3670    0.3769    0.1286              0.0350    0.0003    0.0019
0.0849    0.0054    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.723     1.284     1.210     1.265     2.521    0.505     0.734
7.215      2.02     1.618
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban principle arterial TDM Q4
* File 8, Run 1, Scenario 9.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:               <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3834    0.3935    0.1342              0.0237    0.0003    0.0020
0.0573    0.0056    1.0000
  -----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.683     1.230     1.164     1.213     2.280    0.390     0.567
5.172      1.73     1.263
  -----------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban minor arterial TDM Q4
* File 8, Run 1, Scenario 10.
* # # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No
```

```
      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3939    0.4046    0.1380              0.0161    0.0004    0.0021
0.0392    0.0058    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.679     1.225     1.160     1.209     2.250    0.387     0.562
5.120      1.72     1.171
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban collector TDM Q4
* File 8, Run 1, Scenario 11.
* # # # # # # # # # # # # # # # # # # # # # # # # #
                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
                 Reformulated Gas:  No

      Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
              GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3973    0.4080    0.1391              0.0137    0.0004    0.0021
0.0335    0.0059    1.0000
  ---------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.679     1.225     1.160     1.209     2.249    0.387     0.562
5.125      1.72     1.145
  ---------------------------------------------------------------------------------------------
----------------------

* # # # # # # # # # # # # # # # # # # # # # # # # #
* Urban local TDM Q4
* File 8, Run 1, Scenario 12.
* # # # # # # # # # # # # # # # # # # # # # # # # #

                    Calendar Year:  2010
                            Month:  Jan.
                         Altitude:  Low
              Minimum Temperature:  44.0 (F)
              Maximum Temperature:  55.9 (F)
                Minimum Rel. Hum.:  61.6 (%)
                Maximum Rel. Hum.:  85.1 (%)
              Barometric Pressure: 30.00 (inches Hg)
                 Nominal Fuel RVP:  14.0 psi
                    Weathered RVP:  14.0 psi
              Fuel Sulfur Content:   30. ppm

              Exhaust I/M Program:  No
                 Evap I/M Program:  No
                      ATP Program:  Yes
```

```
                 Reformulated Gas:  No

       Vehicle Type:      LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT
HDDV        MC   All Veh
               GVWR:              <6000     >6000     (All)
                        ------    ------    ------    ------    ------    ------    ------    ---
---    ------    ------
   VMT Distribution:    0.3835    0.3933    0.1341              0.0237    0.0003    0.0020
0.0575    0.0056    1.0000
  ----------------------------------------------------------------------------------------------
----------------------
 Composite Emission Factors (g/mi):
     Composite NOX :      0.677     1.223     1.157     1.206     2.232    0.385     0.559
5.097      1.71     1.252
  ----------------------------------------------------------------------------------------------
----------------------
```

6.3 2009 State Vehicle Mix

6.3.1 2009 State Vehicle Mix for PM2.5 using 2006 count data

Rural 2009 State Vehicle Mix

LDV	LDT1	LDT2	LDT3	LDT4	HDV2B	HDV3	HDV4
HDV5	HDV6	HDV7	HDV8a	HDV8b	HDBS	HDBT	MC
Interstate							
0.3030	0.0718	0.2389	0.0736	0.0339	0.0880	0.0086	0.0072
0.0054	0.0197	0.0233	0.0253	0.0900	0.0045	0.0023	0.0045
Princ. Art.							
0.3591	0.0851	0.2833	0.0873	0.0401	0.0448	0.0044	0.0037
0.0028	0.0100	0.0119	0.0129	0.0458	0.0023	0.0012	0.0053
Minor Art.							
0.3668	0.0869	0.2894	0.0892	0.0410	0.0389	0.0038	0.0032
0.0024	0.0087	0.0103	0.0112	0.0398	0.0020	0.0010	0.0054
Major Collector							
0.3827	0.0906	0.3018	0.0930	0.0428	0.0267	0.0026	0.0022
0.0017	0.0060	0.0071	0.0077	0.0274	0.0014	0.0007	0.0056
Minor Collector							
0.3821	0.0905	0.3014	0.0929	0.0427	0.0272	0.0027	0.0022
0.0017	0.0061	0.0072	0.0078	0.0278	0.0014	0.0007	0.0056
Local							
0.3805	0.0901	0.3001	0.0925	0.0425	0.0284	0.0028	0.0023
0.0018	0.0064	0.0075	0.0082	0.0291	0.0015	0.0007	0.0056

Urban

LDV	LDT1	LDT2	LDT3	LDT4	HDV2B	HDV3	HDV4
HDV5	HDV6	HDV7	HDV8a	HDV8b	HDBS	HDBT	MC
Interstate							
0.3442	0.0815	0.2714	0.0836	0.0384	0.0564	0.0055	0.0046
0.0035	0.0126	0.0149	0.0162	0.0577	0.0029	0.0015	0.0051
Freeway							
0.3699	0.0876	0.2918	0.0899	0.0413	0.0366	0.0036	0.0030
0.0023	0.0082	0.0097	0.0105	0.0374	0.0019	0.0009	0.0054
Princ. Art.							
0.3837	0.0909	0.3026	0.0933	0.0429	0.0260	0.0025	0.0021
0.0016	0.0058	0.0069	0.0075	0.0266	0.0013	0.0007	0.0056
Minor Art							
0.3930	0.0931	0.3100	0.0956	0.0439	0.0188	0.0018	0.0015
0.0012	0.0042	0.0050	0.0054	0.0192	0.0010	0.0005	0.0058
Coll							
0.3967	0.0939	0.3127	0.0964	0.0443	0.0161	0.0016	0.0013
0.0010	0.0036	0.0043	0.0046	0.0165	0.0008	0.0004	0.0058
Local							
0.3872	0.0917	0.3054	0.0941	0.0433	0.0233	0.0023	0.0019
0.0014	0.0052	0.0062	0.0067	0.0238	0.0012	0.0006	0.0057

6.3.2 2009 State Vehicle Mix for NOx using 2007 count data

Rural 2009 State Vehicle Mix

LDV	LDT1	LDT2	LDT3	LDT4	HDV2B	HDV3	HDV4
HDV5	HDV6	HDV7	HDV8a	HDV8b	HDBS	HDBT	MC
Interstate							
0.3039	0.0719	0.2396	0.0738	0.0339	0.0874	0.0085	0.0072
0.0054	0.0195	0.0231	0.0252	0.0894	0.0045	0.0022	0.0045
Princ. Art.							
0.3590	0.0851	0.2833	0.0873	0.0401	0.0448	0.0044	0.0037
0.0028	0.0100	0.0119	0.0129	0.0459	0.0023	0.0012	0.0053
Minor Art.							
0.3656	0.0866	0.2884	0.0889	0.0409	0.0398	0.0039	0.0033
0.0025	0.0089	0.0105	0.0115	0.0408	0.0020	0.0010	0.0054

```
Major Collector
0.3859    0.0914    0.3043    0.0938    0.0431    0.0243    0.0024    0.0020
0.0015    0.0054    0.0064    0.0070    0.0249    0.0013    0.0006    0.0057
Minor Collector
0.3838    0.0909    0.3027    0.0933    0.0429    0.0259    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0265    0.0013    0.0007    0.0056
Local
0.3713    0.0880    0.2930    0.0903    0.0415    0.0354    0.0035    0.0029
0.0022    0.0079    0.0094    0.0102    0.0362    0.0018    0.0009    0.0055

Urban
LDV       LDT1      LDT2      LDT3      LDT4      HDV2B     HDV3      HDV4
HDV5      HDV6      HDV7      HDV8a     HDV8b     HDBS      HDBT      MC
Interstate
0.3439    0.0815    0.2713    0.0836    0.0384    0.0565    0.0055    0.0046
0.0035    0.0126    0.0150    0.0163    0.0578    0.0029    0.0015    0.0051
Freeway
0.3673    0.0870    0.2899    0.0894    0.0411    0.0384    0.0037    0.0032
0.0024    0.0086    0.0102    0.0111    0.0393    0.0020    0.0010    0.0054
Princ. Art.
0.3837    0.0909    0.3026    0.0933    0.0429    0.0260    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0266    0.0013    0.0007    0.0056
Minor Art
0.3943    0.0934    0.3112    0.0959    0.0441    0.0177    0.0017    0.0015
0.0011    0.0040    0.0047    0.0051    0.0181    0.0009    0.0005    0.0058
Coll
0.3977    0.0942    0.3138    0.0967    0.0445    0.0151    0.0015    0.0012
0.0009    0.0034    0.0040    0.0044    0.0155    0.0008    0.0004    0.0059
Local
0.3838    0.0908    0.3025    0.0932    0.0429    0.0261    0.0025    0.0021
0.0016    0.0058    0.0069    0.0075    0.0267    0.0013    0.0007    0.0056
```

6.4 2005 Vehicle Age Distribution Files used for PM2.5

6.4.1 2005 Triad Vehicle Age Distribution File Used for Guilford County

```
*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year:         2005.000User-Input
*
*MOBILE5b Reg Fractions
*          0.071   0.067   0.067   0.069   0.069   0.076   0.073   0.066   0.062   0.055
*          0.059   0.046   0.040   0.032   0.026   0.023   0.020   0.016   0.012   0.009
*          0.007   0.005   0.003   0.001   0.024
*          0.041   0.052   0.054   0.052   0.055   0.061   0.058   0.058   0.059   0.048
*          0.053   0.055   0.037   0.032   0.027   0.024   0.031   0.030   0.024   0.024
*          0.017   0.014   0.008   0.006   0.081
*          0.091   0.081   0.078   0.052   0.062   0.070   0.079   0.062   0.060   0.044
*          0.052   0.042   0.029   0.019   0.017   0.018   0.019   0.020   0.013   0.013
*          0.011   0.007   0.005   0.004   0.053
*          0.083   0.079   0.068   0.048   0.069   0.086   0.068   0.045   0.053   0.036
*          0.043   0.029   0.020   0.016   0.012   0.018   0.023   0.021   0.017   0.020
*          0.014   0.009   0.007   0.007   0.109
*          0.075   0.047   0.056   0.061   0.062   0.060   0.054   0.034   0.030   0.024
*          0.034   0.016   0.023   0.019   0.026   0.016   0.014   0.009   0.041   0.033
*          0.059   0.046   0.052   0.036   0.072
*          0.063   0.080   0.082   0.060   0.083   0.071   0.088   0.025   0.064   0.049
*          0.053   0.032   0.030   0.023   0.015   0.021   0.020   0.013   0.019   0.018
*          0.017   0.020   0.013   0.019   0.023
*          0.114   0.090   0.059   0.056   0.082   0.102   0.100   0.047   0.055   0.045
*          0.049   0.033   0.023   0.018   0.018   0.021   0.022   0.016   0.015   0.011
*          0.008   0.006   0.002   0.002   0.008
*          0.098   0.088   0.105   0.092   0.081   0.073   0.058   0.043   0.038   0.039
*          0.030   0.026   0.023   0.015   0.012   0.010   0.010   0.008   0.012   0.017
*          0.017   0.012   0.011   0.016   0.069
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
```

```
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                       RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV          M5 LDGV
      1   0.071   0.067   0.067   0.069   0.069   0.076   0.073   0.066   0.062   0.055
          0.059   0.046   0.040   0.032   0.026   0.023   0.020   0.016   0.012   0.009
          0.007   0.005   0.003   0.001   0.024
* LDT1         M5 LDGT1
      2   0.041   0.052   0.054   0.052   0.055   0.061   0.058   0.058   0.059   0.048
          0.053   0.055   0.037   0.032   0.027   0.024   0.031   0.030   0.024   0.024
          0.017   0.014   0.008   0.006   0.081
* LDT2         M5 LDGT1
      3   0.041   0.052   0.054   0.052   0.055   0.061   0.058   0.058   0.059   0.048
          0.053   0.055   0.037   0.032   0.027   0.024   0.031   0.030   0.024   0.024
          0.017   0.014   0.008   0.006   0.081
* LDT3         M5 LDGT2
      4   0.091   0.081   0.078   0.052   0.062   0.070   0.079   0.062   0.060   0.044
          0.052   0.042   0.029   0.019   0.017   0.018   0.019   0.020   0.013   0.013
          0.011   0.007   0.005   0.004   0.053
* LDT4         M5 LDGT2
      5   0.091   0.081   0.078   0.052   0.062   0.070   0.079   0.062   0.060   0.044
          0.052   0.042   0.029   0.019   0.017   0.018   0.019   0.020   0.013   0.013
          0.011   0.007   0.005   0.004   0.053
* HDV2B        M5 HDVs (Combined HDGV and HDDV)
      6   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV3         M5 HDVs (Combined HDGV and HDDV)
      7   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV4         M5 HDVs (Combined HDGV and HDDV)
      8   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV5         M5 HDVs (Combined HDGV and HDDV)
      9   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV6         M5 HDVs (Combined HDGV and HDDV)
     10   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV7         M5 HDVs (Combined HDGV and HDDV)
     11   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV8a        M5 HDVs (Combined HDGV and HDDV)
     12   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDV8b        M5 HDVs (Combined HDGV and HDDV)
     13   0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
```

```
          0.011   0.008   0.005   0.005   0.059
* HDBS          M5 HDVs (Combined HDGV and HDDV)
      14  0.098   0.084   0.063   0.052   0.076   0.094   0.084   0.046   0.054   0.040
          0.046   0.031   0.022   0.017   0.015   0.019   0.022   0.018   0.016   0.015
          0.011   0.008   0.005   0.005   0.059
* HDBT          M5 HDDVs
      15  0.114   0.090   0.059   0.056   0.082   0.102   0.100   0.047   0.055   0.045
          0.049   0.033   0.023   0.018   0.018   0.021   0.022   0.016   0.015   0.011
          0.008   0.006   0.002   0.002   0.008
* Motorcycles   M5 MC
      16  0.098   0.088   0.105   0.092   0.081   0.073   0.058   0.043   0.038   0.039
          0.030   0.026   0.023   0.015   0.012   0.010   0.010   0.008   0.012   0.017
          0.017   0.012   0.011   0.016   0.069
```

6.4.2 2005 NC Vehicle Age Distribution File Used for Catawba and Davidson Counties used for PM2.5

```
*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year:         2005.000User-Input
*
*MOBILE5b Reg Fractions
*          0.061   0.064   0.063   0.065   0.064   0.072   0.069   0.063   0.061   0.056
*          0.061   0.049   0.043   0.035   0.029   0.025   0.023   0.019   0.015   0.011
*          0.009   0.006   0.004   0.002   0.030
*          0.040   0.050   0.047   0.047   0.052   0.058   0.056   0.055   0.057   0.047
*          0.051   0.054   0.039   0.032   0.029   0.028   0.034   0.033   0.028   0.028
*          0.021   0.018   0.012   0.007   0.078
*          0.071   0.079   0.060   0.049   0.053   0.061   0.059   0.047   0.053   0.041
*          0.050   0.040   0.030   0.023   0.021   0.025   0.031   0.028   0.019   0.021
*          0.018   0.014   0.009   0.006   0.090
*          0.046   0.048   0.045   0.039   0.048   0.053   0.050   0.033   0.041   0.036
*          0.047   0.034   0.025   0.022   0.020   0.024   0.031   0.029   0.023   0.027
*          0.023   0.018   0.013   0.011   0.215
*          0.092   0.065   0.068   0.071   0.063   0.065   0.047   0.034   0.027   0.031
*          0.029   0.021   0.018   0.015   0.024   0.016   0.015   0.012   0.030   0.053
*          0.047   0.039   0.034   0.027   0.056
*          0.084   0.087   0.090   0.077   0.084   0.069   0.087   0.022   0.070   0.042
*          0.037   0.029   0.024   0.018   0.016   0.018   0.018   0.013   0.013   0.019
*          0.016   0.019   0.012   0.020   0.016
*          0.093   0.074   0.064   0.051   0.071   0.087   0.089   0.051   0.063   0.044
*          0.051   0.037   0.027   0.019   0.020   0.027   0.026   0.025   0.021   0.014
*          0.013   0.009   0.004   0.004   0.016
*          0.122   0.092   0.104   0.087   0.076   0.066   0.056   0.042   0.038   0.037
*          0.028   0.024   0.019   0.013   0.010   0.010   0.010   0.010   0.011   0.018
*          0.016   0.013   0.013   0.015   0.070
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                       RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV           M5 LDGV
       1   0.061   0.064   0.063   0.065   0.064   0.072   0.069   0.063   0.061   0.056
           0.061   0.049   0.043   0.035   0.029   0.025   0.023   0.019   0.015   0.011
           0.009   0.006   0.004   0.002   0.030
* LDT1          M5 LDGT1
       2   0.040   0.050   0.047   0.047   0.052   0.058   0.056   0.055   0.057   0.047
           0.051   0.054   0.039   0.032   0.029   0.028   0.034   0.033   0.028   0.028
           0.021   0.018   0.012   0.007   0.078
* LDT2          M5 LDGT1
       3   0.040   0.050   0.047   0.047   0.052   0.058   0.056   0.055   0.057   0.047
           0.051   0.054   0.039   0.032   0.029   0.028   0.034   0.033   0.028   0.028
           0.021   0.018   0.012   0.007   0.078
* LDT3          M5 LDGT2
       4   0.071   0.079   0.060   0.049   0.053   0.061   0.059   0.047   0.053   0.041
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          0.050   0.040   0.030   0.023   0.021   0.025   0.031   0.028   0.019   0.021
          0.018   0.014   0.009   0.006   0.090
* LDT4         M5 LDGT2
       5  0.071   0.079   0.060   0.049   0.053   0.061   0.059   0.047   0.053   0.041
          0.050   0.040   0.030   0.023   0.021   0.025   0.031   0.028   0.019   0.021
          0.018   0.014   0.009   0.006   0.090
* HDV2B        M5 HDVs (Combined HDGV and HDDV)
       6  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV3         M5 HDVs (Combined HDGV and HDDV)
       7  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV4         M5 HDVs (Combined HDGV and HDDV)
       8  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV5         M5 HDVs (Combined HDGV and HDDV)
       9  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV6         M5 HDVs (Combined HDGV and HDDV)
      10  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV7         M5 HDVs (Combined HDGV and HDDV)
      11  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV8a        M5 HDVs (Combined HDGV and HDDV)
      12  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDV8b        M5 HDVs (Combined HDGV and HDDV)
      13  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDBS         M5 HDVs (Combined HDGV and HDDV)
      14  0.069   0.061   0.054   0.045   0.060   0.069   0.069   0.042   0.052   0.040
          0.049   0.036   0.026   0.021   0.020   0.026   0.028   0.027   0.022   0.021
          0.018   0.014   0.008   0.007   0.116
* HDBT         M5 HDDVs
      15  0.093   0.074   0.064   0.051   0.071   0.087   0.089   0.051   0.063   0.044
          0.051   0.037   0.027   0.019   0.020   0.027   0.026   0.025   0.021   0.014
          0.013   0.009   0.004   0.004   0.016
* Motorcycles  M5 MC
      16  0.122   0.092   0.104   0.087   0.076   0.066   0.056   0.042   0.038   0.037
          0.028   0.024   0.019   0.013   0.010   0.010   0.010   0.010   0.011   0.018
          0.016   0.013   0.013   0.015   0.070
```

6.5 2007 Vehicle Age Distribution Files used for NOx

6.5.1 2007 Triad Vehicle Age Distribution File Used for Guilford County NOx

```
*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year:         2007.000User-Input
*
*MOBILE5b Reg Fractions
*         0.068   0.059   0.066   0.067   0.068   0.068   0.065   0.072   0.067   0.059
*         0.052   0.046   0.047   0.036   0.031   0.024   0.019   0.017   0.014   0.011
*         0.008   0.006   0.004   0.003   0.022
*         0.040   0.039   0.040   0.052   0.051   0.052   0.053   0.058   0.056   0.057
*         0.054   0.044   0.047   0.050   0.033   0.028   0.024   0.021   0.026   0.025
*         0.021   0.021   0.015   0.012   0.082
*         0.094   0.095   0.087   0.082   0.066   0.055   0.049   0.062   0.072   0.050
```

```
*          0.045   0.032   0.036   0.028   0.018   0.012   0.013   0.012   0.013   0.010
*          0.007   0.010   0.007   0.006   0.035
*          0.083   0.104   0.092   0.074   0.059   0.043   0.057   0.072   0.052   0.039
*          0.044   0.027   0.030   0.020   0.014   0.012   0.010   0.012   0.016   0.014
*          0.014   0.016   0.010   0.005   0.081
*          0.033   0.090   0.067   0.039   0.044   0.058   0.072   0.058   0.041   0.032
*          0.028   0.022   0.033   0.016   0.016   0.015   0.024   0.016   0.009   0.010
*          0.036   0.030   0.048   0.036   0.127
*          0.030   0.064   0.056   0.075   0.097   0.062   0.086   0.067   0.077   0.024
*          0.058   0.046   0.044   0.029   0.028   0.017   0.012   0.019   0.014   0.011
*          0.010   0.017   0.008   0.012   0.039
*          0.125   0.104   0.098   0.085   0.053   0.043   0.062   0.077   0.074   0.031
*          0.041   0.027   0.036   0.025   0.016   0.012   0.013   0.014   0.017   0.013
*          0.011   0.007   0.004   0.003   0.007
*          0.090   0.099   0.086   0.072   0.088   0.075   0.069   0.059   0.048   0.034
*          0.030   0.028   0.021   0.023   0.019   0.012   0.007   0.009   0.007   0.007
*          0.009   0.015   0.011   0.009   0.075
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                       RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV           M5 LDGV
      1   0.068   0.059   0.066   0.067   0.068   0.068   0.065   0.072   0.067   0.059
          0.052   0.046   0.047   0.036   0.031   0.024   0.019   0.017   0.014   0.011
          0.008   0.006   0.004   0.003   0.022
* LDT1          M5 LDGT1
      2   0.040   0.039   0.040   0.052   0.051   0.052   0.053   0.058   0.056   0.057
          0.054   0.044   0.047   0.050   0.033   0.028   0.024   0.021   0.026   0.025
          0.021   0.021   0.015   0.012   0.082
* LDT2          M5 LDGT1
      3   0.040   0.039   0.040   0.052   0.051   0.052   0.053   0.058   0.056   0.057
          0.054   0.044   0.047   0.050   0.033   0.028   0.024   0.021   0.026   0.025
          0.021   0.021   0.015   0.012   0.082
* LDT3          M5 LDGT2
      4   0.094   0.095   0.087   0.082   0.066   0.055   0.049   0.062   0.072   0.050
          0.045   0.032   0.036   0.028   0.018   0.012   0.013   0.012   0.013   0.010
          0.007   0.010   0.007   0.006   0.035
* LDT4          M5 LDGT2
      5   0.094   0.095   0.087   0.082   0.066   0.055   0.049   0.062   0.072   0.050
          0.045   0.032   0.036   0.028   0.018   0.012   0.013   0.012   0.013   0.010
          0.007   0.010   0.007   0.006   0.035
* HDV2B         M5 HDVs (Combined HDGV and HDDV)
      6   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV3          M5 HDVs (Combined HDGV and HDDV)
      7   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV4          M5 HDVs (Combined HDGV and HDDV)
      8   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
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          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV5         M5 HDVs (Combined HDGV and HDDV)
      9   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV6         M5 HDVs (Combined HDGV and HDDV)
     10   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV7         M5 HDVs (Combined HDGV and HDDV)
     11   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV8a        M5 HDVs (Combined HDGV and HDDV)
     12   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDV8b        M5 HDVs (Combined HDGV and HDDV)
     13   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDBS         M5 HDVs (Combined HDGV and HDDV)
     14   0.104   0.104   0.095   0.080   0.056   0.043   0.059   0.075   0.063   0.035
          0.042   0.027   0.033   0.023   0.015   0.012   0.011   0.013   0.017   0.013
          0.013   0.011   0.007   0.004   0.044
* HDBT         M5 HDDVs
     15   0.125   0.104   0.098   0.085   0.053   0.043   0.062   0.077   0.074   0.031
          0.041   0.027   0.036   0.025   0.016   0.012   0.013   0.014   0.017   0.013
          0.011   0.007   0.004   0.003   0.007
* Motorcycles  M5 MC
     16   0.090   0.099   0.086   0.072   0.088   0.075   0.069   0.059   0.048   0.034
          0.030   0.028   0.021   0.023   0.019   0.012   0.007   0.009   0.007   0.007
          0.009   0.015   0.011   0.009   0.075
```

6.5.2 2007 Triad Vehicle Age Distribution File Used for Catawba and Davidson Counties NOx

```
*Convert MOBILE5 Registration Fractions to MOBILE6-Based Registration Fractions
*
*Calendar Year:        2007.000User-Input
*
*MOBILE5b Reg Fractions
*         0.057   0.060   0.066   0.065   0.064   0.064   0.062   0.069   0.064   0.057
*         0.053   0.046   0.050   0.039   0.033   0.026   0.021   0.018   0.016   0.012
*         0.010   0.007   0.006   0.004   0.030
*         0.036   0.039   0.041   0.051   0.047   0.048   0.051   0.057   0.055   0.053
*         0.054   0.043   0.047   0.050   0.036   0.028   0.025   0.025   0.030   0.028
*         0.024   0.023   0.017   0.015   0.078
*         0.074   0.075   0.069   0.071   0.056   0.045   0.050   0.057   0.054   0.042
*         0.047   0.035   0.043   0.033   0.024   0.018   0.016   0.019   0.024   0.020
*         0.014   0.016   0.012   0.010   0.074
*         0.045   0.056   0.049   0.051   0.047   0.039   0.049   0.052   0.047   0.033
*         0.040   0.032   0.041   0.030   0.022   0.019   0.017   0.021   0.026   0.025
*         0.019   0.022   0.018   0.015   0.184
*         0.039   0.103   0.081   0.057   0.061   0.064   0.057   0.059   0.043   0.031
*         0.023   0.028   0.025   0.017   0.017   0.014   0.019   0.015   0.012   0.011
*         0.025   0.039   0.039   0.031   0.091
*         0.049   0.085   0.069   0.078   0.079   0.067   0.076   0.061   0.078   0.020
*         0.061   0.040   0.033   0.027   0.021   0.014   0.013   0.016   0.014   0.010
*         0.010   0.015   0.013   0.014   0.036
*         0.083   0.087   0.077   0.066   0.057   0.047   0.065   0.075   0.076   0.042
*         0.052   0.036   0.039   0.028   0.021   0.014   0.016   0.022   0.020   0.019
*         0.015   0.010   0.009   0.007   0.016
*         0.102   0.107   0.094   0.073   0.084   0.070   0.061   0.053   0.045   0.034
*         0.030   0.029   0.022   0.019   0.016   0.010   0.008   0.008   0.008   0.008
*         0.009   0.014   0.012   0.010   0.076
```

```
*
*
* MOBILE6 Vehicle Classes:
*  1  LDV    Light-Duty Vehicles (Passenger Cars)
*  2  LDT1   Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
*  3  LDT2   Light Duty Trucks 2 (0-6,000 lbs. GVWR, 3751-5750 lbs. LVW)
*  4  LDT3   Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-3750 lbs. LVW)
*  5  LDT4   Light Duty Trucks 4 (6,001-8500 lbs. GVWR, 3751-5750 lbs. LVW)
*  6  HDV2B  Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
*  7  HDV3   Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
*  8  HDV4   Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
*  9  HDV5   Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
* 10  HDV6   Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
* 11  HDV7   Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
* 12  HDV8A  Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
* 13  HDV8B  Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
* 14  HDBS   School Busses
* 15  HDBT   Transit and Urban Busses
* 16  MC     Motorcycles (All)
*
REG DIST
*                       RESULTING MOBILE6-BASED REGISTRATION FRACTIONS
*
*MOBILE6 REGISTRATION FRACTIONS BY VEHICLE CLASS AND AGE
* LDV          M5 LDGV
       1   0.057   0.060   0.066   0.065   0.064   0.064   0.062   0.069   0.064   0.057
           0.053   0.046   0.050   0.039   0.033   0.026   0.021   0.018   0.016   0.012
           0.010   0.007   0.006   0.004   0.030
* LDT1         M5 LDGT1
       2   0.036   0.039   0.041   0.051   0.047   0.048   0.051   0.057   0.055   0.053
           0.054   0.043   0.047   0.050   0.036   0.028   0.025   0.025   0.030   0.028
           0.024   0.023   0.017   0.015   0.078
* LDT2         M5 LDGT1
       3   0.036   0.039   0.041   0.051   0.047   0.048   0.051   0.057   0.055   0.053
           0.054   0.043   0.047   0.050   0.036   0.028   0.025   0.025   0.030   0.028
           0.024   0.023   0.017   0.015   0.078
* LDT3         M5 LDGT2
       4   0.074   0.075   0.069   0.071   0.056   0.045   0.050   0.057   0.054   0.042
           0.047   0.035   0.043   0.033   0.024   0.018   0.016   0.019   0.024   0.020
           0.014   0.016   0.012   0.010   0.074
* LDT4         M5 LDGT2
       5   0.074   0.075   0.069   0.071   0.056   0.045   0.050   0.057   0.054   0.042
           0.047   0.035   0.043   0.033   0.024   0.018   0.016   0.019   0.024   0.020
           0.014   0.016   0.012   0.010   0.074
* HDV2B        M5 HDVs (Combined HDGV and HDDV)
       6   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
           0.017   0.016   0.014   0.011   0.099
* HDV3         M5 HDVs (Combined HDGV and HDDV)
       7   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
           0.017   0.016   0.014   0.011   0.099
* HDV4         M5 HDVs (Combined HDGV and HDDV)
       8   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
           0.017   0.016   0.014   0.011   0.099
* HDV5         M5 HDVs (Combined HDGV and HDDV)
       9   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
           0.017   0.016   0.014   0.011   0.099
* HDV6         M5 HDVs (Combined HDGV and HDDV)
      10   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
           0.017   0.016   0.014   0.011   0.099
* HDV7         M5 HDVs (Combined HDGV and HDDV)
      11   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
           0.017   0.016   0.014   0.011   0.099
* HDV8a        M5 HDVs (Combined HDGV and HDDV)
      12   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
           0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
```

```
        0.017   0.016   0.014   0.011   0.099
* HDV8b         M5 HDVs (Combined HDGV and HDDV)
     13   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
          0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
          0.017   0.016   0.014   0.011   0.099
* HDBS          M5 HDVs (Combined HDGV and HDDV)
     14   0.064   0.072   0.063   0.059   0.052   0.043   0.057   0.064   0.062   0.037
          0.046   0.034   0.040   0.029   0.021   0.017   0.016   0.021   0.023   0.022
          0.017   0.016   0.014   0.011   0.099
* HDBT          M5 HDDVs
     15   0.083   0.087   0.077   0.066   0.057   0.047   0.065   0.075   0.076   0.042
          0.052   0.036   0.039   0.028   0.021   0.014   0.016   0.022   0.020   0.019
          0.015   0.010   0.009   0.007   0.016
* Motorcycles   M5 MC
     16   0.102   0.107   0.094   0.073   0.084   0.070   0.061   0.053   0.045   0.034
          0.030   0.029   0.022   0.019   0.016   0.010   0.008   0.008   0.008   0.008
          0.009   0.014   0.012   0.010   0.076
```

Appendix G
Emissions Inventory
Quality Assurance Project Plan

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FUTURE YEAR EMISSION INVENTORY DEVELOPMENT TO SUPPORT ATMOSPHERIC MODELING OF FINE PARTICULATE MATTER AND OZONE IN THE SOUTHEASTERN US

DRAFT
QUALITY ASSURANCE PROJECT PLAN

Effective Date: March 2006

ASSOCIATION FOR SOUTHEASTERN INTEGRATED PLANNING

ASIP

FUTURE YEAR EMISSION INVENTORY DEVELOPMENT TO SUPPORT ATMOSPHERIC MODELING OF FINE PARTICULATE MATTER AND OZONE IN THE SOUTHEASTERN US

QUALITY ASSURANCE PROJECT PLAN

Effective Date: March 2006

APPROVED BY

(ASIP Technical Director)	(ASIP Emission Inventory Tech. Advisor)
(MACTEC Program Manager	(MACTEC Quality Assurance Coordinator)
(MACTEC Task Manager)	(MACTEC Task Manager)

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TABLES AND FIGURES

Distribution List:
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William Barnard, MACTEC (Program Manager, Area and Nonroad Source Task Leader)
Edward Sabo, MACTEC (Point Source Task Leader)
Dan Meszler, MESZLER Engineering Services, Inc. (Mobile Source Task Leader)

1.0 PROJECT MANAGEMENT

1.1 Problem Definition/Background

The Southeastern States Air Resource Managers (SESARM) has been designated by the United States Environmental Protection Agency (EPA) as the entity responsible for coordinating and implementing regional planning for the eight SESARM states (Alabama, Florida, Kentucky, Georgia, Mississippi, North Carolina, South Carolina and Tennessee) plus Virginia, West Virginia, and Tribes. Through a memorandum of understanding, these parties are collaborating in the organization Visibility Improvement State and Tribal Association of the Southeast (VISTAS) on the technical analysis and planning activities that support state implementation plans for regional haze. The participating agencies have concluded that a collaborative regional process is also the most efficient approach for the states to develop the technical analyses supporting attainment demonstrations for the fine particulate matter (PM2.5) and eight-hour ozone standards. Along with the local air regulatory agencies for Jefferson County, AL, Jefferson County, KY, Mecklenberg County, NC, Forsythe County, NC, Knox County, TN, and Shelby County, TN, these agencies have become signatory parties to the collaborative effort called the Association for Southeastern Integrated Planning (ASIP). SESARM will coordinate among participating agencies and oversee the performance of the ASIP inventory and modeling tasks in parallel with the VISTAS regional haze project tasks. Emissions inventory efforts include the development of emissions inventories and forecasts to be utilized in ASIP modeling efforts.
At least one area in seven states (Alabama, Georgia, North Carolina, Kentucky, Tennessee, Virginia, and West Virginia) has been designated as nonattainment for the $PM_{2.5}$. In addition, South Carolina has one three-county area that was designated as unclassifiable. The $PM_{2.5}$ compliance date is April 2010 unless a state demonstrates that more time is necessary in which case up to five additional years may be granted. State implementation plans (SIPs) will be due in April 2008 and the modeling year for the $PM_{2.5}$ attainment demonstration will be 2009.

The States of Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia have one or more nonattainment areas for the eight hour ozone standard. Basic nonattainment areas are required to attain the 8-hour ozone standard by June 15, 2009, while moderate nonattainment areas are required to attain by June 15, 2010. This will require states with basic 8-hour ozone nonattainment areas to demonstrate attainment for the year 2008 and moderate areas will require 2009 as the modeling year

The objective of this project is to compile future year emission inventories to support fine particulate matter and ozone modeling efforts in the ASIP region for all source categories. This project has the following overall design specifications:

- Pollutant Coverage - primary and precursor annual and seasonal emissions necessary to accurately model fine particulate matter and ozone, including primary PM2.5 and

PM10, ammonia (NH3), oxides of sulfur (SOx), volatile organic compounds (VOCs), oxides of nitrogen (NOx) and carbon monoxide (CO)

- Source Coverage – all source categories except biogenic.
- Geographic Areas – the ASIP states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia)

The inventories created under this contract will be used in creating future year modeling inventories (modeled under other ASIP work tasks) to support chemical transport modeling of fine particulate matter and ozone in the southeastern U.S. and to evaluate potential control strategies for the National Ambient Air Quality Standards (NAAQS) for fine particulate and ozone. Two future year inventories will be prepared along with evaluations of various controls for those inventories. In addition, updates of the 2002 base year inventory will be performed under this contract as necessary to develop the projection years.

The purpose of this Quality Assurance Project Plan (QAPP) is to outline and guide the process for quality assuring the inventory development to ensure the development of complete, accurate, and consistent emission inventories. The QAPP is consistent with the recommendations in the EPA quality assurance requirements[1] and the Emission Inventory Improvement Program's QA guidance[2]. The QAPP includes tasks associated with obtaining State data, merging and augmenting State submittals with available EPA databases, improving the activity data and emission factors for important source categories, obtaining and developing growth and control factors, obtaining State and stakeholder review of the emission inventory, and providing documentation of the maintenance (revisions, updates, corrections) of the inventory.

1.2 Project/Task Description

EPA[3] has specified that calendar year 2002 be used as the base year for emission inventories to support planning efforts under the 8-hour ozone, PM2.5, and Regional Haze programs. ASIP has planned an iterative process to use and enhance the 2002 base inventory prepared by MATEC for the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) as part of regional haze planning, that incorporates improved information as it becomes available. In addition, work on the PM2.5 and ozone NAAQS calls for continued measures of progress. As a consequence, emissions inventories for 2008 and 2009 will be required to assess such progress.

- A revised 2009 Base G future year inventory based off of the 2009 projections developed previously for VISTAS (Base G due May 2006). This inventory will be developed using the final version of the 2002 VISTAS base year. The revised 2009 inventory is designed to support modeling runs for fine particulate and ozone. It will be created using readily available growth and control information from the Clean Air Interstate Rule (CAIR), the Heavy Duty Diesel Rule (HDD Rule), the DOE's Annual Energy Outlook 2006, and other EPA rules. In addition, control programs under these rules as well as State Implementation Plans (SIP) will be incorporated. The growth and control factors will be those developed for the VISTAS 2009 regional haze and PM2.5 inventory development effort augmented by updated information from other regional inventory development work and modifications based on State comments. Typical year emissions for electric generating units (EGUs), wildfire and prescribed burning sources will be revised as necessary to incorporate new data. Control programs that are "on-the-books" and "on-the-way" will be incorporated into the estimates. Three control strategy inventories will also be developed for 2009.

- A 2008 Inventory Base G (available Spring/Summer 2006). This inventory will be created using information developed for the 2009 inventory with revised growth and control factors to account for a 2008 projection rather than a 2009 projection. The inventory will still include "on-the-books" and "on-the-way" control programs as well as any SIP or other State specific controls.

This QAPP focuses on the tasks associated with developing these inventories.

Projection Inventory Activities. The effort includes the following area source activities:

1. Assemble data needed to update the 2009 VISTAS inventory to account for Base G changes to the base year 2002 inventory and any changes to growth or control factors for 2009 based on State/workgroup review.
2. Prepare the 2009 inventory using data received as part of step 1.
3. Assemble data needed to develop the 2008 ASIP inventory. This includes development of growth and control factors for 2008 which are not currently available.
4. Prepare the 2008 ASIP projection inventory using data developed in step 3.
5. Recommend methods for control strategies for 2009.
6. Prepare 2009 control strategy inventories.
7. Revise the 2002 "typical year" inventory for electric generating units (EGUs) with any updated data.
8. Revise the "typical year" inventory for wild and prescribed fires with any updated data.

Other Activities. In addition to the above tasks related to projecting emissions, a report detailing the methods used to develop the projections will be prepared.

1.3 Project Organization

Figure 1 and Table 1 identify the individuals and organizations participating in the project. Their specific roles and responsibilities include:

- Ms. Pat Brewer, Technical Coordinator, will plan, conduct, and supervise technical and managerial aspects of the project. She will facilitate communications among State/local agencies, MACTEC, and the SESARM Executive Director.
- Mr. Greg Stella, Emission Inventory Technical Advisor, will work with the Technical Coordinator to define the emission inventory development activities needed to support PM2.5 and ozone modeling and planning activities.

- State/local Agency Coordinators will compile and submit data to MACTEC, participate in QA/QC reviews, and help revise, update, and correct the inventory.
- William Barnard, MACTEC Program Manager, will direct and monitor technical and financial performance throughout the project and will serve as a senior primary contact with ASIP on contract and project management issues. Mr. Barnard will also direct aspects of the projection inventory development related to area and mobile sources. He will plan and conduct the technical aspects of the development of the area and mobile source inventories, supervise daily activities, identify effective QC procedures and make recommendations on needed QC procedures.
- Edward Sabo, MACTEC Point Source Task Leader, will plan and manage all point source activities. He will plan and conduct the technical aspects of the development of the point source inventory, supervise daily activities, identify effective QC procedures and make recommendations on needed QC procedures.
- Dan Meszler, MACTEC Mobile Source Task Leader, will plan and manage all mobile source activities. He will plan and conduct the technical aspects of the development of input files for the MOBILE and NONROAD models and for nonroad sources not covered by the NONROAD model. He will help identify effective QC procedures and make recommendations on needed QC procedures.
- Douglas Toothman, MACTEC QA Coordinator, will help ensure that adequate QA/QC procedures are incorporated into the inventory development process. He will work independent of the inventory development Task Leaders to assist in the conduct of project QA/QC assessments.

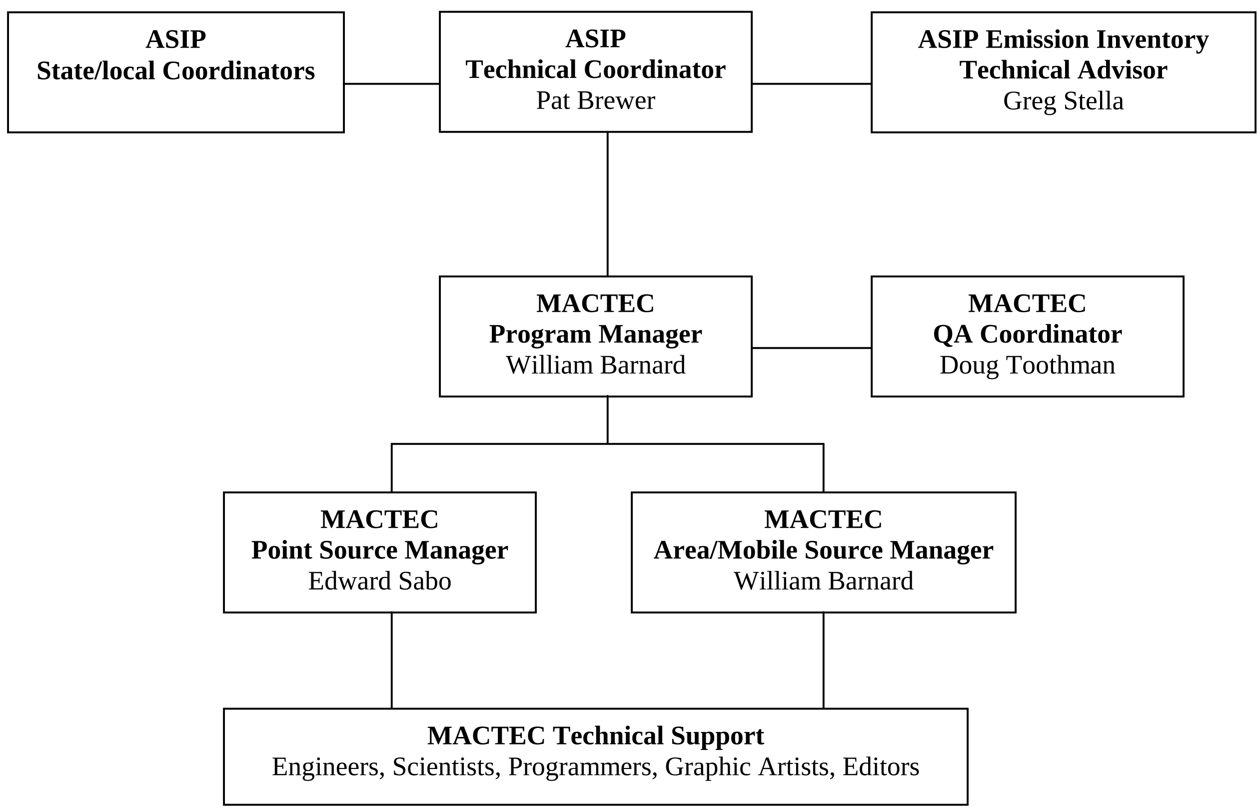


FIGURE 1 – PROJECT ORGANIZATION CHART

1.4 Quality Objectives and Criteria

The goal of the inventory process is to provide the best possible inventory under given resource constraints. Data Quality Objectives (DQO) are statements about the level of acceptable uncertainty or error. Their purpose is to ensure that the final data will be sufficient for the intended use of the inventory. A well-developed and implemented quality assurance program fosters confidence in the inventory and any resulting regulatory program. It also gives the end user important information about the limitations of the emission estimates in order to avoid misuse of data.

Table 1 summarizes the Data Quality Objectives for the ASIP inventories that will be compiled for this contract. The first column of Table 1 defines four data quality objectives: accuracy, completeness, comparability and representativeness. The second column identifies the procedures that will be used to achieve each objective. The third column identifies Data Quality Indicators (DQI), which are qualitative and quantitative descriptors used in interpreting the degree of acceptability or utility of data.

1.5 Special Training/Certification

All staff performing data review and analysis are air quality professionals and have sufficient education/experience to perform emission estimation calculations and work with emission inventory databases. Most staff have received specific emission inventory training through conferences, workshops, self-study programs, and on-the-job work experiences. There are no specifically mandated training requirements for work performed on this project.

1.6 Documents and Records

QAPP Control. Any changes to this QAPP will be initiated either by the Program Manager, the Task Leaders, or the QA coordinator. Each change will be given a revision number and date in the document control block in the upper corner of the affected pages. It will be the responsibility of the initiating person to distribute copies of the changed pages to all the persons on the Distribution List and to the appropriate project team members.

Data Collection Records. Clear documentation of the data collected from the State/local agencies, EPA, and other agencies is integral to the quality analysis review. Records will be maintained containing a description of the data received, the name of the person and agency submitting the data, the date of the submission, and other relevant information about the data submission. The following types of data will be collected during this project:

- EPA's 1999 National Emission Inventory (Version 2 Final)
- State CERR submittals
- State/local agency data submittals in NIF 3.0 format
- Growth factors assembled by EPA

- EPA's Final Summary Emission Reports for 2002 with CEM information for electric utilities regulated by the Acid Rain Program
- EPA's Toxic Release Inventory for 1999/2000 with ammonia emissions data
- Point source surveys for target facilities to obtain missing information
- State/local agency submittals of updated activity data related to fugitive dust sources, primarily paved and unpaved roads, livestock activities and agricultural activity (tilling).
- State agency submittals of information necessary to calculate fire emissions and geographically locate where these fires occurred in 2002.
- State agency submittals of updated activity data for animal operations for use with the Carnegie Mellon University ammonia model.
- State/local agency revisions, updates, corrections in response to various QA/QC checks. These may be provided in a variety of formats depending on the nature of the response.
- Department of Energy fuel efficiency data
- EGAS growth factors
- VMT data

TABLE 1

DATA QUALITY OBJECTIVES, PROCEDURES, AND INDICATORS

Data Quality Objective	Procedures	Example Indicators
Accuracy - reduce uncertainty in emission estimates where possible, validate that data elements needed for modeling are within accepted parameters, and verify that emission estimates agree with accepted reference values.	1. Identify weaknesses in existing inventories, identify new methods/data to reduce uncertainty, and obtain new activity/emission factor data where available. 2. Use EPA's NIF QA tool and ad-hoc reports to perform computerized checks of valid codes/data ranges and to identify outliers. 3. Conduct senior technical review of pollutant totals by facility, source category, state, and region. 4. Compare to other published data.	1. Qualitative assessment of the inventory's strengths and weaknesses. 2. 100% of stack data and temporal factors in valid ranges for > 100 tpy sources. 3. 100% of sources have valid geographic coordinates. 4. 100% correction of significant outliers. 5. Agreement of ASIP emissions and EPA CEM data and EPA TRI data. 6. Compare projection emissions to base year emissions to ensure that values are within expected ranges.
Completeness – include all major point sources, include emission estimates for PM2.5 and ammonia, verify that all important areas source categories are included for all counties and all mobile source categories are accounted for.	1. Compare ASIP utility data to EPA CEM data. 2. Compare ASIP point source ammonia data to EPA TRI data. 3. State/local agencies compare facility list to their Title V permit lists. 4. Compare small point source emissions to area source emissions. 5. Compare PM10 and PM2.5 emissions. 6. Plot area source spatial distributions by source category and county.	1. 100% of all utilities accounted for in database. 2. 100% of large ammonia sources in TRI accounted for in database. 3. 100% of Title V sources accounted for in database 4. Small point sources included as either small point sources or as area sources. 5. PM2.5 and ammonia emissions included in inventory 6. Area source emissions for important source categories for all counties in region. 7. All mobile sources accounted for. 8. Explanation of any missing data or sources.
Comparability – verify that emission estimates are similar to other peer-reviewed inventories and that any major deviations are explained.	1. Compare emission totals by source category, pollutant, geographic region, and year with previous emission inventories.	1. Explanation for large discrepancies in emissions
Representativeness – use emission estimation methods that reflect local conditions and the time period of interest.	1. Identify where national defaults used instead of local activity data. 2. Identify where emissions were grown for base year 2002 data were not available. 3. Identify growth factors for projection years.	1. Explanation for use of national defaults. 2. Determination of representative values for "typical years" for some sources for projections (i.e., fires, utility emissions).

Data Handling Records. Another key element of the QA program is maintaining written documentation of calculations, assumptions, and all other activities associated with incorporating the State/local agency submittals and other data with the projection and base year inventories. Nearly all data being developed and/or compiled will use computerized databases or other electronic files. For many of these databases, we will use blank fields in the database tables to keep track of the source of the data. We will also maintain a log of activities to document how the data described above were incorporated to create the ASIP inventories. The log will include complete descriptions of the data sources used, the procedures used to incorporate the data, the approach used to determine the completeness, and any contacts made with data submitters to resolve questions. A file will be maintained to ensure that the data handling records are retained and easily located.

QA/QC Records. We will perform a variety of quality control reviews of the inventory. For example, we will check stack parameters, source classification codes, and geographic coordinates for point sources that emit at least 100 tons of any pollutant per year. Reports containing the results of these checks will be transmitted to the State/local agencies for investigation and correction. Documentation of each finding will include a description of the action or data reviewed that led to the quality concern and will provide recommendations for corrective actions.

Corrective Action Records. Records of corrective and follow-up actions identified during the quality review process will be maintained. Both the corrective action identified and the results of the actions taken in response will be documented for inclusion in the final report. If no corrective action can be made, we will document the implications on the overall quality of the inventory.

Data Reporting Package. The final data reporting package will contain four elements:

- An emission summary report that describes the emissions inventory by pollutant and source category, summarizes the methods and data used to compile the inventory, assesses the limitations and appropriate uses of the inventory data, and contains any other information pertinent to the inventory;
- A quality assurance summary report that describes the quality assurance efforts completed, summarizes the corrective actions taken, and provides suggestions for further inventory improvement based on the results of the quality assurance process;
- Electronic data files containing the ASIP inventories in NIF 3.0 format; and
- Electronic and paper files containing all original data submittals and all backup documentation will be stored on file at MACTEC for a period of no less than three years.

2.0 DATA ACQUISITION

The projection year ASIP inventories will rely primarily on air emission information from existing databases. The data collection, handling, and management process is described below, along with the associated quality control procedures and methods. The QC system is designed to:

- Provide routine and consistent checks and documentation points in the inventory development process to verify data integrity, correctness, and completeness;
- Identify and reduce errors and omissions;
- Maximize consistency within the inventory preparation and documentation process;
- Facilitate internal and external inventory review processes.

The data acquisition process should be viewed as an iterative process. As decisions are made, new questions will surface that require solutions, until the iterations are complete.

2.1 Projection Year Inventory Procedures

For the projection inventories, the following procedures will be used to compile and quality assure the inventory:

1. Use the final version (Base G) of the 2002 VISTAS Base/Typical Year inventory as a starting point.
    a. Back calculate uncontrolled emissions for 2002 Base/Typical Year inventory to use as starting point for sources that will be grown for the projection inventory. (unclear)
2. Prepare/Obtain Growth and Control files
    a. Obtain growth factor files from EGAS for use with categories that will be grown with EGAS growth factors; incorporate Annual Energy Outlook 2006 information into EGAS to replace the AEO 2004 data currently embedded in EGAS.
    b. Obtain control factors for "on-the-book" and "on-the-way" controls as well as any controls for control strategy evaluations. Controls will be obtained from recent EPA rulemakings, proposed rules (e.g., Clean Air Interstate Rule [CAIR]), and State SIPs. For EGUs, control information will be obtained from VISTAS-sponsored IPM runs, supplemented with state-supplied adjustments as to where future controls will be installed.
    c. Determine/obtain growth factors for non-EGAS sources (e.g., agricultural crops, fertilizers, etc.). Growth factors for these sources will be calculated from existing projection inventories prepared by EPA (e.g., EPA Ammonia Inventory). Growth factors will be calculated using linear interpolation of projected emissions if the actual year is not available.
3. Project sources using growth and control factors

   a. For sources to be grown using EGAS growth factors, apply growth and control factors.
   b. For sources not using EGAS growth factors, apply non-EGAS growth factors.
   c. Identify and resolve any errors/discrepancies from the use of EGAS growth factors or other growth factor data
   d. Track comments/concerns received and corrective actions taken

4. Determine emissions for sources requiring "typical" year emission updates.
   a. These sources include EGUs and fires
   b. For fires make any modifications needed including incorporating the long-term effects of prescribed burning programs. Update and revise the typical emissions based on changes submitted by State air and forestry personnel and to include future year projections of prescribed burning.
   c. Update the typical year emission data from EGU sources based on State comments and any revised CEM or IPM data.

5. Develop mobile source emission inventories
   a. Prepare projected VMT for review by States/stakeholders for onroad mobile sources.
   b. Prepare SMOKE ready MOBILE input files for review by States/stakeholders. MOBILE input files will contain required control programs either "on-the-books" or "on-the-way". (my understanding is this subtask is not MACTEC's responsibility)
   c. Prepare NONROAD model input files for review by States/stakeholders. NONROAD input files will contain required control programs either "on-the-books" or "on-the-way".
   d. Run the NONROAD 2005 model, develop emission summaries and provide to States/Stakeholders for review/comment.
   e. Develop growth factors and projected emissions for nonroad sources not in the NONROAD model. Growth factors will be based on existing estimates from EPA rulemaking projections (e.g., Heavy Duty Diesel and other rules). Provide growth factors for review by States/Stakeholders.
   f. Prepare non-NONROAD model emission estimates. Provide for States/Stakeholder review/comment.

6. Conduct QA/QC to identify errors and inconsistencies
   a. Prepare ad-hoc reports to identify gaps and logical inconsistencies.
   b. Ask States/local agencies to provide feedback on large scale inconsistencies and on missing sources.
   c. Update database with State/local supplied revisions.
   d. Track comments/concerns received and corrective actions taken

7. Provide inventory for review by stakeholders

a. Prepare an emission summary report that describes the emissions inventory by pollutant and source category, summarizes the methods and data used to compile the inventory, assesses the limitations and appropriate uses of the inventory data, and contains any other information pertinent to the inventory
b. Prepare a quality assurance summary report that describes the quality assurance efforts completed, summarizes the corrective actions taken, and provides suggestions for further inventory improvement based on the results of the quality assurance process
c. Provide electronic data files containing the ASIP inventories in NIF 3.0 format
d. Track comments/concerns received and corrective actions taken

8. Incorporate feedback from stakeholders and prepare final reports and electronic files

3.0 ASSESSMENT AND OVERSIGHT

The subsections in this group address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of the assessment is to ensure that the QA Project Plan is implemented as prescribed. The assessment consists of external activities that include a planned system of review and audit procedures by personnel not actively involved in the inventory development process. The key concept of this component is independent objective review by a third party to access the effectiveness of the internal Quality Control program and the quality of the inventory, and to reduce or eliminate any inherent bias in the inventory process.

3.1 Assessments and Response Actions

The MACTEC Quality Assurance Coordinator will conduct technical systems audits throughout the project. Audits are managerial tools used to evaluate how effectively the emission inventory team complies with predetermined specifications for developing an accurate and complete inventory. The MACTEC QAC will conduct audits at the initiation of each project to review the Work Plan and QAPP, at the 50% complete and 75% complete levels to review the technical aspects of each project and at the 95% completion level to review the data submittal package. This provides assessment of the project during the planning stage, the data collection stage, the emissions calculations stage, and the report preparation stage. An example audit checklist for point sources is presented in Figure 2.

3.2 Reports to Management

Audit reports will be distributed within two weeks of the conduct of each audit to the persons interviewed and the MACTEC Task Leaders. A summary of the types of quality concerns found will be periodically forwarded to the MACTEC Program Manager to keep him informed of the quality issues found and actions being taken to resolve them. Audit reports will be retained in a file and used to conduct subsequent audits and plan follow-up activities. When an audit team finds items that require immediate action, they will inform the MACTEC Program Manager of the necessary corrective actions.

AUDIT CHECKLIST

Auditor: ______________________________________

Date: ____

Data/Procedure Reviewed: ____
____

Project Personnel Involved in Work: ____
____

Instructions: Select a facility or source category with high emissions and evaluate the quality of the data and adequacy of the data handling procedures. Record the findings and recommendations for corrective actions, if any, on this checklist and comment sheet. If recommendations for corrective actions are made, discuss them with the Project Manager immediately following the audit. Conduct follow-up activities to determine if the actions taken in response to the recommendations appropriately resolved the quality issues identified.

I. DATA

A. Identify the source category evaluated: ____

B. Describe the data included in the master file for the facility or source category.

____
____

C. Are the data documented in a manner that will not have the potential to be misinterpreted? Y/N

Were the instructions for documenting the data followed? .... Y/N

D. Are there missing data fields? .... Y/N

What procedures are taken by the Task Leaders to ascertain missing?

____
____

At what point in the inventory process are requests for missing data made?

____
____

How is the receipt of the missing data handled?

____
____

Is the procedure followed to ascertain missing data efficient and adequate? .... Y/N

E. How do emissions compare to other inventories?

1999 NEI Version 2 Final ____

2000 TRI ____

2002 ETS/CEM ____

Are differences in emissions understandable and explainable? .... Y/N

If any of the values are incorrect, explain how the emissions data were corrected.

____

Figure 2 Audit Check Form

II. EMISSIONS DATABASE

A. Who provided the data for incorporation into the database? ____________________________
____

B. Was there evidence that the data were reviewed for accuracy and completeness prior to incorporation in the database? .... Y/N

C. Were data logs maintained to describe how the data was incorporated? .... Y/N

D. Ask the data incorporation personnel to explain the QC procedures followed to ensure data quality. Do they agree with the procedures described in the QAPP? .... Y/N

E. Does the computer system appear to be adequate for its intended use? (Ask the data processing personnel about the problems they have experienced with the system.) .... Y/N

F. Is the data entry progressing as expected and are the procedures followed adequate to ensure data quality? .... Y/N

III. RECOMMENDATIONS FOR CORRECTIVE ACTIONS

____
____
____
____
____

IV. COMMENTS

____
____
____
____
____

V. SIGNATURES

______________________ (QA Auditor)	______________________ (QA Coordinator)
______________________ (Program Manager)	______________________ (Task Manager)
______________________ (Project Participant)	______________________ (Project Participant)

Figure 2 Audit Check Form (Concluded)

4.0 DATA VALIDATION AND USABILITY

Section 4 addresses the QA activities that occur after the data collection phase of the project is completed. Implementation of these subsections determines whether or not the data conform to the specified criteria, thus satisfying the project objectives.

4.1 Accuracy Assessment

A qualitative discussion of accuracy will include an assessment of the extent to which the initially identified weaknesses in the inventory have been remedied through the use of improved activity data, emission factors, or other sources of information. Remaining weaknesses will be assessed.

The accuracy assessment will include a summary of whether any data identified as outside of its valid range remained outside of the valid range in the final inventory. If any data remained outside of its valid range, an explanation will be given. The qualitative discussion will also include a summary of errors or discrepancies identified in the QA/QC process.

A final semi-quantitative discussion of accuracy will consist of pollutant summaries for individual facilities, industry types, source categories, and statewide totals. The ASIP inventory will be compared to other peer-reviewed inventories, and where major discrepancies exist, we will provide an assessment of the reasons for the differences in emission estimates.

4.2 Completeness Assessment

A statement will be prepared assessing whether all required facilities, source categories, pollutants, and data elements were included in the inventory. If any facilities or source categories were not included, an explanation of the omission will be provided. If any individual data elements were not provided, we will discuss the elements, frequency of omissions, and overall impact on the quality of the inventory.

4.3 Comparability Assessment

Several summations of emissions data will be made to address comparability. Overall percentage differences for individual facilities (current year to prior year), industry types, processes, and statewide inventory will be calculated. Explanations of any large differences will be made.

4.4 Representativeness Assessment

A statement will be prepared describing where national defaults have been used instead of local activity data.

5.0 REFERENCES

1. U.S. Environmental Protection Agency. March 2001. *EPA Requirements for Quality Assurance Project Plans* (EPA/240/B-01/003). http://www.epa.gov/quality/qs-docs/r5-final.pdf
2. Emission Inventory Improvement Program (EIIP) Document Series - Volume VI Quality Assurance Procedures and DARS Software. EPA | TTN CHIEF | EIIP | Technical Reports | Volume VI Quality Assurance Procedures
3. U.S. Environmental Protection Agency. November 18, 2002. 2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, PM2.5 and Regional Haze Programs. http://www.4cleanair.org/members/committee/criteria/EPA200211181.pdf

Appendix H

Emissions Modeling and Related Documentation

Appendix H.1
Emissions Modeling Documentation

Background

The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad mobile, area, point, fire and biogenic emission sources for photochemical grid models. SMOKE is the fastest emissions processing tool currently available to the air quality modeling community. The sparse matrix approach utilized throughout SMOKE permits both rapid and flexible processing of emissions data. The processing is rapid because SMOKE utilizes a series of matrix calculations instead of less efficient algorithms used in previous systems. The processing is flexible because the processing steps of temporal projection, controls, chemical speciation, temporal allocation, and spatial allocation have been separated into independent operations wherever possible. The results from these steps are merged together at a final stage of processing. Each of these emissions processing steps are detailed below.

Temporal Allocation

VISTAS 2002, 2009 and 2018 annual emissions modeling was configured to generate point, area, nonroad mobile, on-road mobile, and biogenic source emissions. In addition, certain subcategories, such as fires and EGUs were maintained in separate source category files in order to allow maximum flexibility in producing alternate strategies. With the exception of biogenic and on-road mobile source emissions that are generated using the BEIS and MOBILE6 modules in SMOKE, pre-computed annual emissions were processed using the month, day, and hour specific temporal profiles of the SMOKE model. Point and biogenic sources were modeled for each day of the annual period while area and nonroad sources were modeled as a block of Thursday, Friday, Saturday, Sunday, Monday, one per month (total of 60 days modeled).

VISTAS based its temporal profiles and source category cross-reference files on the USEPA CAIR/CAMR/CAVR modeling platform with files located on USEPA's CAIR file transfer website (ftp://www.airmodelingftp.com/). Modifications were made to reflect State specific profiles or updated state of knowledge application of these profiles. Some of these changes included the reallocation of North Carolina NONROAD generated emission categories to a regional set of temporal profiles more consistent with the operation of these source types in the State. Additionally, EGU CEM-based temporal profiles and onroad emissions modeling were prepared in manners deviating from USEPA's original CAIR platform.

New temporal profiles used by VISTAS during modeling of the 2002, 2009 and 2018 EGU emissions took the place of USEPA provided default temporal profiles that are generally accepted as not accurately depicting temporal distribution of emissions from EGUs in the U.S. (see Attachment 1 by Stella et. al.). VISTAS EGU temporal profiles were developed using hourly CEM data as reported to USEPA's Clean Air Market's Division (CAMD) for the Acid Rain Program.

The work conducted in this process had the main objective of developing temporal profiles for VISTAS EGUs necessary to apply in the generation of SMOKE PTHOUR formatted emissions. Additionally, State-level monthly, day-of-week, and diurnal profiles were developed for application to non-CEM matched units in the VISTAS emissions inventory. These temporal distributions represent a significant improvement over the USEPA defaults.

On-road mobile modeling in SMOKE was done for selected weeks (seven days) of each month - using these days as a "representative week" of the entire month. This selection allows for the representation of day-of-the-week variability in the on-road motor vehicles, and models a representation of the meteorological variability in each month. The modeled weeks were selected from mid-month, avoiding inclusion of major holidays. Holidays were modeled as the Sunday of the representative week, while the day after a holiday was modeled as a Monday. VISTAS executed sensitivity tests to examine this "representative week" methodology versus an everyday on-road mobile modeling method. VISTAS determined that the use of representative week on-road mobile emissions produced ozone and particulate matter concentrations (and thus regional haze) that were nearly indistinguishable from the "everyday" mobile method. VISTAS determined that the difference in the modeled air quality - resulting from the on-road mobile modeling methods - was insignificant. For more information on this study see Attachment 2 by Abraczinskas et. al.

<u>On-road mobile emissions are represented by the following weeks per month:</u>

January 15-21
February 12-18
March 12-18
April16-22
May 14-20
June 11-17
July 16-22
August 13-19
September 17-23
October 15-21
November 12-18
December 17-23

Speciation

Speciation is the process of disaggregating inventory pollutants into individual chemical species components or groups of species. The need for speciation is determined by the inventory purpose. Inventory applications that require detailed speciation include photochemical modeling, air toxics inventories, chemical mass balance modeling, and visibility modeling.

Depending on the purpose of a particular emissions inventory, the inventory may include TOG, NOx, sulfur oxides (SOx), CO, total suspended particulate matter (TSP), particulate matter less than 10 micrometers in aerodynamic diameter (PM10), or ammonia (NH3). However, modeling inventories may require these emissions to be expressed in terms of other pollutants. Additionally, for some models, NOx emissions may need to be specified as NO and NO2. Also, PM may need to be separated into various fractions, such as PM10 and PM less than 2.5 micrometers in aerodynamic diameter (PM2.5).

SMOKE was configured to speciate the emissions estimates according to the requirements of the Carbon Bond Mechanism version four (CBM-IV, CB-IV or CB4). The SMOKE model reformats the emissions estimates for use in CMAQ modeling based on source category code (SCC) and speciation profile cross-reference files. The speciation profiles and source category cross-references use in VISTAS modeling are based on USEPA's CAIR/CAVR/CAMR modeling platform with files located on USEPA's CAIR file transfer website (ftp://www.airmodelingftp.com/). Minor modifications were made to reflect State specific profiles or updated state of knowledge application of these profiles. One major change made in the VISTAS modeling was the modification of coal combustion cross-reference from speciation profile "NCOAL" to profile "22001."

Spatial Allocation

Because air quality modeling strives to replicate the actual physical and chemical processes that occur in an inventory domain, it is important that the physical location of emissions be determined as accurately as possible. In an ideal situation, the physical location of all emissions would be known exactly. In reality, however, the spatial allocation of emissions in a modeling inventory only approximates the actual location of emissions.

Gridding surrogates are used to spatially allocate emission sources from a coarse geographic area to finer grid cells used for modeling. There can be hundreds of unique source categories in an emissions inventory, which is typically developed for counties, states, or other areas. The exact location of most major emission sources is known and their geographic coordinates are usually contained in the inventory. These usually are referred to as major point sources and include electric utilities and major industrial facilities. However, other emission sources are estimated for the entire county or other area as an aggregate since the exact locations of each source are not included in the modeling inventory. Surrogates are human activities or land use information that are used to represent a more precise location of emission source category groups. A gridded surrogate ratio is the ratio of the amount of a surrogate in a modeling grid cell to the total amount of that surrogate in a county. Grid cell emissions are calculated by multiplying the cell's gridded surrogate ratio by the county emissions.

These surrogates and their associated SCC cross-references were originally developed by USEPA (http://www.epa.gov/ttn/chief/emch/spatial/newsurrogate.html) and converted to the gridded domain definitions of the VISTAS model requirements.

Development of Gridded Surrogate Files

The general process for creating the SMOKE-ready gridded surrogate files from the ArcGIS shape files is as follows:

1. Overlay the grid on the surrogates. Generate the grid polygons (36/12km) with the specifications of the VISTAS domain and spatially overlay (intersect) the grid onto the surrogate area polygons or points. The resulting geodatabase contains, for each surrogate, the county FIPS code, the grid column and row number, and the amount (area, miles or count) of the county's portion of the surrogate in that cell.

2. Extract and convert each geodatabase table to a useful dataset. Each table contains the gridded area, miles or count in each county for a specific surrogate. The variables include FIPS code, column number, row number and area, miles or count.

3. Calculate surrogate ratios. Surrogate ratios are calculated for each surrogate using a series of program files. The programs sum the surrogates for each county and calculate each the ratio by dividing the county cell surrogate value by the total county surrogate value. Combination surrogates where both are of the same type (i.e., Heavy and High Tech Industrial are both area) were summed prior to calculating the ratio. Combination surrogates with unlike data (i.e., 3/4 Roadway Miles plus 1/4 Population are line and area data) were summed after calculating the ratios and then normalized. The surrogate cross-reference code was also assigned here.

4. Gap-fill surrogates for counties missing data. There will be many instances where inventory emissions exist for a particular county but there is no data, for that county, for the surrogate assigned. For example, a county with class 1 locomotive emissions may not have data for the class 1 railroad surrogate. In this case we have selected to incorporate, within the assigned surrogate, a different source of data (a different surrogate) for that particular county. We incorporate secondary surrogates even if there is no emission source that requires it for that particular county. We denote this process as "gap-filling." All surrogates resulting from the gap-filling process have ratios for all counties.

For each surrogate, we assign a secondary or tertiary surrogate where needed for gap filling. For the class 1 railroad surrogate example mentioned above, we chose total railroads as the secondary surrogate. The secondary or tertiary surrogate chosen would be the same across all counties and apply to all SCCs that use the particular primary surrogate. We pull in and substitute the secondary surrogate for counties where the primary surrogate is missing. Tertiary surrogates will then be assigned to those counties that are still without surrogates.

For identified counties having no values for each surrogate, we assign the data based on the appropriate secondary or tertiary surrogate to these counties. A check to see that surrogate ratios for each county sum to approximately 1.00 is also performed in our surrogate development. Ratios will not always sum exactly to 1.00 due to rounding. However, SMOKE will normalize surrogates greater than 1.00.

5. Create SMOKE-formatted spatial surrogate files. The resulting data from the previous steps is then reconfigured into SMOKE-ready format and used in the spatial allocation process.

Treatment of Large Fire Plume Rise

Wildfire, agricultural, and prescribed burn emissions were handled separately from the standard area source input files. We used day specific or monthly estimates of fire emissions from VISTAS, which include burn acreage and biomass loading information for the VISTAS states. Depending on the completeness and quality of the data received, VISTAS-specific calculations were made to calculate spatial and temporal distributions of the fire emissions, rather than relying on standard distribution profiles. We calculated vertical distribution of the fire emissions, based on fire size and biomass involvement. SMOKE v2.1 can model fire plume rise when provided with the following variables:

PTOP – Top of the fire plume profile (meters above ground level)
PBOT – Bottom of the fire plume profile (meters above ground level)
Lay1 – The percent of the emissions entrained in the first modeling layer

For those fires as having the necessary data elements to site these files with distinct time and space coordinates, these variables were prepared and included in the modeling files used to process this emission source type.

The WRAP Fire Emissions Joint Forum Emissions Inventory Report (see http://www.wrapair.org/forums/fejf/documents/WRAP_2002_PhII_EI_Report_20050722.pdf) has documented an approach for calculating these plume descriptors. In this method, the fires are assigned to one of 5 size categories, based on the total burn acreage, and the biomass fuel loading. These categories are then used to calculate representative hourly plume profiles. These profiles are then used by SMOKE 2.1 to distribute the vertical emissions for the fires. To successfully model fires as elevated point sources, the data included both the day or days on which the fire occurs, and a spatial identifier of the fire location.

Quality Assurance

The Quality Assurance (QA) is one of the most important steps in performing an air quality modeling study. Because emissions inventory development is tedious, time consuming and involves complex manipulation of many different types of large data sets, errors are frequently made and, if rigorous QA measures are not in place, these errors may remain undetected.

A number of QA files were prepared and used to check for gross errors in the emissions inputs. Importing the model-ready emissions into PAVE and looking at both the spatial and temporal distribution of the emission provides insight into the quality and accuracy of the emissions inputs. Some of the additional steps for checking the emissions are summarized in the bulleted list below.

- Visualizing the model-ready emissions with the scale of the plots set to a very low value, we can determine whether there are areas omitted from the raw inventory or if emissions sources are erroneously located in water cells.
- Spot-check the holiday emissions files to confirm that they are temporally allocated like Sundays.
- Producing pie charts emission summaries that highlight the contribution of each emissions source component (e.g. nonroad mobile).
- Normalizing the emissions by population for each state will illustrate where the inventories may be deficient and provide a reality check of the inventories.
- Spot check vertical allocation of point sources using PAVE.

State inventory summaries prepared prior to the emissions processing were compared against SMOKE output report totals generated after each major step of the emissions generation process.

For speciation, a comparison of the inventory state totals versus the same state totals with the speciation matrix applied was completed.

For checking the vertical allocation of the emissions, reports by source, hour, and layer for randomly selected states in the domain were created. These reports were created for a representative weekday in each of the episodes for each of these selected states.

The quantitative QA analyses often reveal significant deficiencies in the input data or the model setup. It may become necessary to tailor these procedures to track down the source of each major problem. As such, we will only outline the basic quantitative QA steps that were performed in an attempt to reveal the underlying problems with the inventories or processing.

Following are some of the reports that were generated to review the processed emissions:

- State and county totals from inventory for each source category
    - (example provided in Table 1 below for Area sources)
- State and county totals after spatial allocation for each source category
- State and county totals by day after temporal allocation for each source category for representative days
- State and county totals by model species after chemical speciation for each source category
- State and county model-ready totals (after spatial allocation, temporal allocation, and chemical speciation) for each source category and for all source categories combined
- If elevated source selection is chosen by user, the report indicating which sources have been selected as elevated and plume-in-grid will be included.

- Totals by source category code (SCC) from the inventory for area, mobile, and point sources
- Totals by state and SCC from the inventory for area, mobile, and point sources
- Totals by county and SCC from the inventory for area, mobile, and point sources
- Totals by SCC and spatial surrogates code for area and mobile sources
- Totals by speciation profile code for area, mobile, and point sources
- Totals by speciation profile code and SCC for area, mobile, and point sources
- Totals by monthly temporal profile code for area, mobile, and point sources
- Totals by monthly temporal profile code and SCC for area, mobile, and point sources
- Totals by weekly temporal profile code for area, mobile, and point sources
- Totals by weekly temporal profile code and SCC for area, mobile, and point sources
- Totals by diurnal temporal profile code for area, mobile, and point sources
- Totals by diurnal temporal profile code and SCC for area, mobile, and point sources
- PAVE plots of gridded inventory pollutants for all pollutants for area, mobile, and point sources

Table 1. Example of a State totals report for Area Sources

Stationary area
Processed as Area sources
Base inventory year 2018
No gridding matrix applied
No speciation matrix applied
Temporal factors applied for episode from
Thursday July 18, 2002 at 000000 to
Thursday July 18, 2002 at 230000
Annual total data basis in report

Date	Region	State	CO [tons/day]	NOX [tons/day]	VOC [tons/day]	NH3 [tons/day]	SO2 [tons/day]	PM10 [tons/day]	PM2_5 [tons/day]	PMC [tons/day]
07/18/200	1000	Alabama	5.21E+01	2.19E+01	3.88E+02	2.16E+02	9.34E+01	3.66E+01	2.52E+01	1.14E+01
07/18/200	4000	Arizona	4.34E+02	1.94E+02	3.55E+02	1.22E+02	1.01E+01	5.17E+01	4.84E+01	3.24E+00
07/18/200	5000	Arkansas	4.48E+02	6.06E+01	2.14E+02	4.51E+02	7.90E+01	7.08E+01	6.25E+01	8.30E+00
07/18/200	6000	California	8.67E+02	3.73E+02	1.48E+03	9.55E+02	2.65E+01	2.71E+02	2.18E+02	5.26E+01
07/18/200	8000	Colorado	9.01E+00	1.01E+01	1.83E+02	2.16E+02	2.80E+00	2.39E+00	2.30E+00	9.67E-02
07/18/200	9000	Connecticu	6.37E+00	1.05E+01	1.18E+02	1.99E+01	5.39E-01	3.81E+00	3.54E+00	2.69E-01
07/18/200	10000	Delaware	6.56E+00	4.74E+00	2.36E+01	6.12E+01	1.48E+00	7.90E+00	2.75E+00	5.15E+00
07/18/200	11000	District of C	1.74E+00	1.99E+00	1.33E+01	2.68E-02	2.32E+00	9.36E-01	8.92E-01	4.37E-02
07/18/200	12000	Florida	1.14E+02	8.36E+01	1.35E+03	1.08E+02	1.36E+02	3.07E+01	2.56E+01	5.03E+00
07/18/200	13000	Georgia	1.63E+02	8.88E+01	8.71E+02	3.11E+02	1.68E+02	6.60E+01	5.05E+01	1.55E+01
07/18/200	16000	Idaho	1.06E+02	1.32E+02	7.85E+02	2.00E+02	2.93E+00	9.50E+01	6.70E+01	2.81E+01
07/18/200	17000	Illinois	8.25E+01	6.82E+01	5.73E+02	2.14E+02	1.50E+01	2.69E+01	2.40E+01	4.38E+00
07/18/200	18000	Indiana	1.27E+02	6.27E+01	5.45E+02	2.69E+02	1.58E+02	1.56E+02	8.07E+01	7.51E+01
07/18/200	19000	Iowa	4.81E+01	6.41E+00	3.07E+02	7.24E+02	2.23E+00	1.86E+01	1.65E+01	2.19E+00
07/18/200	20000	Kansas	2.26E+03	1.09E+02	3.71E+02	2.32E+02	3.86E+01	2.86E+02	2.19E+02	6.72E+01
07/18/200	21000	Kentucky	8.95E+01	1.21E+02	2.70E+02	1.24E+02	1.02E+02	3.00E+01	2.55E+01	4.50E+00
07/18/200	22000	Louisiana	1.66E+03	3.31E+02	3.21E+02	2.24E+02	2.51E+02	1.93E+02	1.65E+02	2.81E+01
07/18/200	23000	Maine	2.74E+01	7.23E+00	1.21E+02	3.06E+01	1.53E+01	1.19E+01	1.09E+01	1.04E+00
07/18/200	24000	Maryland	2.49E+02	2.66E+01	2.06E+02	9.56E+01	2.21E+01	3.43E+01	3.31E+01	1.14E+00
07/18/200	25000	Massachus	9.95E+01	6.14E+01	2.80E+02	3.87E+01	3.46E+01	5.01E+01	4.36E+01	6.46E+00
07/18/200	26000	Michigan	4.64E+01	5.89E+01	5.22E+02	1.39E+02	1.06E+02	1.98E+01	8.99E+00	1.08E+01
07/18/200	27000	Minnesota	1.80E+02	1.41E+02	4.52E+02	3.66E+02	3.55E+01	4.87E+01	4.19E+01	6.78E+00
07/18/200	28000	Mississippi	4.91E+00	3.25E+00	3.41E+02	1.76E+02	7.73E-01	5.19E+00	1.50E+00	3.69E+00
07/18/200	29000	Missouri	2.32E+02	7.43E+01	4.40E+02	3.90E+02	1.24E+02	6.70E+01	5.39E+01	1.31E+01
07/18/200	30000	Montana	4.60E+01	3.25E+01	1.02E+02	9.16E+01	2.63E+00	8.46E+00	7.97E+00	4.88E-01
07/18/200	31000	Nebraska	1.38E+02	4.25E+01	2.07E+02	3.43E+02	2.68E+01	2.20E+01	1.80E+01	4.06E+00
07/18/200	32000	Nevada	1.44E+02	1.95E+01	1.35E+02	2.41E+01	8.17E+00	1.77E+01	1.71E+01	6.02E-01
07/18/200	33000	New Hamp	3.82E+01	2.61E+01	8.11E+01	7.21E+00	7.62E+00	2.30E+01	2.06E+01	2.40E+00
07/18/200	34000	New Jerse	1.45E+01	2.24E+01	2.70E+02	5.55E+01	8.55E+00	1.94E+01	9.83E+00	9.72E+00
07/18/200	35000	New Mexic	8.55E+01	7.68E+01	1.48E+02	1.37E+02	1.78E+01	1.52E+01	1.37E+01	1.55E+00
07/18/200	36000	New York	7.14E+01	1.15E+02	7.02E+02	2.64E+02	2.28E+02	9.92E+01	4.78E+01	5.14E+01
07/18/200	37000	North Caro	1.08E+03	1.12E+02	4.50E+02	5.32E+02	1.63E+01	1.97E+01	1.53E+01	4.51E+00
07/18/200	38000	North Dako	1.80E+01	5.18E+01	1.28E+02	1.25E+02	1.43E+02	7.04E+00	3.74E+00	3.30E+00
07/18/200	39000	Ohio	4.02E+01	5.19E+01	6.51E+02	2.81E+02	3.48E+01	5.26E+00	4.70E+00	5.61E-01
07/18/200	40000	Oklahoma	1.00E+03	3.38E+02	5.98E+02	3.30E+02	3.23E+01	1.48E+02	1.18E+02	2.97E+01
07/18/200	41000	Oregon	1.77E+02	5.42E+01	5.19E+02	9.80E+01	5.96E+01	7.30E+01	6.81E+01	4.93E+00
07/18/200	42000	Pennsylvar	3.47E+02	5.72E+01	5.80E+02	3.18E+02	7.39E+01	7.30E+01	5.08E+01	2.22E+01
07/18/200	44000	Rhode Isla	1.11E+01	5.57E+00	1.29E+02	2.85E+00	5.43E+00	2.17E+00	2.00E+00	1.65E-01
07/18/200	45000	South Caro	1.23E+02	5.25E+01	3.95E+02	9.36E+01	3.12E+01	2.27E+01	1.95E+01	3.20E+00
07/18/200	46000	South Dako	1.73E+01	1.43E+01	8.98E+01	2.69E+02	5.49E+01	5.92E+00	4.44E+00	1.48E+00
07/18/200	47000	Tennessee	8.91E+01	3.53E+01	4.42E+02	8.82E+01	7.95E+01	3.51E+01	2.80E+01	7.16E+00
07/18/200	48000	Texas	1.71E+03	2.24E+02	1.18E+03	8.96E+02	1.87E+01	1.96E+02	1.65E+02	3.32E+01
07/18/200	49000	Utah	1.99E+02	5.54E+01	1.62E+02	9.43E+01	2.39E+01	2.68E+01	2.54E+01	1.41E+00
07/18/200	50000	Vermont	3.95E+01	4.55E+00	3.79E+01	4.14E+01	1.05E+01	6.09E+00	5.48E+00	6.09E-01
07/18/200	51000	Virginia	1.98E+02	1.26E+02	3.34E+02	1.40E+02	2.87E+01	5.71E+01	2.31E+01	3.40E+01
07/18/200	53000	Washingto	3.64E+02	4.41E+01	3.26E+02	1.21E+02	4.90E+00	6.00E+01	5.81E+01	1.92E+00
07/18/200	54000	West Virgir	3.84E+01	3.07E+01	1.57E+02	3.65E+01	3.15E+01	1.56E+01	1.36E+01	2.03E+00
07/18/200	55000	Wisconsin	8.57E+01	3.00E+01	4.35E+02	3.56E+02	9.08E+00	1.62E+01	1.49E+01	1.30E+00
07/18/200	56000	Wyoming	5.24E+01	2.14E+02	4.57E+01	6.93E+01	3.83E+01	7.36E+00	6.09E+00	1.27E+00

Additional State QA Procedures

Once the on-road mobile SMOKE outputs were acquired by NCDAQ, a number of metrics were generated to further QA and summarize the emissions. Those included:

- County emissions totals, bar charts to visually examine whether the counties with the highest emissions are consistent with what was expected from county VMT distribution. (example provided in Figure 1)
- County emissions by SCC code (vehicle and facility) were examined with pie charts to ensure distribution of emissions by vehicle type fits the conceptual model.
- PAVE plots were generated to check to ensure emissions where showing up in all counties in NC. Scale was lowered to make sure no emissions were omitted.
- PAVE plots were animated over a 24-hr period to ensure diurnal changes in emissions were as they should be.
- PAVE plots were visually inspected to make sure emissions were highest/lowest in logical places.

The following QA checks were performed both together and separate for EGU and non-EGU point sources:

- Data product summaries and raw NIF 3.0 data files were examined.
- County emissions totals were examined to assure the counties with the highest emissions were consistent with what was expected.
- PAVE plots were generated to check to ensure emissions where showing up in all counties in NC. Scale was lowered to make sure no emissions were omitted.
- PAVE plots were animated over a 24-hr period to ensure diurnal changes in emissions were as they should be.
- PAVE plots were visually inspected to make sure emissions were highest/lowest in logical places.
- Errors detected in earlier model runs were rechecked with each successive model run to assure their correction was carried forward in subsequent runs.
- NIF files were examined to identify problems with latitude and longitude, as well as, stack parameters.
- Parsed files were examined (i.e., Excel spreadsheets that provide unit-level results derived from the model plant projections obtained by the IPM) for accuracy.
- Facility level emission summaries for 2018 were examined for both the base case and CAIR case to ensure that emissions were consistent and that there were no missing sources.
- Emissions and controls for Duke Energy and Progress Energy were compared to their latest updated plans for complying with North Carolina's Clean Smokestack Act. (These plans varied substantially from the IPM results both in terms of current and future controls and timing of these controls. As a result, NCDAQ replaced the IPM emission projections for 2009 with projections from the Duke Energy and Progress Energy compliance plans. NCDAQ elected to use the IPM

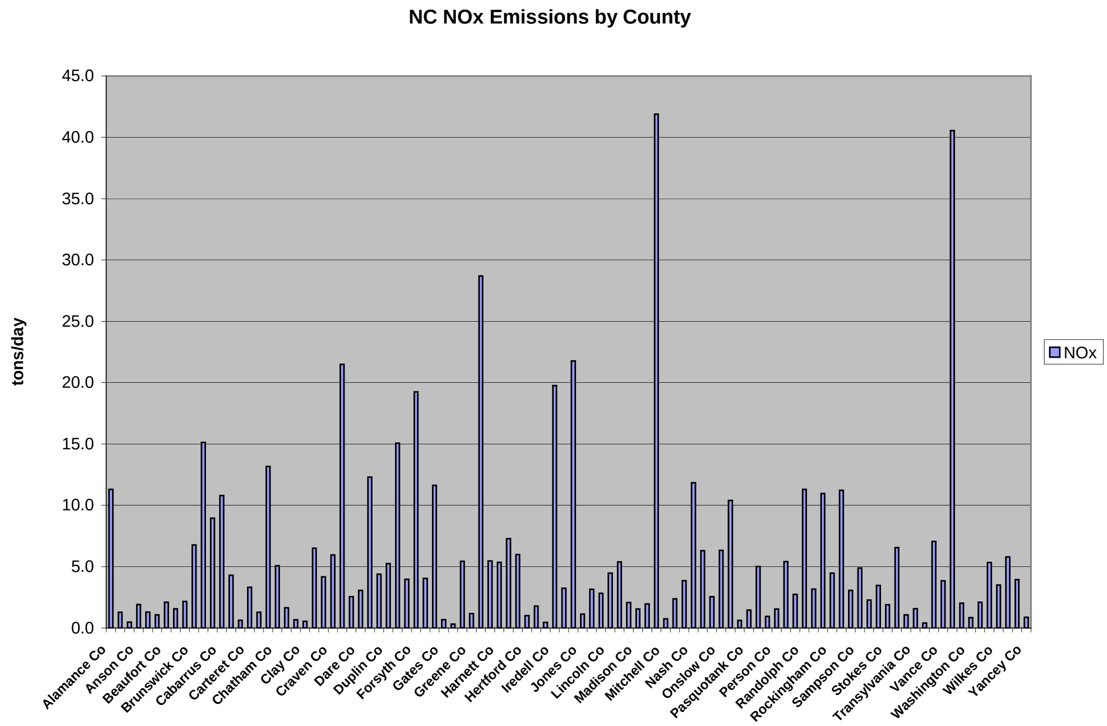
results for 2018, with the exception of Duke Lee 3, for which IPM imposed a scrubber that will not exist. This scrubber was removed from the final run.)

- Ensured that stack parameters were modified appropriately and where necessary at facilities where new controls are scheduled to be installed.
- Input files were examined to assure there were no double counted facilities (example would be if a facility was known by two different names and counted under each).

Typical fire emissions SMOKE output in the VISTAS states were acquired by NCDAQ from Alpine Geophysics. The plots and summary reports for these area source fire emissions were spot-checked for QA and included:

- County emissions totals and County emissions by SCC code, were visually examine whether the counties with the highest emissions are consistent with what was expected.
- PAVE plots were generated to check to ensure emissions where showing up in all counties in NC. Scale was lowered to make sure no emissions were omitted.
- PAVE plots were animated over a 24-hr period to ensure diurnal changes in emissions were as they should be.
- PAVE plots were visually inspected to make sure emissions were highest/lowest in logical places.

Figure 1. Example of a bar chart showing county total NOx emissions.



Appendix H.2
Temporal Profile Development for Electric Generating Units

Development of Temporal Profiles for Electric Generating Units (EGUs) In the VISTAS States:
Final Technical Memorandum

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1.0 Introduction

The objective of this analysis was to develop temporal profiles for EGUs in the VISTAS states (AL, GA, FL, KY, MS, NC, SC, TN, VA, and WV). These temporal profiles will be used by the VISTAS Emissions and Air Quality Modeling Team during modeling of the VISTAS 2002 and 2018 EGU emissions, in place of SMOKE default temporal profiles that are accepted to not accurately depict temporal distribution of emissions from EGUs in the U.S. VISTAS EGU temporal profiles were developed using hourly CEM data as reported to EPA's Clean Air Market's Division (CAMD) for the Acid Rain Program.

This technical memorandum describes the work conducted by Alpine Geophysics (Alpine) in order to assist VISTAS in this task with the main objective of developing temporal profiles for VISTAS EGUs necessary to apply in the generation of SMOKE PTHOUR formatted emissions. Additionally, State-level monthly, day-of-week, and diurnal profiles were developed for application to non-CEM matched units in the VISTAS emissions inventory. These temporal distributions represent a significant improvement over the SMOKE defaults, and will be used for both actual 2002 and "typical" 2002 and 2018 modeling.

Two sets of monthly profiles were developed by Alpine:

1. Profiles based solely on actual 2002 CEM-based data at the state level. The 2002-only profiles are intended to be used by VISTAS in developing model performance evaluation metrics necessary for configuring air quality models in attainment demonstration analyses.

2. Profiles based on historical averages of 2000 through 2004 CEM-based data. These historical 2000-2004 average profiles were developed and are recommended to be used to represent consistent "typical" operating conditions at EGUs in the VISTAS domain for the base year and future year emission estimates.

Analyses conducted by Alpine Geophysics indicate an added benefit to the modeling results with the application of CEM-based day-of-week and diurnal profiles, in addition to the monthly profiles for each state. As part of this analysis, specific day-of-week (Monday, Tuesday, Wednesday, etc.) and diurnal profiles were developed for each month and State to better represent operating conditions at units within each State. The day of week and diurnal profiles were developed from averages of CEM-based emissions and heat input activity occurring on that day-of-week or during that hour-of-day. These profiles are intended to be applied to units were CEM matches cannot be made to VISTAS emission inventories.

2.0 Data Obtained

2.1. Source of Information

Five years (2000 through 2004) of hourly CEM information from EPA's CAMD website were obtained for each unit in the VISTAS states[1]. The "Prepackaged Data" option allows the download of files containing emissions data for a specific state, quarter or month, and year. Each prepackaged data file is in .csv (comma delimited) format and contains the following fields: State, Facility Name, Facility ID (ORISPL), Unit ID, Date, Hour, SO_2 Emissions (lbs), CO_2 Emissions (tons), NO_x Emissions Rate (lb/mmBtu), NO_x Emissions (lbs), Heat Input (mmBtu), Operating Time (hours), Gross Load (MW), and Steam Load (1000 lb/hr). For this analysis, we obtained the prepackaged monthly unit-level hourly emissions data by state and year. Using these data, we reformatted the files and quality assured for applicability to this analysis.

[1] http://cfpub.epa.gov/gdm/index.cfm?fuseaction=prepackaged.select

2.2. File Contents

The reformatted files were prepared as identified in Table 1.

Table 1. CEM data file format.

Column	Description
State	State in which the facility is located.
Facility Name	The name given by the owners and operators to a facility.
Facility ID (ORISPL)	The unique six-digit facility identification number, also called an ORISPL, assigned by the Energy Information Administration, a component of the Department of Energy.
Unit ID	Each unit at a facility has a unique identification number. It is alphanumeric and may be from one to six characters in length. For utility units and other units that generate energy for sale, the unit ID used for Part 75 reporting is the same unit ID that appears in the National Allowance Database (NADB) (for Acid Rain Program units) or in the State's allowance allocation list.
Day	Day on which a unit was operating.
Hour	Hour on which a unit was operating.
Operating Hours	Percent of hour in which a unit was operating.
Gross Load (MW)	Gross load is the output of the unit as measured in megawatts.
Steam Load (1000 lb/hr)	Steam load is the output of the unit as measured in 1000 lb/hr of steam.
SO_2 Mass (lbs)	SO_2 released for the hour in pounds.
SO_2 Mass Measurement Flag	Indicates whether the value for SO_2 mass was measured or derived due to missing data.
SO_2 Rate (lbs/mmBtu)	SO_2 emissions rate in pounds per million British thermal units (lbs/mmBtu).
SO_2 Rate Measurement Flag	Indicates whether the value for SO_2 rate was measured or derived due to missing data.
NO_x Rate (lb/mmBtu)	NOx emissions rate in pounds per million British thermal units (lbs/mmBtu).
NO_x Rate Measurement Flag	Indicates whether the value for NO_x rate was measured or derived due to missing data.
NO_x Mass (lbs)	NO_x released for the hour in pounds.
NO_x Mass Measurement Flag	Indicates whether the value for NO_x mass was measured or derived due to missing data.
CO_2 Mass (lbs)	CO_2 released for the hour in pounds.
CO_2 Mass Measurement Flag	Indicates whether the value for CO_2 mass was measured or derived due to missing data.
CO_2 Rate (lbs/mmBtu)	CO_2 emissions rate in pounds per million British thermal units (lbs/mmBtu).
CO_2 Rate Measurement Flag	Indicates whether the value for CO_2 rate was measured or derived due to missing data.
Heat Input (mmBtu)	Heat per hour as calculated by multiplying the quantity of fuel by the fuel's heat content.

2.3. Quality Control / Quality Assurance

Each file was reviewed to determine if NOx, SO2 and heat input values were represented for each hour of every day for each unit in the obtained data. Zero values were considered to be valid if operating time identifiers indicated no operation during that hour (e.g., data value of zero but operating hours greater than zero).

Using the measurement flags and field values in the reformatted files, numerous spot checks were made of anomalous or missing variable data to ensure that data corruption was not impacting the statistical analyses. Additionally, each year's hourly total of NOx, SO2, and heat input (per state) were summed and compared to EPA annual summaries of the same data elements.

When there were facilities or units with no emissions data or unit characteristics, we verified that these sources are not required to report emissions data or had not yet reported emissions data to EPA. In some cases, certain months or quarters of the year were blank for individual units or facilities and using EPA data caveat reports, we verified these units were not in operation during those times.

3.0 Inventory Matching

Prior to the development of the unit-specific SO2, NOx, and heat input ratios for each hour, the step of matching CEM units to the VISTAS 2002 modeling inventory started. Because naming convention and facility or unit numbering can be unique at the Federal, State, local, or facility level, the step of matching existing units from an emissions inventory to the CEM data base proved to be more complicated than anticipated.

The VISTAS EGU emission inventory accounted for approximately 3.7 million tons of SO2 and 1.5 million tons of NOx in calendar year 2002. There were 861 units reporting to the CEM database in 2002 for the ten VISTAS States. The primary objective of the inventory matching steps was to account for as many units and tons as possible allowing for the unit-specific application of hourly temporal distribution profiles.

Under the direction of VISTAS, staff at MACTEC Engineering and Consulting, Inc. prepared comparisons of the VISTAS 2002 emission inventory of EGU sources to that of CEM-based emissions, heat input, and operating characteristics. For each unit identified as an EGU source in the VISTAS inventory, an attempt was made to match it to a CEM unit and associated data.

Automated facility (ORIS) and unit identification was made for a majority of units who maintained the same numbering and nomenclature between the two data sets. This first computerized step captured the majority of emissions by matching some of the largest units in the VISTAS domain. The remaining steps were followed in order to match the outstanding facilities and emissions as reported by VISTAS States in the 2002 emission inventory.

MACTEC developed county-level reports of the remaining unmatched facilities and units from the VISTAS inventory and made comparisons of annual emissions of SO2 and NOx to the CEM-based SO2 and NOx for sources also identified within the same county. This step of the matching process allowed an incremental amount of emissions and units to be accounted for and assigned unit-specific profiles for model performance evaluation.

Finally, remaining VISTAS inventory and CEM sources were manually compared to each other in an effort to determine if reporting errors in State or county codes or facility or unit identification codes accounted for this reminder of unmatched sources. These manual matches were confirmed or revised with VISTAS State and stakeholder participation and input. With this step, a few sources were identified to have facility identification changes or misreported county codes preventing automated matching from occurring and corrected for the final application of factors.

Once all methods of comparison were exhausted, the remaining unmatched VISTAS emission inventory of EGU sources was excluded from the unit-specific profile assignment steps and was allocated more generalized facility or State temporal profiles as described in the following section.

This inventory comparison process allowed for the match of over 650 of the 861 CEM identified units (76%) to the VISTAS EGU emission inventory for 2002. More importantly, however, was the match of 99.95 percent of the SO2 emissions and over 99.4 percent of the NOx emissions from these sources in the VISTAS domain.

4.0 Assumptions and Calculations

4.1. Profile Calculations

Two sets of profile types have been developed for modeling EGU emissions within the VISTAS domain. The first set are to be applied to individual units able to be matched to CEM data, the second are to be applied to EGU sources within the VISTAS domain where CEM-based matches could not be identified.

The first set of temporal profiles have been developed for specific hour-of-date periods based on historical actual 2002 or average NOx, SO2, and heat input data for sources reporting under EPA's CEM program between 2000 and 2004. These profiles are based on the actual or statistical average of the CEM data variables (NOx, SO2, and heat input) for each hour-of-date (e.g., Hour 12 of March 3) during the year. In the typical profile calculation, variables are calculated for each hour when the operating time of the CEM is greater than 0 (e.g., the unit is in operation during that hour). In the case of 2002-only calculations, all reported NOx, SO2, and heat input data were used in the averaging, including those identified as non-operating hours. This allowed for the best representation of actual 2002 conditions for the expected use of these profiles for model validation studies.

In the second set of profiles, NOx, SO2, and heat input values were averaged over each unit to allow for the calculation of State level monthly, day-of-week, and diurnal profiles for VISTAS States.

For the 2000-2004 averaging period, representation of typical operating conditions was desired, so in the averaging calculation only valid operating hour NOx, SO2, and heat input values were used. This prevented the introduction of equipment shutdown because of power outages, control installation, or planned maintenance into the temporal profile calculation.

4.1.1. Actual 2002 Profiles

Through the EPA's Clean Air Market's Data and Maps website, quarterly unit-level hourly emissions data by State and calendar year 2002 were obtained for purposes of developing temporal allocation factors applicable to EGU sources within the VISTAS domain. Key elements in these data sets include the State where the unit is located, facility name, facility identification (ORISPL) code (assigned by the Department of Energy at the Energy Information Administration), unit identification code, date of record, hour of record, SO2, CO2, and NOx mass (in lbs per hour), heat input (million British thermal units [MMBtu]), and NOx emission rate (lbs/MMBtu).

SO2 and NOx mass and heat input values were summed for each unit to an annual level to allow for the calculation of an hour of date-to-annual ratio estimation. Equation 1 provides this calculation for heat input. Table 1 provides an example result of the ratio calculation.

Equation (1) $$hi_{ratio,hr,date} = hi_{hr,date} / \sum_{Dec31}^{Jan1} hi$$

where hi = heat input (MMBtu)

Table 1. Application of Calculated Ratios for Actual 2002 by Unit

				Actual Reported Values [2002]			Calculated Ratios		
ORISPL	**UnitID**	**Date**	**Hour**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
3	2	01-01-2002	0	15.563	10.294	13.3	1.417E-06	1.915E-06	1.372E-06
3	2	01-01-2002	1	14.977	8.338	12.5	1.364E-06	1.551E-06	1.289E-06
3	2	01-01-2002	2	14.93	9.286	12.6	1.360E-06	1.728E-06	1.300E-06
3	2	01-01-2002	3	14.774	9.677	12.8	1.346E-06	1.800E-06	1.320E-06
…	…	…	…	…	…	…	…	…	…
3	2	07-01-2002	0	1084.017	717.467	995.1	9.873E-05	1.335E-04	1.026E-04
3	2	07-01-2002	1	1102.47	750.04	1012.2	1.004E-04	1.395E-04	1.044E-04
3	2	07-01-2002	2	1109.41	768.55	1016.6	1.010E-04	1.430E-04	1.049E-04
3	2	07-01-2002	3	1102.598	772.614	1012.6	1.004E-04	1.437E-04	1.044E-04
3	2	07-01-2002	4	1087.909	736.967	998.6	9.909E-05	1.371E-04	1.030E-04
3	2	07-01-2002	5	1099.375	731.888	1009.5	1.001E-04	1.362E-04	1.041E-04
3	2	07-01-2002	6	1127.007	693.779	1026.3	1.026E-04	1.291E-04	1.059E-04
3	2	07-01-2002	7	1203.814	644.008	1114.2	1.096E-04	1.198E-04	1.149E-04
…	…	…	…	…	…	…	…	…	…
3	2	12-31-2002	21	712.26	503.505	835	6.487E-05	9.367E-05	8.612E-05
3	2	12-31-2002	22	716.983	587.419	850.1	6.530E-05	1.093E-04	8.768E-05
3	2	12-31-2002	23	521.311	430.787	647.8	4.748E-05	8.014E-05	6.681E-05
3954	**3**	**Annual Sum**		**10979533.36**	**5375215.80**	**9695608.12**	**1.000**	**1.000**	**1.000**

Since it was assumed that all sources in the VISTAS EGU inventory would not be matched to individual CEM-based units, the same calculations were performed for each State so that a hierarchical application of ratios (unit first, State second) could be assigned as necessary. Table 2 shows example ratios calculated for each month by State. Table 3 reflects an example of the State-month-day of week ratio calculation and Table 4 shows a State-month-diurnal ratio calculation example. Each of these ratios were calculated for each State in the VISTAS domain and used in instances where CEM unit matches could not be made to the VISTAS base year emissions inventory.

Three parameter values (SO2 mass, NOx mass, heat input) were calculated at each aggregation as NOx and SO2 emissions vary due to fuel blend, sulfur content, or seasonal control and are not necessarily representative of the other variables' seasonal, daily, or even hourly variation. As seen in Figure 1, when viewed on a VISTAS-domain total, the monthly variation in relative distribution of SO2, NOx, and heat input differs enough to justify calculating each parameter value set of temporal profiles with CEM data.

Table 2. Application of Calculated Ratios for Actual 2002 by Example State and Month

		Actual Reported Values [2002]			Calculated Ratios		
State	**Month**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
FL	Jan	67,755,539	42,004,513	113,531,981	0.0726	0.0813	0.0733
FL	Feb	56,516,278	34,145,451	91,969,840	0.0605	0.0661	0.0594
FL	Mar	69,997,283	39,244,669	107,685,763	0.0750	0.0759	0.0695
FL	Apr	73,678,638	40,824,242	118,170,997	0.0789	0.0790	0.0763
FL	May	88,889,603	48,974,695	142,351,045	0.0952	0.0948	0.0919
FL	Jun	79,736,153	44,027,147	138,648,667	0.0854	0.0852	0.0895
FL	Jul	94,401,559	50,007,339	157,075,598	0.1011	0.0968	0.1014
FL	Aug	93,041,423	50,077,048	160,601,359	0.0996	0.0969	0.1037
FL	Sep	93,349,234	49,183,990	155,433,110	0.1000	0.0952	0.1003
FL	Oct	84,214,449	46,837,495	146,347,289	0.0902	0.0906	0.0945
FL	Nov	60,374,969	33,098,684	105,854,682	0.0647	0.0641	0.0683
FL	Dec	71,853,245	38,331,463	111,702,695	0.0769	0.0742	0.0721
FL	**Total**	**933,808,373**	**516,756,735**	**1,549,373,024**	**1.0000**	**1.0000**	**1.0000**

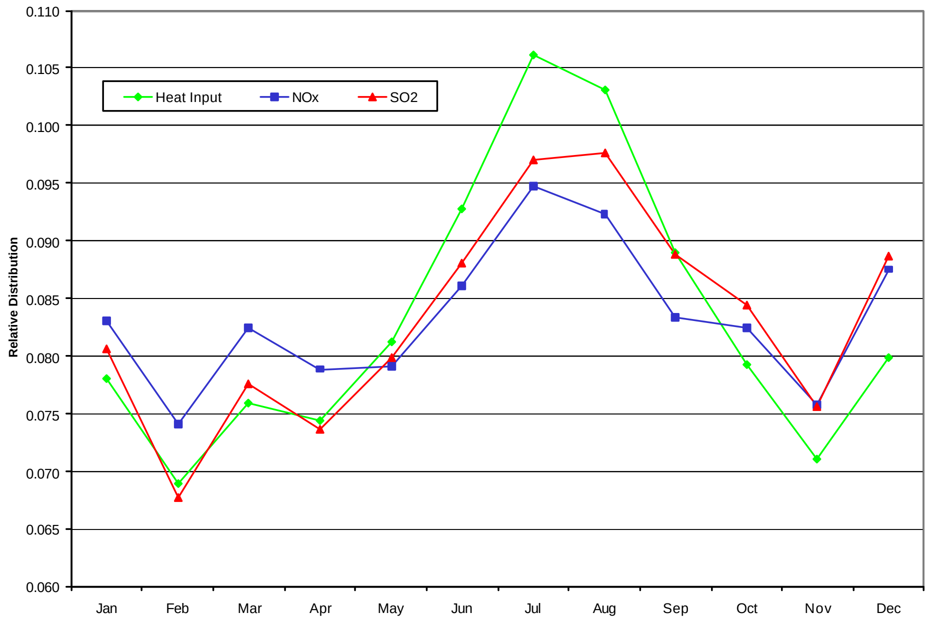
Table 3. Application of Calculated Ratios for Actual 2002 by Example State and Month and Day of Week

			Actual Reported Values [2002]			Calculated Ratios		
State	**Month**	**Day of Week**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
GA	Mar	Sun	13,057,959	4,005,097	10,089,522	0.1467	0.1437	0.1458
GA	Mar	Mon	11,937,355	3,841,172	9,564,295	0.1341	0.1378	0.1382
GA	Mar	Tue	11,860,749	3,766,317	9,351,652	0.1332	0.1351	0.1352
GA	Mar	Wed	12,020,458	3,764,653	9,232,574	0.1350	0.1351	0.1334
GA	Mar	Thu	11,560,778	3,677,100	9,056,011	0.1299	0.1319	0.1309
GA	Mar	Fri	14,572,757	4,616,042	11,368,579	0.1637	0.1656	0.1643
GA	Mar	Sat	14,005,730	4,197,929	10,522,180	0.1573	0.1506	0.1521
GA	**Mar**	**Total**	**89,015,786**	**27,868,311**	**69,184,812**	**1.0000**	**1.0000**	**1.0000**

Table 4. Application of Calculated Ratios for Actual 2002 by Example State and Month and Hour of Day

			Actual Reported Values [2002]			Calculated Ratios		
State	**Month**	**Hour**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
SC	Dec	0	1,356,270	556,321	1,309,476	0.0399	0.0399	0.0398
SC	Dec	1	1,332,499	540,268	1,279,485	0.0392	0.0387	0.0389
SC	Dec	2	1,324,618	536,330	1,275,732	0.0389	0.0384	0.0388
SC	Dec	3	1,330,924	538,908	1,284,514	0.0391	0.0386	0.0391
SC	Dec	4	1,335,158	545,819	1,296,880	0.0392	0.0391	0.0394
SC	Dec	5	1,385,906	565,695	1,340,759	0.0407	0.0405	0.0408
SC	Dec	6	1,436,829	586,536	1,387,329	0.0422	0.0420	0.0422
SC	Dec	7	1,488,961	611,648	1,440,753	0.0438	0.0438	0.0438
SC	Dec	8	1,491,509	613,176	1,444,956	0.0438	0.0440	0.0440
SC	Dec	9	1,501,425	618,516	1,447,916	0.0441	0.0443	0.0440
SC	Dec	10	1,484,685	610,879	1,431,441	0.0436	0.0438	0.0435
SC	Dec	11	1,459,697	593,638	1,395,938	0.0429	0.0426	0.0425
SC	Dec	12	1,423,246	578,669	1,365,957	0.0418	0.0415	0.0415
SC	Dec	13	1,391,851	570,939	1,345,091	0.0409	0.0409	0.0409
SC	Dec	14	1,352,161	557,078	1,319,068	0.0397	0.0399	0.0401
SC	Dec	15	1,344,643	551,497	1,312,670	0.0395	0.0395	0.0399
SC	Dec	16	1,369,024	559,569	1,333,589	0.0402	0.0401	0.0406
SC	Dec	17	1,449,587	595,765	1,398,917	0.0426	0.0427	0.0426
SC	Dec	18	1,493,742	621,423	1,438,833	0.0439	0.0445	0.0438
SC	Dec	19	1,473,502	611,050	1,427,712	0.0433	0.0438	0.0434
SC	Dec	20	1,479,504	608,223	1,424,664	0.0435	0.0436	0.0433
SC	Dec	21	1,475,680	608,049	1,421,202	0.0434	0.0436	0.0432
SC	Dec	22	1,450,119	597,906	1,401,208	0.0426	0.0429	0.0426
SC	Dec	23	1,391,087	573,310	1,351,539	0.0409	0.0411	0.0411
SC	**Dec**	**Daily**	**34,022,628**	**13,951,210**	**32,875,627**	**1.0000**	**1.0000**	**1.0000**

Figure 1. Monthly variation in 2002 of CEM reported heat input, NOx mass, and SO2 mass for VISTAS domain.



When viewed on a State by State basis, the differences in monthly variation are even more pronounced as individual facilities within each State may be affected during any calendar year by extreme temperature variation, shutdowns, or regular maintenance or installation of equipment. As an example, Figure 2 represents CEM data from the State of Mississippi during calendar year 2002 and reveals that SO2 emissions increase throughout the year, NOx emissions stay relatively high during the summer months, and heat input peaks during the month of July. Although Figures 1 and 2 are roughly comparable in shape and monthly distribution, the relative distribution of these values is quite different. In Mississippi's case, close to thirteen percent of the State's CEM-based heat input occurs in July. This compares to the VISTAS average of just over ten percent of CEM-based heat input in July.

Finally, when these data are reviewed at a unit level, the differences become incrementally more distinct due to the unique nature of individual facilities, their operating schedules, pollution regulation, fuel characteristics, and applied technologies. For example, a facility that is complying with summertime NOx regulation may have selective catalytic reduction (SCR) installed on its boiler(s) which in practice may only be run during ozone season months. During this period of time, heat input and SO2 emissions may remain consistent with State or regional monthly profiles, but the NOx emissions may drop significantly relative to the rest of the year.

Figure 3 represents an extreme unit-specific case for monthly differences from State or regional temporal allocation. The unit presented is a Mississippi baseload coal-fired boiler which in 2002 emitted over 4,000 tons of NOx and over 11,000 tons of SO2. This unit would typically run at consistent levels during the entire period, but due to a planned maintenance outage was not in operation in late January through the middle of April in 2002. Given the unique operation of this boiler during this year, the use of a regional or even State-level monthly temporal distribution would introduce significant inaccuracy to air quality modeling in the immediate or downwind area associated with this facility. While this may not be significant at great distance downwind of the source or for annual concentration estimates, more locally, and especially over shorter time scales (daily or weekly), such simplifications would have a noticeable effect on air quality model predictions.

Figure 2. Monthly variation in 2002 of CEM reported heat input, NOx mass, and SO2 mass for Mississippi.

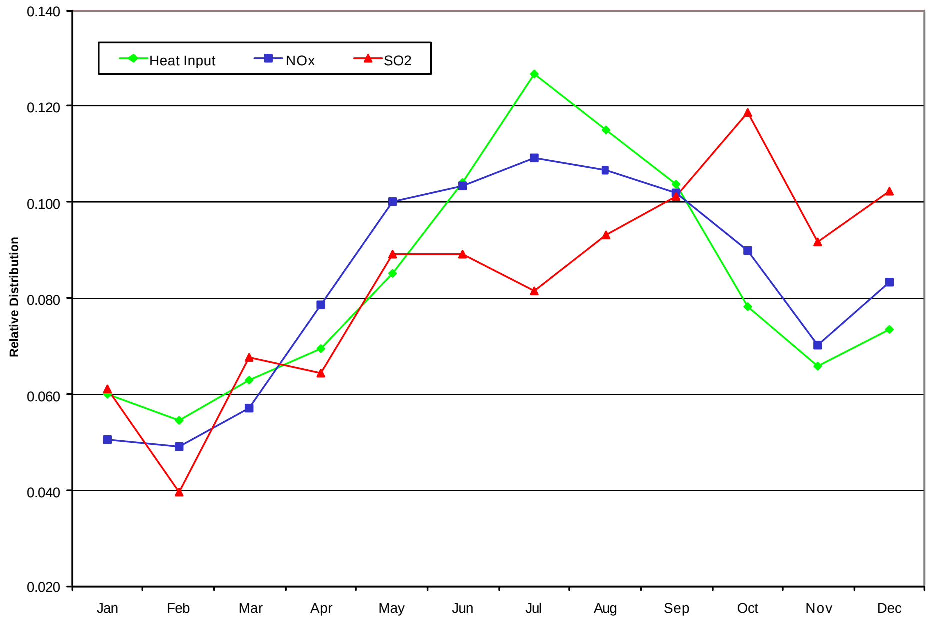
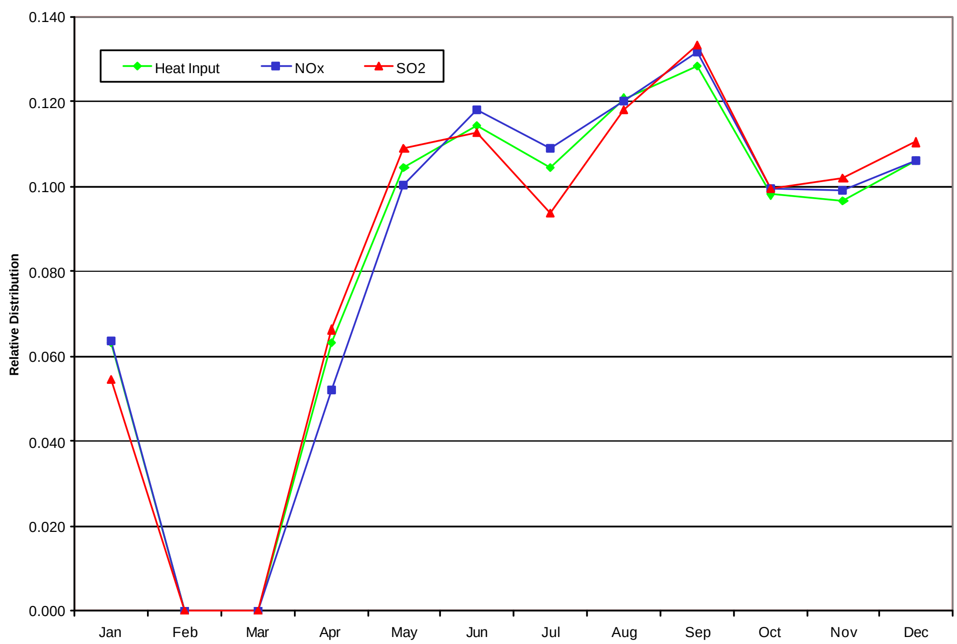


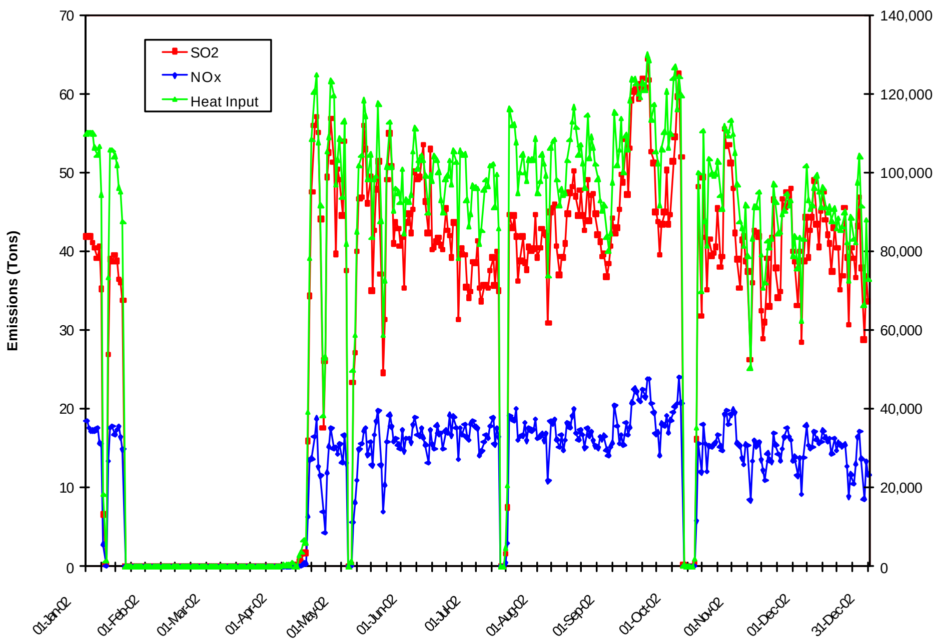
Figure 3. Monthly variation in 2002 of CEM reported heat input, NOx mass, and SO2 mass for specific baseload coal-fired unit in Mississippi with planned outage in late January through mid April.



Thus, while improving the representativeness of unit-specific monthly temporal profiles is desirable, providing day and hour-specific values are clearly better. For this reason, during the model performance evaluation process in the VISTAS Phase II modeling, hour-specific temporal ratios were developed for every CEM reporting unit in the VISTAS domain. These ratios allowed for the hour-by-hour accounting of emissions released at each unit at each facility within the VISTAS domain that reported output under the CEM guidelines.

Figure 4 represents the actual daily distribution of SO2 and NOx emissions and heat input from the Mississippi baseload unit from the above example. As can been seen in this figure, not only is the planned January through April outage represented correctly, there are significant peaks and valleys throughout the calendar year which could not be accurately represented with the application of average monthly, day-of-week, or hourly distribution factors. In reality, only the actual operating characteristics of this unit could capture the differences from hour to hour which are potentially quite important in terms of correctly modeling the impact of the source on downwind oxidant and fine particulate concentrations[2].

Figure 4. Actual daily unit-specific 2002 SO2 (tons), NOx, (tons), and heat input (MMBtu) distribution from CEM data.



[2] Stella, G.M., "Development of Hourly Inventories Utilizing CEM-Based Data," presented at the International Emission Inventory Conference, Las Vegas, NV, April, 2005.

4.1.2. Typical EGU Profiles

Hour of day of month specific temporal profiles were developed by calculating the arithmetic mean of each unit's NOx, SO2, and heat input by specific hour of day per month (e.g., Hour 21 of Wednesdays in July) from the data obtained from 2000 through 2004. In order to accomplish this calculation, each record of CEM data was first assigned a day of week. This assignment was based on the actual CEM's date of record and day of week of that record. An example of this assignment is shown in Table 5.

Table 5. Example Day-of-Week per Month Assignment

Date	Day of Week
08/01/02	Thu
08/02/02	Fri
08/03/02	Sat
08/04/02	Sun
08/05/02	Mon
08/06/02	Tue
08/07/02	Wed

Once days of week were assigned to each record in the CEM data base, the arithmetic mean of each unit's NOx, SO2, and heat input were calculated for the ORISPL-UNITID-MONTH-DAY OF WEEK-HOUR combination. Only records where the CEMs were operating for more than half the recorded hour (OPTIME > 0.5) were used in the averaging calculation. An example of the averaged results can be seen in Table 6.

Table 6. Arithmetic Mean of CEM -based Variables for Temporal Profile Calculation

							Calculated Average Values [2000 – 2004]		
State	Facility	ORISPL	UnitID	Month	Day of Week	Hour	SO2 Mass	NOx Mass	Heat Input
WV	Mount Storm Power Station	3954	3	1	Tue	0	406.0526	3384.074	5196.11
WV	Mount Storm Power Station	3954	3	1	Tue	1	389.6474	3287.845	5103.06
WV	Mount Storm Power Station	3954	3	1	Tue	2	395.2737	3342.848	5175.95
…	…	…	…	…	…	…	…	…	…
WV	Mount Storm Power Station	3954	3	7	Mon	4	524.7864	2505.9391	4654.34
WV	Mount Storm Power Station	3954	3	7	Mon	5	690.5636	2602.9887	4795.64
WV	Mount Storm Power Station	3954	3	7	Mon	6	912.4227	2572.0275	4727.08
WV	Mount Storm Power Station	3954	3	7	Mon	7	1060.3	2664.8686	4914.25
WV	Mount Storm Power Station	3954	3	7	Mon	8	850.2364	2678.231	5029.58
WV	Mount Storm Power Station	3954	3	7	Mon	9	415.3455	2716.8	5042.55
WV	Mount Storm Power Station	3954	3	7	Mon	10	408.8591	2876.5008	5123.71
WV	Mount Storm Power Station	3954	3	7	Mon	11	371.9909	2776.0361	5147.85
WV	Mount Storm Power Station	3954	3	7	Mon	12	327.2045	2785.5325	5129.66
WV	Mount Storm Power Station	3954	3	7	Mon	13	316.0364	2826.901	5172.29
WV	Mount Storm Power Station	3954	3	7	Mon	14	317.1136	2816.1328	5146.07
WV	Mount Storm Power Station	3954	3	7	Mon	15	329.6455	2789.0962	5121.75
WV	Mount Storm Power Station	3954	3	7	Mon	16	332.7773	2818.5379	5147.05
…	…	…	…	…	…	…	…	…	…
WV	Mount Storm Power Station	3954	3	12	Tue	21	806.7	3432.001	5375.49
WV	Mount Storm Power Station	3954	3	12	Tue	22	806.5778	3447.709	5377.68
WV	Mount Storm Power Station	3954	3	12	Tue	23	795.4667	3419.069	5359.43

These values were then applied to each unit and hour based on the 2002 calendar to match the meteorological data used in the emissions processing. An example of this application can be seen in Table 7. The date specific hourly averages were then summed to a unit summer (May – Sept) and winter months total and ratios were developed based on each daily hour's average value divided by the average sum total depending on the season of the day. This permitted the appropriate allocation of summertime NOx (as forecasted by IPM) when summer control only was predicted. Using the annual average ratios instead of the seasonal distributions would produce summertime emissions different than what was output from the model.

Table 7. Application of Calculated Ratios to Day of Year by Unit

					Calculated Average Values [2000 – 2004]			Calculated Ratios		
ORISPL	**UnitID**	**Date**	**Day of Week**	**Hour**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
3797	4	09/30/02	Mon	19	2591.95	381.78	1527.26	2.899E-04	2.396E-04	2.863E-04
3797	4	09/30/02	Mon	20	2596.81	379.88	1525.60	2.904E-04	2.385E-04	2.860E-04
3797	4	09/30/02	Mon	21	2569.03	370.50	1506.74	2.873E-04	2.326E-04	2.824E-04
3797	4	09/30/02	Mon	22	2547.62	367.24	1498.66	2.849E-04	2.305E-04	2.809E-04
3797	4	09/30/02	Mon	23	2483.88	360.66	1465.68	2.778E-04	2.264E-04	2.747E-04
3797	4	10/01/02	Tue	0	1968.94	478.47	1170.76	1.587E-04	1.517E-04	1.604E-04
3797	4	10/01/02	Tue	1	1942.47	480.28	1160.68	1.565E-04	1.522E-04	1.590E-04
3797	4	10/01/02	Tue	2	1858.54	462.44	1122.29	1.498E-04	1.466E-04	1.537E-04
3797	4	10/01/02	Tue	3	1988.43	486.07	1187.56	1.602E-04	1.541E-04	1.627E-04
3797	4	10/01/02	Tue	4	2125.96	528.59	1263.00	1.713E-04	1.676E-04	1.730E-04
3797	4	10/01/02	Tue	5	2255.22	562.18	1325.40	1.818E-04	1.782E-04	1.815E-04
3797	4	10/01/02	Tue	6	2267.27	558.77	1337.81	1.827E-04	1.771E-04	1.832E-04
3797	4	10/01/02	Tue	7	2313.00	579.94	1370.73	1.864E-04	1.838E-04	1.878E-04
3797	**4**	**Summer**				**8941480.78**	**1593123.80**	**5334723.17**		
3797	**4**	**Winter**				**12408352.17**	**3154758.40**	**7300596.69**		
3797	**4**	**Annual Sum**				**21349832.95**	**4747882.21**	**12635319.86**		

Equation 2 reflects this calculation for heat input for a summer hour. Ratios were calculated for NOx, SO2, and heat input values. These ratios were then applied to each unit's seasonal (summer or winter) emission value for NOx, SO2, and all other pollutants, respectively.

Equation (2)

$$hi_{ratio,hr,date,sum} = hi_{hr,date,sum} / \sum_{Sep30}^{May1} hi$$

where hi = heat input (MMBtu)

The actual hour-of-day-of-month averages calculated from the CEM data were not used directly as emissions for that hour, but were used only in the calculation of the ratios to be applied to a pre-calculated seasonal (summer or winter) emission value. This allowed for the retention of emission estimates calculated using means other than CEM data, if a State or local agency found them to be more appropriate or if it were derived by other means (e.g., IPM) but an improved distribution of emissions using CEM-based ratios.

As in the actual 2002 profiles calculations, these same calculations were additionally performed for each State so that a hierarchical application of ratios (unit first, State second) could be assigned as necessary. Instead of having variables at the unit level, however, State level values were used. These State value calculations were based on the sum of the unit-level variable averages to the level of aggregation required by the calculation (e.g., State-month. State-month-day-of-week, or State-month-hour). Table 8 shows example ratios calculated for each month by State. Table 9 reflects an example of the State-month-day of week ratio calculation and Table 10 shows a State-month-diurnal ratio calculation example. Each of these ratios were calculated for each State in the VISTAS domain and used in instances where CEM unit matches could not be made to the VISTAS base year emissions inventory.

Again, three parameter values (SO2 mass, NOx mass, heat input) were calculated at each aggregation as NOx and SO2 emissions vary due to fuel blend, sulfur content, or seasonal control and are not necessarily representative of the other variables' seasonal, daily, or even hourly variation.

Table 8. Application of Calculated Ratios for Typical Operation by Example State and Month

		Calculated Average Values [2000 – 2004]			Calculated Ratios		
State	**Month**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
FL	Jan	116,011,253	62,989,958	198,751,048	0.0858	0.0875	0.0831
FL	Feb	93,958,786	50,831,818	164,949,702	0.0695	0.0706	0.0690
FL	Mar	111,505,553	60,285,972	196,705,697	0.0824	0.0838	0.0822
FL	Apr	107,015,438	59,071,792	195,338,204	0.0791	0.0821	0.0817
FL	May	118,589,361	61,811,604	207,803,996	0.0877	0.0859	0.0869
FL	Jun	116,068,987	59,801,640	202,716,214	0.0858	0.0831	0.0848
FL	Jul	123,868,749	62,500,169	212,478,437	0.0916	0.0868	0.0888
FL	Aug	125,384,940	64,572,843	214,637,218	0.0927	0.0897	0.0897
FL	Sep	113,080,789	59,913,723	206,712,956	0.0836	0.0832	0.0864
FL	Oct	109,960,828	61,551,310	206,924,170	0.0813	0.0855	0.0865
FL	Nov	101,781,383	55,861,718	186,984,665	0.0752	0.0776	0.0782
FL	Dec	115,588,740	60,566,444	197,592,133	0.0854	0.0841	0.0826
FL	**Total**	**1,352,814,807**	**719,758,990**	**2,391,594,439**	**1.0000**	**1.0000**	**1.0000**

Table 9. Application of Calculated Ratios for Typical Operation by Example State and Month and Day of Week

			Calculated Average Values [2000 – 2004]			Calculated Ratios		
State	**Month**	**Day of Week**	**SO2 Mass**	**NOx Mass**	**Heat Input**	**SO2**	**NOx**	**Heat Input**
GA	Mar	Sun	15,495,089	4,641,883	12,167,666	0.1455	0.1403	0.1319
GA	Mar	Mon	14,334,901	4,513,847	13,362,335	0.1346	0.1365	0.1449
GA	Mar	Tue	14,420,895	4,532,750	13,463,600	0.1354	0.1370	0.1460
GA	Mar	Wed	14,170,345	4,489,531	13,057,182	0.1331	0.1357	0.1416
GA	Mar	Thu	14,004,649	4,446,853	12,249,119	0.1315	0.1344	0.1328
GA	Mar	Fri	17,177,952	5,357,920	14,842,639	0.1613	0.1620	0.1609
GA	Mar	Sat	16,881,455	5,096,281	13,100,433	0.1585	0.1541	0.1420
GA	**Mar**	**Total**	**106,485,284**	**33,079,065**	**92,242,973**	**1.0000**	**1.0000**	**1.0000**

Table 10. Application of Calculated Ratios for Typical Operation by Example State and Month and Hour of Day

			Calculated Average Values [2000 – 2004]			Calculated Ratios		
State	Month	Hour	SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
SC	Dec	0	1,790,705	674,127	1,908,284	0.0401	0.0395	0.0375
SC	Dec	1	1,760,847	659,279	1,877,399	0.0395	0.0386	0.0369
SC	Dec	2	1,766,498	660,719	1,890,957	0.0396	0.0387	0.0372
SC	Dec	3	1,766,455	664,407	1,922,535	0.0396	0.0389	0.0378
SC	Dec	4	1,788,023	677,882	2,005,041	0.0401	0.0397	0.0394
SC	Dec	5	1,839,136	708,796	2,193,779	0.0412	0.0415	0.0431
SC	Dec	6	1,903,431	736,781	2,379,535	0.0427	0.0432	0.0468
SC	Dec	7	1,957,422	760,608	2,504,498	0.0439	0.0446	0.0492
SC	Dec	8	1,958,923	768,669	2,515,860	0.0439	0.0450	0.0494
SC	Dec	9	1,974,624	767,392	2,419,052	0.0443	0.0450	0.0475
SC	Dec	10	1,944,825	751,207	2,264,252	0.0436	0.0440	0.0445
SC	Dec	11	1,888,552	723,857	2,140,166	0.0423	0.0424	0.0421
SC	Dec	12	1,833,408	694,261	2,022,036	0.0411	0.0407	0.0397
SC	Dec	13	1,781,162	673,316	1,936,841	0.0399	0.0395	0.0381
SC	Dec	14	1,755,403	663,791	1,911,001	0.0393	0.0389	0.0376
SC	Dec	15	1,743,443	660,042	1,897,088	0.0391	0.0387	0.0373
SC	Dec	16	1,775,717	669,264	1,937,000	0.0398	0.0392	0.0381
SC	Dec	17	1,877,548	713,920	2,099,275	0.0421	0.0418	0.0413
SC	Dec	18	1,948,165	753,627	2,255,923	0.0437	0.0442	0.0443
SC	Dec	19	1,940,185	753,123	2,258,417	0.0435	0.0441	0.0444
SC	Dec	20	1,941,859	750,942	2,221,568	0.0435	0.0440	0.0437
SC	Dec	21	1,930,605	743,880	2,182,689	0.0433	0.0436	0.0429
SC	Dec	22	1,909,077	732,480	2,140,416	0.0428	0.0429	0.0421
SC	Dec	23	1,841,457	702,464	2,003,560	0.0413	0.0412	0.0394
SC	**Dec**	**Daily**	**44,617,469**	**17,064,833**	**50,887,170**	**1.0000**	**1.0000**	**1.0000**

5.0 Application of Factors

VISTAS chose to prepare its air quality modeling inventories with Version 2.1 of the Sparse Matrix Operating Kernel Emissions (SMOKE) model. For this reason, all emissions were required to be converted to SMOKE's data formats. In particular, because hour specific temporal profiles for each day of a year are not accepted directly by the model, it was necessary to develop a set of hourly emissions inputs to circumvent this limitation. These were generated in the EMS PTHOUR format as described in SMOKE input file documentation[3].

The CEM format for individual hour-specific data files as available in SMOKE was not utilized for VISTAS emissions processing as the emissions allowable by hour would have been limited to NOx, SO2, and CO2. If this file format and optional run configuration were exercised, the NOx, SO2, and CO2 emissions processed by the model would have been accurate for CEM reported emissions, but the remaining pollutants coupled with each CEM unit would have received the monthly, daily, and diurnal temporal profiles associated with the source category codes from the unit. This could lead to potentially displaced emissions if a unit were operating at different times than the default profiles indicated. Additionally, in cases where States may not have reported annual emission estimates directly based on CEMs, these emissions would be slightly different that the original annual inventory.

In VISTAS Phase II modeling, for those EGU sources where CEM data were utilized, NOx, SO2, and heat input-based hour-specific profiles were developed and applied to annual NOx, SO2, and all other emissions, respectively, for both the actual and typical 2002 modeling. Heat input was chosen as a surrogate for non-CEM reported pollutants as the majority of remaining compounds are not as significantly impacted by controls or fuel content, yet the distribution of these emissions would occur during the same times CEM reported pollutants were emitted.

The application of hourly ratios to annual emissions ensured that the annual values provided by States under the CERR were maintained, but distributed using actual hourly to annual profiles. Additionally, for stakeholder sources providing hour-specific data approved by the State in which they operated, data were substituted for State provided emissions and CEM-based distributions.

To temporally allocate the remaining EGU point sources, the NOx, SO2, and heat input data were collected from the 2002 or 2000-2004 CEM datasets, and used to develop State-level temporal distributions. These month-specific hour and day of week temporal profiles were used in conjunction with the emissions inventory to calculate hourly EGU emissions by unit.

Although not as accurate a distribution as the unit-specific factors, the State-based temporal distribution provided improved results to the default profiles provided with the emissions model. Figure 10 represents the monthly distribution comparisons of VISTAS State heat input to the default monthly distribution from Version 2.0 of SMOKE for source category code (SCC) 10100201, representing External Combustion Boilers; Electric Generation; Bituminous/Subbituminous Coal; Pulverized Coal: Wet Bottom (Bituminous Coal), a relatively common boiler type and fuel configuration in the VISTAS domain. This example is for the actual 2002 modeling exercise.

Much like the distinction in month to month variation of the profiles, day of week and diurnal patterns based on CEM data vary from unit to unit. Again, if one were to assign the same day of week or diurnal profile to every unit in the inventory, emissions from these sources would inappropriately be distributed during the episode of interest. In addition to the unique distribution provided by the unit-specific factors based on CEM data, aggregate State level daily and diurnal temporal distribution factors were developed and applied during this process. Figure 11 shows the variance in diurnal distribution from Tennessee's average CEM-based NOx emissions data for each of the twelve months of calendar year 2002 as would have been applied to units unmatched to CEM sources.

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[3] University of North Carolina at Chapel Hill, *Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System*, http://cf.unc.edu/cep/empd/products/smoke/index.cfm.

Figure 10. Relative distribution of actual 2002 monthly VISTAS State CEM -based heat input.

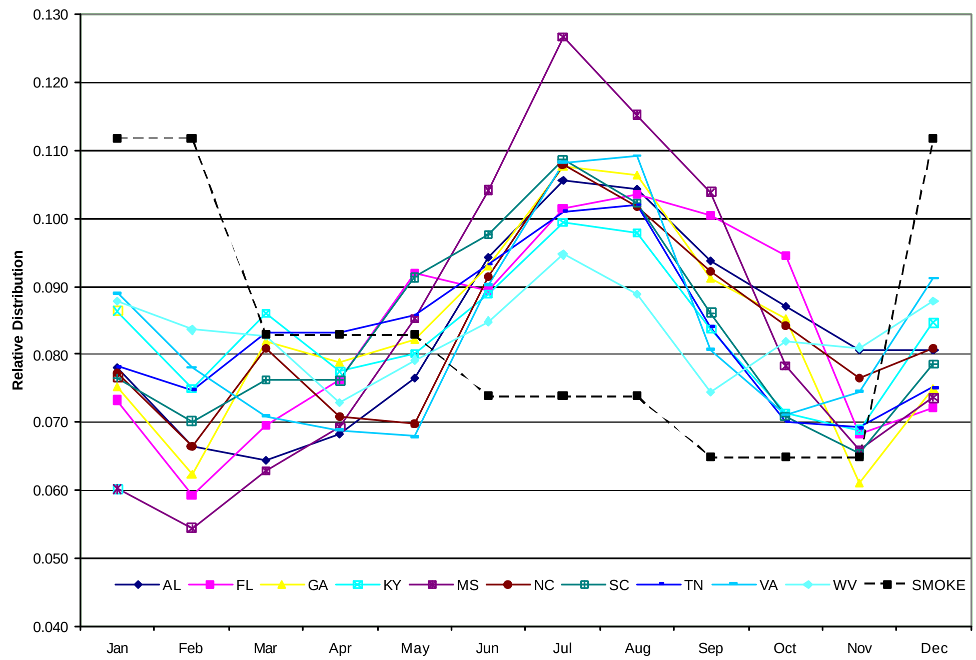
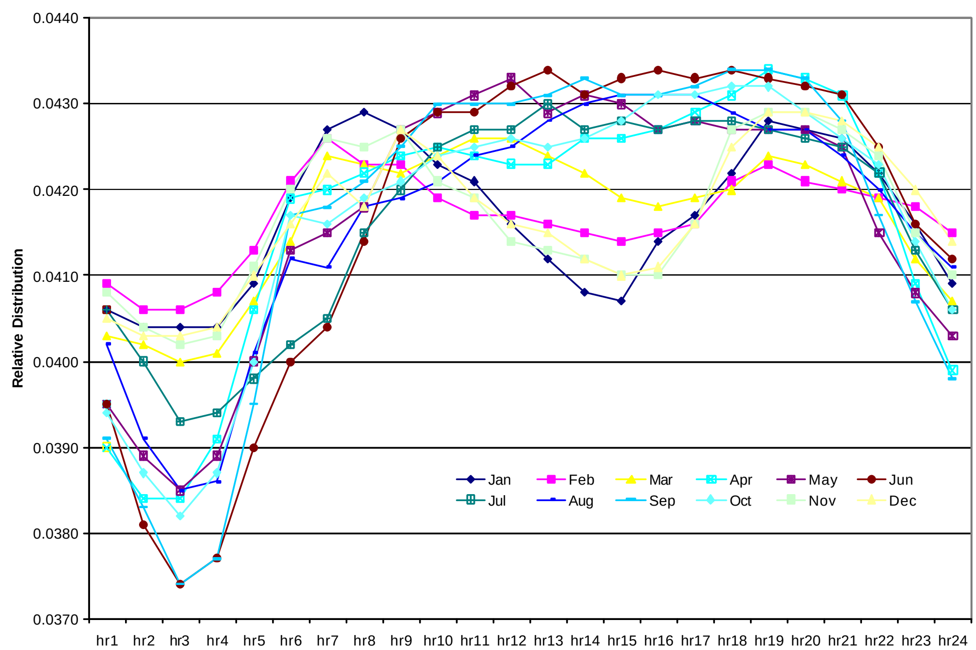


Figure 11. Relative distribution of diurnal actual 2002 CEM -based NOx emissions for Tennessee.



Development of Temporal Profiles for Electric Generating Units (EGUs) In the VISTAS States:
Appendices

Actual 2002 State Level Monthly Profiles
CEM-Based Distribution

		Actual Reported Values [2002]					
		SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	01	71,985,561	26,094,534	70,343,696	0.080297	0.080758	0.078053
AL	02	57,903,388	22,121,272	59,816,548	0.064589	0.068462	0.066372
AL	03	59,481,424	22,711,853	58,082,148	0.066349	0.070289	0.064447
AL	04	60,498,479	22,601,336	61,617,037	0.067483	0.069947	0.068370
AL	05	67,141,301	24,842,210	69,022,034	0.074893	0.076883	0.076586
AL	06	81,679,140	28,448,320	85,011,304	0.091109	0.088043	0.094328
AL	07	89,737,924	30,849,625	95,110,736	0.100099	0.095475	0.105534
AL	08	88,893,542	30,600,954	93,950,509	0.099157	0.094705	0.104246
AL	09	82,237,240	28,090,654	84,414,970	0.091732	0.086936	0.093666
AL	10	80,712,208	29,703,883	78,387,675	0.090031	0.091929	0.086978
AL	11	74,242,553	28,277,348	72,760,471	0.082814	0.087514	0.080734
AL	12	81,983,321	28,776,840	72,718,335	0.091449	0.089060	0.080687
FL	01	67,755,539	42,004,513	113,531,981	0.072558	0.081285	0.073276
FL	02	56,516,278	34,145,451	91,969,840	0.060522	0.066076	0.059359
FL	03	69,997,283	39,244,669	107,685,763	0.074959	0.075944	0.069503
FL	04	73,678,638	40,824,242	118,170,997	0.078901	0.079001	0.076270
FL	05	88,889,603	48,974,695	142,351,045	0.095190	0.094773	0.091877
FL	06	79,736,153	44,027,147	138,648,667	0.085388	0.085199	0.089487
FL	07	94,401,559	50,007,339	157,075,598	0.101093	0.096772	0.101380
FL	08	93,041,423	50,077,048	160,601,359	0.099637	0.096906	0.103656
FL	09	93,349,234	49,183,990	155,433,110	0.099966	0.095178	0.100320
FL	10	84,214,449	46,837,495	146,347,289	0.090184	0.090637	0.094456
FL	11	60,374,969	33,098,684	105,854,682	0.064655	0.064051	0.068321
FL	12	71,853,245	38,331,463	111,702,695	0.076946	0.074177	0.072095
GA	01	81,756,601	27,799,209	63,415,895	0.079739	0.094906	0.075141
GA	02	68,133,493	22,814,914	52,566,583	0.066452	0.077890	0.062285
GA	03	89,015,786	27,868,311	69,184,812	0.086819	0.095142	0.081976
GA	04	80,522,787	25,019,836	66,614,357	0.078535	0.085417	0.078930
GA	05	84,874,780	21,939,581	69,424,347	0.082780	0.074901	0.082260
GA	06	91,768,073	23,452,819	78,443,585	0.089503	0.080068	0.092947
GA	07	101,133,038	25,987,636	90,892,421	0.098637	0.088721	0.107697
GA	08	100,105,847	25,722,660	89,736,768	0.097635	0.087817	0.106328
GA	09	90,266,321	23,228,209	76,918,862	0.088038	0.079301	0.091140
GA	10	86,793,068	25,058,379	72,028,619	0.084651	0.085549	0.085346
GA	11	65,803,396	19,848,168	51,567,258	0.064179	0.067761	0.061101
GA	12	85,135,314	24,172,877	63,170,593	0.083034	0.082526	0.074850
KY	01	88,386,777	39,297,968	83,186,021	0.091572	0.098968	0.086426
KY	02	73,148,461	34,435,644	72,214,276	0.075785	0.086723	0.075027
KY	03	82,734,302	41,124,378	82,802,323	0.085716	0.103568	0.086027
KY	04	72,547,026	33,467,755	74,544,260	0.075162	0.084285	0.077447
KY	05	76,980,636	27,980,223	77,097,793	0.079755	0.070466	0.080100
KY	06	85,293,823	30,542,925	85,578,097	0.088368	0.076919	0.088911
KY	07	92,870,696	35,215,707	95,716,558	0.096218	0.088687	0.099444
KY	08	96,501,913	33,121,796	94,222,283	0.099980	0.083414	0.097892
KY	09	82,195,196	27,877,611	80,643,890	0.085157	0.070207	0.083785
KY	10	62,185,552	27,638,495	68,747,591	0.064427	0.069605	0.071425
KY	11	63,939,037	28,358,494	66,295,502	0.066243	0.071418	0.068877
KY	12	88,431,377	38,015,871	81,464,864	0.091618	0.095739	0.084638
MS	01	8,031,682	4,498,565	18,693,278	0.061085	0.050717	0.060192
MS	02	5,223,761	4,352,472	16,918,379	0.039730	0.049070	0.054477
MS	03	8,904,502	5,053,631	19,528,557	0.067724	0.056975	0.062882

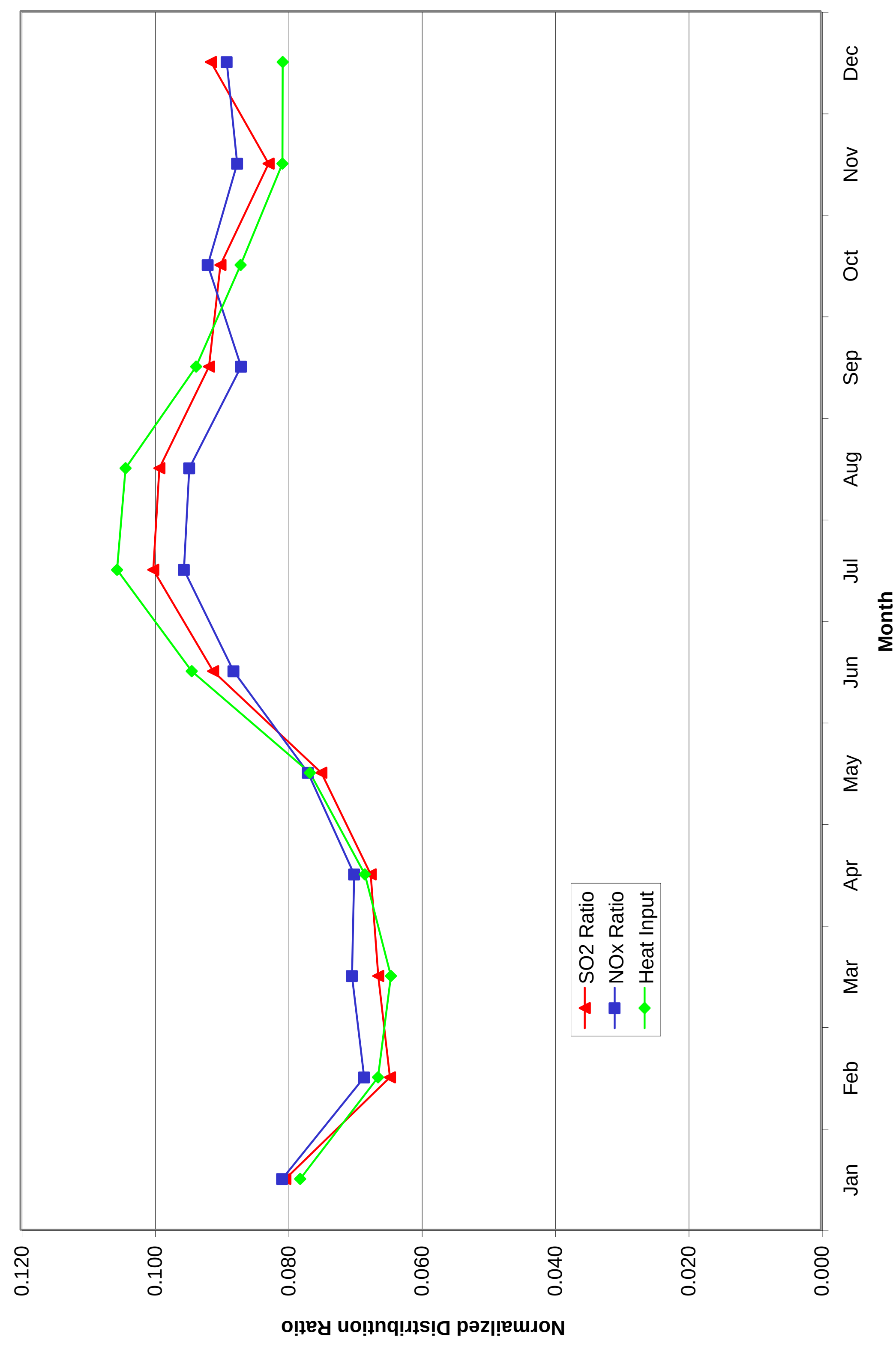
Actual 2002 State Level Monthly Profiles
CEM-Based Distribution

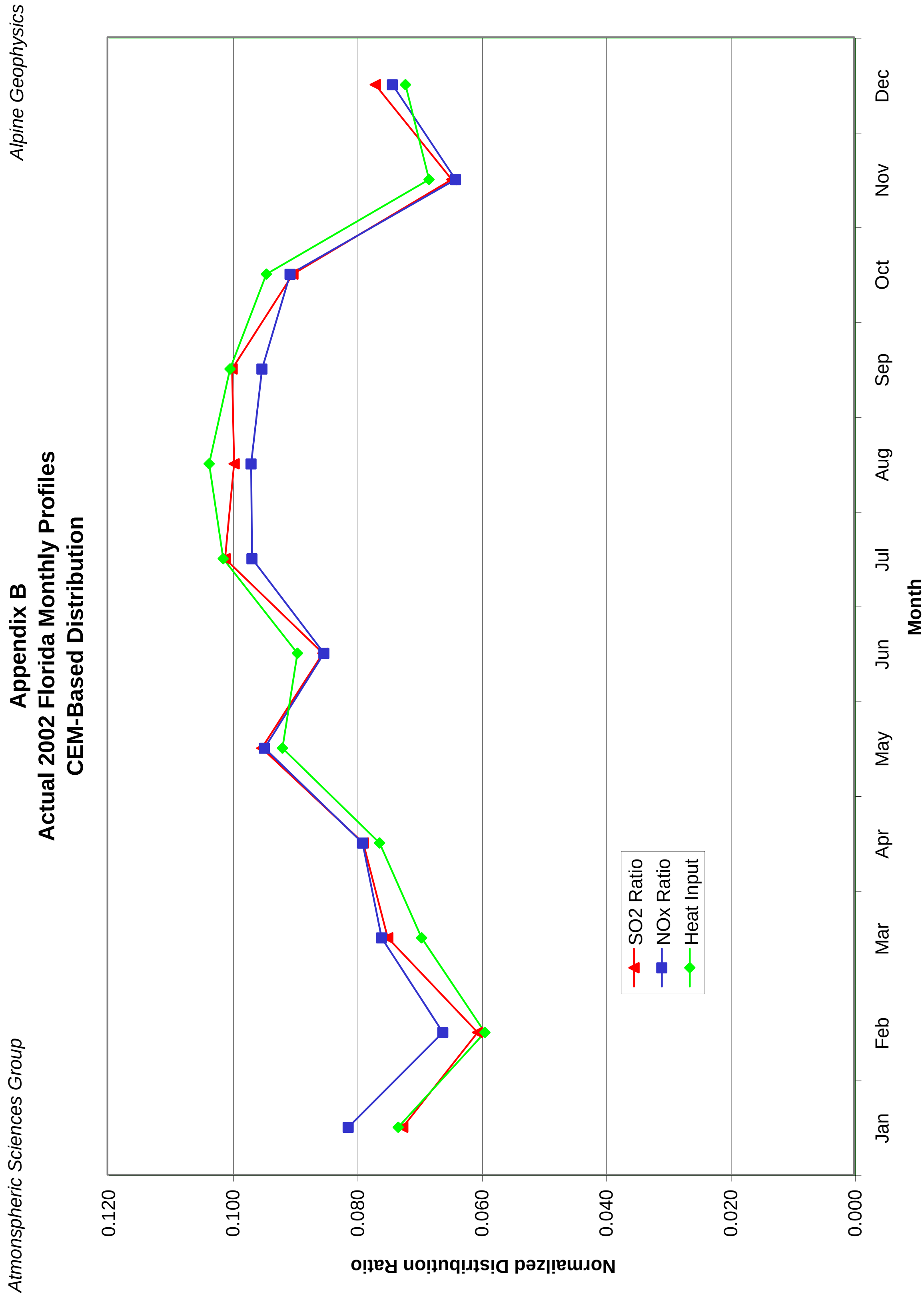
		Actual Reported Values [2002]					
		SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	04	8,490,345	6,990,633	21,539,003	0.064574	0.078813	0.069355
MS	05	11,716,102	8,877,359	26,494,505	0.089107	0.100084	0.085312
MS	06	11,720,087	9,160,148	32,351,189	0.089138	0.103272	0.104171
MS	07	10,698,661	9,678,640	39,353,163	0.081369	0.109118	0.126717
MS	08	12,248,376	9,455,323	35,788,550	0.093156	0.106600	0.115239
MS	09	13,318,131	9,033,521	32,264,075	0.101292	0.101845	0.103890
MS	10	15,606,833	7,970,595	24,320,790	0.118699	0.089861	0.078313
MS	11	12,055,561	6,231,694	20,456,689	0.091689	0.070257	0.065870
MS	12	13,468,929	7,396,477	22,851,683	0.102439	0.083388	0.073582
NC	01	75,136,353	24,858,345	55,899,678	0.081142	0.085303	0.077304
NC	02	62,625,577	21,049,420	48,060,753	0.067631	0.072233	0.066464
NC	03	76,510,384	25,871,214	58,529,352	0.082626	0.088779	0.080941
NC	04	64,544,010	20,896,091	51,248,689	0.069703	0.071706	0.070873
NC	05	66,362,875	19,060,689	50,405,626	0.071667	0.065408	0.069707
NC	06	84,872,317	24,704,467	66,064,806	0.091656	0.084775	0.091362
NC	07	97,274,800	27,668,346	78,086,028	0.105050	0.094946	0.107986
NC	08	91,520,225	25,673,272	73,521,724	0.098835	0.088100	0.101674
NC	09	85,254,440	25,011,683	66,746,058	0.092069	0.085829	0.092304
NC	10	75,964,852	25,715,410	60,880,736	0.082037	0.088244	0.084193
NC	11	70,335,464	24,469,355	55,259,007	0.075957	0.083968	0.076418
NC	12	75,584,957	26,433,121	58,408,497	0.081626	0.090707	0.080774
SC	01	31,082,047	12,447,442	32,071,078	0.078049	0.075075	0.076619
SC	02	27,616,162	12,022,360	29,372,326	0.069346	0.072511	0.070172
SC	03	30,786,036	13,748,694	31,919,340	0.077306	0.082923	0.076257
SC	04	30,808,574	13,051,703	31,881,213	0.077363	0.078719	0.076166
SC	05	33,379,734	14,540,834	38,224,387	0.083819	0.087701	0.091320
SC	06	36,455,084	15,294,979	40,844,336	0.091541	0.092249	0.097579
SC	07	40,837,836	17,082,250	45,488,310	0.102547	0.103029	0.108674
SC	08	38,676,732	15,591,844	42,790,308	0.097120	0.094040	0.102228
SC	09	35,679,673	14,131,599	36,057,937	0.089594	0.085233	0.086144
SC	10	30,213,689	12,200,904	29,683,343	0.075869	0.073588	0.070915
SC	11	28,677,840	11,736,758	27,369,314	0.072012	0.070788	0.065386
SC	12	34,022,628	13,951,210	32,875,627	0.085433	0.084145	0.078541
TN	01	55,962,590	26,490,714	50,517,218	0.083032	0.083381	0.078240
TN	02	49,772,972	25,111,225	48,268,869	0.073848	0.079039	0.074758
TN	03	53,888,451	27,786,281	53,773,402	0.079954	0.087459	0.083283
TN	04	53,635,523	26,944,116	53,669,004	0.079579	0.084808	0.083121
TN	05	53,793,041	26,211,598	55,397,434	0.079813	0.082503	0.085798
TN	06	58,083,892	28,960,784	60,205,128	0.086179	0.091156	0.093244
TN	07	62,716,273	29,685,685	65,260,117	0.093052	0.093438	0.101073
TN	08	64,732,592	30,656,307	65,844,216	0.096044	0.096493	0.101978
TN	09	55,363,943	25,203,715	54,267,287	0.082144	0.079330	0.084048
TN	10	54,815,971	22,361,942	45,237,221	0.081331	0.070386	0.070062
TN	11	52,473,786	22,941,078	44,704,253	0.077856	0.072209	0.069237
TN	12	58,750,090	25,351,968	48,528,016	0.087168	0.079797	0.075159
VA	01	38,475,114	13,884,068	35,726,965	0.083335	0.088021	0.089043
VA	02	36,246,280	12,707,978	31,318,850	0.078508	0.080565	0.078057
VA	03	34,493,035	12,014,135	28,445,130	0.074710	0.076167	0.070894
VA	04	33,658,381	11,725,743	27,639,417	0.072902	0.074338	0.068886
VA	05	30,058,763	11,157,143	27,241,039	0.065106	0.070733	0.067893
VA	06	40,434,224	13,273,415	36,207,957	0.087578	0.084150	0.090242

Actual 2002 State Level Monthly Profiles
CEM-Based Distribution

		Actual Reported Values [2002]					
		SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	07	46,742,629	15,010,587	43,450,363	0.101242	0.095163	0.108292
VA	08	48,824,486	15,473,443	43,802,591	0.105751	0.098098	0.109170
VA	09	38,575,335	12,737,625	32,393,260	0.083552	0.080753	0.080734
VA	10	33,870,666	11,850,176	28,537,080	0.073362	0.075127	0.071124
VA	11	35,473,124	12,423,503	29,886,473	0.076833	0.078762	0.074487
VA	12	44,839,404	15,477,229	36,583,137	0.097120	0.098122	0.091177
WV	01	96,944,793	42,044,442	79,092,849	0.095586	0.093087	0.087747
WV	02	82,119,857	40,236,394	75,363,295	0.080968	0.089084	0.083610
WV	03	80,265,558	39,449,563	74,655,220	0.079140	0.087342	0.082824
WV	04	73,771,312	36,354,805	65,768,483	0.072737	0.080490	0.072965
WV	05	77,750,748	29,700,855	71,390,537	0.076661	0.065758	0.079202
WV	06	81,443,429	33,281,430	76,494,657	0.080302	0.073686	0.084865
WV	07	92,721,546	37,174,696	85,322,770	0.091422	0.082305	0.094659
WV	08	90,767,443	34,927,795	80,025,146	0.089495	0.077331	0.088782
WV	09	75,981,801	31,220,707	67,184,933	0.074916	0.069123	0.074536
WV	10	84,776,265	40,999,243	73,853,919	0.083588	0.090773	0.081935
WV	11	85,826,466	41,795,648	73,025,375	0.084623	0.092536	0.081016
WV	12	91,850,814	44,482,447	79,194,247	0.090563	0.098485	0.087860

Appendix B
Actual 2002 Alabama Monthly Profiles
CEM-Based Distribution

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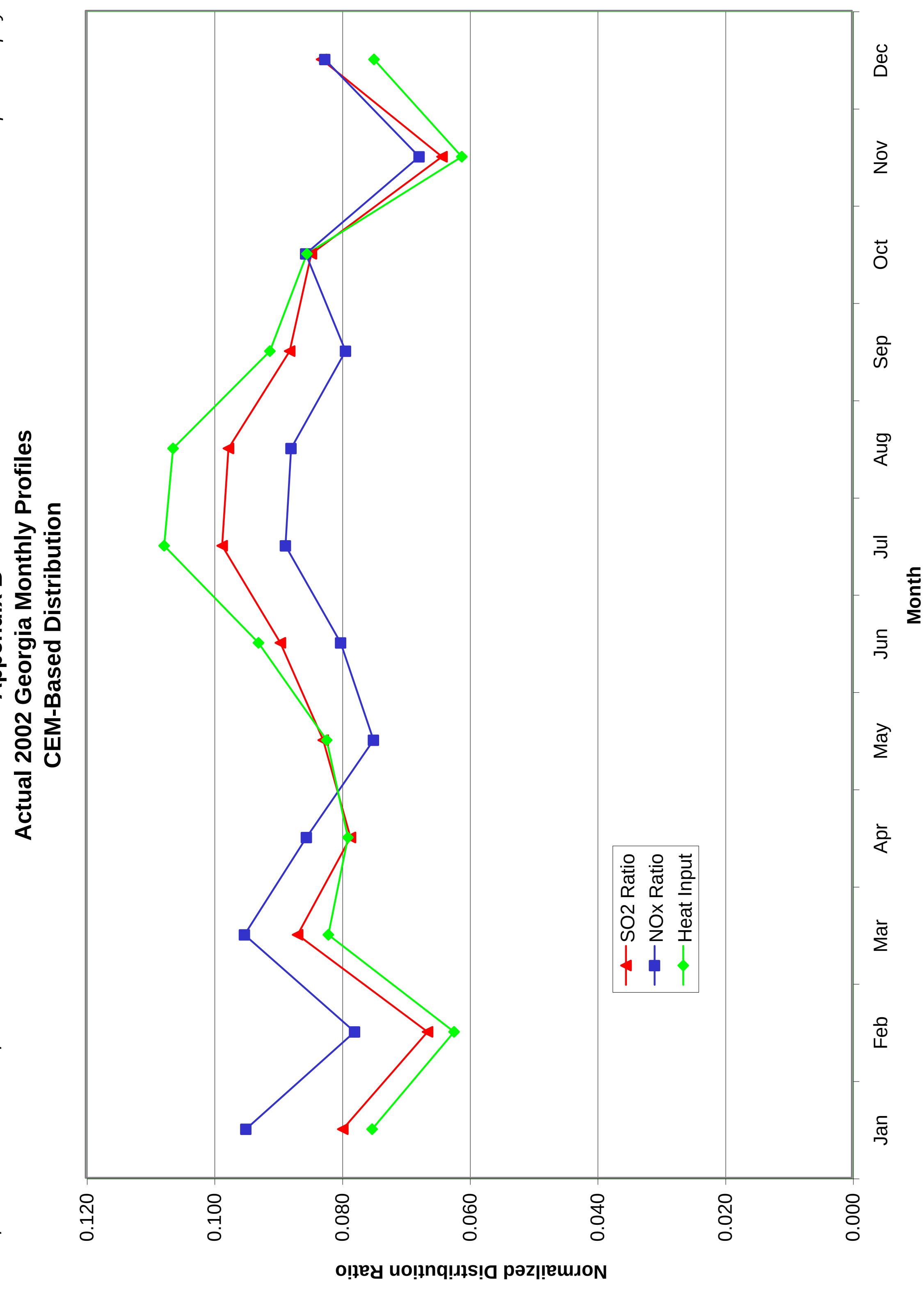
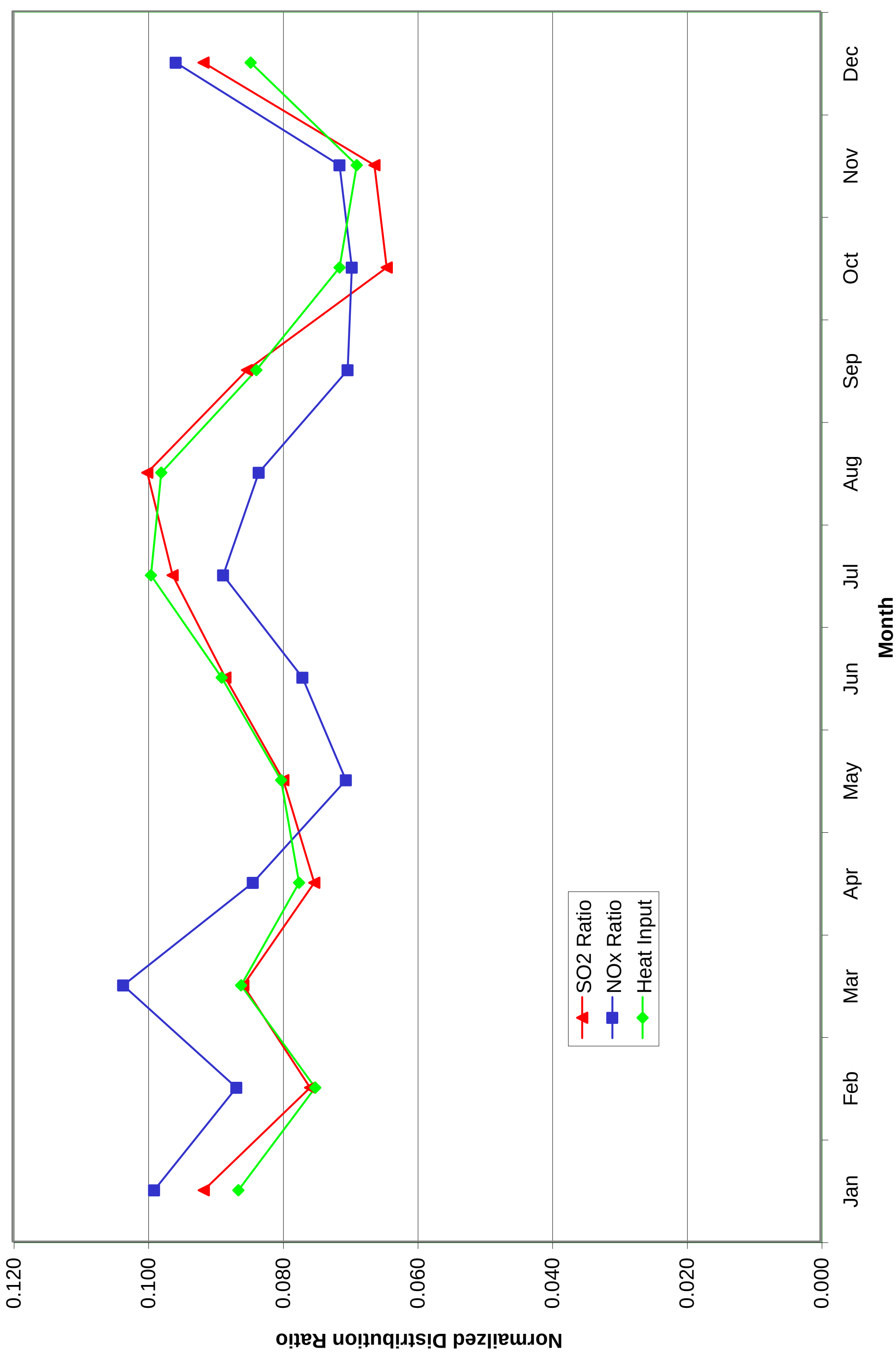
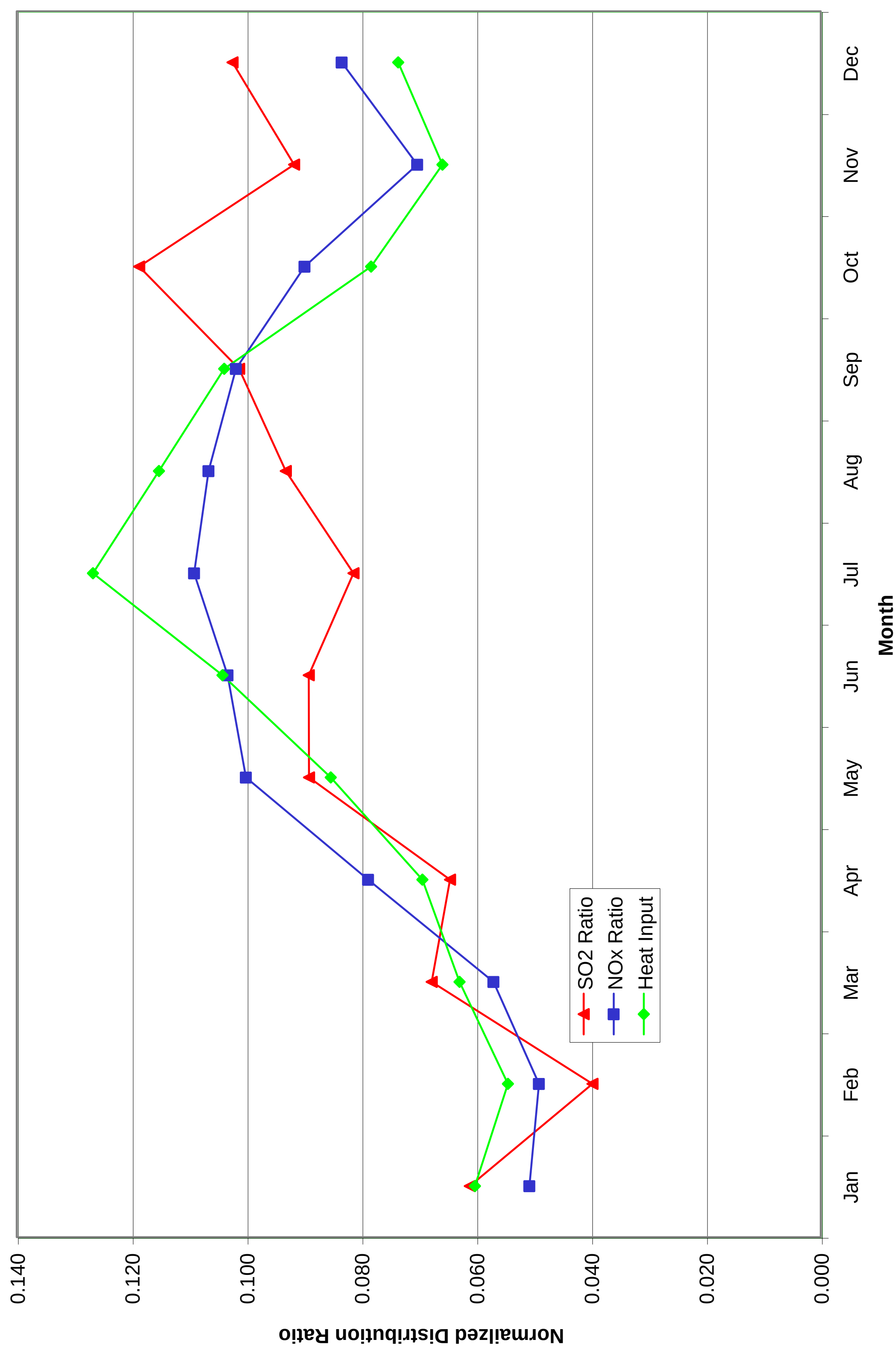
Alpine Geophysics
Appendix B
Actual 2002 Florida Monthly Profiles
CEM-Based Distribution
Normalized Distribution Ratio
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
SO2 Ratio
NOx Ratio
Heat Input


Appendix B
Actual 2002 Georgia Monthly Profiles
CEM-Based Distribution
Normalized Distribution Ratio
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
SO2 Ratio
NOx Ratio
Heat Input

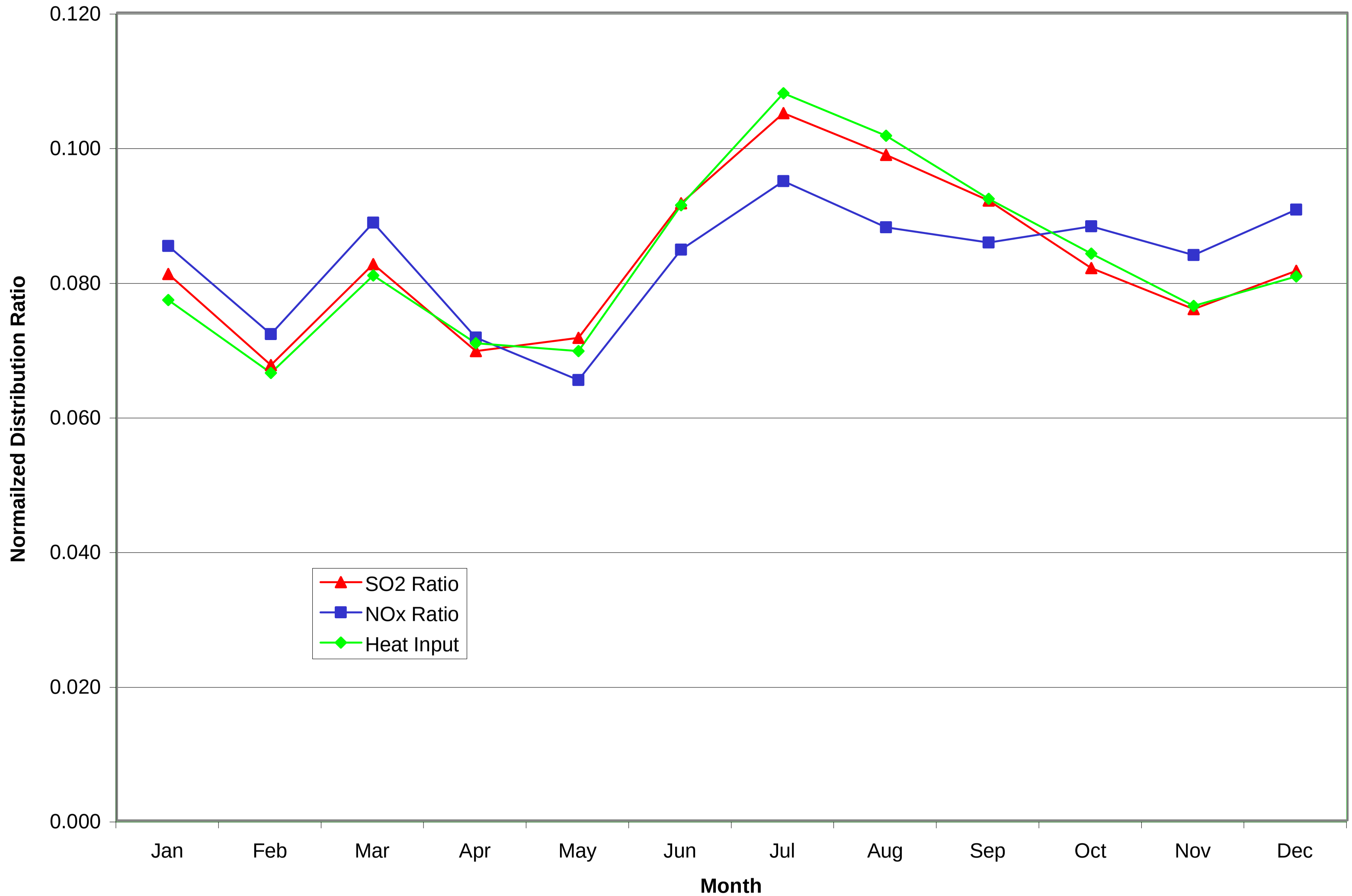
Appendix B
Actual 2002 Kentucky Monthly Profiles
CEM-Based Distribution



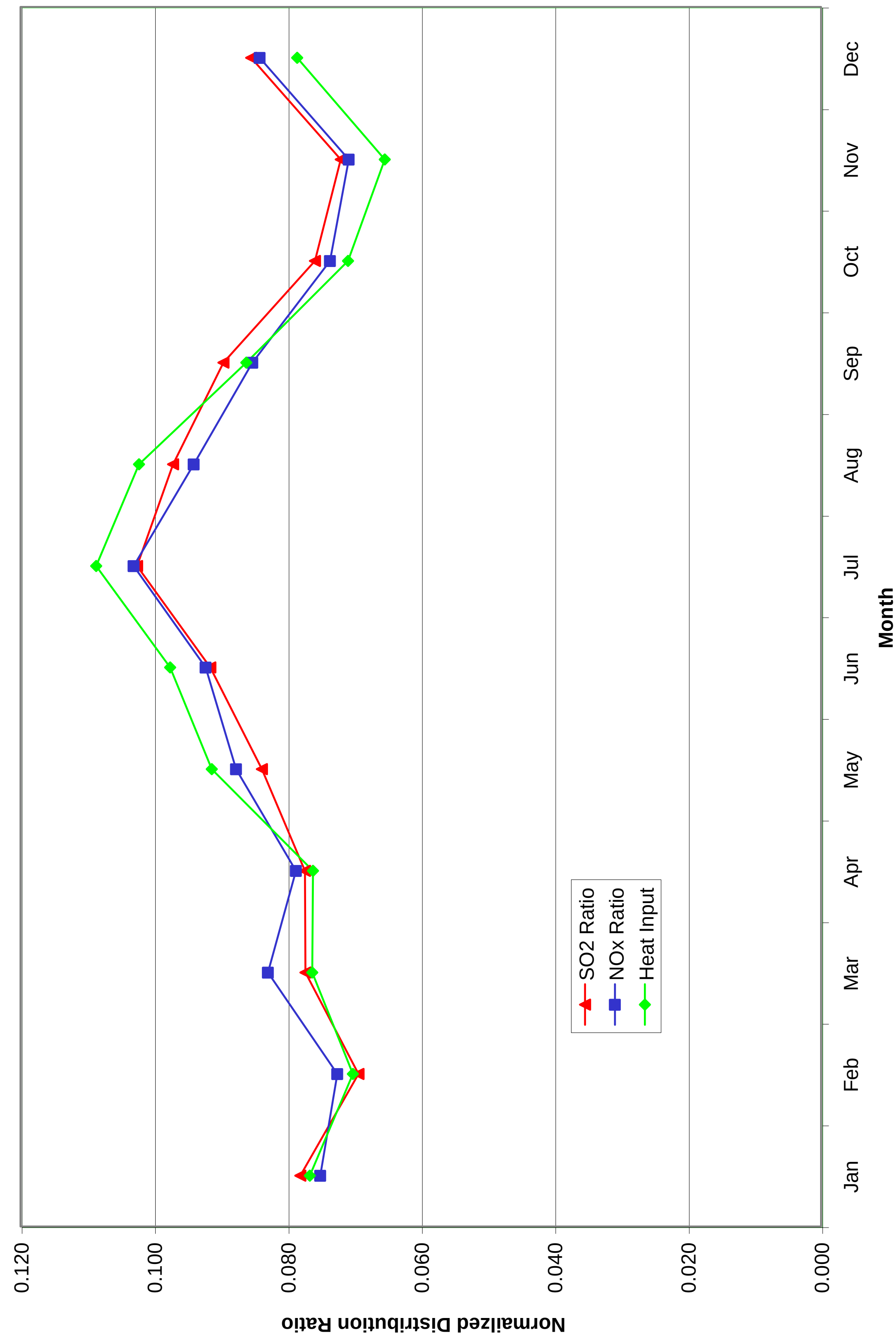
Appendix B
Actual 2002 Mississippi Monthly Profiles
CEM-Based Distribution



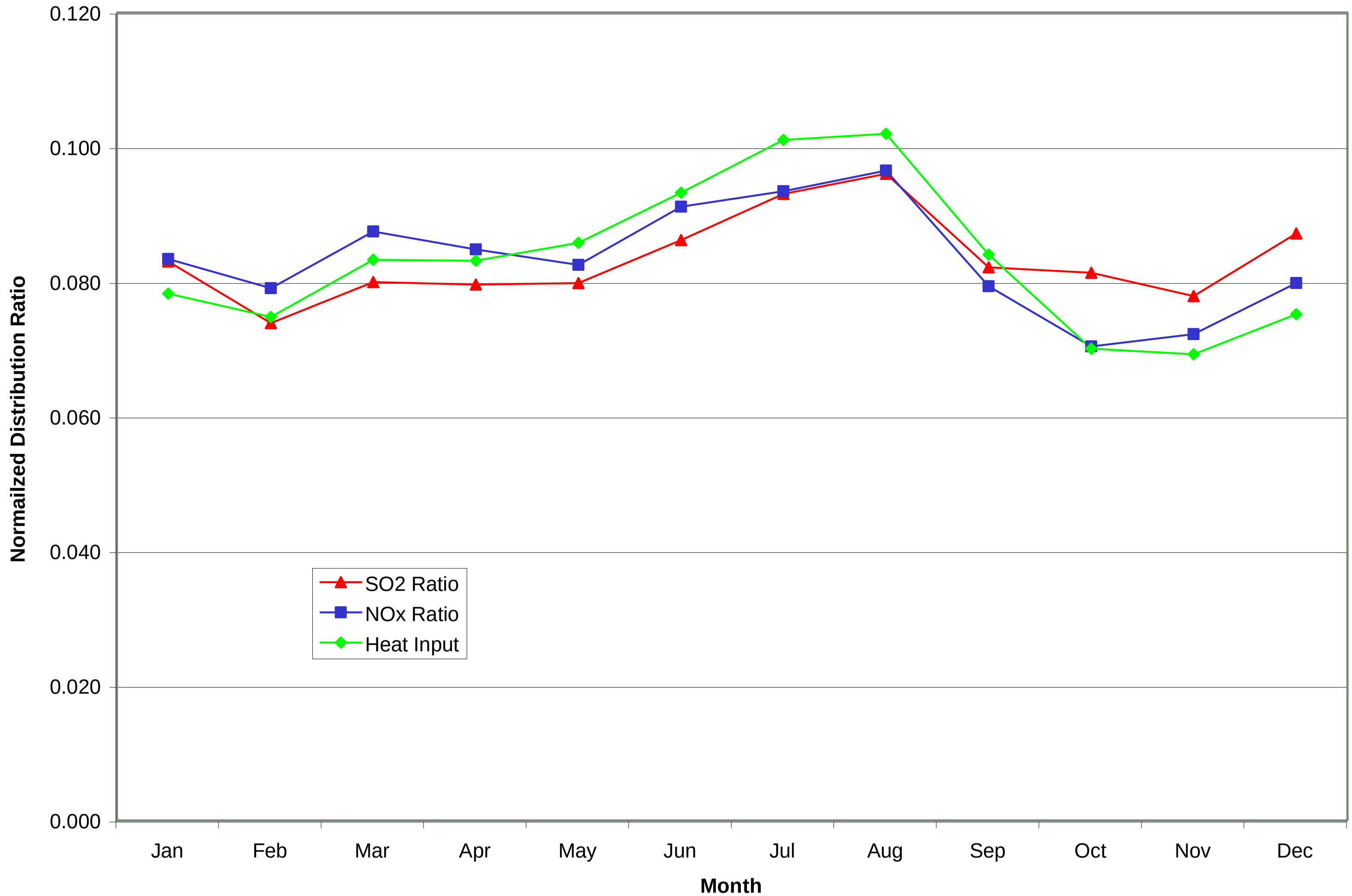
Appendix B
Actual 2002 North Carolina Monthly Profiles
CEM-Based Distribution



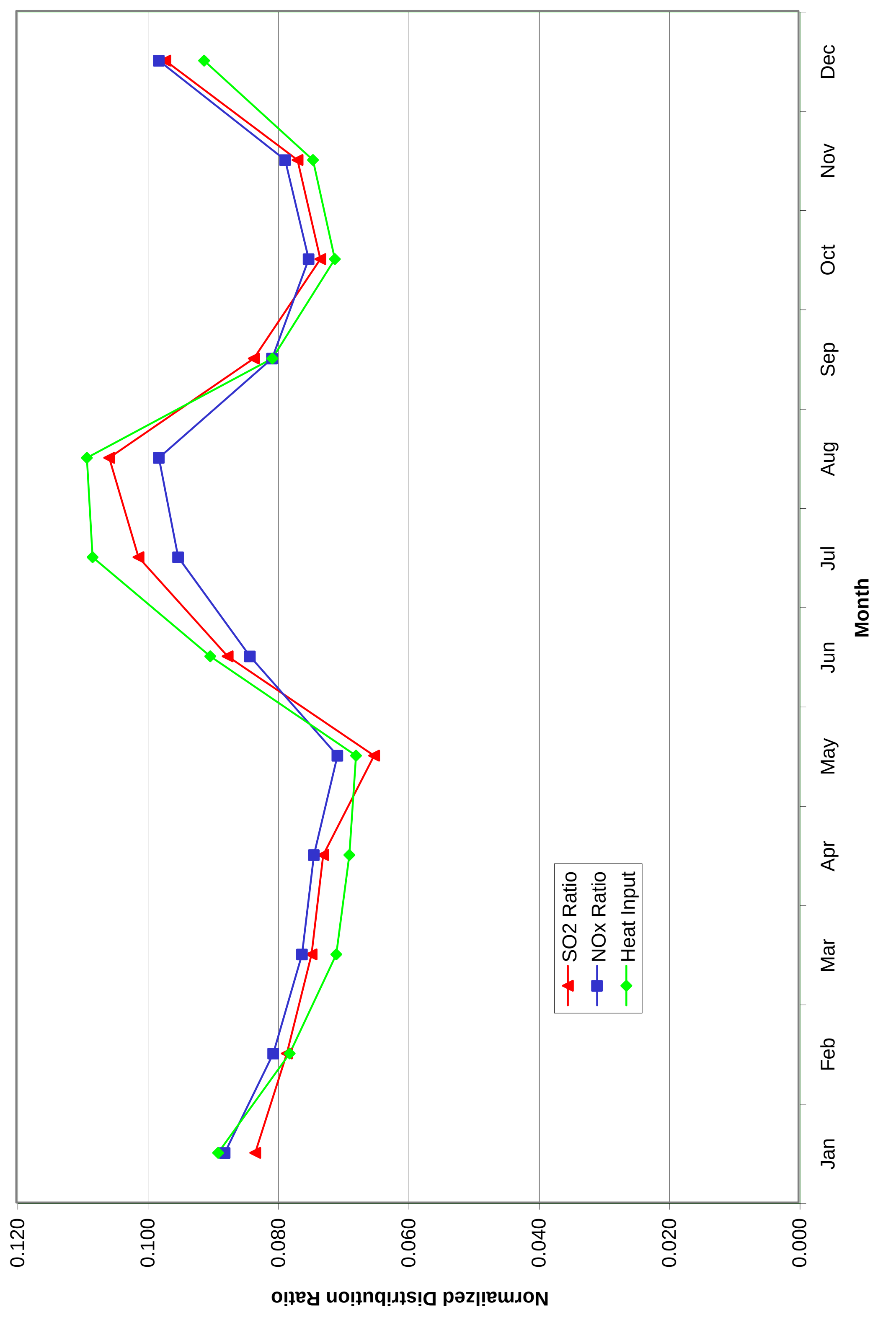
Appendix B
Actual 2002 South Carolina Monthly Profiles
CEM-Based Distribution



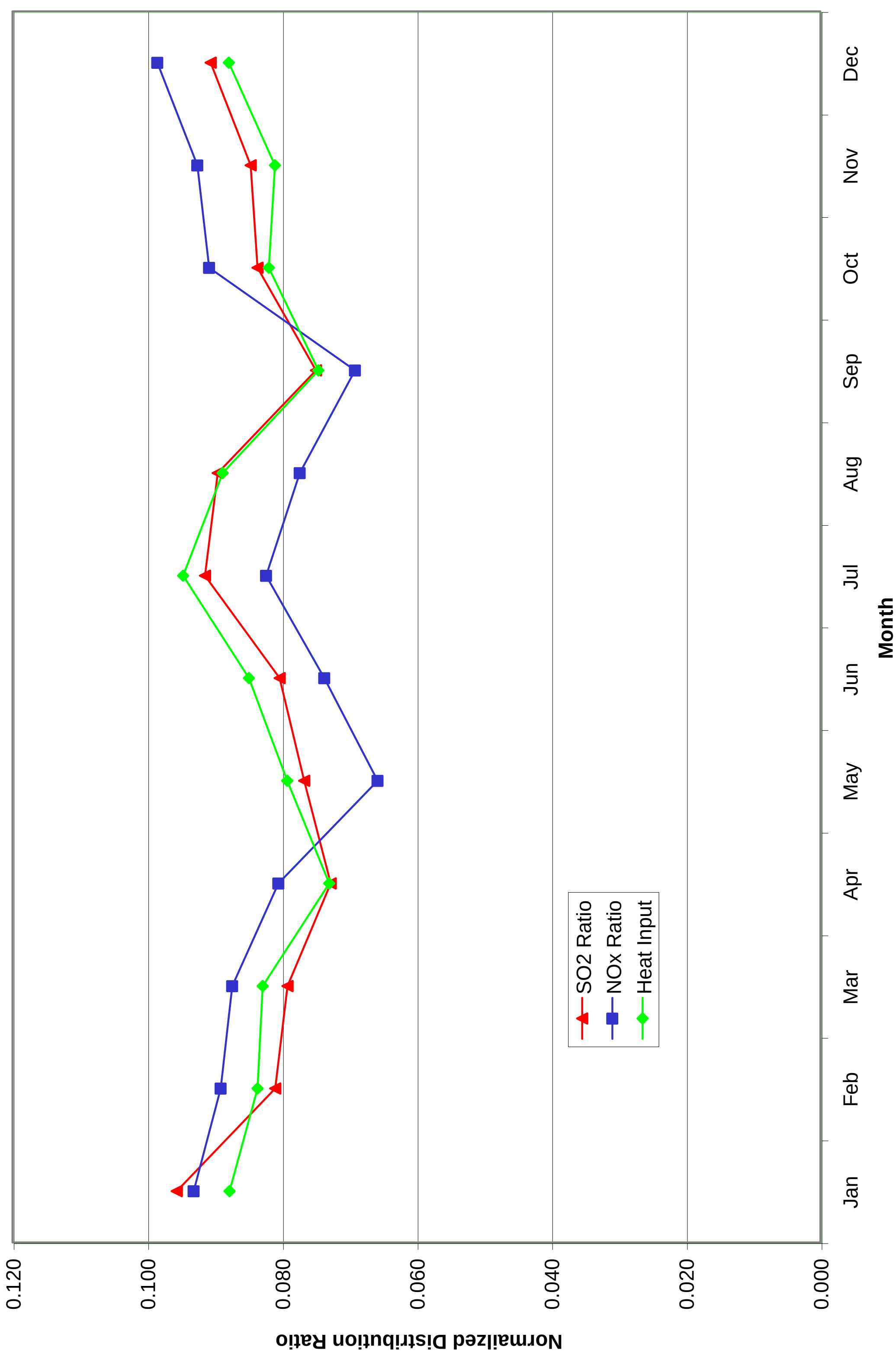
Appendix B
Actual 2002 Tennessee Monthly Profiles
CEM-Based Distribution



Appendix B
Actual 2002 Virginia Monthly Profiles
CEM-Based Distribution



Appendix B
Actual 2002 West Virginia Monthly Profiles
CEM-Based Distribution



Actual 2002 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Jan	Sun	9,078,807	3,231,646	8,611,813	0.1261	0.1238	0.1224
AL	Jan	Mon	9,587,489	3,364,368	8,983,683	0.1332	0.1289	0.1277
AL	Jan	Tue	11,871,297	4,316,474	11,635,467	0.1649	0.1654	0.1654
AL	Jan	Wed	11,552,004	4,141,961	11,476,100	0.1605	0.1587	0.1631
AL	Jan	Thu	11,404,376	4,160,093	11,262,809	0.1584	0.1594	0.1601
AL	Jan	Fri	9,219,511	3,479,116	9,299,661	0.1281	0.1333	0.1322
AL	Jan	Sat	9,272,077	3,400,877	9,074,163	0.1288	0.1303	0.1290
AL	Feb	Sun	7,678,659	2,884,011	7,851,550	0.1326	0.1304	0.1313
AL	Feb	Mon	8,259,941	3,146,902	8,605,518	0.1427	0.1423	0.1439
AL	Feb	Tue	8,577,231	3,342,049	8,942,171	0.1481	0.1511	0.1495
AL	Feb	Wed	8,906,514	3,447,121	9,212,008	0.1538	0.1558	0.1540
AL	Feb	Thu	8,898,663	3,439,817	9,113,886	0.1537	0.1555	0.1524
AL	Feb	Fri	7,896,813	2,939,154	8,119,378	0.1364	0.1329	0.1357
AL	Feb	Sat	7,685,567	2,922,218	7,972,038	0.1327	0.1321	0.1333
AL	Mar	Sun	9,169,116	3,442,468	8,988,048	0.1542	0.1516	0.1547
AL	Mar	Mon	7,985,823	3,055,344	7,932,040	0.1343	0.1345	0.1366
AL	Mar	Tue	7,961,605	3,080,761	7,836,035	0.1339	0.1356	0.1349
AL	Mar	Wed	8,057,393	3,064,834	7,756,403	0.1355	0.1349	0.1335
AL	Mar	Thu	7,646,534	2,976,099	7,493,543	0.1286	0.1310	0.1290
AL	Mar	Fri	9,624,602	3,716,488	9,419,901	0.1618	0.1636	0.1622
AL	Mar	Sat	9,036,351	3,375,859	8,656,178	0.1519	0.1486	0.1490
AL	Apr	Sun	7,620,840	2,872,729	7,843,393	0.1260	0.1271	0.1273
AL	Apr	Mon	10,150,271	3,847,452	10,442,420	0.1678	0.1702	0.1695
AL	Apr	Tue	10,493,280	3,823,328	10,456,244	0.1734	0.1692	0.1697
AL	Apr	Wed	8,320,056	3,020,201	8,435,022	0.1375	0.1336	0.1369
AL	Apr	Thu	7,965,139	3,041,039	8,333,366	0.1317	0.1346	0.1352
AL	Apr	Fri	8,062,984	3,022,769	8,122,807	0.1333	0.1337	0.1318
AL	Apr	Sat	7,885,908	2,973,818	7,983,785	0.1303	0.1316	0.1296
AL	May	Sun	8,107,156	2,976,706	8,104,159	0.1207	0.1198	0.1174
AL	May	Mon	8,344,498	3,122,652	8,602,771	0.1243	0.1257	0.1246
AL	May	Tue	8,661,029	3,272,698	9,166,876	0.1290	0.1317	0.1328
AL	May	Wed	11,060,209	4,019,235	11,271,411	0.1647	0.1618	0.1633
AL	May	Thu	11,105,548	4,148,329	11,677,777	0.1654	0.1670	0.1692
AL	May	Fri	11,312,659	4,217,537	11,782,733	0.1685	0.1698	0.1707
AL	May	Sat	8,550,201	3,085,052	8,416,307	0.1273	0.1242	0.1219
AL	Jun	Sun	12,587,947	4,402,497	12,982,636	0.1541	0.1548	0.1527
AL	Jun	Mon	11,311,870	3,948,700	11,605,638	0.1385	0.1388	0.1365
AL	Jun	Tue	11,236,776	3,984,947	11,798,088	0.1376	0.1401	0.1388
AL	Jun	Wed	11,369,518	3,928,254	12,018,504	0.1392	0.1381	0.1414
AL	Jun	Thu	11,706,257	3,940,713	12,092,484	0.1433	0.1385	0.1422
AL	Jun	Fri	10,946,286	3,800,514	11,469,300	0.1340	0.1336	0.1349
AL	Jun	Sat	12,520,487	4,442,695	13,044,653	0.1533	0.1562	0.1534
AL	Jul	Sun	11,366,228	3,975,824	12,027,702	0.1267	0.1289	0.1265
AL	Jul	Mon	14,589,504	5,091,302	15,716,753	0.1626	0.1650	0.1652
AL	Jul	Tue	14,544,109	5,000,409	15,611,007	0.1621	0.1621	0.1641
AL	Jul	Wed	14,205,305	4,936,355	15,547,284	0.1583	0.1600	0.1635
AL	Jul	Thu	11,905,134	3,883,382	12,075,394	0.1327	0.1259	0.1270
AL	Jul	Fri	11,644,249	3,998,238	12,084,420	0.1298	0.1296	0.1271
AL	Jul	Sat	11,483,394	3,964,115	12,048,177	0.1280	0.1285	0.1267
AL	Aug	Sun	10,825,551	3,821,512	11,515,637	0.1218	0.1249	0.1226
AL	Aug	Mon	11,445,364	4,000,822	12,190,122	0.1288	0.1307	0.1298
AL	Aug	Tue	12,007,879	4,045,329	12,492,605	0.1351	0.1322	0.1330
AL	Aug	Wed	11,922,474	4,052,097	12,481,993	0.1341	0.1324	0.1329
AL	Aug	Thu	14,078,738	4,923,253	15,268,914	0.1584	0.1609	0.1625
AL	Aug	Fri	14,553,733	4,962,397	15,356,359	0.1637	0.1622	0.1635
AL	Aug	Sat	14,059,804	4,795,544	14,644,879	0.1582	0.1567	0.1559
AL	Sep	Sun	13,072,758	4,471,264	13,196,855	0.1590	0.1592	0.1563

Actual 2002 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Sep	Mon	13,294,919	4,721,035	14,078,907	0.1617	0.1681	0.1668
AL	Sep	Tue	11,047,145	3,741,275	11,630,507	0.1343	0.1332	0.1378
AL	Sep	Wed	11,238,257	3,759,477	11,648,841	0.1367	0.1338	0.1380
AL	Sep	Thu	11,442,771	3,799,645	11,604,738	0.1391	0.1353	0.1375
AL	Sep	Fri	11,202,342	3,873,202	11,416,026	0.1362	0.1379	0.1352
AL	Sep	Sat	10,939,047	3,724,756	10,839,095	0.1330	0.1326	0.1284
AL	Oct	Sun	10,266,327	3,811,745	9,910,846	0.1272	0.1283	0.1264
AL	Oct	Mon	10,511,864	3,893,598	10,251,681	0.1302	0.1311	0.1308
AL	Oct	Tue	13,228,690	4,772,703	12,828,813	0.1639	0.1607	0.1637
AL	Oct	Wed	12,878,703	4,736,208	12,615,330	0.1596	0.1594	0.1609
AL	Oct	Thu	12,833,772	4,840,532	12,710,749	0.1590	0.1630	0.1622
AL	Oct	Fri	10,462,972	3,882,324	10,152,030	0.1296	0.1307	0.1295
AL	Oct	Sat	10,529,880	3,766,773	9,918,226	0.1305	0.1268	0.1265
AL	Nov	Sun	9,435,823	3,618,731	9,252,124	0.1271	0.1280	0.1272
AL	Nov	Mon	9,815,895	3,866,691	9,985,632	0.1322	0.1367	0.1372
AL	Nov	Tue	9,908,528	3,758,532	9,858,206	0.1335	0.1329	0.1355
AL	Nov	Wed	10,263,466	3,844,651	9,895,694	0.1382	0.1360	0.1360
AL	Nov	Thu	10,032,649	3,798,189	9,806,574	0.1351	0.1343	0.1348
AL	Nov	Fri	12,478,956	4,733,218	12,183,571	0.1681	0.1674	0.1674
AL	Nov	Sat	12,307,237	4,657,337	11,778,669	0.1658	0.1647	0.1619
AL	Dec	Sun	13,039,568	4,497,908	11,373,273	0.1591	0.1563	0.1564
AL	Dec	Mon	13,332,284	4,684,608	11,658,842	0.1626	0.1628	0.1603
AL	Dec	Tue	12,586,572	4,509,227	11,390,750	0.1535	0.1567	0.1566
AL	Dec	Wed	10,401,903	3,640,431	9,394,390	0.1269	0.1265	0.1292
AL	Dec	Thu	10,699,833	3,718,555	9,589,043	0.1305	0.1292	0.1319
AL	Dec	Fri	11,098,568	3,886,991	9,771,669	0.1354	0.1351	0.1344
AL	Dec	Sat	10,824,595	3,839,120	9,540,370	0.1320	0.1334	0.1312
FL	Jan	Sun	6,460,018	4,145,458	12,075,614	0.0953	0.0987	0.1064
FL	Jan	Mon	8,223,824	5,249,656	14,295,053	0.1214	0.1250	0.1259
FL	Jan	Tue	11,267,068	6,878,180	18,626,699	0.1663	0.1637	0.1641
FL	Jan	Wed	12,006,882	7,370,189	19,424,661	0.1772	0.1755	0.1711
FL	Jan	Thu	11,580,132	7,146,149	19,145,131	0.1709	0.1701	0.1686
FL	Jan	Fri	9,933,130	6,055,862	15,781,937	0.1466	0.1442	0.1390
FL	Jan	Sat	8,284,487	5,159,019	14,182,886	0.1223	0.1228	0.1249
FL	Feb	Sun	6,580,888	4,153,211	11,712,808	0.1164	0.1216	0.1274
FL	Feb	Mon	7,821,429	4,772,468	12,898,655	0.1384	0.1398	0.1402
FL	Feb	Tue	8,529,572	5,203,703	13,717,324	0.1509	0.1524	0.1492
FL	Feb	Wed	8,869,381	5,320,865	13,997,444	0.1569	0.1558	0.1522
FL	Feb	Thu	9,547,499	5,584,277	14,448,682	0.1689	0.1635	0.1571
FL	Feb	Fri	8,171,784	4,783,682	13,156,243	0.1446	0.1401	0.1430
FL	Feb	Sat	6,995,726	4,327,246	12,038,684	0.1238	0.1267	0.1309
FL	Mar	Sun	10,436,073	5,703,152	16,073,032	0.1491	0.1453	0.1493
FL	Mar	Mon	10,042,536	5,525,518	14,872,599	0.1435	0.1408	0.1381
FL	Mar	Tue	10,504,478	5,792,477	15,448,467	0.1501	0.1476	0.1435
FL	Mar	Wed	9,340,619	5,216,743	14,425,208	0.1334	0.1329	0.1340
FL	Mar	Thu	8,492,454	4,795,916	13,518,581	0.1213	0.1222	0.1255
FL	Mar	Fri	11,164,084	6,463,221	17,344,633	0.1595	0.1647	0.1611
FL	Mar	Sat	10,017,039	5,747,641	16,003,244	0.1431	0.1465	0.1486
FL	Apr	Sun	8,585,377	4,964,930	14,931,077	0.1165	0.1216	0.1264
FL	Apr	Mon	12,745,138	6,974,440	20,136,929	0.1730	0.1708	0.1704
FL	Apr	Tue	13,343,375	7,153,016	20,555,830	0.1811	0.1752	0.1739
FL	Apr	Wed	10,008,186	5,591,661	15,816,344	0.1358	0.1370	0.1338
FL	Apr	Thu	10,282,959	5,571,398	16,008,555	0.1396	0.1365	0.1355
FL	Apr	Fri	9,897,428	5,469,872	15,727,299	0.1343	0.1340	0.1331
FL	Apr	Sat	8,816,175	5,098,925	14,994,963	0.1197	0.1249	0.1269
FL	May	Sun	10,872,937	5,917,228	17,154,454	0.1223	0.1208	0.1205
FL	May	Mon	11,087,315	6,389,920	18,204,704	0.1247	0.1305	0.1279

Actual 2002 State Level Monthly-Day of Week Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	May	Tue	11,144,651	6,436,362	18,386,978	0.1254	0.1314	0.1292
FL	May	Wed	14,157,439	7,871,861	23,067,275	0.1593	0.1607	0.1620
FL	May	Thu	14,810,343	8,012,280	23,271,348	0.1666	0.1636	0.1635
FL	May	Fri	15,308,300	8,088,722	23,788,784	0.1722	0.1652	0.1671
FL	May	Sat	11,508,619	6,258,321	18,477,502	0.1295	0.1278	0.1298
FL	Jun	Sun	12,367,759	6,882,537	21,942,803	0.1551	0.1563	0.1583
FL	Jun	Mon	11,089,956	6,219,462	19,326,803	0.1391	0.1413	0.1394
FL	Jun	Tue	10,971,633	6,121,052	18,888,412	0.1376	0.1390	0.1362
FL	Jun	Wed	11,459,795	6,206,384	19,340,130	0.1437	0.1410	0.1395
FL	Jun	Thu	11,212,701	6,178,620	19,271,553	0.1406	0.1403	0.1390
FL	Jun	Fri	10,572,042	5,742,576	18,179,541	0.1326	0.1304	0.1311
FL	Jun	Sat	12,062,267	6,676,517	21,699,426	0.1513	0.1516	0.1565
FL	Jul	Sun	11,389,822	6,203,670	19,727,509	0.1207	0.1241	0.1256
FL	Jul	Mon	15,576,693	8,073,373	25,570,026	0.1650	0.1614	0.1628
FL	Jul	Tue	15,745,575	8,312,180	25,816,928	0.1668	0.1662	0.1644
FL	Jul	Wed	16,455,780	8,585,816	26,347,891	0.1743	0.1717	0.1677
FL	Jul	Thu	12,386,180	6,441,152	20,216,893	0.1312	0.1288	0.1287
FL	Jul	Fri	11,671,181	6,307,316	19,905,505	0.1236	0.1261	0.1267
FL	Jul	Sat	11,176,329	6,083,834	19,490,845	0.1184	0.1217	0.1241
FL	Aug	Sun	11,119,169	6,052,295	20,141,414	0.1195	0.1209	0.1254
FL	Aug	Mon	12,439,096	6,729,392	21,508,484	0.1337	0.1344	0.1339
FL	Aug	Tue	12,028,439	6,501,920	20,980,955	0.1293	0.1298	0.1306
FL	Aug	Wed	11,903,888	6,410,214	20,537,494	0.1279	0.1280	0.1279
FL	Aug	Thu	15,997,665	8,468,246	26,490,393	0.1719	0.1691	0.1649
FL	Aug	Fri	15,513,519	8,145,000	25,857,372	0.1667	0.1626	0.1610
FL	Aug	Sat	14,039,647	7,769,981	25,085,246	0.1509	0.1552	0.1562
FL	Sep	Sun	14,248,272	7,881,518	25,139,667	0.1526	0.1602	0.1617
FL	Sep	Mon	15,481,285	8,321,569	26,523,726	0.1658	0.1692	0.1706
FL	Sep	Tue	13,875,523	6,610,166	21,058,066	0.1486	0.1344	0.1355
FL	Sep	Wed	12,827,853	6,510,169	20,695,394	0.1374	0.1324	0.1331
FL	Sep	Thu	12,381,697	6,587,855	20,702,534	0.1326	0.1339	0.1332
FL	Sep	Fri	12,599,112	6,705,049	20,791,900	0.1350	0.1363	0.1338
FL	Sep	Sat	11,935,491	6,567,663	20,521,823	0.1279	0.1335	0.1320
FL	Oct	Sun	10,201,802	5,635,841	18,079,248	0.1211	0.1203	0.1235
FL	Oct	Mon	10,950,396	6,102,400	19,331,362	0.1300	0.1303	0.1321
FL	Oct	Tue	14,462,004	7,914,664	24,697,888	0.1717	0.1690	0.1688
FL	Oct	Wed	13,960,820	7,814,557	24,127,857	0.1658	0.1668	0.1649
FL	Oct	Thu	13,145,418	7,478,321	23,145,375	0.1561	0.1597	0.1582
FL	Oct	Fri	10,799,123	6,073,134	18,679,147	0.1282	0.1297	0.1276
FL	Oct	Sat	10,694,885	5,818,576	18,286,411	0.1270	0.1242	0.1250
FL	Nov	Sun	7,657,765	4,160,806	13,477,795	0.1268	0.1257	0.1273
FL	Nov	Mon	8,709,070	4,831,448	15,459,908	0.1442	0.1460	0.1460
FL	Nov	Tue	8,565,162	4,743,499	15,536,089	0.1419	0.1433	0.1468
FL	Nov	Wed	7,928,875	4,569,865	14,424,685	0.1313	0.1381	0.1363
FL	Nov	Thu	7,349,917	4,039,745	13,034,212	0.1217	0.1221	0.1231
FL	Nov	Fri	10,189,470	5,494,954	17,273,306	0.1688	0.1660	0.1632
FL	Nov	Sat	9,974,710	5,258,366	16,648,687	0.1652	0.1589	0.1573
FL	Dec	Sun	10,845,001	5,969,341	17,326,559	0.1509	0.1557	0.1551
FL	Dec	Mon	12,472,114	6,696,988	18,977,359	0.1736	0.1747	0.1699
FL	Dec	Tue	11,633,954	6,196,791	18,110,973	0.1619	0.1617	0.1621
FL	Dec	Wed	8,614,557	4,632,533	13,804,951	0.1199	0.1209	0.1236
FL	Dec	Thu	9,417,556	4,917,346	14,754,058	0.1311	0.1283	0.1321
FL	Dec	Fri	9,766,113	4,987,111	14,570,949	0.1359	0.1301	0.1304
FL	Dec	Sat	9,103,950	4,931,354	14,157,847	0.1267	0.1287	0.1267
GA	Jan	Sun	9,232,479	3,069,863	7,033,231	0.1129	0.1104	0.1109
GA	Jan	Mon	10,338,614	3,448,548	7,991,068	0.1265	0.1241	0.1260
GA	Jan	Tue	13,705,744	4,638,953	10,633,396	0.1676	0.1669	0.1677

Actual 2002 State Level Monthly-Day of Week Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Jan	Wed	13,582,481	4,709,185	10,869,230	0.1661	0.1694	0.1714
GA	Jan	Thu	13,486,891	4,777,788	10,715,734	0.1650	0.1719	0.1690
GA	Jan	Fri	11,438,830	3,805,041	8,528,349	0.1399	0.1369	0.1345
GA	Jan	Sat	9,971,562	3,349,832	7,644,887	0.1220	0.1205	0.1206
GA	Feb	Sun	8,517,612	2,781,030	6,474,213	0.1250	0.1219	0.1232
GA	Feb	Mon	10,022,044	3,306,596	7,599,264	0.1471	0.1449	0.1446
GA	Feb	Tue	10,492,127	3,510,987	8,053,143	0.1540	0.1539	0.1532
GA	Feb	Wed	10,239,133	3,550,856	8,250,818	0.1503	0.1556	0.1570
GA	Feb	Thu	10,364,380	3,560,605	8,216,068	0.1521	0.1561	0.1563
GA	Feb	Fri	9,479,298	3,170,924	7,167,972	0.1391	0.1390	0.1364
GA	Feb	Sat	9,018,899	2,933,916	6,805,104	0.1324	0.1286	0.1295
GA	Mar	Sun	13,057,959	4,005,097	10,089,522	0.1467	0.1437	0.1458
GA	Mar	Mon	11,937,355	3,841,172	9,564,295	0.1341	0.1378	0.1382
GA	Mar	Tue	11,860,749	3,766,317	9,351,652	0.1332	0.1351	0.1352
GA	Mar	Wed	12,020,458	3,764,653	9,232,574	0.1350	0.1351	0.1334
GA	Mar	Thu	11,560,778	3,677,100	9,056,011	0.1299	0.1319	0.1309
GA	Mar	Fri	14,572,757	4,616,042	11,368,579	0.1637	0.1656	0.1643
GA	Mar	Sat	14,005,730	4,197,929	10,522,180	0.1573	0.1506	0.1521
GA	Apr	Sun	10,010,321	3,054,871	8,130,063	0.1243	0.1221	0.1220
GA	Apr	Mon	13,726,614	4,219,606	11,234,934	0.1705	0.1687	0.1687
GA	Apr	Tue	13,642,243	4,159,996	11,257,306	0.1694	0.1663	0.1690
GA	Apr	Wed	11,119,160	3,557,859	9,454,040	0.1381	0.1422	0.1419
GA	Apr	Thu	11,121,181	3,547,214	9,402,072	0.1381	0.1418	0.1411
GA	Apr	Fri	10,992,958	3,469,508	9,154,244	0.1365	0.1387	0.1374
GA	Apr	Sat	9,910,312	3,010,782	7,981,698	0.1231	0.1203	0.1198
GA	May	Sun	9,954,317	2,489,279	7,718,318	0.1173	0.1135	0.1112
GA	May	Mon	11,083,543	2,846,449	8,849,737	0.1306	0.1297	0.1275
GA	May	Tue	10,860,158	2,817,251	8,937,307	0.1280	0.1284	0.1287
GA	May	Wed	14,055,700	3,723,984	11,705,218	0.1656	0.1697	0.1686
GA	May	Thu	14,190,755	3,795,027	12,132,195	0.1672	0.1730	0.1748
GA	May	Fri	14,364,190	3,677,935	11,892,964	0.1692	0.1676	0.1713
GA	May	Sat	10,366,117	2,589,657	8,188,607	0.1221	0.1180	0.1180
GA	Jun	Sun	14,272,108	3,565,552	11,872,006	0.1555	0.1520	0.1513
GA	Jun	Mon	12,565,097	3,230,084	10,796,899	0.1369	0.1377	0.1376
GA	Jun	Tue	12,662,512	3,342,327	11,036,638	0.1380	0.1425	0.1407
GA	Jun	Wed	12,559,472	3,370,089	11,213,296	0.1369	0.1437	0.1429
GA	Jun	Thu	12,721,557	3,228,578	11,169,416	0.1386	0.1377	0.1424
GA	Jun	Fri	12,401,462	3,087,958	10,360,176	0.1351	0.1317	0.1321
GA	Jun	Sat	14,585,864	3,628,231	11,995,154	0.1589	0.1547	0.1529
GA	Jul	Sun	13,058,471	3,295,789	10,898,881	0.1291	0.1268	0.1199
GA	Jul	Mon	17,056,043	4,331,902	15,504,540	0.1686	0.1667	0.1706
GA	Jul	Tue	16,718,544	4,271,189	15,356,784	0.1653	0.1644	0.1690
GA	Jul	Wed	16,380,787	4,258,436	15,192,772	0.1620	0.1639	0.1672
GA	Jul	Thu	12,544,497	3,284,625	11,428,407	0.1240	0.1264	0.1257
GA	Jul	Fri	12,723,398	3,311,110	11,501,703	0.1258	0.1274	0.1265
GA	Jul	Sat	12,651,296	3,234,586	11,009,335	0.1251	0.1245	0.1211
GA	Aug	Sun	12,591,882	3,173,151	11,054,009	0.1258	0.1234	0.1232
GA	Aug	Mon	12,689,424	3,377,612	12,101,546	0.1268	0.1313	0.1349
GA	Aug	Tue	12,811,575	3,370,696	11,902,603	0.1280	0.1310	0.1326
GA	Aug	Wed	13,615,740	3,466,528	11,742,465	0.1360	0.1348	0.1309
GA	Aug	Thu	16,548,070	4,256,601	14,871,154	0.1653	0.1655	0.1657
GA	Aug	Fri	16,223,157	4,132,201	14,523,344	0.1621	0.1606	0.1618
GA	Aug	Sat	15,625,999	3,945,870	13,541,647	0.1561	0.1534	0.1509
GA	Sep	Sun	14,076,695	3,552,007	11,239,335	0.1559	0.1529	0.1461
GA	Sep	Mon	15,118,284	3,952,189	12,971,319	0.1675	0.1701	0.1686
GA	Sep	Tue	12,290,870	3,222,102	10,846,543	0.1362	0.1387	0.1410
GA	Sep	Wed	12,207,239	3,171,924	10,870,491	0.1352	0.1366	0.1413

Actual 2002 State Level Monthly-Day of Week Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Sep	Thu	12,591,996	3,238,385	10,829,315	0.1395	0.1394	0.1408
GA	Sep	Fri	12,421,915	3,205,151	10,688,743	0.1376	0.1380	0.1390
GA	Sep	Sat	11,559,321	2,886,451	9,473,115	0.1281	0.1243	0.1232
GA	Oct	Sun	10,397,107	2,974,956	8,483,587	0.1198	0.1187	0.1178
GA	Oct	Mon	11,403,595	3,298,001	9,526,894	0.1314	0.1316	0.1323
GA	Oct	Tue	14,439,466	4,101,982	11,815,930	0.1664	0.1637	0.1640
GA	Oct	Wed	14,214,276	4,088,386	11,998,314	0.1638	0.1632	0.1666
GA	Oct	Thu	13,694,824	4,055,175	11,641,902	0.1578	0.1618	0.1616
GA	Oct	Fri	12,031,671	3,451,730	9,692,488	0.1386	0.1377	0.1346
GA	Oct	Sat	10,612,129	3,088,149	8,869,504	0.1223	0.1232	0.1231
GA	Nov	Sun	7,942,685	2,407,347	6,217,734	0.1207	0.1213	0.1206
GA	Nov	Mon	8,844,920	2,615,409	7,084,667	0.1344	0.1318	0.1374
GA	Nov	Tue	9,227,463	2,767,059	7,247,112	0.1402	0.1394	0.1405
GA	Nov	Wed	9,082,791	2,734,529	7,082,431	0.1380	0.1378	0.1373
GA	Nov	Thu	8,610,960	2,620,947	6,807,102	0.1309	0.1320	0.1320
GA	Nov	Fri	11,542,238	3,520,543	9,025,713	0.1754	0.1774	0.1750
GA	Nov	Sat	10,552,339	3,182,333	8,102,499	0.1604	0.1603	0.1571
GA	Dec	Sun	13,004,566	3,746,897	9,702,453	0.1528	0.1550	0.1536
GA	Dec	Mon	13,858,316	3,958,234	10,421,734	0.1628	0.1637	0.1650
GA	Dec	Tue	13,256,445	3,711,914	9,632,877	0.1557	0.1536	0.1525
GA	Dec	Wed	11,138,682	3,116,085	8,141,135	0.1308	0.1289	0.1289
GA	Dec	Thu	11,563,462	3,248,852	8,623,577	0.1358	0.1344	0.1365
GA	Dec	Fri	11,123,706	3,221,012	8,415,659	0.1307	0.1332	0.1332
GA	Dec	Sat	11,190,137	3,169,883	8,233,157	0.1314	0.1311	0.1303
KY	Jan	Sun	10,270,235	4,703,579	9,758,647	0.1162	0.1197	0.1173
KY	Jan	Mon	11,539,709	5,046,171	10,626,099	0.1306	0.1284	0.1277
KY	Jan	Tue	15,061,302	6,731,703	14,077,147	0.1704	0.1713	0.1692
KY	Jan	Wed	14,510,265	6,483,005	13,921,770	0.1642	0.1650	0.1674
KY	Jan	Thu	14,358,226	6,395,736	13,698,769	0.1624	0.1627	0.1647
KY	Jan	Fri	11,886,600	5,269,506	11,149,264	0.1345	0.1341	0.1340
KY	Jan	Sat	10,760,440	4,668,269	9,954,325	0.1217	0.1188	0.1197
KY	Feb	Sun	9,273,118	4,493,769	9,287,609	0.1268	0.1305	0.1286
KY	Feb	Mon	10,698,695	5,006,598	10,493,992	0.1463	0.1454	0.1453
KY	Feb	Tue	11,049,604	5,019,573	10,675,037	0.1511	0.1458	0.1478
KY	Feb	Wed	10,988,215	5,204,070	10,974,160	0.1502	0.1511	0.1520
KY	Feb	Thu	10,907,690	5,180,909	10,864,856	0.1491	0.1505	0.1505
KY	Feb	Fri	10,657,807	4,893,188	10,379,093	0.1457	0.1421	0.1437
KY	Feb	Sat	9,573,332	4,637,537	9,539,529	0.1309	0.1347	0.1321
KY	Mar	Sun	12,449,952	6,209,245	12,535,877	0.1505	0.1510	0.1514
KY	Mar	Mon	10,769,505	5,314,571	11,106,869	0.1302	0.1292	0.1341
KY	Mar	Tue	10,934,200	5,430,959	11,060,798	0.1322	0.1321	0.1336
KY	Mar	Wed	10,792,115	5,419,872	10,805,019	0.1304	0.1318	0.1305
KY	Mar	Thu	11,387,697	5,600,168	10,998,489	0.1376	0.1362	0.1328
KY	Mar	Fri	13,969,862	6,871,102	13,744,840	0.1689	0.1671	0.1660
KY	Mar	Sat	12,430,971	6,278,461	12,550,430	0.1503	0.1527	0.1516
KY	Apr	Sun	9,440,462	4,040,042	9,003,071	0.1301	0.1207	0.1208
KY	Apr	Mon	12,029,772	5,556,708	12,233,952	0.1658	0.1660	0.1641
KY	Apr	Tue	12,169,395	5,716,910	12,665,327	0.1677	0.1708	0.1699
KY	Apr	Wed	9,755,391	4,714,274	10,387,544	0.1345	0.1409	0.1393
KY	Apr	Thu	9,918,828	4,690,559	10,520,996	0.1367	0.1402	0.1411
KY	Apr	Fri	10,189,074	4,497,976	10,237,877	0.1404	0.1344	0.1373
KY	Apr	Sat	9,044,103	4,251,285	9,495,495	0.1247	0.1270	0.1274
KY	May	Sun	8,721,837	3,096,807	8,845,557	0.1133	0.1107	0.1147
KY	May	Mon	9,805,389	3,493,285	9,768,175	0.1274	0.1248	0.1267
KY	May	Tue	10,172,511	3,691,499	10,248,717	0.1321	0.1319	0.1329
KY	May	Wed	12,873,917	4,704,825	13,036,482	0.1672	0.1681	0.1691
KY	May	Thu	13,075,505	4,867,081	13,146,483	0.1699	0.1739	0.1705

Actual 2002 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	May	Fri	13,102,085	4,803,200	12,929,328	0.1702	0.1717	0.1677
KY	May	Sat	9,229,392	3,323,525	9,123,052	0.1199	0.1188	0.1183
KY	Jun	Sun	13,097,530	4,814,592	13,368,251	0.1536	0.1576	0.1562
KY	Jun	Mon	11,562,934	4,122,623	11,797,191	0.1356	0.1350	0.1379
KY	Jun	Tue	11,825,018	4,125,795	11,986,840	0.1386	0.1351	0.1401
KY	Jun	Wed	11,913,603	4,146,870	11,814,114	0.1397	0.1358	0.1381
KY	Jun	Thu	11,761,537	4,223,220	11,682,495	0.1379	0.1383	0.1365
KY	Jun	Fri	11,657,871	4,138,851	11,416,531	0.1367	0.1355	0.1334
KY	Jun	Sat	13,475,330	4,970,974	13,512,676	0.1580	0.1628	0.1579
KY	Jul	Sun	11,000,103	4,228,753	11,474,666	0.1184	0.1201	0.1199
KY	Jul	Mon	15,221,903	5,799,467	16,236,060	0.1639	0.1647	0.1696
KY	Jul	Tue	15,586,161	5,892,652	16,250,857	0.1678	0.1673	0.1698
KY	Jul	Wed	15,848,885	5,960,625	16,059,029	0.1707	0.1693	0.1678
KY	Jul	Thu	12,087,649	4,641,082	12,271,901	0.1302	0.1318	0.1282
KY	Jul	Fri	11,938,622	4,480,461	12,055,761	0.1286	0.1272	0.1260
KY	Jul	Sat	11,187,371	4,212,667	11,368,284	0.1205	0.1196	0.1188
KY	Aug	Sun	11,464,975	3,968,809	11,390,677	0.1188	0.1198	0.1209
KY	Aug	Mon	12,722,876	4,364,195	12,550,331	0.1318	0.1318	0.1332
KY	Aug	Tue	12,838,881	4,348,497	12,127,449	0.1330	0.1313	0.1287
KY	Aug	Wed	12,425,590	4,305,000	11,887,785	0.1288	0.1300	0.1262
KY	Aug	Thu	16,393,313	5,629,334	16,016,227	0.1699	0.1700	0.1700
KY	Aug	Fri	15,928,210	5,441,996	15,728,517	0.1651	0.1643	0.1669
KY	Aug	Sat	14,728,068	5,063,965	14,521,296	0.1526	0.1529	0.1541
KY	Sep	Sun	12,334,892	4,393,170	12,436,610	0.1501	0.1576	0.1542
KY	Sep	Mon	13,086,486	4,521,776	13,321,536	0.1592	0.1622	0.1652
KY	Sep	Tue	11,454,621	3,771,255	11,237,734	0.1394	0.1353	0.1394
KY	Sep	Wed	11,907,326	3,898,335	11,356,949	0.1449	0.1398	0.1408
KY	Sep	Thu	12,209,265	3,979,824	11,420,214	0.1485	0.1428	0.1416
KY	Sep	Fri	11,475,114	3,934,062	11,034,323	0.1396	0.1411	0.1368
KY	Sep	Sat	9,727,491	3,379,189	9,836,525	0.1183	0.1212	0.1220
KY	Oct	Sun	7,030,398	3,265,328	8,040,664	0.1131	0.1181	0.1170
KY	Oct	Mon	7,922,852	3,562,669	8,966,781	0.1274	0.1289	0.1304
KY	Oct	Tue	10,269,313	4,485,604	11,437,533	0.1651	0.1623	0.1664
KY	Oct	Wed	10,417,054	4,606,075	11,429,565	0.1675	0.1667	0.1663
KY	Oct	Thu	10,272,497	4,614,147	11,437,553	0.1652	0.1669	0.1664
KY	Oct	Fri	8,629,280	3,726,376	9,200,723	0.1388	0.1348	0.1338
KY	Oct	Sat	7,644,159	3,378,296	8,234,771	0.1229	0.1222	0.1198
KY	Nov	Sun	8,150,962	3,587,210	8,195,700	0.1275	0.1265	0.1236
KY	Nov	Mon	8,513,454	3,754,778	8,830,831	0.1331	0.1324	0.1332
KY	Nov	Tue	8,956,056	3,849,691	9,157,593	0.1401	0.1358	0.1381
KY	Nov	Wed	9,009,202	3,930,605	9,392,895	0.1409	0.1386	0.1417
KY	Nov	Thu	8,785,090	3,867,535	9,137,339	0.1374	0.1364	0.1378
KY	Nov	Fri	10,638,305	4,839,143	11,154,899	0.1664	0.1706	0.1683
KY	Nov	Sat	9,885,969	4,529,531	10,426,245	0.1546	0.1597	0.1573
KY	Dec	Sun	13,751,086	5,791,894	12,574,986	0.1555	0.1524	0.1544
KY	Dec	Mon	14,708,462	6,185,093	13,319,447	0.1663	0.1627	0.1635
KY	Dec	Tue	13,646,586	5,957,038	12,733,986	0.1543	0.1567	0.1563
KY	Dec	Wed	11,490,561	4,982,102	10,673,162	0.1299	0.1311	0.1310
KY	Dec	Thu	11,581,339	4,966,695	10,704,120	0.1310	0.1306	0.1314
KY	Dec	Fri	11,670,703	5,125,253	10,866,627	0.1320	0.1348	0.1334
KY	Dec	Sat	11,582,639	5,007,797	10,592,536	0.1310	0.1317	0.1300
MS	Jan	Sun	904,897	540,780	2,229,272	0.1127	0.1202	0.1193
MS	Jan	Mon	884,693	538,688	2,419,669	0.1102	0.1197	0.1294
MS	Jan	Tue	1,272,678	763,344	3,176,764	0.1585	0.1697	0.1699
MS	Jan	Wed	1,256,638	725,387	3,015,192	0.1565	0.1612	0.1613
MS	Jan	Thu	1,435,210	724,606	2,987,585	0.1787	0.1611	0.1598
MS	Jan	Fri	1,279,731	647,676	2,591,505	0.1593	0.1440	0.1386

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Jan	Sat	997,835	558,084	2,273,291	0.1242	0.1241	0.1216
MS	Feb	Sun	704,878	502,518	1,954,626	0.1349	0.1155	0.1155
MS	Feb	Mon	750,012	600,918	2,445,498	0.1436	0.1381	0.1445
MS	Feb	Tue	769,346	683,480	2,604,310	0.1473	0.1570	0.1539
MS	Feb	Wed	745,941	672,171	2,688,374	0.1428	0.1544	0.1589
MS	Feb	Thu	734,368	695,394	2,753,744	0.1406	0.1598	0.1628
MS	Feb	Fri	729,864	613,779	2,339,840	0.1397	0.1410	0.1383
MS	Feb	Sat	789,351	584,212	2,131,987	0.1511	0.1342	0.1260
MS	Mar	Sun	1,313,576	763,531	2,842,229	0.1475	0.1511	0.1455
MS	Mar	Mon	1,305,394	744,917	2,942,525	0.1466	0.1474	0.1507
MS	Mar	Tue	1,240,604	737,401	2,723,527	0.1393	0.1459	0.1395
MS	Mar	Wed	1,014,880	591,810	2,447,882	0.1140	0.1171	0.1253
MS	Mar	Thu	1,203,282	568,338	2,433,636	0.1351	0.1125	0.1246
MS	Mar	Fri	1,411,498	839,796	3,277,887	0.1585	0.1662	0.1679
MS	Mar	Sat	1,415,268	807,839	2,860,871	0.1589	0.1599	0.1465
MS	Apr	Sun	1,031,720	896,711	2,547,692	0.1215	0.1283	0.1183
MS	Apr	Mon	1,418,557	1,119,333	3,749,101	0.1671	0.1601	0.1741
MS	Apr	Tue	1,448,693	1,151,001	3,823,746	0.1706	0.1646	0.1775
MS	Apr	Wed	1,181,200	1,025,202	2,989,515	0.1391	0.1467	0.1388
MS	Apr	Thu	1,158,271	974,419	2,974,759	0.1364	0.1394	0.1381
MS	Apr	Fri	1,257,424	960,388	2,979,508	0.1481	0.1374	0.1383
MS	Apr	Sat	994,479	863,580	2,474,681	0.1171	0.1235	0.1149
MS	May	Sun	1,422,694	1,064,533	3,121,756	0.1214	0.1199	0.1178
MS	May	Mon	1,468,064	1,154,670	3,426,385	0.1253	0.1301	0.1293
MS	May	Tue	1,486,600	1,157,161	3,569,177	0.1269	0.1303	0.1347
MS	May	Wed	1,996,595	1,534,145	4,559,048	0.1704	0.1728	0.1721
MS	May	Thu	2,011,508	1,429,857	4,350,367	0.1717	0.1611	0.1642
MS	May	Fri	1,882,909	1,419,566	4,303,561	0.1607	0.1599	0.1624
MS	May	Sat	1,447,731	1,117,427	3,164,211	0.1236	0.1259	0.1194
MS	Jun	Sun	1,832,954	1,451,407	4,926,211	0.1564	0.1584	0.1523
MS	Jun	Mon	1,661,528	1,310,917	4,491,165	0.1418	0.1431	0.1388
MS	Jun	Tue	1,653,189	1,337,291	4,696,628	0.1411	0.1460	0.1452
MS	Jun	Wed	1,612,479	1,245,751	4,617,148	0.1376	0.1360	0.1427
MS	Jun	Thu	1,570,037	1,184,933	4,493,868	0.1340	0.1294	0.1389
MS	Jun	Fri	1,513,745	1,142,742	4,270,744	0.1292	0.1248	0.1320
MS	Jun	Sat	1,876,156	1,487,107	4,855,426	0.1601	0.1623	0.1501
MS	Jul	Sun	1,358,639	1,254,953	4,798,594	0.1270	0.1297	0.1219
MS	Jul	Mon	1,689,165	1,629,981	6,863,935	0.1579	0.1684	0.1744
MS	Jul	Tue	1,675,253	1,569,842	6,583,694	0.1566	0.1622	0.1673
MS	Jul	Wed	1,735,708	1,530,321	6,472,288	0.1622	0.1581	0.1645
MS	Jul	Thu	1,396,555	1,176,693	4,815,474	0.1305	0.1216	0.1224
MS	Jul	Fri	1,459,492	1,229,244	4,975,617	0.1364	0.1270	0.1264
MS	Jul	Sat	1,383,849	1,287,607	4,843,560	0.1293	0.1330	0.1231
MS	Aug	Sun	1,497,659	1,159,011	4,262,061	0.1223	0.1226	0.1191
MS	Aug	Mon	1,589,252	1,245,350	4,802,292	0.1298	0.1317	0.1342
MS	Aug	Tue	1,554,535	1,269,499	4,718,796	0.1269	0.1343	0.1319
MS	Aug	Wed	1,655,644	1,263,557	4,645,132	0.1352	0.1336	0.1298
MS	Aug	Thu	2,050,836	1,530,464	6,097,728	0.1674	0.1619	0.1704
MS	Aug	Fri	1,970,009	1,506,798	5,957,979	0.1608	0.1594	0.1665
MS	Aug	Sat	1,930,441	1,480,644	5,304,563	0.1576	0.1566	0.1482
MS	Sep	Sun	2,075,570	1,344,183	4,728,914	0.1558	0.1488	0.1466
MS	Sep	Mon	2,226,209	1,541,736	5,542,349	0.1672	0.1707	0.1718
MS	Sep	Tue	1,801,422	1,218,091	4,585,278	0.1353	0.1348	0.1421
MS	Sep	Wed	1,798,606	1,224,911	4,480,227	0.1350	0.1356	0.1389
MS	Sep	Thu	1,806,354	1,224,706	4,390,807	0.1356	0.1356	0.1361
MS	Sep	Fri	1,857,849	1,274,918	4,472,483	0.1395	0.1411	0.1386
MS	Sep	Sat	1,752,121	1,204,977	4,064,017	0.1316	0.1334	0.1260

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Oct	Sun	2,220,003	962,280	2,894,748	0.1422	0.1207	0.1190
MS	Oct	Mon	1,981,879	996,422	3,021,027	0.1270	0.1250	0.1242
MS	Oct	Tue	2,322,184	1,327,051	4,117,422	0.1488	0.1665	0.1693
MS	Oct	Wed	2,340,334	1,273,244	4,160,206	0.1500	0.1597	0.1711
MS	Oct	Thu	2,607,752	1,260,699	3,968,751	0.1671	0.1582	0.1632
MS	Oct	Fri	2,152,085	1,122,427	3,209,223	0.1379	0.1408	0.1320
MS	Oct	Sat	1,982,595	1,028,473	2,949,412	0.1270	0.1290	0.1213
MS	Nov	Sun	1,640,681	807,360	2,569,335	0.1361	0.1296	0.1256
MS	Nov	Mon	1,693,415	914,715	2,966,915	0.1405	0.1468	0.1450
MS	Nov	Tue	1,601,550	832,892	2,793,803	0.1328	0.1337	0.1366
MS	Nov	Wed	1,576,741	831,228	2,755,602	0.1308	0.1334	0.1347
MS	Nov	Thu	1,596,917	832,323	2,785,168	0.1325	0.1336	0.1361
MS	Nov	Fri	1,996,460	1,047,089	3,453,120	0.1656	0.1680	0.1688
MS	Nov	Sat	1,949,796	966,088	3,132,747	0.1617	0.1550	0.1531
MS	Dec	Sun	1,996,486	1,008,277	3,334,370	0.1482	0.1363	0.1459
MS	Dec	Mon	2,203,790	1,145,523	3,649,094	0.1636	0.1549	0.1597
MS	Dec	Tue	2,106,378	1,140,221	3,585,275	0.1564	0.1542	0.1569
MS	Dec	Wed	1,716,941	1,026,918	3,164,414	0.1275	0.1388	0.1385
MS	Dec	Thu	1,928,610	1,106,585	3,198,528	0.1432	0.1496	0.1400
MS	Dec	Fri	1,821,097	1,029,176	3,056,645	0.1352	0.1391	0.1338
MS	Dec	Sat	1,695,628	939,777	2,863,358	0.1259	0.1271	0.1253
NC	Jan	Sun	8,446,366	2,681,807	6,134,314	0.1124	0.1079	0.1097
NC	Jan	Mon	10,171,604	3,345,762	7,371,709	0.1354	0.1346	0.1319
NC	Jan	Tue	12,566,630	4,153,575	9,290,616	0.1673	0.1671	0.1662
NC	Jan	Wed	13,221,695	4,348,717	9,904,866	0.1760	0.1749	0.1772
NC	Jan	Thu	11,787,737	3,925,957	8,899,677	0.1569	0.1579	0.1592
NC	Jan	Fri	9,197,100	3,117,223	6,972,591	0.1224	0.1254	0.1247
NC	Jan	Sat	9,745,220	3,285,303	7,325,904	0.1297	0.1322	0.1311
NC	Feb	Sun	7,304,746	2,355,707	5,555,402	0.1166	0.1119	0.1156
NC	Feb	Mon	10,056,545	3,418,509	7,593,637	0.1606	0.1624	0.1580
NC	Feb	Tue	10,385,306	3,595,088	7,978,509	0.1658	0.1708	0.1660
NC	Feb	Wed	9,981,814	3,455,989	7,768,728	0.1594	0.1642	0.1616
NC	Feb	Thu	9,831,231	3,369,143	7,670,776	0.1570	0.1601	0.1596
NC	Feb	Fri	8,018,270	2,576,448	6,077,023	0.1280	0.1224	0.1264
NC	Feb	Sat	7,047,666	2,278,536	5,416,679	0.1125	0.1082	0.1127
NC	Mar	Sun	9,739,481	3,163,701	7,352,756	0.1273	0.1223	0.1256
NC	Mar	Mon	10,962,526	3,746,649	8,610,209	0.1433	0.1448	0.1471
NC	Mar	Tue	11,050,595	3,808,634	8,676,652	0.1444	0.1472	0.1482
NC	Mar	Wed	11,143,002	3,781,070	8,419,884	0.1456	0.1461	0.1439
NC	Mar	Thu	10,503,277	3,560,977	7,894,508	0.1373	0.1376	0.1349
NC	Mar	Fri	12,350,667	4,207,136	9,412,951	0.1614	0.1626	0.1608
NC	Mar	Sat	10,760,836	3,603,048	8,162,391	0.1406	0.1393	0.1395
NC	Apr	Sun	7,418,351	2,442,417	5,924,501	0.1149	0.1169	0.1156
NC	Apr	Mon	11,101,684	3,538,012	8,670,601	0.1720	0.1693	0.1692
NC	Apr	Tue	11,123,979	3,624,636	8,873,339	0.1723	0.1735	0.1731
NC	Apr	Wed	9,040,206	2,943,073	7,348,177	0.1401	0.1408	0.1434
NC	Apr	Thu	9,109,135	2,973,631	7,390,821	0.1411	0.1423	0.1442
NC	Apr	Fri	9,127,925	2,905,104	7,047,939	0.1414	0.1390	0.1375
NC	Apr	Sat	7,622,729	2,469,220	5,993,311	0.1181	0.1182	0.1169
NC	May	Sun	6,302,423	1,845,303	4,899,811	0.0950	0.0968	0.0972
NC	May	Mon	8,011,934	2,375,964	6,157,806	0.1207	0.1247	0.1222
NC	May	Tue	8,543,861	2,433,460	6,537,302	0.1287	0.1277	0.1297
NC	May	Wed	11,761,292	3,325,775	8,839,985	0.1772	0.1745	0.1754
NC	May	Thu	12,618,376	3,596,311	9,346,529	0.1901	0.1887	0.1854
NC	May	Fri	12,025,175	3,450,325	9,189,881	0.1812	0.1810	0.1823
NC	May	Sat	7,099,814	2,033,551	5,434,312	0.1070	0.1067	0.1078
NC	Jun	Sun	11,994,684	3,486,676	9,165,389	0.1413	0.1411	0.1387

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Jun	Mon	11,802,811	3,608,397	9,302,131	0.1391	0.1461	0.1408
NC	Jun	Tue	12,049,906	3,592,704	9,704,591	0.1420	0.1454	0.1469
NC	Jun	Wed	12,231,769	3,538,150	9,829,867	0.1441	0.1432	0.1488
NC	Jun	Thu	12,381,596	3,536,034	9,714,573	0.1459	0.1431	0.1470
NC	Jun	Fri	11,684,595	3,366,516	8,745,531	0.1377	0.1363	0.1324
NC	Jun	Sat	12,726,957	3,575,990	9,602,725	0.1500	0.1448	0.1454
NC	Jul	Sun	11,448,700	3,228,094	8,995,898	0.1177	0.1167	0.1152
NC	Jul	Mon	16,133,073	4,702,944	13,537,615	0.1659	0.1700	0.1734
NC	Jul	Tue	16,479,766	4,824,393	13,766,597	0.1694	0.1744	0.1763
NC	Jul	Wed	16,984,370	4,745,921	13,527,744	0.1746	0.1715	0.1732
NC	Jul	Thu	12,260,436	3,411,582	9,549,979	0.1260	0.1233	0.1223
NC	Jul	Fri	12,122,655	3,431,079	9,595,200	0.1246	0.1240	0.1229
NC	Jul	Sat	11,845,801	3,324,333	9,112,995	0.1218	0.1201	0.1167
NC	Aug	Sun	11,072,635	2,963,784	8,703,011	0.1210	0.1154	0.1184
NC	Aug	Mon	12,661,063	3,599,089	10,326,051	0.1383	0.1402	0.1404
NC	Aug	Tue	12,513,775	3,590,375	10,109,127	0.1367	0.1398	0.1375
NC	Aug	Wed	11,559,338	3,181,655	9,187,608	0.1263	0.1239	0.1250
NC	Aug	Thu	15,351,044	4,399,396	12,387,874	0.1677	0.1714	0.1685
NC	Aug	Fri	15,014,139	4,273,209	12,191,345	0.1641	0.1664	0.1658
NC	Aug	Sat	13,348,231	3,665,764	10,616,707	0.1459	0.1428	0.1444
NC	Sep	Sun	12,011,365	3,358,571	9,205,904	0.1409	0.1343	0.1379
NC	Sep	Mon	14,043,987	4,198,925	11,017,684	0.1647	0.1679	0.1651
NC	Sep	Tue	11,751,511	3,495,842	9,439,256	0.1378	0.1398	0.1414
NC	Sep	Wed	12,138,403	3,552,624	9,630,051	0.1424	0.1420	0.1443
NC	Sep	Thu	11,993,148	3,573,649	9,308,881	0.1407	0.1429	0.1395
NC	Sep	Fri	12,027,878	3,610,121	9,457,121	0.1411	0.1443	0.1417
NC	Sep	Sat	11,288,147	3,221,952	8,687,161	0.1324	0.1288	0.1302
NC	Oct	Sun	8,155,718	2,677,025	6,437,025	0.1074	0.1041	0.1057
NC	Oct	Mon	9,680,927	3,251,014	7,687,946	0.1274	0.1264	0.1263
NC	Oct	Tue	13,212,603	4,454,524	10,414,004	0.1739	0.1732	0.1711
NC	Oct	Wed	13,209,662	4,369,215	10,439,442	0.1739	0.1699	0.1715
NC	Oct	Thu	12,906,984	4,463,457	10,491,107	0.1699	0.1736	0.1723
NC	Oct	Fri	9,780,095	3,482,496	8,158,376	0.1287	0.1354	0.1340
NC	Oct	Sat	9,018,864	3,017,679	7,252,836	0.1187	0.1173	0.1191
NC	Nov	Sun	7,482,715	2,561,724	5,927,852	0.1064	0.1047	0.1073
NC	Nov	Mon	9,596,784	3,288,922	7,495,268	0.1364	0.1344	0.1356
NC	Nov	Tue	10,365,457	3,623,153	8,194,564	0.1474	0.1481	0.1483
NC	Nov	Wed	10,225,631	3,596,784	8,059,773	0.1454	0.1470	0.1459
NC	Nov	Thu	9,964,891	3,504,538	7,895,958	0.1417	0.1432	0.1429
NC	Nov	Fri	12,363,616	4,334,489	9,634,353	0.1758	0.1771	0.1743
NC	Nov	Sat	10,336,370	3,559,744	8,051,239	0.1470	0.1455	0.1457
NC	Dec	Sun	10,688,597	3,665,976	8,147,974	0.1414	0.1387	0.1395
NC	Dec	Mon	11,982,304	4,325,079	9,419,769	0.1585	0.1636	0.1613
NC	Dec	Tue	12,467,509	4,340,982	9,585,056	0.1649	0.1642	0.1641
NC	Dec	Wed	11,024,801	3,814,348	8,498,463	0.1459	0.1443	0.1455
NC	Dec	Thu	10,051,949	3,533,212	7,913,104	0.1330	0.1337	0.1355
NC	Dec	Fri	9,810,173	3,482,215	7,703,877	0.1298	0.1317	0.1319
NC	Dec	Sat	9,559,625	3,271,310	7,140,253	0.1265	0.1238	0.1222
SC	Jan	Sun	3,636,970	1,476,366	3,944,497	0.1170	0.1186	0.1230
SC	Jan	Mon	3,942,696	1,560,978	4,121,987	0.1268	0.1254	0.1285
SC	Jan	Tue	5,151,041	2,079,859	5,256,067	0.1657	0.1671	0.1639
SC	Jan	Wed	5,259,530	2,160,283	5,399,384	0.1692	0.1736	0.1684
SC	Jan	Thu	4,997,169	1,988,044	5,097,835	0.1608	0.1597	0.1590
SC	Jan	Fri	4,044,225	1,554,409	4,086,561	0.1301	0.1249	0.1274
SC	Jan	Sat	4,050,417	1,627,503	4,164,747	0.1303	0.1307	0.1299
SC	Feb	Sun	3,505,008	1,568,059	3,903,760	0.1269	0.1304	0.1329
SC	Feb	Mon	4,069,438	1,751,384	4,190,347	0.1474	0.1457	0.1427

Actual 2002 State Level Monthly-Day of Week Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Feb	Tue	4,430,044	1,863,072	4,448,544	0.1604	0.1550	0.1515
SC	Feb	Wed	4,318,396	1,855,284	4,505,578	0.1564	0.1543	0.1534
SC	Feb	Thu	4,205,690	1,845,750	4,471,557	0.1523	0.1535	0.1522
SC	Feb	Fri	3,624,500	1,603,802	3,987,755	0.1312	0.1334	0.1358
SC	Feb	Sat	3,463,086	1,535,008	3,864,784	0.1254	0.1277	0.1316
SC	Mar	Sun	4,336,524	1,973,802	4,537,629	0.1409	0.1436	0.1422
SC	Mar	Mon	4,183,356	1,816,900	4,262,600	0.1359	0.1322	0.1335
SC	Mar	Tue	4,240,162	1,866,062	4,468,803	0.1377	0.1357	0.1400
SC	Mar	Wed	4,254,321	1,846,213	4,300,152	0.1382	0.1343	0.1347
SC	Mar	Thu	4,145,005	1,864,218	4,245,007	0.1346	0.1356	0.1330
SC	Mar	Fri	5,182,524	2,287,889	5,306,269	0.1683	0.1664	0.1662
SC	Mar	Sat	4,444,143	2,093,609	4,798,881	0.1444	0.1523	0.1503
SC	Apr	Sun	4,017,490	1,649,192	4,084,689	0.1304	0.1264	0.1281
SC	Apr	Mon	5,125,101	2,150,863	5,324,631	0.1664	0.1648	0.1670
SC	Apr	Tue	4,979,358	2,126,442	5,184,660	0.1616	0.1629	0.1626
SC	Apr	Wed	4,233,850	1,773,496	4,320,385	0.1374	0.1359	0.1355
SC	Apr	Thu	4,229,100	1,837,077	4,399,336	0.1373	0.1408	0.1380
SC	Apr	Fri	4,300,860	1,827,319	4,422,361	0.1396	0.1400	0.1387
SC	Apr	Sat	3,922,816	1,687,315	4,145,150	0.1273	0.1293	0.1300
SC	May	Sun	4,058,982	1,768,790	4,629,139	0.1216	0.1216	0.1211
SC	May	Mon	4,369,970	1,898,496	4,968,000	0.1309	0.1306	0.1300
SC	May	Tue	4,205,508	1,822,100	4,774,535	0.1260	0.1253	0.1249
SC	May	Wed	5,327,689	2,312,421	6,085,422	0.1596	0.1590	0.1592
SC	May	Thu	5,552,853	2,407,456	6,467,533	0.1664	0.1656	0.1692
SC	May	Fri	5,710,821	2,482,088	6,611,345	0.1711	0.1707	0.1730
SC	May	Sat	4,153,912	1,849,484	4,688,413	0.1244	0.1272	0.1227
SC	Jun	Sun	5,422,310	2,325,012	5,940,742	0.1487	0.1520	0.1454
SC	Jun	Mon	4,950,283	2,099,485	5,639,270	0.1358	0.1373	0.1381
SC	Jun	Tue	5,193,496	2,170,648	5,935,461	0.1425	0.1419	0.1453
SC	Jun	Wed	5,212,633	2,181,658	6,016,294	0.1430	0.1426	0.1473
SC	Jun	Thu	5,085,180	2,111,423	5,811,622	0.1395	0.1380	0.1423
SC	Jun	Fri	4,963,259	2,031,580	5,346,414	0.1361	0.1328	0.1309
SC	Jun	Sat	5,627,924	2,375,174	6,154,533	0.1544	0.1553	0.1507
SC	Jul	Sun	4,952,032	2,105,431	5,426,837	0.1213	0.1233	0.1193
SC	Jul	Mon	6,752,415	2,802,511	7,673,334	0.1653	0.1641	0.1687
SC	Jul	Tue	6,809,749	2,824,594	7,748,669	0.1668	0.1654	0.1703
SC	Jul	Wed	6,874,946	2,798,981	7,695,441	0.1683	0.1639	0.1692
SC	Jul	Thu	5,251,525	2,201,617	5,760,574	0.1286	0.1289	0.1266
SC	Jul	Fri	5,212,751	2,210,808	5,700,322	0.1276	0.1294	0.1253
SC	Jul	Sat	4,984,418	2,138,308	5,483,132	0.1221	0.1252	0.1205
SC	Aug	Sun	4,857,872	1,938,847	5,355,760	0.1256	0.1244	0.1252
SC	Aug	Mon	5,119,566	2,068,536	5,777,624	0.1324	0.1327	0.1350
SC	Aug	Tue	5,066,437	2,036,102	5,681,494	0.1310	0.1306	0.1328
SC	Aug	Wed	5,172,581	2,034,297	5,579,938	0.1337	0.1305	0.1304
SC	Aug	Thu	6,236,009	2,453,044	6,793,190	0.1612	0.1573	0.1588
SC	Aug	Fri	6,262,985	2,595,706	6,994,996	0.1619	0.1665	0.1635
SC	Aug	Sat	5,961,282	2,465,312	6,607,305	0.1541	0.1581	0.1544
SC	Sep	Sun	5,498,826	2,178,099	5,470,366	0.1541	0.1541	0.1517
SC	Sep	Mon	5,960,568	2,369,286	5,977,253	0.1671	0.1677	0.1658
SC	Sep	Tue	4,801,579	1,876,836	4,973,585	0.1346	0.1328	0.1379
SC	Sep	Wed	4,883,651	1,904,108	5,127,470	0.1369	0.1347	0.1422
SC	Sep	Thu	4,971,406	1,973,186	5,012,399	0.1393	0.1396	0.1390
SC	Sep	Fri	4,849,982	1,939,577	4,839,884	0.1359	0.1373	0.1342
SC	Sep	Sat	4,713,661	1,890,509	4,656,981	0.1321	0.1338	0.1292
SC	Oct	Sun	3,474,565	1,447,631	3,546,049	0.1150	0.1186	0.1195
SC	Oct	Mon	3,731,594	1,539,738	3,703,080	0.1235	0.1262	0.1248
SC	Oct	Tue	5,047,781	1,994,340	4,807,363	0.1671	0.1635	0.1620

Actual 2002 State Level Monthly-Day of Week Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Oct	Wed	5,129,931	2,032,331	4,942,086	0.1698	0.1666	0.1665
SC	Oct	Thu	5,248,856	2,061,315	4,976,570	0.1737	0.1689	0.1677
SC	Oct	Fri	3,999,885	1,628,467	4,041,772	0.1324	0.1335	0.1362
SC	Oct	Sat	3,581,077	1,497,082	3,666,423	0.1185	0.1227	0.1235
SC	Nov	Sun	3,600,924	1,476,229	3,448,462	0.1256	0.1258	0.1260
SC	Nov	Mon	3,687,208	1,524,774	3,579,756	0.1286	0.1299	0.1308
SC	Nov	Tue	3,880,976	1,573,954	3,696,134	0.1353	0.1341	0.1350
SC	Nov	Wed	3,868,341	1,582,952	3,670,084	0.1349	0.1349	0.1341
SC	Nov	Thu	3,956,142	1,625,215	3,755,471	0.1380	0.1385	0.1372
SC	Nov	Fri	4,948,051	2,026,053	4,752,479	0.1725	0.1726	0.1736
SC	Nov	Sat	4,736,198	1,927,582	4,466,927	0.1652	0.1642	0.1632
SC	Dec	Sun	5,391,234	2,143,010	5,049,728	0.1585	0.1536	0.1536
SC	Dec	Mon	5,548,299	2,290,764	5,366,100	0.1631	0.1642	0.1632
SC	Dec	Tue	5,480,807	2,216,128	5,356,259	0.1611	0.1588	0.1629
SC	Dec	Wed	4,622,930	1,853,300	4,391,836	0.1359	0.1328	0.1336
SC	Dec	Thu	4,440,114	1,871,504	4,393,124	0.1305	0.1341	0.1336
SC	Dec	Fri	4,181,951	1,765,482	4,128,271	0.1229	0.1265	0.1256
SC	Dec	Sat	4,357,292	1,811,023	4,190,308	0.1281	0.1298	0.1275
TN	Jan	Sun	7,151,423	3,277,424	6,179,940	0.1278	0.1237	0.1223
TN	Jan	Mon	7,106,220	3,226,742	6,301,100	0.1270	0.1218	0.1247
TN	Jan	Tue	8,852,906	4,256,829	8,158,335	0.1582	0.1607	0.1615
TN	Jan	Wed	8,794,062	4,368,528	8,265,550	0.1571	0.1649	0.1636
TN	Jan	Thu	8,948,768	4,340,296	8,335,659	0.1599	0.1638	0.1650
TN	Jan	Fri	7,598,313	3,605,119	6,880,280	0.1358	0.1361	0.1362
TN	Jan	Sat	7,510,899	3,415,776	6,396,355	0.1342	0.1289	0.1266
TN	Feb	Sun	6,639,711	3,313,368	6,378,482	0.1334	0.1319	0.1321
TN	Feb	Mon	7,275,325	3,618,611	6,948,514	0.1462	0.1441	0.1440
TN	Feb	Tue	7,277,165	3,684,542	7,067,758	0.1462	0.1467	0.1464
TN	Feb	Wed	7,251,055	3,660,125	7,093,264	0.1457	0.1458	0.1470
TN	Feb	Thu	7,367,583	3,746,576	7,227,135	0.1480	0.1492	0.1497
TN	Feb	Fri	7,029,233	3,684,932	6,981,685	0.1412	0.1467	0.1446
TN	Feb	Sat	6,932,900	3,403,070	6,572,031	0.1393	0.1355	0.1362
TN	Mar	Sun	8,164,525	4,299,233	8,212,236	0.1515	0.1547	0.1527
TN	Mar	Mon	7,166,283	3,645,887	7,289,591	0.1330	0.1312	0.1356
TN	Mar	Tue	7,154,085	3,699,328	7,142,489	0.1328	0.1331	0.1328
TN	Mar	Wed	7,162,657	3,629,929	7,104,015	0.1329	0.1306	0.1321
TN	Mar	Thu	7,191,347	3,577,816	6,909,033	0.1334	0.1288	0.1285
TN	Mar	Fri	8,858,548	4,552,595	8,820,839	0.1644	0.1638	0.1640
TN	Mar	Sat	8,191,006	4,381,492	8,295,199	0.1520	0.1577	0.1543
TN	Apr	Sun	6,738,807	3,413,870	6,820,527	0.1256	0.1267	0.1271
TN	Apr	Mon	8,702,386	4,493,505	8,874,848	0.1623	0.1668	0.1654
TN	Apr	Tue	9,096,288	4,547,297	9,064,902	0.1696	0.1688	0.1689
TN	Apr	Wed	7,240,318	3,711,499	7,315,348	0.1350	0.1377	0.1363
TN	Apr	Thu	7,480,487	3,660,029	7,384,760	0.1395	0.1358	0.1376
TN	Apr	Fri	7,415,532	3,611,558	7,183,531	0.1383	0.1340	0.1338
TN	Apr	Sat	6,961,705	3,506,357	7,025,087	0.1298	0.1301	0.1309
TN	May	Sun	6,310,558	3,129,930	6,706,450	0.1173	0.1194	0.1211
TN	May	Mon	6,708,857	3,342,190	7,078,696	0.1247	0.1275	0.1278
TN	May	Tue	7,132,449	3,470,921	7,312,958	0.1326	0.1324	0.1320
TN	May	Wed	9,272,405	4,464,382	9,471,156	0.1724	0.1703	0.1710
TN	May	Thu	9,008,800	4,305,927	9,106,279	0.1675	0.1643	0.1644
TN	May	Fri	8,685,462	4,265,685	8,918,043	0.1615	0.1627	0.1610
TN	May	Sat	6,674,510	3,232,563	6,803,853	0.1241	0.1233	0.1228
TN	Jun	Sun	9,319,933	4,709,925	9,500,878	0.1605	0.1626	0.1578
TN	Jun	Mon	7,841,052	3,833,472	8,260,443	0.1350	0.1324	0.1372
TN	Jun	Tue	8,046,824	3,892,653	8,267,340	0.1385	0.1344	0.1373
TN	Jun	Wed	8,115,635	3,924,083	8,181,840	0.1397	0.1355	0.1359

Actual 2002 State Level Monthly-Day of Week Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Jun	Thu	7,908,747	3,897,867	8,264,116	0.1362	0.1346	0.1373
TN	Jun	Fri	7,440,089	3,934,565	8,020,227	0.1281	0.1359	0.1332
TN	Jun	Sat	9,411,612	4,768,219	9,710,283	0.1620	0.1646	0.1613
TN	Jul	Sun	7,774,543	3,623,011	7,974,059	0.1240	0.1220	0.1222
TN	Jul	Mon	10,307,744	4,999,148	11,264,465	0.1644	0.1684	0.1726
TN	Jul	Tue	10,464,081	5,093,362	11,321,319	0.1668	0.1716	0.1735
TN	Jul	Wed	10,596,757	5,070,165	11,084,819	0.1690	0.1708	0.1699
TN	Jul	Thu	8,064,229	3,736,165	8,023,553	0.1286	0.1259	0.1229
TN	Jul	Fri	7,890,085	3,649,213	7,881,373	0.1258	0.1229	0.1208
TN	Jul	Sat	7,618,834	3,514,621	7,710,530	0.1215	0.1184	0.1182
TN	Aug	Sun	8,174,467	3,845,977	8,115,355	0.1263	0.1255	0.1233
TN	Aug	Mon	8,399,769	3,946,405	8,671,939	0.1298	0.1287	0.1317
TN	Aug	Tue	8,539,977	4,068,471	8,665,993	0.1319	0.1327	0.1316
TN	Aug	Wed	8,532,687	4,082,232	8,596,692	0.1318	0.1332	0.1306
TN	Aug	Thu	10,531,971	4,969,209	10,880,135	0.1627	0.1621	0.1652
TN	Aug	Fri	10,402,230	4,923,961	10,609,855	0.1607	0.1606	0.1611
TN	Aug	Sat	10,151,492	4,820,052	10,304,247	0.1568	0.1572	0.1565
TN	Sep	Sun	9,116,699	4,077,524	8,671,313	0.1647	0.1618	0.1598
TN	Sep	Mon	9,469,339	4,198,698	9,160,298	0.1710	0.1666	0.1688
TN	Sep	Tue	7,829,458	3,581,195	7,726,770	0.1414	0.1421	0.1424
TN	Sep	Wed	7,343,362	3,488,344	7,362,144	0.1326	0.1384	0.1357
TN	Sep	Thu	7,301,205	3,426,916	7,270,427	0.1319	0.1360	0.1340
TN	Sep	Fri	7,193,620	3,320,429	7,187,551	0.1299	0.1317	0.1324
TN	Sep	Sat	7,110,260	3,110,608	6,888,784	0.1284	0.1234	0.1269
TN	Oct	Sun	6,708,010	2,833,598	5,647,137	0.1224	0.1267	0.1248
TN	Oct	Mon	7,342,244	3,079,627	6,044,894	0.1339	0.1377	0.1336
TN	Oct	Tue	8,702,014	3,502,606	7,163,112	0.1587	0.1566	0.1583
TN	Oct	Wed	8,873,754	3,587,670	7,418,539	0.1619	0.1604	0.1640
TN	Oct	Thu	8,965,902	3,612,495	7,272,597	0.1636	0.1615	0.1608
TN	Oct	Fri	7,181,995	2,835,539	5,852,668	0.1310	0.1268	0.1294
TN	Oct	Sat	7,042,051	2,910,409	5,838,274	0.1285	0.1302	0.1291
TN	Nov	Sun	6,634,653	2,977,876	5,712,119	0.1264	0.1298	0.1278
TN	Nov	Mon	6,868,040	2,986,966	5,856,205	0.1309	0.1302	0.1310
TN	Nov	Tue	6,912,082	3,014,858	5,895,146	0.1317	0.1314	0.1319
TN	Nov	Wed	7,386,472	3,138,730	6,180,765	0.1408	0.1368	0.1383
TN	Nov	Thu	7,266,754	3,137,786	6,131,963	0.1385	0.1368	0.1372
TN	Nov	Fri	8,736,435	3,862,733	7,534,521	0.1665	0.1684	0.1685
TN	Nov	Sat	8,669,349	3,822,128	7,393,534	0.1652	0.1666	0.1654
TN	Dec	Sun	9,120,079	3,928,257	7,327,683	0.1552	0.1549	0.1510
TN	Dec	Mon	9,492,230	3,968,058	7,741,356	0.1616	0.1565	0.1595
TN	Dec	Tue	9,136,375	3,894,752	7,595,049	0.1555	0.1536	0.1565
TN	Dec	Wed	7,742,072	3,388,273	6,504,259	0.1318	0.1336	0.1340
TN	Dec	Thu	7,732,612	3,400,001	6,571,263	0.1316	0.1341	0.1354
TN	Dec	Fri	7,885,726	3,475,255	6,579,511	0.1342	0.1371	0.1356
TN	Dec	Sat	7,640,994	3,297,372	6,208,895	0.1301	0.1301	0.1279
VA	Jan	Sun	4,671,075	1,627,775	4,289,396	0.1214	0.1172	0.1201
VA	Jan	Mon	5,127,288	1,888,213	4,792,953	0.1333	0.1360	0.1342
VA	Jan	Tue	6,288,913	2,330,010	5,917,567	0.1635	0.1678	0.1656
VA	Jan	Wed	6,426,139	2,349,164	5,998,072	0.1670	0.1692	0.1679
VA	Jan	Thu	6,087,252	2,199,341	5,596,030	0.1582	0.1584	0.1566
VA	Jan	Fri	4,942,574	1,758,916	4,611,180	0.1285	0.1267	0.1291
VA	Jan	Sat	4,931,872	1,730,649	4,521,767	0.1282	0.1246	0.1266
VA	Feb	Sun	4,661,072	1,603,715	3,882,421	0.1286	0.1262	0.1240
VA	Feb	Mon	5,294,467	1,854,921	4,541,253	0.1461	0.1460	0.1450
VA	Feb	Tue	5,544,956	1,997,045	4,953,922	0.1530	0.1571	0.1582
VA	Feb	Wed	5,493,596	1,936,049	4,814,990	0.1516	0.1523	0.1537
VA	Feb	Thu	5,623,211	1,961,653	4,981,039	0.1551	0.1544	0.1590

Actual 2002 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Feb	Fri	5,164,652	1,819,180	4,435,077	0.1425	0.1432	0.1416
VA	Feb	Sat	4,464,327	1,535,416	3,710,148	0.1232	0.1208	0.1185
VA	Mar	Sun	4,771,702	1,689,644	4,031,521	0.1383	0.1406	0.1417
VA	Mar	Mon	4,673,869	1,659,957	3,933,598	0.1355	0.1382	0.1383
VA	Mar	Tue	4,912,351	1,712,399	4,076,583	0.1424	0.1425	0.1433
VA	Mar	Wed	4,539,833	1,611,426	3,835,600	0.1316	0.1341	0.1348
VA	Mar	Thu	4,608,329	1,571,027	3,657,444	0.1336	0.1308	0.1286
VA	Mar	Fri	5,913,571	2,012,689	4,756,675	0.1714	0.1675	0.1672
VA	Mar	Sat	5,073,380	1,756,992	4,153,709	0.1471	0.1462	0.1460
VA	Apr	Sun	3,934,246	1,285,481	3,053,611	0.1169	0.1096	0.1105
VA	Apr	Mon	5,487,481	1,952,750	4,544,203	0.1630	0.1665	0.1644
VA	Apr	Tue	5,689,972	2,001,568	4,733,486	0.1691	0.1707	0.1713
VA	Apr	Wed	4,875,005	1,730,770	4,111,619	0.1448	0.1476	0.1488
VA	Apr	Thu	4,882,307	1,719,776	4,095,300	0.1451	0.1467	0.1482
VA	Apr	Fri	4,773,451	1,670,964	3,904,637	0.1418	0.1425	0.1413
VA	Apr	Sat	4,015,919	1,364,434	3,196,561	0.1193	0.1164	0.1157
VA	May	Sun	3,218,291	1,163,169	2,909,963	0.1071	0.1043	0.1068
VA	May	Mon	3,852,292	1,404,101	3,460,786	0.1282	0.1258	0.1270
VA	May	Tue	4,028,549	1,542,377	3,718,889	0.1340	0.1382	0.1365
VA	May	Wed	5,065,619	1,882,276	4,450,655	0.1685	0.1687	0.1634
VA	May	Thu	5,218,813	1,929,634	4,651,484	0.1736	0.1730	0.1708
VA	May	Fri	5,113,973	1,935,832	4,824,797	0.1701	0.1735	0.1771
VA	May	Sat	3,561,226	1,299,755	3,224,466	0.1185	0.1165	0.1184
VA	Jun	Sun	5,918,371	1,954,176	5,228,149	0.1464	0.1472	0.1444
VA	Jun	Mon	5,380,536	1,858,027	5,033,669	0.1331	0.1400	0.1390
VA	Jun	Tue	5,741,465	1,910,216	5,231,137	0.1420	0.1439	0.1445
VA	Jun	Wed	5,844,449	1,938,523	5,480,711	0.1445	0.1460	0.1514
VA	Jun	Thu	5,888,810	1,926,866	5,360,703	0.1456	0.1452	0.1481
VA	Jun	Fri	5,444,340	1,697,644	4,586,981	0.1346	0.1279	0.1267
VA	Jun	Sat	6,216,252	1,987,961	5,286,607	0.1537	0.1498	0.1460
VA	Jul	Sun	5,618,750	1,698,805	4,978,472	0.1202	0.1132	0.1146
VA	Jul	Mon	7,735,624	2,576,732	7,511,844	0.1655	0.1717	0.1729
VA	Jul	Tue	7,964,202	2,674,568	7,864,148	0.1704	0.1782	0.1810
VA	Jul	Wed	8,008,050	2,551,626	7,541,354	0.1713	0.1700	0.1736
VA	Jul	Thu	6,087,237	1,963,497	5,580,009	0.1302	0.1308	0.1284
VA	Jul	Fri	5,780,446	1,875,879	5,270,813	0.1237	0.1250	0.1213
VA	Jul	Sat	5,548,321	1,669,481	4,703,724	0.1187	0.1112	0.1083
VA	Aug	Sun	5,942,163	1,945,966	5,528,807	0.1217	0.1258	0.1262
VA	Aug	Mon	6,544,591	2,183,768	6,273,049	0.1340	0.1411	0.1432
VA	Aug	Tue	6,430,299	2,089,827	5,843,290	0.1317	0.1351	0.1334
VA	Aug	Wed	6,337,564	1,935,351	5,454,543	0.1298	0.1251	0.1245
VA	Aug	Thu	7,906,645	2,450,182	6,995,583	0.1619	0.1583	0.1597
VA	Aug	Fri	8,036,876	2,519,734	7,102,004	0.1646	0.1628	0.1621
VA	Aug	Sat	7,626,348	2,348,614	6,605,314	0.1562	0.1518	0.1508
VA	Sep	Sun	6,151,617	1,978,118	4,929,060	0.1595	0.1553	0.1522
VA	Sep	Mon	6,566,603	2,133,784	5,391,407	0.1702	0.1675	0.1664
VA	Sep	Tue	5,365,799	1,794,621	4,651,991	0.1391	0.1409	0.1436
VA	Sep	Wed	5,465,825	1,804,007	4,743,694	0.1417	0.1416	0.1464
VA	Sep	Thu	5,045,993	1,717,372	4,362,899	0.1308	0.1348	0.1347
VA	Sep	Fri	5,033,204	1,678,732	4,222,150	0.1305	0.1318	0.1303
VA	Sep	Sat	4,946,295	1,630,991	4,092,060	0.1282	0.1280	0.1263
VA	Oct	Sun	3,692,119	1,251,585	3,100,156	0.1090	0.1056	0.1086
VA	Oct	Mon	4,206,900	1,484,768	3,550,480	0.1242	0.1253	0.1244
VA	Oct	Tue	5,577,237	1,958,392	4,648,356	0.1647	0.1653	0.1629
VA	Oct	Wed	5,640,810	1,985,068	4,767,390	0.1665	0.1675	0.1671
VA	Oct	Thu	5,918,145	2,042,093	4,932,204	0.1747	0.1723	0.1728
VA	Oct	Fri	4,677,931	1,668,985	3,951,402	0.1381	0.1408	0.1385

Actual 2002 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Oct	Sat	4,157,525	1,459,285	3,587,092	0.1227	0.1231	0.1257
VA	Nov	Sun	4,220,213	1,431,590	3,617,607	0.1190	0.1152	0.1210
VA	Nov	Mon	4,891,550	1,737,603	4,153,022	0.1379	0.1399	0.1390
VA	Nov	Tue	5,029,654	1,788,688	4,263,728	0.1418	0.1440	0.1427
VA	Nov	Wed	4,952,524	1,733,240	4,099,073	0.1396	0.1395	0.1372
VA	Nov	Thu	4,840,374	1,663,470	3,976,369	0.1365	0.1339	0.1330
VA	Nov	Fri	5,923,766	2,111,331	5,016,854	0.1670	0.1699	0.1679
VA	Nov	Sat	5,615,042	1,957,581	4,759,820	0.1583	0.1576	0.1593
VA	Dec	Sun	6,746,456	2,206,423	5,350,646	0.1505	0.1426	0.1463
VA	Dec	Mon	7,125,574	2,493,055	5,902,703	0.1589	0.1611	0.1614
VA	Dec	Tue	7,232,167	2,512,962	5,984,967	0.1613	0.1624	0.1636
VA	Dec	Wed	6,074,987	2,139,652	5,051,424	0.1355	0.1382	0.1381
VA	Dec	Thu	5,954,834	2,128,843	4,939,470	0.1328	0.1375	0.1350
VA	Dec	Fri	5,915,700	2,055,015	4,810,763	0.1319	0.1328	0.1315
VA	Dec	Sat	5,789,687	1,941,279	4,543,164	0.1291	0.1254	0.1242
WV	Jan	Sun	11,362,417	4,706,298	9,184,827	0.1172	0.1119	0.1161
WV	Jan	Mon	12,746,157	5,609,443	10,329,318	0.1315	0.1334	0.1306
WV	Jan	Tue	16,025,452	6,936,712	12,928,984	0.1653	0.1650	0.1635
WV	Jan	Wed	16,587,904	7,210,448	13,412,571	0.1711	0.1715	0.1696
WV	Jan	Thu	15,888,932	7,111,818	13,366,382	0.1639	0.1692	0.1690
WV	Jan	Fri	12,499,459	5,419,092	10,203,801	0.1289	0.1289	0.1290
WV	Jan	Sat	11,834,473	5,050,631	9,666,967	0.1221	0.1201	0.1222
WV	Feb	Sun	9,761,299	4,892,152	9,703,703	0.1189	0.1216	0.1288
WV	Feb	Mon	12,044,491	6,038,110	11,178,623	0.1467	0.1501	0.1483
WV	Feb	Tue	12,832,974	6,116,505	11,350,011	0.1563	0.1520	0.1506
WV	Feb	Wed	12,896,606	6,141,238	11,321,181	0.1570	0.1526	0.1502
WV	Feb	Thu	12,943,440	6,145,521	11,332,231	0.1576	0.1527	0.1504
WV	Feb	Fri	11,297,042	5,729,243	10,551,962	0.1376	0.1424	0.1400
WV	Feb	Sat	10,344,006	5,173,626	9,925,582	0.1260	0.1286	0.1317
WV	Mar	Sun	11,411,568	5,522,778	10,810,556	0.1422	0.1400	0.1448
WV	Mar	Mon	11,185,040	5,704,666	10,255,251	0.1394	0.1446	0.1374
WV	Mar	Tue	10,875,143	5,424,842	10,034,164	0.1355	0.1375	0.1344
WV	Mar	Wed	11,063,397	5,350,789	10,059,659	0.1378	0.1356	0.1347
WV	Mar	Thu	10,804,359	5,341,667	10,059,216	0.1346	0.1354	0.1347
WV	Mar	Fri	12,999,519	6,389,171	12,235,557	0.1620	0.1620	0.1639
WV	Mar	Sat	11,926,532	5,715,649	11,200,817	0.1486	0.1449	0.1500
WV	Apr	Sun	8,230,926	4,008,590	7,520,679	0.1116	0.1103	0.1144
WV	Apr	Mon	13,019,560	6,516,027	11,564,401	0.1765	0.1792	0.1758
WV	Apr	Tue	13,421,803	6,624,951	11,914,166	0.1819	0.1822	0.1812
WV	Apr	Wed	10,288,018	5,090,179	9,209,586	0.1395	0.1400	0.1400
WV	Apr	Thu	10,413,172	5,023,528	9,062,366	0.1412	0.1382	0.1378
WV	Apr	Fri	9,902,694	4,928,496	8,726,917	0.1342	0.1356	0.1327
WV	Apr	Sat	8,495,137	4,163,034	7,770,368	0.1152	0.1145	0.1181
WV	May	Sun	8,306,339	2,944,167	7,996,162	0.1068	0.0991	0.1120
WV	May	Mon	10,130,014	3,834,464	9,355,254	0.1303	0.1291	0.1310
WV	May	Tue	10,407,395	4,128,373	9,758,847	0.1339	0.1390	0.1367
WV	May	Wed	13,266,098	5,204,946	11,969,899	0.1706	0.1752	0.1677
WV	May	Thu	13,398,522	5,207,201	12,053,920	0.1723	0.1753	0.1688
WV	May	Fri	13,674,556	5,093,689	12,138,618	0.1759	0.1715	0.1700
WV	May	Sat	8,567,825	3,288,016	8,117,837	0.1102	0.1107	0.1137
WV	Jun	Sun	12,605,642	5,081,170	11,780,562	0.1548	0.1527	0.1540
WV	Jun	Mon	11,290,645	4,540,816	10,591,380	0.1386	0.1364	0.1385
WV	Jun	Tue	11,610,911	4,595,418	10,739,527	0.1426	0.1381	0.1404
WV	Jun	Wed	11,368,121	4,657,261	10,615,897	0.1396	0.1399	0.1388
WV	Jun	Thu	11,062,252	4,695,347	10,545,153	0.1358	0.1411	0.1379
WV	Jun	Fri	10,791,181	4,515,861	10,203,905	0.1325	0.1357	0.1334
WV	Jun	Sat	12,714,677	5,195,557	12,018,233	0.1561	0.1561	0.1571

Actual 2002 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Jul	Sun	10,897,546	4,532,340	10,352,667	0.1175	0.1219	0.1213
WV	Jul	Mon	15,472,405	6,114,793	14,028,539	0.1669	0.1645	0.1644
WV	Jul	Tue	15,799,247	6,415,584	14,425,103	0.1704	0.1726	0.1691
WV	Jul	Wed	15,507,068	6,193,792	14,322,772	0.1672	0.1666	0.1679
WV	Jul	Thu	12,372,989	4,863,245	11,133,926	0.1334	0.1308	0.1305
WV	Jul	Fri	12,071,926	4,767,363	10,919,490	0.1302	0.1282	0.1280
WV	Jul	Sat	10,600,364	4,287,577	10,140,273	0.1143	0.1153	0.1188
WV	Aug	Sun	11,656,231	4,162,352	9,827,247	0.1284	0.1192	0.1228
WV	Aug	Mon	12,809,925	4,830,501	10,895,778	0.1411	0.1383	0.1362
WV	Aug	Tue	11,776,614	4,749,439	10,679,474	0.1297	0.1360	0.1335
WV	Aug	Wed	11,329,372	4,587,980	10,316,041	0.1248	0.1314	0.1289
WV	Aug	Thu	14,736,121	5,897,056	13,280,919	0.1624	0.1688	0.1660
WV	Aug	Fri	14,529,434	5,615,164	13,019,969	0.1601	0.1608	0.1627
WV	Aug	Sat	13,929,746	5,085,303	12,005,717	0.1535	0.1456	0.1500
WV	Sep	Sun	11,612,005	4,708,389	10,262,147	0.1528	0.1508	0.1527
WV	Sep	Mon	12,788,760	5,326,795	11,523,815	0.1683	0.1706	0.1715
WV	Sep	Tue	9,976,375	4,316,273	9,123,357	0.1313	0.1383	0.1358
WV	Sep	Wed	10,491,744	4,220,061	9,039,473	0.1381	0.1352	0.1345
WV	Sep	Thu	10,601,754	4,245,287	9,084,482	0.1395	0.1360	0.1352
WV	Sep	Fri	10,657,825	4,361,606	9,347,806	0.1403	0.1397	0.1391
WV	Sep	Sat	9,853,339	4,042,295	8,803,854	0.1297	0.1295	0.1310
WV	Oct	Sun	9,141,960	4,267,809	8,053,453	0.1078	0.1041	0.1090
WV	Oct	Mon	10,673,339	5,381,381	9,467,208	0.1259	0.1313	0.1282
WV	Oct	Tue	14,435,264	6,771,443	12,431,127	0.1703	0.1652	0.1683
WV	Oct	Wed	14,553,965	7,066,114	12,720,143	0.1717	0.1723	0.1722
WV	Oct	Thu	14,417,207	7,121,049	12,715,645	0.1701	0.1737	0.1722
WV	Oct	Fri	11,616,706	5,706,283	9,914,309	0.1370	0.1392	0.1342
WV	Oct	Sat	9,937,824	4,685,164	8,552,034	0.1172	0.1143	0.1158
WV	Nov	Sun	9,830,355	4,646,371	8,666,821	0.1145	0.1112	0.1187
WV	Nov	Mon	12,283,095	5,937,267	10,150,235	0.1431	0.1421	0.1390
WV	Nov	Tue	12,392,447	5,929,688	10,141,362	0.1444	0.1419	0.1389
WV	Nov	Wed	12,176,489	6,016,380	10,080,562	0.1419	0.1439	0.1380
WV	Nov	Thu	11,901,060	5,578,593	9,845,417	0.1387	0.1335	0.1348
WV	Nov	Fri	14,642,524	7,429,822	12,695,913	0.1706	0.1778	0.1739
WV	Nov	Sat	12,600,494	6,257,527	11,445,065	0.1468	0.1497	0.1567
WV	Dec	Sun	12,753,680	6,146,041	11,504,752	0.1389	0.1382	0.1453
WV	Dec	Mon	14,784,590	7,460,520	13,164,425	0.1610	0.1677	0.1662
WV	Dec	Tue	15,188,434	7,493,324	13,307,758	0.1654	0.1685	0.1680
WV	Dec	Wed	12,822,904	6,234,917	10,932,624	0.1396	0.1402	0.1380
WV	Dec	Thu	12,945,118	6,180,002	10,710,641	0.1409	0.1389	0.1352
WV	Dec	Fri	12,381,927	5,734,914	10,125,916	0.1348	0.1289	0.1279
WV	Dec	Sat	10,974,161	5,232,730	9,448,131	0.1195	0.1176	0.1193

Actual 2002 State Level Monthly-Diurnal Profiles
CEM-Based Distribution

			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Jan	0	2,741,987	1,004,315	2,690,807	0.0381	0.0385	0.0383
AL	Jan	1	2,717,405	994,117	2,656,333	0.0377	0.0381	0.0378
AL	Jan	2	2,732,495	993,417	2,670,658	0.0380	0.0381	0.0380
AL	Jan	3	2,787,197	1,006,543	2,711,547	0.0387	0.0386	0.0385
AL	Jan	4	2,892,370	1,044,668	2,813,871	0.0402	0.0400	0.0400
AL	Jan	5	3,043,742	1,095,960	2,973,281	0.0423	0.0420	0.0423
AL	Jan	6	3,165,246	1,139,346	3,102,993	0.0440	0.0437	0.0441
AL	Jan	7	3,153,129	1,138,326	3,101,803	0.0438	0.0436	0.0441
AL	Jan	8	3,140,327	1,131,614	3,097,499	0.0436	0.0434	0.0440
AL	Jan	9	3,203,467	1,153,016	3,087,739	0.0445	0.0442	0.0439
AL	Jan	10	3,143,675	1,132,663	3,039,305	0.0437	0.0434	0.0432
AL	Jan	11	3,102,170	1,119,903	2,983,100	0.0431	0.0429	0.0424
AL	Jan	12	3,066,551	1,107,992	2,969,232	0.0426	0.0425	0.0422
AL	Jan	13	3,013,840	1,088,445	2,924,398	0.0419	0.0417	0.0416
AL	Jan	14	2,940,305	1,072,596	2,886,458	0.0408	0.0411	0.0410
AL	Jan	15	2,936,570	1,074,049	2,879,720	0.0408	0.0412	0.0409
AL	Jan	16	2,986,108	1,094,245	2,934,536	0.0415	0.0419	0.0417
AL	Jan	17	3,128,407	1,131,955	3,060,818	0.0435	0.0434	0.0435
AL	Jan	18	3,165,955	1,140,293	3,094,074	0.0440	0.0437	0.0440
AL	Jan	19	3,119,814	1,124,019	3,053,305	0.0433	0.0431	0.0434
AL	Jan	20	3,079,102	1,118,468	3,026,147	0.0428	0.0429	0.0430
AL	Jan	21	3,025,517	1,100,925	2,976,770	0.0420	0.0422	0.0423
AL	Jan	22	2,923,913	1,069,313	2,876,314	0.0406	0.0410	0.0409
AL	Jan	23	2,776,269	1,018,348	2,732,989	0.0386	0.0390	0.0389
AL	Feb	0	2,253,373	868,185	2,357,008	0.0389	0.0392	0.0394
AL	Feb	1	2,224,059	859,658	2,318,041	0.0384	0.0389	0.0388
AL	Feb	2	2,229,268	866,148	2,328,309	0.0385	0.0392	0.0389
AL	Feb	3	2,261,953	879,145	2,365,382	0.0391	0.0397	0.0395
AL	Feb	4	2,338,927	903,372	2,441,093	0.0404	0.0408	0.0408
AL	Feb	5	2,436,805	933,109	2,532,481	0.0421	0.0422	0.0423
AL	Feb	6	2,515,424	963,393	2,611,818	0.0434	0.0436	0.0437
AL	Feb	7	2,538,948	968,548	2,610,717	0.0438	0.0438	0.0436
AL	Feb	8	2,515,296	955,200	2,583,556	0.0434	0.0432	0.0432
AL	Feb	9	2,540,711	958,276	2,552,241	0.0439	0.0433	0.0427
AL	Feb	10	2,492,642	937,659	2,545,359	0.0430	0.0424	0.0426
AL	Feb	11	2,470,000	931,823	2,519,838	0.0427	0.0421	0.0421
AL	Feb	12	2,425,186	917,544	2,500,106	0.0419	0.0415	0.0418
AL	Feb	13	2,383,050	900,232	2,447,506	0.0412	0.0407	0.0409
AL	Feb	14	2,352,497	894,740	2,423,254	0.0406	0.0404	0.0405
AL	Feb	15	2,337,173	891,481	2,410,974	0.0404	0.0403	0.0403
AL	Feb	16	2,353,899	898,603	2,435,772	0.0407	0.0406	0.0407
AL	Feb	17	2,420,477	924,045	2,509,107	0.0418	0.0418	0.0419
AL	Feb	18	2,501,328	953,661	2,588,924	0.0432	0.0431	0.0433
AL	Feb	19	2,491,231	950,950	2,576,810	0.0430	0.0430	0.0431
AL	Feb	20	2,502,966	955,068	2,583,883	0.0432	0.0432	0.0432
AL	Feb	21	2,495,709	954,918	2,577,873	0.0431	0.0432	0.0431
AL	Feb	22	2,459,759	942,871	2,539,927	0.0425	0.0426	0.0425
AL	Feb	23	2,362,705	912,645	2,456,568	0.0408	0.0413	0.0411
AL	Mar	0	2,344,204	896,246	2,291,650	0.0394	0.0395	0.0395
AL	Mar	1	2,290,492	878,336	2,235,146	0.0385	0.0387	0.0385
AL	Mar	2	2,268,031	871,699	2,220,460	0.0381	0.0384	0.0382
AL	Mar	3	2,270,932	876,499	2,233,320	0.0382	0.0386	0.0385
AL	Mar	4	2,328,738	894,751	2,285,963	0.0392	0.0394	0.0394

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Mar	5	2,428,390	925,936	2,383,519	0.0408	0.0408	0.0410
AL	Mar	6	2,508,590	953,226	2,464,397	0.0422	0.0420	0.0424
AL	Mar	7	2,530,656	959,550	2,462,077	0.0425	0.0422	0.0424
AL	Mar	8	2,561,924	977,286	2,477,056	0.0431	0.0430	0.0426
AL	Mar	9	2,579,385	986,553	2,474,954	0.0434	0.0434	0.0426
AL	Mar	10	2,557,475	978,823	2,477,934	0.0430	0.0431	0.0427
AL	Mar	11	2,548,567	973,844	2,475,127	0.0428	0.0429	0.0426
AL	Mar	12	2,542,765	970,831	2,484,634	0.0427	0.0427	0.0428
AL	Mar	13	2,520,064	957,301	2,456,497	0.0424	0.0421	0.0423
AL	Mar	14	2,505,486	955,765	2,446,978	0.0421	0.0421	0.0421
AL	Mar	15	2,503,392	956,547	2,449,363	0.0421	0.0421	0.0422
AL	Mar	16	2,524,971	964,459	2,460,914	0.0424	0.0425	0.0424
AL	Mar	17	2,540,478	967,101	2,478,745	0.0427	0.0426	0.0427
AL	Mar	18	2,591,567	986,968	2,543,551	0.0436	0.0435	0.0438
AL	Mar	19	2,589,398	988,472	2,548,349	0.0435	0.0435	0.0439
AL	Mar	20	2,568,710	979,980	2,519,139	0.0432	0.0431	0.0434
AL	Mar	21	2,532,064	962,803	2,471,543	0.0426	0.0424	0.0426
AL	Mar	22	2,474,817	941,870	2,414,411	0.0416	0.0415	0.0416
AL	Mar	23	2,370,330	907,008	2,326,421	0.0398	0.0399	0.0401
AL	Apr	0	2,228,515	836,202	2,285,448	0.0368	0.0370	0.0371
AL	Apr	1	2,173,032	822,140	2,247,199	0.0359	0.0364	0.0365
AL	Apr	2	2,153,881	818,757	2,234,410	0.0356	0.0362	0.0363
AL	Apr	3	2,232,176	844,256	2,286,631	0.0369	0.0374	0.0371
AL	Apr	4	2,389,439	897,207	2,408,707	0.0395	0.0397	0.0391
AL	Apr	5	2,493,826	933,813	2,505,623	0.0412	0.0413	0.0407
AL	Apr	6	2,554,599	952,174	2,560,375	0.0422	0.0421	0.0416
AL	Apr	7	2,582,156	963,601	2,591,138	0.0427	0.0426	0.0421
AL	Apr	8	2,639,813	979,628	2,624,462	0.0436	0.0433	0.0426
AL	Apr	9	2,643,446	980,260	2,662,754	0.0437	0.0434	0.0432
AL	Apr	10	2,653,155	984,214	2,694,000	0.0439	0.0435	0.0437
AL	Apr	11	2,645,360	984,831	2,711,517	0.0437	0.0436	0.0440
AL	Apr	12	2,624,188	978,349	2,708,341	0.0434	0.0433	0.0440
AL	Apr	13	2,632,266	979,546	2,719,694	0.0435	0.0433	0.0441
AL	Apr	14	2,652,217	987,702	2,721,904	0.0438	0.0437	0.0442
AL	Apr	15	2,648,834	990,953	2,705,156	0.0438	0.0438	0.0439
AL	Apr	16	2,621,452	984,228	2,687,882	0.0433	0.0435	0.0436
AL	Apr	17	2,614,784	979,617	2,682,079	0.0432	0.0433	0.0435
AL	Apr	18	2,628,751	978,975	2,699,451	0.0435	0.0433	0.0438
AL	Apr	19	2,653,626	987,709	2,716,044	0.0439	0.0437	0.0441
AL	Apr	20	2,631,521	977,459	2,680,736	0.0435	0.0432	0.0435
AL	Apr	21	2,567,425	952,799	2,603,716	0.0424	0.0422	0.0423
AL	Apr	22	2,464,894	919,642	2,483,958	0.0407	0.0407	0.0403
AL	Apr	23	2,369,125	887,276	2,395,812	0.0392	0.0393	0.0389
AL	May	0	2,465,552	908,349	2,524,318	0.0367	0.0366	0.0366
AL	May	1	2,420,701	890,183	2,472,941	0.0361	0.0358	0.0358
AL	May	2	2,406,368	883,322	2,446,821	0.0358	0.0356	0.0354
AL	May	3	2,479,383	904,473	2,501,796	0.0369	0.0364	0.0362
AL	May	4	2,602,268	957,753	2,624,949	0.0388	0.0386	0.0380
AL	May	5	2,677,066	993,418	2,712,234	0.0399	0.0400	0.0393
AL	May	6	2,779,517	1,027,989	2,806,238	0.0414	0.0414	0.0407
AL	May	7	2,848,345	1,045,051	2,875,058	0.0424	0.0421	0.0417
AL	May	8	2,931,694	1,063,579	2,953,366	0.0437	0.0428	0.0428
AL	May	9	2,924,381	1,075,077	2,989,107	0.0436	0.0433	0.0433

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	May	10	2,938,699	1,091,747	3,041,252	0.0438	0.0439	0.0441
AL	May	11	2,947,674	1,099,596	3,077,771	0.0439	0.0443	0.0446
AL	May	12	2,936,754	1,089,078	3,069,164	0.0437	0.0438	0.0445
AL	May	13	2,945,390	1,097,482	3,103,684	0.0439	0.0442	0.0450
AL	May	14	2,939,698	1,112,440	3,106,993	0.0438	0.0448	0.0450
AL	May	15	2,956,416	1,106,665	3,113,515	0.0440	0.0445	0.0451
AL	May	16	2,955,262	1,103,806	3,100,165	0.0440	0.0444	0.0449
AL	May	17	2,952,378	1,102,965	3,079,650	0.0440	0.0444	0.0446
AL	May	18	2,938,574	1,092,977	3,038,781	0.0438	0.0440	0.0440
AL	May	19	2,977,607	1,102,186	3,069,979	0.0443	0.0444	0.0445
AL	May	20	2,937,077	1,085,710	3,009,359	0.0437	0.0437	0.0436
AL	May	21	2,844,515	1,047,367	2,889,529	0.0424	0.0422	0.0419
AL	May	22	2,722,348	1,000,434	2,758,208	0.0405	0.0403	0.0400
AL	May	23	2,613,635	960,563	2,657,155	0.0389	0.0387	0.0385
AL	Jun	0	2,968,696	1,028,663	3,076,335	0.0363	0.0362	0.0362
AL	Jun	1	2,832,644	987,788	2,984,774	0.0347	0.0347	0.0351
AL	Jun	2	2,738,909	957,899	2,906,863	0.0335	0.0337	0.0342
AL	Jun	3	2,793,854	970,712	2,944,737	0.0342	0.0341	0.0346
AL	Jun	4	2,930,010	1,012,097	3,057,162	0.0359	0.0356	0.0360
AL	Jun	5	3,078,245	1,058,356	3,187,128	0.0377	0.0372	0.0375
AL	Jun	6	3,296,494	1,139,625	3,346,605	0.0404	0.0401	0.0394
AL	Jun	7	3,446,820	1,200,750	3,495,633	0.0422	0.0422	0.0411
AL	Jun	8	3,612,260	1,245,866	3,641,676	0.0442	0.0438	0.0428
AL	Jun	9	3,661,396	1,262,673	3,742,119	0.0448	0.0444	0.0440
AL	Jun	10	3,677,963	1,274,079	3,805,701	0.0450	0.0448	0.0448
AL	Jun	11	3,698,926	1,293,955	3,868,213	0.0453	0.0455	0.0455
AL	Jun	12	3,656,461	1,279,429	3,883,824	0.0448	0.0450	0.0457
AL	Jun	13	3,671,689	1,294,921	3,919,363	0.0450	0.0455	0.0461
AL	Jun	14	3,671,228	1,285,782	3,902,063	0.0449	0.0452	0.0459
AL	Jun	15	3,680,401	1,290,857	3,892,849	0.0451	0.0454	0.0458
AL	Jun	16	3,674,613	1,292,845	3,881,062	0.0450	0.0454	0.0457
AL	Jun	17	3,664,720	1,285,717	3,864,300	0.0449	0.0452	0.0455
AL	Jun	18	3,642,194	1,271,867	3,811,846	0.0446	0.0447	0.0448
AL	Jun	19	3,676,208	1,284,584	3,825,728	0.0450	0.0452	0.0450
AL	Jun	20	3,642,893	1,269,302	3,753,943	0.0446	0.0446	0.0442
AL	Jun	21	3,519,611	1,223,561	3,591,565	0.0431	0.0430	0.0422
AL	Jun	22	3,310,525	1,150,005	3,391,162	0.0405	0.0404	0.0399
AL	Jun	23	3,132,379	1,086,983	3,236,656	0.0383	0.0382	0.0381
AL	Jul	0	3,351,891	1,159,796	3,519,285	0.0374	0.0376	0.0370
AL	Jul	1	3,209,694	1,111,818	3,419,808	0.0358	0.0360	0.0360
AL	Jul	2	3,133,780	1,087,810	3,361,520	0.0349	0.0353	0.0353
AL	Jul	3	3,149,495	1,096,513	3,374,098	0.0351	0.0355	0.0355
AL	Jul	4	3,264,237	1,136,963	3,477,228	0.0364	0.0369	0.0366
AL	Jul	5	3,354,945	1,164,931	3,584,943	0.0374	0.0378	0.0377
AL	Jul	6	3,552,275	1,231,220	3,722,799	0.0396	0.0399	0.0391
AL	Jul	7	3,762,714	1,273,158	3,855,300	0.0419	0.0413	0.0405
AL	Jul	8	3,898,906	1,328,282	4,027,155	0.0434	0.0431	0.0423
AL	Jul	9	4,004,317	1,358,026	4,162,034	0.0446	0.0440	0.0438
AL	Jul	10	4,052,600	1,369,903	4,248,781	0.0452	0.0444	0.0447
AL	Jul	11	4,042,434	1,373,838	4,301,796	0.0450	0.0445	0.0452
AL	Jul	12	3,998,643	1,371,727	4,328,386	0.0446	0.0445	0.0455
AL	Jul	13	4,005,257	1,379,736	4,338,694	0.0446	0.0447	0.0456
AL	Jul	14	4,021,426	1,382,915	4,351,967	0.0448	0.0448	0.0458

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Jul	15	4,011,322	1,377,002	4,328,342	0.0447	0.0446	0.0455
AL	Jul	16	3,971,531	1,374,932	4,297,663	0.0443	0.0446	0.0452
AL	Jul	17	3,970,177	1,371,961	4,279,469	0.0442	0.0445	0.0450
AL	Jul	18	3,954,613	1,361,364	4,219,046	0.0441	0.0441	0.0444
AL	Jul	19	3,971,366	1,363,853	4,222,712	0.0443	0.0442	0.0444
AL	Jul	20	3,954,276	1,354,338	4,162,522	0.0441	0.0439	0.0438
AL	Jul	21	3,868,801	1,324,102	4,014,526	0.0431	0.0429	0.0422
AL	Jul	22	3,688,548	1,270,811	3,827,832	0.0411	0.0412	0.0402
AL	Jul	23	3,544,676	1,224,624	3,684,831	0.0395	0.0397	0.0387
AL	Aug	0	3,315,508	1,145,136	3,467,179	0.0373	0.0374	0.0369
AL	Aug	1	3,191,575	1,096,332	3,357,297	0.0359	0.0358	0.0357
AL	Aug	2	3,131,686	1,066,341	3,295,620	0.0352	0.0348	0.0351
AL	Aug	3	3,189,797	1,076,150	3,316,610	0.0359	0.0352	0.0353
AL	Aug	4	3,345,349	1,131,553	3,442,497	0.0376	0.0370	0.0366
AL	Aug	5	3,467,950	1,178,821	3,586,753	0.0390	0.0385	0.0382
AL	Aug	6	3,557,705	1,212,665	3,669,843	0.0400	0.0396	0.0391
AL	Aug	7	3,691,415	1,251,997	3,792,486	0.0415	0.0409	0.0404
AL	Aug	8	3,908,307	1,308,189	3,947,840	0.0440	0.0427	0.0420
AL	Aug	9	3,903,178	1,333,735	4,068,709	0.0439	0.0436	0.0433
AL	Aug	10	3,934,441	1,349,001	4,168,401	0.0443	0.0441	0.0444
AL	Aug	11	3,966,574	1,365,544	4,245,039	0.0446	0.0446	0.0452
AL	Aug	12	3,955,846	1,368,079	4,265,544	0.0445	0.0447	0.0454
AL	Aug	13	3,956,345	1,373,515	4,303,852	0.0445	0.0449	0.0458
AL	Aug	14	3,983,111	1,378,187	4,308,814	0.0448	0.0450	0.0459
AL	Aug	15	3,973,821	1,380,620	4,309,578	0.0447	0.0451	0.0459
AL	Aug	16	3,951,313	1,378,479	4,282,645	0.0444	0.0450	0.0456
AL	Aug	17	3,942,194	1,377,544	4,257,902	0.0443	0.0450	0.0453
AL	Aug	18	3,922,582	1,366,680	4,225,247	0.0441	0.0447	0.0450
AL	Aug	19	3,921,040	1,364,494	4,214,527	0.0441	0.0446	0.0449
AL	Aug	20	3,850,720	1,347,245	4,126,683	0.0433	0.0440	0.0439
AL	Aug	21	3,747,671	1,301,451	3,947,717	0.0422	0.0425	0.0420
AL	Aug	22	3,597,935	1,245,039	3,741,936	0.0405	0.0407	0.0398
AL	Aug	23	3,487,479	1,204,159	3,607,788	0.0392	0.0394	0.0384
AL	Sep	0	3,172,931	1,062,515	3,165,623	0.0386	0.0378	0.0375
AL	Sep	1	3,095,788	1,041,210	3,108,778	0.0376	0.0371	0.0368
AL	Sep	2	3,047,740	1,023,435	3,062,886	0.0371	0.0364	0.0363
AL	Sep	3	3,072,181	1,031,217	3,082,703	0.0374	0.0367	0.0365
AL	Sep	4	3,194,890	1,073,982	3,203,935	0.0388	0.0382	0.0380
AL	Sep	5	3,281,892	1,105,758	3,315,138	0.0399	0.0394	0.0393
AL	Sep	6	3,311,581	1,124,098	3,345,868	0.0403	0.0400	0.0396
AL	Sep	7	3,413,675	1,137,808	3,402,796	0.0415	0.0405	0.0403
AL	Sep	8	3,486,832	1,172,114	3,507,791	0.0424	0.0417	0.0416
AL	Sep	9	3,535,599	1,195,133	3,590,521	0.0430	0.0425	0.0425
AL	Sep	10	3,565,956	1,216,228	3,668,282	0.0434	0.0433	0.0435
AL	Sep	11	3,545,009	1,223,250	3,704,548	0.0431	0.0435	0.0439
AL	Sep	12	3,551,028	1,225,644	3,731,097	0.0432	0.0436	0.0442
AL	Sep	13	3,573,196	1,241,350	3,768,609	0.0434	0.0442	0.0446
AL	Sep	14	3,597,339	1,252,545	3,808,605	0.0437	0.0446	0.0451
AL	Sep	15	3,614,664	1,261,701	3,827,550	0.0440	0.0449	0.0453
AL	Sep	16	3,617,021	1,261,578	3,819,086	0.0440	0.0449	0.0452
AL	Sep	17	3,619,580	1,257,109	3,813,056	0.0440	0.0448	0.0452
AL	Sep	18	3,627,053	1,260,241	3,819,723	0.0441	0.0449	0.0452
AL	Sep	19	3,623,409	1,261,463	3,790,437	0.0441	0.0449	0.0449

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Sep	20	3,577,183	1,236,416	3,705,718	0.0435	0.0440	0.0439
AL	Sep	21	3,487,786	1,192,909	3,538,876	0.0424	0.0425	0.0419
AL	Sep	22	3,359,963	1,136,427	3,376,674	0.0409	0.0405	0.0400
AL	Sep	23	3,264,945	1,096,522	3,256,671	0.0397	0.0390	0.0386
AL	Oct	0	3,110,672	1,130,772	2,995,713	0.0385	0.0381	0.0382
AL	Oct	1	3,075,088	1,117,841	2,961,641	0.0381	0.0376	0.0378
AL	Oct	2	3,065,688	1,114,839	2,951,087	0.0380	0.0375	0.0376
AL	Oct	3	3,104,259	1,130,696	2,975,923	0.0385	0.0381	0.0380
AL	Oct	4	3,196,004	1,158,663	3,059,006	0.0396	0.0390	0.0390
AL	Oct	5	3,315,156	1,198,160	3,168,032	0.0411	0.0403	0.0404
AL	Oct	6	3,364,686	1,323,201	3,197,922	0.0417	0.0445	0.0408
AL	Oct	7	3,422,774	1,235,158	3,245,934	0.0424	0.0416	0.0414
AL	Oct	8	3,489,941	1,264,016	3,330,052	0.0432	0.0426	0.0425
AL	Oct	9	3,501,328	1,284,386	3,360,289	0.0434	0.0432	0.0429
AL	Oct	10	3,500,981	1,287,602	3,397,817	0.0434	0.0433	0.0433
AL	Oct	11	3,501,855	1,285,763	3,431,617	0.0434	0.0433	0.0438
AL	Oct	12	3,484,004	1,282,104	3,416,445	0.0432	0.0432	0.0436
AL	Oct	13	3,474,043	1,280,710	3,419,364	0.0430	0.0431	0.0436
AL	Oct	14	3,479,549	1,285,734	3,426,303	0.0431	0.0433	0.0437
AL	Oct	15	3,488,225	1,289,705	3,429,926	0.0432	0.0434	0.0438
AL	Oct	16	3,484,827	1,287,241	3,425,513	0.0432	0.0433	0.0437
AL	Oct	17	3,492,875	1,294,313	3,450,441	0.0433	0.0436	0.0440
AL	Oct	18	3,487,520	1,296,565	3,450,107	0.0432	0.0436	0.0440
AL	Oct	19	3,470,708	1,291,892	3,423,988	0.0430	0.0435	0.0437
AL	Oct	20	3,448,538	1,278,748	3,382,095	0.0427	0.0430	0.0431
AL	Oct	21	3,358,028	1,244,928	3,277,885	0.0416	0.0419	0.0418
AL	Oct	22	3,232,770	1,188,205	3,147,611	0.0401	0.0400	0.0402
AL	Oct	23	3,162,688	1,152,640	3,062,964	0.0392	0.0388	0.0391
AL	Nov	0	2,874,503	1,104,123	2,854,064	0.0387	0.0390	0.0392
AL	Nov	1	2,824,556	1,075,192	2,803,283	0.0380	0.0380	0.0385
AL	Nov	2	2,803,979	1,066,604	2,785,904	0.0378	0.0377	0.0383
AL	Nov	3	2,835,080	1,074,985	2,809,520	0.0382	0.0380	0.0386
AL	Nov	4	2,931,408	1,112,758	2,879,968	0.0395	0.0394	0.0396
AL	Nov	5	3,064,807	1,168,346	3,003,774	0.0413	0.0413	0.0413
AL	Nov	6	3,161,339	1,208,664	3,112,630	0.0426	0.0427	0.0428
AL	Nov	7	3,177,846	1,205,865	3,112,150	0.0428	0.0426	0.0428
AL	Nov	8	3,177,364	1,213,164	3,104,175	0.0428	0.0429	0.0427
AL	Nov	9	3,223,552	1,221,702	3,125,561	0.0434	0.0432	0.0430
AL	Nov	10	3,199,469	1,210,652	3,111,519	0.0431	0.0428	0.0428
AL	Nov	11	3,162,935	1,200,713	3,087,776	0.0426	0.0425	0.0424
AL	Nov	12	3,139,935	1,192,359	3,070,345	0.0423	0.0422	0.0422
AL	Nov	13	3,111,729	1,180,161	3,045,946	0.0419	0.0417	0.0419
AL	Nov	14	3,093,392	1,177,945	3,039,804	0.0417	0.0417	0.0418
AL	Nov	15	3,107,507	1,183,590	3,050,221	0.0419	0.0419	0.0419
AL	Nov	16	3,158,072	1,200,446	3,085,113	0.0425	0.0425	0.0424
AL	Nov	17	3,232,524	1,226,969	3,161,025	0.0435	0.0434	0.0434
AL	Nov	18	3,242,583	1,233,932	3,174,638	0.0437	0.0436	0.0436
AL	Nov	19	3,223,480	1,228,574	3,146,189	0.0434	0.0434	0.0432
AL	Nov	20	3,221,533	1,230,598	3,134,188	0.0434	0.0435	0.0431
AL	Nov	21	3,189,452	1,222,540	3,104,203	0.0430	0.0432	0.0427
AL	Nov	22	3,093,471	1,190,949	3,024,037	0.0417	0.0421	0.0416
AL	Nov	23	2,992,038	1,146,518	2,934,438	0.0403	0.0405	0.0403
AL	Dec	0	3,205,831	1,118,722	2,838,057	0.0391	0.0389	0.0390

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Dec	1	3,167,538	1,104,087	2,799,640	0.0386	0.0384	0.0385
AL	Dec	2	3,164,469	1,107,980	2,806,818	0.0386	0.0385	0.0386
AL	Dec	3	3,208,038	1,121,620	2,831,324	0.0391	0.0390	0.0389
AL	Dec	4	3,281,914	1,146,890	2,893,251	0.0400	0.0399	0.0398
AL	Dec	5	3,375,405	1,177,736	2,976,587	0.0412	0.0409	0.0409
AL	Dec	6	3,488,636	1,217,589	3,099,293	0.0426	0.0423	0.0426
AL	Dec	7	3,537,289	1,235,510	3,119,173	0.0431	0.0429	0.0429
AL	Dec	8	3,552,158	1,245,669	3,132,449	0.0433	0.0433	0.0431
AL	Dec	9	3,557,325	1,246,315	3,125,154	0.0434	0.0433	0.0430
AL	Dec	10	3,526,064	1,227,192	3,100,960	0.0430	0.0426	0.0426
AL	Dec	11	3,483,264	1,214,331	3,082,794	0.0425	0.0422	0.0424
AL	Dec	12	3,434,044	1,241,858	3,048,547	0.0419	0.0432	0.0419
AL	Dec	13	3,374,003	1,174,327	2,992,974	0.0412	0.0408	0.0412
AL	Dec	14	3,345,612	1,170,860	2,976,566	0.0408	0.0407	0.0409
AL	Dec	15	3,362,456	1,180,238	2,991,073	0.0410	0.0410	0.0411
AL	Dec	16	3,459,775	1,207,176	3,083,525	0.0422	0.0419	0.0424
AL	Dec	17	3,581,738	1,253,741	3,194,905	0.0437	0.0436	0.0439
AL	Dec	18	3,594,082	1,267,370	3,214,573	0.0438	0.0440	0.0442
AL	Dec	19	3,561,608	1,260,092	3,184,828	0.0434	0.0438	0.0438
AL	Dec	20	3,553,749	1,262,191	3,182,503	0.0433	0.0439	0.0438
AL	Dec	21	3,531,360	1,250,529	3,142,266	0.0431	0.0435	0.0432
AL	Dec	22	3,391,080	1,202,136	3,015,338	0.0414	0.0418	0.0415
AL	Dec	23	3,245,883	1,142,679	2,885,737	0.0396	0.0397	0.0397
FL	Jan	0	2,299,429	1,317,982	3,802,850	0.0339	0.0314	0.0335
FL	Jan	1	2,205,527	1,257,798	3,697,919	0.0326	0.0299	0.0326
FL	Jan	2	2,203,963	1,246,266	3,666,185	0.0325	0.0297	0.0323
FL	Jan	3	2,224,477	1,250,434	3,680,320	0.0328	0.0298	0.0324
FL	Jan	4	2,284,250	1,290,657	3,781,954	0.0337	0.0307	0.0333
FL	Jan	5	2,459,505	1,414,683	4,091,805	0.0363	0.0337	0.0360
FL	Jan	6	2,811,845	1,692,344	4,638,345	0.0415	0.0403	0.0409
FL	Jan	7	3,064,938	1,880,467	5,019,589	0.0452	0.0448	0.0442
FL	Jan	8	3,170,024	1,940,985	5,162,357	0.0468	0.0462	0.0455
FL	Jan	9	3,170,704	1,963,743	5,230,019	0.0468	0.0468	0.0461
FL	Jan	10	3,124,703	1,969,530	5,213,708	0.0461	0.0469	0.0459
FL	Jan	11	3,017,949	1,946,980	5,117,836	0.0445	0.0464	0.0451
FL	Jan	12	2,945,721	1,910,654	5,051,668	0.0435	0.0455	0.0445
FL	Jan	13	2,865,363	1,885,266	4,973,371	0.0423	0.0449	0.0438
FL	Jan	14	2,787,986	1,852,388	4,892,552	0.0411	0.0441	0.0431
FL	Jan	15	2,763,289	1,845,891	4,887,769	0.0408	0.0439	0.0431
FL	Jan	16	2,818,523	1,852,995	4,954,466	0.0416	0.0441	0.0436
FL	Jan	17	2,988,376	1,932,657	5,171,039	0.0441	0.0460	0.0455
FL	Jan	18	3,403,106	2,208,330	5,663,489	0.0502	0.0526	0.0499
FL	Jan	19	3,437,839	2,218,481	5,659,902	0.0507	0.0528	0.0499
FL	Jan	20	3,262,336	2,059,050	5,394,295	0.0481	0.0490	0.0475
FL	Jan	21	3,069,958	1,894,485	5,044,943	0.0453	0.0451	0.0444
FL	Jan	22	2,845,762	1,696,995	4,601,522	0.0420	0.0404	0.0405
FL	Jan	23	2,529,965	1,475,452	4,134,079	0.0373	0.0351	0.0364
FL	Feb	0	1,739,031	1,000,902	2,955,834	0.0308	0.0293	0.0321
FL	Feb	1	1,639,945	950,067	2,863,918	0.0290	0.0278	0.0311
FL	Feb	2	1,614,541	940,528	2,835,025	0.0286	0.0275	0.0308
FL	Feb	3	1,628,970	945,847	2,850,111	0.0288	0.0277	0.0310
FL	Feb	4	1,703,212	985,965	2,959,196	0.0301	0.0289	0.0322
FL	Feb	5	1,883,746	1,113,555	3,227,540	0.0333	0.0326	0.0351

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Feb	6	2,231,263	1,369,389	3,744,256	0.0395	0.0401	0.0407
FL	Feb	7	2,549,195	1,574,901	4,140,555	0.0451	0.0461	0.0450
FL	Feb	8	2,630,878	1,622,353	4,229,664	0.0466	0.0475	0.0460
FL	Feb	9	2,663,642	1,636,975	4,275,492	0.0471	0.0479	0.0465
FL	Feb	10	2,676,062	1,647,364	4,281,343	0.0474	0.0482	0.0466
FL	Feb	11	2,589,032	1,594,755	4,186,358	0.0458	0.0467	0.0455
FL	Feb	12	2,572,962	1,574,694	4,160,030	0.0455	0.0461	0.0452
FL	Feb	13	2,533,366	1,542,525	4,100,874	0.0448	0.0452	0.0446
FL	Feb	14	2,468,675	1,505,675	4,040,322	0.0437	0.0441	0.0439
FL	Feb	15	2,437,319	1,489,801	4,018,065	0.0431	0.0436	0.0437
FL	Feb	16	2,485,234	1,511,169	4,053,660	0.0440	0.0443	0.0441
FL	Feb	17	2,622,007	1,570,652	4,176,316	0.0464	0.0460	0.0454
FL	Feb	18	2,909,760	1,767,552	4,517,601	0.0515	0.0518	0.0491
FL	Feb	19	3,042,293	1,880,881	4,673,318	0.0538	0.0551	0.0508
FL	Feb	20	2,864,365	1,746,495	4,466,848	0.0507	0.0511	0.0486
FL	Feb	21	2,616,249	1,578,955	4,147,251	0.0463	0.0462	0.0451
FL	Feb	22	2,372,582	1,405,912	3,744,772	0.0420	0.0412	0.0407
FL	Feb	23	2,041,951	1,188,540	3,321,492	0.0361	0.0348	0.0361
FL	Mar	0	2,065,747	1,118,271	3,326,436	0.0295	0.0285	0.0309
FL	Mar	1	1,892,868	1,021,148	3,150,206	0.0270	0.0260	0.0293
FL	Mar	2	1,812,928	972,919	3,049,145	0.0259	0.0248	0.0283
FL	Mar	3	1,780,953	952,037	3,015,716	0.0254	0.0243	0.0280
FL	Mar	4	1,794,312	964,647	3,063,493	0.0256	0.0246	0.0284
FL	Mar	5	1,909,055	1,036,145	3,261,928	0.0273	0.0264	0.0303
FL	Mar	6	2,197,426	1,257,075	3,709,903	0.0314	0.0320	0.0345
FL	Mar	7	2,503,340	1,433,445	4,059,937	0.0358	0.0365	0.0377
FL	Mar	8	2,796,992	1,591,721	4,400,782	0.0400	0.0406	0.0409
FL	Mar	9	3,082,333	1,761,870	4,705,991	0.0440	0.0449	0.0437
FL	Mar	10	3,304,592	1,893,779	4,950,066	0.0472	0.0483	0.0460
FL	Mar	11	3,406,777	1,952,537	5,100,355	0.0487	0.0498	0.0474
FL	Mar	12	3,531,215	2,002,825	5,258,910	0.0504	0.0510	0.0488
FL	Mar	13	3,603,289	2,037,519	5,371,325	0.0515	0.0519	0.0499
FL	Mar	14	3,621,294	2,053,895	5,419,103	0.0517	0.0523	0.0503
FL	Mar	15	3,636,365	2,071,947	5,469,103	0.0520	0.0528	0.0508
FL	Mar	16	3,658,356	2,077,598	5,508,128	0.0523	0.0529	0.0512
FL	Mar	17	3,649,044	2,063,222	5,486,935	0.0521	0.0526	0.0510
FL	Mar	18	3,665,857	2,064,820	5,509,632	0.0524	0.0526	0.0512
FL	Mar	19	3,797,955	2,163,173	5,651,331	0.0543	0.0551	0.0525
FL	Mar	20	3,647,981	2,045,159	5,355,404	0.0521	0.0521	0.0497
FL	Mar	21	3,305,681	1,824,702	4,851,991	0.0472	0.0465	0.0451
FL	Mar	22	2,894,733	1,577,278	4,272,169	0.0414	0.0402	0.0397
FL	Mar	23	2,438,191	1,306,940	3,737,774	0.0348	0.0333	0.0347
FL	Apr	0	2,122,556	1,128,625	3,490,862	0.0288	0.0276	0.0295
FL	Apr	1	1,955,149	1,040,978	3,289,089	0.0265	0.0255	0.0278
FL	Apr	2	1,855,862	981,468	3,170,624	0.0252	0.0240	0.0268
FL	Apr	3	1,800,327	958,514	3,132,493	0.0244	0.0235	0.0265
FL	Apr	4	1,863,832	997,119	3,259,524	0.0253	0.0244	0.0276
FL	Apr	5	2,120,117	1,141,959	3,624,431	0.0288	0.0280	0.0307
FL	Apr	6	2,331,975	1,283,729	3,880,292	0.0317	0.0314	0.0328
FL	Apr	7	2,593,181	1,413,140	4,196,646	0.0352	0.0346	0.0355
FL	Apr	8	2,975,070	1,642,288	4,675,402	0.0404	0.0402	0.0396
FL	Apr	9	3,343,630	1,872,994	5,163,994	0.0454	0.0459	0.0437
FL	Apr	10	3,504,661	1,982,715	5,463,767	0.0476	0.0486	0.0462

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Apr	11	3,649,330	2,073,756	5,789,773	0.0495	0.0508	0.0490
FL	Apr	12	3,781,688	2,159,615	6,046,237	0.0513	0.0529	0.0512
FL	Apr	13	3,893,061	2,220,023	6,221,809	0.0528	0.0544	0.0527
FL	Apr	14	3,953,203	2,259,477	6,332,557	0.0537	0.0553	0.0536
FL	Apr	15	3,998,628	2,280,871	6,378,876	0.0543	0.0559	0.0540
FL	Apr	16	3,990,290	2,262,393	6,361,091	0.0542	0.0554	0.0538
FL	Apr	17	3,908,528	2,184,250	6,242,845	0.0530	0.0535	0.0528
FL	Apr	18	3,791,245	2,074,985	6,058,031	0.0515	0.0508	0.0513
FL	Apr	19	3,820,024	2,129,698	6,089,124	0.0518	0.0522	0.0515
FL	Apr	20	3,646,766	2,031,072	5,761,902	0.0495	0.0498	0.0488
FL	Apr	21	3,324,598	1,811,729	5,154,381	0.0451	0.0444	0.0436
FL	Apr	22	2,970,775	1,575,175	4,510,460	0.0403	0.0386	0.0382
FL	Apr	23	2,484,141	1,317,669	3,876,789	0.0337	0.0323	0.0328
FL	May	0	2,689,862	1,391,174	4,381,615	0.0303	0.0284	0.0308
FL	May	1	2,468,891	1,278,539	4,145,946	0.0278	0.0261	0.0291
FL	May	2	2,325,003	1,204,227	3,980,709	0.0262	0.0246	0.0280
FL	May	3	2,263,462	1,166,204	3,915,140	0.0255	0.0238	0.0275
FL	May	4	2,325,504	1,208,506	4,009,619	0.0262	0.0247	0.0282
FL	May	5	2,493,137	1,339,156	4,332,215	0.0280	0.0273	0.0304
FL	May	6	2,667,714	1,485,846	4,601,428	0.0300	0.0303	0.0323
FL	May	7	3,067,426	1,686,661	5,044,905	0.0345	0.0344	0.0354
FL	May	8	3,530,119	1,979,806	5,639,262	0.0397	0.0404	0.0396
FL	May	9	3,943,577	2,225,986	6,170,132	0.0444	0.0455	0.0433
FL	May	10	4,229,022	2,370,428	6,568,070	0.0476	0.0484	0.0461
FL	May	11	4,442,858	2,502,439	6,970,468	0.0500	0.0511	0.0490
FL	May	12	4,600,077	2,610,520	7,266,157	0.0518	0.0533	0.0510
FL	May	13	4,735,876	2,671,933	7,475,686	0.0533	0.0546	0.0525
FL	May	14	4,772,662	2,713,834	7,601,247	0.0537	0.0554	0.0534
FL	May	15	4,826,640	2,741,605	7,677,735	0.0543	0.0560	0.0539
FL	May	16	4,790,138	2,732,148	7,651,794	0.0539	0.0558	0.0538
FL	May	17	4,712,657	2,661,594	7,508,591	0.0530	0.0543	0.0527
FL	May	18	4,578,167	2,542,934	7,229,033	0.0515	0.0519	0.0508
FL	May	19	4,537,772	2,516,298	7,101,309	0.0510	0.0514	0.0499
FL	May	20	4,395,449	2,403,361	6,791,659	0.0494	0.0491	0.0477
FL	May	21	3,973,920	2,134,501	6,149,474	0.0447	0.0436	0.0432
FL	May	22	3,509,330	1,847,059	5,393,998	0.0395	0.0377	0.0379
FL	May	23	3,010,341	1,559,934	4,744,853	0.0339	0.0319	0.0333
FL	Jun	0	2,327,977	1,218,145	4,260,414	0.0292	0.0277	0.0307
FL	Jun	1	2,170,264	1,120,203	4,058,007	0.0272	0.0254	0.0293
FL	Jun	2	2,087,072	1,061,400	3,928,415	0.0262	0.0241	0.0283
FL	Jun	3	2,049,322	1,027,751	3,878,517	0.0257	0.0233	0.0280
FL	Jun	4	2,110,924	1,074,696	3,972,435	0.0265	0.0244	0.0287
FL	Jun	5	2,262,760	1,191,967	4,205,780	0.0284	0.0271	0.0303
FL	Jun	6	2,413,993	1,314,488	4,465,226	0.0303	0.0299	0.0322
FL	Jun	7	2,773,342	1,503,293	4,951,556	0.0348	0.0341	0.0357
FL	Jun	8	3,209,213	1,786,352	5,594,830	0.0402	0.0406	0.0404
FL	Jun	9	3,631,593	2,050,735	6,222,743	0.0455	0.0466	0.0449
FL	Jun	10	3,909,068	2,236,325	6,667,647	0.0490	0.0508	0.0481
FL	Jun	11	4,142,700	2,366,376	7,050,242	0.0520	0.0537	0.0508
FL	Jun	12	4,280,226	2,453,926	7,283,016	0.0537	0.0557	0.0525
FL	Jun	13	4,329,363	2,497,502	7,406,475	0.0543	0.0567	0.0534
FL	Jun	14	4,342,046	2,501,575	7,447,835	0.0545	0.0568	0.0537
FL	Jun	15	4,373,068	2,492,079	7,424,718	0.0548	0.0566	0.0536

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Jun	16	4,297,804	2,451,182	7,307,677	0.0539	0.0557	0.0527
FL	Jun	17	4,185,382	2,363,754	7,110,051	0.0525	0.0537	0.0513
FL	Jun	18	4,004,746	2,239,952	6,807,106	0.0502	0.0509	0.0491
FL	Jun	19	3,955,616	2,197,245	6,650,925	0.0496	0.0499	0.0480
FL	Jun	20	3,848,942	2,108,853	6,425,375	0.0483	0.0479	0.0463
FL	Jun	21	3,473,837	1,852,184	5,819,896	0.0436	0.0421	0.0420
FL	Jun	22	2,994,965	1,572,011	5,141,817	0.0376	0.0357	0.0371
FL	Jun	23	2,561,929	1,345,153	4,567,964	0.0321	0.0306	0.0329
FL	Jul	0	2,764,634	1,386,971	4,816,291	0.0293	0.0277	0.0307
FL	Jul	1	2,545,942	1,280,746	4,581,235	0.0270	0.0256	0.0292
FL	Jul	2	2,436,428	1,224,798	4,438,465	0.0258	0.0245	0.0283
FL	Jul	3	2,377,262	1,199,963	4,383,175	0.0252	0.0240	0.0279
FL	Jul	4	2,429,436	1,233,367	4,456,088	0.0257	0.0247	0.0284
FL	Jul	5	2,639,313	1,348,365	4,696,660	0.0280	0.0270	0.0299
FL	Jul	6	2,834,109	1,491,803	4,967,819	0.0300	0.0298	0.0316
FL	Jul	7	3,267,863	1,700,966	5,528,838	0.0346	0.0340	0.0352
FL	Jul	8	3,821,763	2,022,891	6,248,963	0.0405	0.0405	0.0398
FL	Jul	9	4,365,148	2,340,596	6,971,523	0.0462	0.0468	0.0444
FL	Jul	10	4,659,769	2,540,243	7,541,648	0.0494	0.0508	0.0480
FL	Jul	11	4,938,917	2,677,430	7,996,631	0.0523	0.0535	0.0509
FL	Jul	12	5,043,492	2,757,728	8,295,607	0.0534	0.0551	0.0528
FL	Jul	13	5,104,851	2,795,003	8,439,245	0.0541	0.0559	0.0537
FL	Jul	14	5,115,175	2,792,514	8,465,961	0.0542	0.0558	0.0539
FL	Jul	15	5,105,309	2,772,194	8,441,744	0.0541	0.0554	0.0537
FL	Jul	16	5,058,076	2,740,193	8,339,669	0.0536	0.0548	0.0531
FL	Jul	17	4,909,169	2,648,749	8,102,609	0.0520	0.0530	0.0516
FL	Jul	18	4,706,304	2,524,426	7,752,706	0.0499	0.0505	0.0494
FL	Jul	19	4,682,476	2,493,147	7,516,717	0.0496	0.0499	0.0479
FL	Jul	20	4,574,717	2,417,075	7,252,137	0.0485	0.0483	0.0462
FL	Jul	21	4,180,311	2,159,689	6,642,740	0.0443	0.0432	0.0423
FL	Jul	22	3,690,444	1,863,713	5,927,220	0.0391	0.0373	0.0377
FL	Jul	23	3,150,654	1,594,768	5,271,908	0.0334	0.0319	0.0336
FL	Aug	0	2,608,883	1,386,882	4,979,830	0.0280	0.0277	0.0310
FL	Aug	1	2,437,417	1,276,225	4,755,731	0.0262	0.0255	0.0296
FL	Aug	2	2,354,421	1,214,270	4,627,584	0.0253	0.0242	0.0288
FL	Aug	3	2,313,626	1,192,577	4,574,524	0.0249	0.0238	0.0285
FL	Aug	4	2,395,781	1,248,024	4,668,581	0.0257	0.0249	0.0291
FL	Aug	5	2,688,209	1,412,342	4,977,943	0.0289	0.0282	0.0310
FL	Aug	6	2,880,070	1,555,155	5,209,770	0.0310	0.0311	0.0324
FL	Aug	7	3,164,114	1,702,356	5,623,819	0.0340	0.0340	0.0350
FL	Aug	8	3,626,746	1,991,233	6,319,345	0.0390	0.0398	0.0393
FL	Aug	9	4,226,563	2,323,985	7,000,308	0.0454	0.0464	0.0436
FL	Aug	10	4,636,871	2,548,869	7,564,068	0.0498	0.0509	0.0471
FL	Aug	11	4,957,215	2,688,031	8,078,386	0.0533	0.0537	0.0503
FL	Aug	12	5,111,701	2,758,274	8,439,913	0.0549	0.0551	0.0526
FL	Aug	13	5,173,346	2,779,967	8,610,449	0.0556	0.0555	0.0536
FL	Aug	14	5,162,257	2,796,689	8,674,792	0.0555	0.0558	0.0540
FL	Aug	15	5,164,485	2,800,364	8,660,851	0.0555	0.0559	0.0539
FL	Aug	16	5,109,262	2,768,931	8,561,034	0.0549	0.0553	0.0533
FL	Aug	17	4,943,811	2,672,121	8,286,667	0.0531	0.0534	0.0516
FL	Aug	18	4,738,381	2,558,304	7,938,631	0.0509	0.0511	0.0494
FL	Aug	19	4,694,499	2,563,794	7,774,096	0.0505	0.0512	0.0484
FL	Aug	20	4,439,949	2,401,878	7,361,739	0.0477	0.0480	0.0458

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Aug	21	3,921,356	2,096,770	6,659,633	0.0421	0.0419	0.0415
FL	Aug	22	3,382,248	1,799,085	5,939,495	0.0364	0.0359	0.0370
FL	Aug	23	2,910,211	1,540,920	5,314,172	0.0313	0.0308	0.0331
FL	Sep	0	2,708,611	1,387,186	4,784,932	0.0290	0.0282	0.0308
FL	Sep	1	2,514,397	1,279,494	4,573,301	0.0269	0.0260	0.0294
FL	Sep	2	2,398,720	1,225,302	4,424,367	0.0257	0.0249	0.0285
FL	Sep	3	2,422,626	1,203,096	4,388,493	0.0260	0.0245	0.0282
FL	Sep	4	2,506,904	1,261,239	4,510,807	0.0269	0.0256	0.0290
FL	Sep	5	2,794,786	1,444,834	4,896,159	0.0299	0.0294	0.0315
FL	Sep	6	3,005,639	1,592,511	5,171,211	0.0322	0.0324	0.0333
FL	Sep	7	3,270,983	1,716,554	5,497,234	0.0350	0.0349	0.0354
FL	Sep	8	3,786,093	2,002,631	6,124,390	0.0406	0.0407	0.0394
FL	Sep	9	4,229,653	2,275,995	6,778,310	0.0453	0.0463	0.0436
FL	Sep	10	4,554,202	2,445,027	7,319,218	0.0488	0.0497	0.0471
FL	Sep	11	4,740,934	2,544,115	7,752,600	0.0508	0.0517	0.0499
FL	Sep	12	4,839,713	2,614,613	8,047,634	0.0518	0.0532	0.0518
FL	Sep	13	4,933,152	2,649,517	8,199,271	0.0528	0.0539	0.0528
FL	Sep	14	4,958,121	2,667,247	8,261,451	0.0531	0.0542	0.0532
FL	Sep	15	5,021,128	2,695,063	8,304,722	0.0538	0.0548	0.0534
FL	Sep	16	5,024,782	2,673,650	8,237,181	0.0538	0.0544	0.0530
FL	Sep	17	4,878,090	2,594,131	8,034,281	0.0523	0.0527	0.0517
FL	Sep	18	4,805,646	2,553,110	7,856,441	0.0515	0.0519	0.0505
FL	Sep	19	4,768,398	2,545,932	7,693,340	0.0511	0.0518	0.0495
FL	Sep	20	4,493,000	2,355,915	7,183,854	0.0481	0.0479	0.0462
FL	Sep	21	4,052,049	2,090,276	6,459,353	0.0434	0.0425	0.0416
FL	Sep	22	3,578,820	1,811,223	5,782,777	0.0383	0.0368	0.0372
FL	Sep	23	3,062,785	1,555,331	5,151,784	0.0328	0.0316	0.0331
FL	Oct	0	2,422,224	1,290,455	4,446,933	0.0288	0.0276	0.0304
FL	Oct	1	2,221,106	1,205,028	4,239,433	0.0264	0.0257	0.0290
FL	Oct	2	2,105,140	1,161,576	4,097,228	0.0250	0.0248	0.0280
FL	Oct	3	2,092,128	1,169,293	4,070,536	0.0248	0.0250	0.0278
FL	Oct	4	2,160,334	1,221,328	4,181,679	0.0257	0.0261	0.0286
FL	Oct	5	2,463,876	1,392,473	4,598,178	0.0293	0.0297	0.0314
FL	Oct	6	2,719,176	1,558,485	4,924,325	0.0323	0.0333	0.0336
FL	Oct	7	2,956,227	1,659,338	5,200,175	0.0351	0.0354	0.0355
FL	Oct	8	3,400,452	1,939,313	5,776,142	0.0404	0.0414	0.0395
FL	Oct	9	3,818,689	2,193,478	6,389,625	0.0453	0.0468	0.0437
FL	Oct	10	4,066,601	2,304,802	6,845,470	0.0483	0.0492	0.0468
FL	Oct	11	4,228,972	2,388,141	7,234,608	0.0502	0.0510	0.0494
FL	Oct	12	4,352,260	2,458,552	7,565,589	0.0517	0.0525	0.0517
FL	Oct	13	4,459,482	2,509,089	7,723,420	0.0530	0.0536	0.0528
FL	Oct	14	4,537,436	2,534,034	7,803,083	0.0539	0.0541	0.0533
FL	Oct	15	4,558,251	2,547,198	7,842,287	0.0541	0.0544	0.0536
FL	Oct	16	4,519,088	2,517,130	7,772,732	0.0537	0.0537	0.0531
FL	Oct	17	4,448,813	2,462,966	7,617,209	0.0528	0.0526	0.0520
FL	Oct	18	4,427,654	2,477,421	7,609,288	0.0526	0.0529	0.0520
FL	Oct	19	4,329,673	2,406,661	7,377,367	0.0514	0.0514	0.0504
FL	Oct	20	4,076,034	2,232,148	6,770,143	0.0484	0.0477	0.0463
FL	Oct	21	3,741,614	2,013,886	6,066,147	0.0444	0.0430	0.0415
FL	Oct	22	3,308,374	1,739,951	5,422,231	0.0393	0.0371	0.0371
FL	Oct	23	2,800,845	1,454,747	4,773,460	0.0333	0.0311	0.0326
FL	Nov	0	1,905,132	1,003,990	3,433,701	0.0316	0.0303	0.0324
FL	Nov	1	1,776,295	942,635	3,297,448	0.0294	0.0285	0.0312

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Nov	2	1,720,649	915,919	3,241,600	0.0285	0.0277	0.0306
FL	Nov	3	1,716,201	912,836	3,232,048	0.0284	0.0276	0.0305
FL	Nov	4	1,752,891	941,352	3,301,467	0.0290	0.0284	0.0312
FL	Nov	5	1,923,578	1,034,631	3,553,069	0.0319	0.0313	0.0336
FL	Nov	6	2,206,824	1,219,971	4,004,690	0.0366	0.0369	0.0378
FL	Nov	7	2,429,823	1,354,748	4,353,493	0.0402	0.0409	0.0411
FL	Nov	8	2,539,198	1,427,671	4,577,180	0.0421	0.0431	0.0432
FL	Nov	9	2,699,341	1,513,974	4,772,232	0.0447	0.0457	0.0451
FL	Nov	10	2,792,366	1,563,604	4,873,110	0.0463	0.0472	0.0460
FL	Nov	11	2,831,979	1,586,315	4,913,748	0.0469	0.0479	0.0464
FL	Nov	12	2,859,948	1,597,981	4,974,149	0.0474	0.0483	0.0470
FL	Nov	13	2,882,171	1,613,453	4,999,215	0.0477	0.0487	0.0472
FL	Nov	14	2,859,560	1,605,351	4,994,232	0.0474	0.0485	0.0472
FL	Nov	15	2,861,307	1,590,790	4,986,532	0.0474	0.0481	0.0471
FL	Nov	16	2,884,918	1,583,826	4,972,123	0.0478	0.0479	0.0470
FL	Nov	17	3,033,337	1,663,972	5,145,039	0.0502	0.0503	0.0486
FL	Nov	18	3,307,458	1,829,838	5,449,317	0.0548	0.0553	0.0515
FL	Nov	19	3,160,750	1,739,759	5,286,470	0.0524	0.0526	0.0499
FL	Nov	20	2,947,565	1,597,543	4,995,779	0.0488	0.0483	0.0472
FL	Nov	21	2,689,128	1,442,497	4,604,876	0.0445	0.0436	0.0435
FL	Nov	22	2,447,020	1,285,405	4,154,027	0.0405	0.0388	0.0392
FL	Nov	23	2,147,528	1,130,622	3,739,137	0.0356	0.0342	0.0353
FL	Dec	0	2,372,123	1,264,648	3,881,404	0.0330	0.0330	0.0347
FL	Dec	1	2,245,185	1,183,650	3,717,536	0.0312	0.0309	0.0333
FL	Dec	2	2,206,899	1,157,339	3,654,568	0.0307	0.0302	0.0327
FL	Dec	3	2,236,869	1,165,095	3,679,289	0.0311	0.0304	0.0329
FL	Dec	4	2,322,902	1,210,969	3,801,230	0.0323	0.0316	0.0340
FL	Dec	5	2,510,538	1,322,618	4,098,961	0.0349	0.0345	0.0367
FL	Dec	6	2,874,429	1,544,008	4,618,700	0.0400	0.0403	0.0413
FL	Dec	7	3,213,825	1,716,219	5,019,009	0.0447	0.0448	0.0449
FL	Dec	8	3,356,460	1,784,855	5,171,955	0.0467	0.0466	0.0463
FL	Dec	9	3,393,441	1,801,923	5,174,899	0.0472	0.0470	0.0463
FL	Dec	10	3,356,634	1,791,702	5,082,097	0.0467	0.0467	0.0455
FL	Dec	11	3,222,421	1,737,039	4,907,740	0.0448	0.0453	0.0439
FL	Dec	12	3,123,973	1,689,904	4,791,163	0.0435	0.0441	0.0429
FL	Dec	13	3,025,463	1,634,947	4,687,544	0.0421	0.0427	0.0420
FL	Dec	14	2,925,363	1,568,048	4,596,479	0.0407	0.0409	0.0411
FL	Dec	15	2,897,980	1,556,949	4,581,226	0.0403	0.0406	0.0410
FL	Dec	16	2,996,515	1,599,374	4,667,701	0.0417	0.0417	0.0418
FL	Dec	17	3,357,392	1,784,690	5,030,380	0.0467	0.0466	0.0450
FL	Dec	18	3,804,081	2,038,224	5,585,788	0.0529	0.0532	0.0500
FL	Dec	19	3,740,986	2,008,136	5,549,078	0.0521	0.0524	0.0497
FL	Dec	20	3,612,719	1,923,594	5,383,213	0.0503	0.0502	0.0482
FL	Dec	21	3,353,392	1,793,466	5,093,614	0.0467	0.0468	0.0456
FL	Dec	22	3,034,792	1,622,585	4,679,589	0.0422	0.0423	0.0419
FL	Dec	23	2,668,864	1,431,479	4,249,530	0.0371	0.0373	0.0380
GA	Jan	0	3,081,484	1,016,202	2,340,253	0.0377	0.0366	0.0369
GA	Jan	1	2,949,286	964,517	2,195,318	0.0361	0.0347	0.0346
GA	Jan	2	2,865,505	936,415	2,126,012	0.0350	0.0337	0.0335
GA	Jan	3	2,900,519	943,348	2,150,704	0.0355	0.0339	0.0339
GA	Jan	4	2,957,851	966,570	2,217,577	0.0362	0.0348	0.0350
GA	Jan	5	3,145,168	1,038,599	2,403,042	0.0385	0.0374	0.0379
GA	Jan	6	3,435,901	1,159,035	2,660,473	0.0420	0.0417	0.0420

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Jan	7	3,604,884	1,224,737	2,834,892	0.0441	0.0441	0.0447
GA	Jan	8	3,628,562	1,254,786	2,879,729	0.0444	0.0451	0.0454
GA	Jan	9	3,688,435	1,273,855	2,917,373	0.0451	0.0458	0.0460
GA	Jan	10	3,677,299	1,270,527	2,895,397	0.0450	0.0457	0.0457
GA	Jan	11	3,615,236	1,245,228	2,829,872	0.0442	0.0448	0.0446
GA	Jan	12	3,539,550	1,221,446	2,764,815	0.0433	0.0439	0.0436
GA	Jan	13	3,470,848	1,199,782	2,719,272	0.0425	0.0432	0.0429
GA	Jan	14	3,378,883	1,167,399	2,656,164	0.0413	0.0420	0.0419
GA	Jan	15	3,380,835	1,159,983	2,647,659	0.0414	0.0417	0.0418
GA	Jan	16	3,387,504	1,158,424	2,648,109	0.0414	0.0417	0.0418
GA	Jan	17	3,476,139	1,193,922	2,719,762	0.0425	0.0429	0.0429
GA	Jan	18	3,714,008	1,288,852	2,925,435	0.0454	0.0464	0.0461
GA	Jan	19	3,729,879	1,296,346	2,945,555	0.0456	0.0466	0.0464
GA	Jan	20	3,677,547	1,272,235	2,884,245	0.0450	0.0458	0.0455
GA	Jan	21	3,662,914	1,258,425	2,847,536	0.0448	0.0453	0.0449
GA	Jan	22	3,513,472	1,196,251	2,711,276	0.0430	0.0430	0.0428
GA	Jan	23	3,274,893	1,092,325	2,495,423	0.0401	0.0393	0.0394
GA	Feb	0	2,595,393	840,335	1,964,091	0.0381	0.0368	0.0374
GA	Feb	1	2,438,479	773,016	1,806,224	0.0358	0.0339	0.0344
GA	Feb	2	2,402,466	761,473	1,772,263	0.0353	0.0334	0.0337
GA	Feb	3	2,430,819	771,214	1,797,003	0.0357	0.0338	0.0342
GA	Feb	4	2,502,545	797,704	1,868,587	0.0367	0.0350	0.0355
GA	Feb	5	2,676,776	872,805	2,052,106	0.0393	0.0383	0.0390
GA	Feb	6	2,954,890	990,105	2,337,884	0.0434	0.0434	0.0445
GA	Feb	7	3,001,646	1,020,225	2,409,980	0.0441	0.0447	0.0458
GA	Feb	8	3,010,620	1,033,092	2,419,402	0.0442	0.0453	0.0460
GA	Feb	9	3,028,005	1,040,937	2,411,898	0.0444	0.0456	0.0459
GA	Feb	10	3,025,164	1,042,323	2,373,556	0.0444	0.0457	0.0452
GA	Feb	11	3,005,101	1,037,541	2,338,672	0.0441	0.0455	0.0445
GA	Feb	12	2,937,709	1,010,754	2,278,298	0.0431	0.0443	0.0433
GA	Feb	13	2,873,477	985,976	2,232,689	0.0422	0.0432	0.0425
GA	Feb	14	2,840,695	969,492	2,199,902	0.0417	0.0425	0.0418
GA	Feb	15	2,823,748	958,191	2,175,080	0.0414	0.0420	0.0414
GA	Feb	16	2,814,802	942,200	2,162,280	0.0413	0.0413	0.0411
GA	Feb	17	2,843,641	945,750	2,176,934	0.0417	0.0415	0.0414
GA	Feb	18	2,993,582	999,573	2,296,217	0.0439	0.0438	0.0437
GA	Feb	19	3,065,711	1,037,202	2,367,065	0.0450	0.0455	0.0450
GA	Feb	20	3,045,727	1,029,512	2,353,794	0.0447	0.0451	0.0448
GA	Feb	21	3,033,325	1,024,219	2,339,301	0.0445	0.0449	0.0445
GA	Feb	22	2,964,313	997,382	2,275,595	0.0435	0.0437	0.0433
GA	Feb	23	2,824,858	933,895	2,157,763	0.0415	0.0409	0.0410
GA	Mar	0	3,417,026	1,057,909	2,624,626	0.0384	0.0380	0.0379
GA	Mar	1	3,223,285	986,736	2,424,761	0.0362	0.0354	0.0350
GA	Mar	2	3,100,577	950,982	2,331,005	0.0348	0.0341	0.0337
GA	Mar	3	3,099,235	951,567	2,335,602	0.0348	0.0341	0.0338
GA	Mar	4	3,160,512	966,120	2,403,292	0.0355	0.0347	0.0347
GA	Mar	5	3,379,124	1,038,161	2,612,688	0.0380	0.0373	0.0378
GA	Mar	6	3,677,933	1,137,574	2,897,527	0.0413	0.0408	0.0419
GA	Mar	7	3,802,103	1,180,891	3,009,686	0.0427	0.0424	0.0435
GA	Mar	8	3,829,788	1,198,884	3,035,573	0.0430	0.0430	0.0439
GA	Mar	9	3,911,099	1,219,591	3,081,701	0.0439	0.0438	0.0445
GA	Mar	10	3,971,013	1,241,090	3,111,307	0.0446	0.0445	0.0450
GA	Mar	11	3,982,510	1,251,231	3,115,945	0.0447	0.0449	0.0450

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Mar	12	3,977,999	1,247,441	3,090,907	0.0447	0.0448	0.0447
GA	Mar	13	3,935,417	1,239,080	3,057,292	0.0442	0.0445	0.0442
GA	Mar	14	3,896,650	1,231,954	3,037,551	0.0438	0.0442	0.0439
GA	Mar	15	3,864,947	1,227,906	3,026,695	0.0434	0.0441	0.0437
GA	Mar	16	3,854,437	1,226,266	3,012,634	0.0433	0.0440	0.0435
GA	Mar	17	3,833,826	1,211,299	2,968,105	0.0431	0.0435	0.0429
GA	Mar	18	3,864,032	1,216,869	2,988,038	0.0434	0.0437	0.0432
GA	Mar	19	4,003,952	1,271,071	3,125,736	0.0450	0.0456	0.0452
GA	Mar	20	3,964,763	1,260,303	3,107,123	0.0445	0.0452	0.0449
GA	Mar	21	3,910,822	1,245,091	3,063,826	0.0439	0.0447	0.0443
GA	Mar	22	3,771,398	1,190,601	2,943,504	0.0424	0.0427	0.0425
GA	Mar	23	3,583,337	1,119,695	2,779,688	0.0403	0.0402	0.0402
GA	Apr	0	2,789,663	843,201	2,174,794	0.0346	0.0337	0.0326
GA	Apr	1	2,548,208	762,521	1,983,443	0.0316	0.0305	0.0298
GA	Apr	2	2,435,657	726,336	1,897,465	0.0302	0.0290	0.0285
GA	Apr	3	2,453,167	728,709	1,906,139	0.0305	0.0291	0.0286
GA	Apr	4	2,618,393	776,135	2,032,694	0.0325	0.0310	0.0305
GA	Apr	5	3,028,015	914,585	2,359,985	0.0376	0.0366	0.0354
GA	Apr	6	3,248,036	998,019	2,550,297	0.0403	0.0399	0.0383
GA	Apr	7	3,387,864	1,048,569	2,678,347	0.0421	0.0419	0.0402
GA	Apr	8	3,516,925	1,096,858	2,792,179	0.0437	0.0438	0.0419
GA	Apr	9	3,601,256	1,129,425	2,901,164	0.0447	0.0451	0.0436
GA	Apr	10	3,660,869	1,154,007	3,010,283	0.0455	0.0461	0.0452
GA	Apr	11	3,685,891	1,165,890	3,083,589	0.0458	0.0466	0.0463
GA	Apr	12	3,690,720	1,170,578	3,143,491	0.0458	0.0468	0.0472
GA	Apr	13	3,712,291	1,177,805	3,220,634	0.0461	0.0471	0.0483
GA	Apr	14	3,730,433	1,186,350	3,265,617	0.0463	0.0474	0.0490
GA	Apr	15	3,754,238	1,194,345	3,303,224	0.0466	0.0477	0.0496
GA	Apr	16	3,738,027	1,186,158	3,287,172	0.0464	0.0474	0.0493
GA	Apr	17	3,679,438	1,161,133	3,232,864	0.0457	0.0464	0.0485
GA	Apr	18	3,578,838	1,122,980	3,121,158	0.0444	0.0449	0.0469
GA	Apr	19	3,725,133	1,172,544	3,227,991	0.0463	0.0469	0.0485
GA	Apr	20	3,791,970	1,189,274	3,240,056	0.0471	0.0475	0.0486
GA	Apr	21	3,651,034	1,132,938	3,033,113	0.0453	0.0453	0.0455
GA	Apr	22	3,386,986	1,039,348	2,724,809	0.0421	0.0415	0.0409
GA	Apr	23	3,109,735	942,129	2,443,848	0.0386	0.0377	0.0367
GA	May	0	2,862,510	703,226	2,229,240	0.0337	0.0321	0.0321
GA	May	1	2,690,290	653,170	2,096,545	0.0317	0.0298	0.0302
GA	May	2	2,628,393	632,035	2,047,433	0.0310	0.0288	0.0295
GA	May	3	2,627,406	630,748	2,046,614	0.0310	0.0287	0.0295
GA	May	4	2,771,990	676,333	2,168,902	0.0327	0.0308	0.0312
GA	May	5	3,111,208	786,240	2,454,397	0.0367	0.0358	0.0354
GA	May	6	3,255,210	828,469	2,571,194	0.0384	0.0378	0.0370
GA	May	7	3,381,486	877,460	2,709,196	0.0398	0.0400	0.0390
GA	May	8	3,592,044	927,355	2,876,947	0.0423	0.0423	0.0414
GA	May	9	3,760,249	983,699	3,017,186	0.0443	0.0448	0.0435
GA	May	10	3,894,932	1,024,621	3,145,229	0.0459	0.0467	0.0453
GA	May	11	3,966,104	1,042,102	3,241,704	0.0467	0.0475	0.0467
GA	May	12	3,984,238	1,053,209	3,316,947	0.0469	0.0480	0.0478
GA	May	13	3,988,683	1,056,839	3,395,215	0.0470	0.0482	0.0489
GA	May	14	4,018,010	1,064,121	3,459,352	0.0473	0.0485	0.0498
GA	May	15	4,048,235	1,069,427	3,488,917	0.0477	0.0487	0.0503
GA	May	16	4,020,133	1,063,467	3,458,272	0.0474	0.0485	0.0498

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	May	17	3,995,337	1,051,934	3,396,551	0.0471	0.0479	0.0489
GA	May	18	3,890,290	1,024,500	3,288,080	0.0458	0.0467	0.0474
GA	May	19	3,894,083	1,029,554	3,276,798	0.0459	0.0469	0.0472
GA	May	20	4,009,084	1,068,147	3,347,594	0.0472	0.0487	0.0482
GA	May	21	3,828,790	1,002,938	3,119,169	0.0451	0.0457	0.0449
GA	May	22	3,489,841	890,368	2,777,349	0.0411	0.0406	0.0400
GA	May	23	3,166,236	799,617	2,495,515	0.0373	0.0364	0.0359
GA	Jun	0	3,008,914	739,466	2,442,026	0.0328	0.0315	0.0311
GA	Jun	1	2,806,664	689,690	2,290,927	0.0306	0.0294	0.0292
GA	Jun	2	2,707,968	661,059	2,214,208	0.0295	0.0282	0.0282
GA	Jun	3	2,658,218	646,893	2,177,901	0.0290	0.0276	0.0278
GA	Jun	4	2,727,775	665,830	2,244,559	0.0297	0.0284	0.0286
GA	Jun	5	2,979,157	728,225	2,453,292	0.0325	0.0311	0.0313
GA	Jun	6	3,220,038	787,563	2,634,034	0.0351	0.0336	0.0336
GA	Jun	7	3,554,723	876,796	2,912,390	0.0387	0.0374	0.0371
GA	Jun	8	3,897,756	960,357	3,200,488	0.0425	0.0409	0.0408
GA	Jun	9	4,211,665	1,074,809	3,481,640	0.0459	0.0458	0.0444
GA	Jun	10	4,401,278	1,155,721	3,684,921	0.0480	0.0493	0.0470
GA	Jun	11	4,499,677	1,182,059	3,814,987	0.0490	0.0504	0.0486
GA	Jun	12	4,474,133	1,191,431	3,917,905	0.0488	0.0508	0.0499
GA	Jun	13	4,468,729	1,191,448	4,024,775	0.0487	0.0508	0.0513
GA	Jun	14	4,444,476	1,167,277	4,045,510	0.0484	0.0498	0.0516
GA	Jun	15	4,453,900	1,174,999	4,081,582	0.0485	0.0501	0.0520
GA	Jun	16	4,435,292	1,170,664	4,040,416	0.0483	0.0499	0.0515
GA	Jun	17	4,420,522	1,162,399	3,983,193	0.0482	0.0496	0.0508
GA	Jun	18	4,323,560	1,125,121	3,854,256	0.0471	0.0480	0.0491
GA	Jun	19	4,300,376	1,114,807	3,762,531	0.0469	0.0475	0.0480
GA	Jun	20	4,400,072	1,149,139	3,788,244	0.0479	0.0490	0.0483
GA	Jun	21	4,232,409	1,079,052	3,558,073	0.0461	0.0460	0.0454
GA	Jun	22	3,771,866	932,998	3,101,363	0.0411	0.0398	0.0395
GA	Jun	23	3,368,903	825,016	2,734,365	0.0367	0.0352	0.0349
GA	Jul	0	3,546,728	850,270	2,801,407	0.0351	0.0327	0.0308
GA	Jul	1	3,286,519	788,821	2,603,679	0.0325	0.0304	0.0286
GA	Jul	2	3,151,827	752,881	2,507,999	0.0312	0.0290	0.0276
GA	Jul	3	3,047,078	727,991	2,439,217	0.0301	0.0280	0.0268
GA	Jul	4	3,076,871	739,541	2,496,442	0.0304	0.0285	0.0275
GA	Jul	5	3,327,006	801,637	2,731,612	0.0329	0.0308	0.0301
GA	Jul	6	3,545,378	862,171	2,936,247	0.0351	0.0332	0.0323
GA	Jul	7	3,886,676	963,246	3,218,154	0.0384	0.0371	0.0354
GA	Jul	8	4,279,139	1,069,723	3,555,188	0.0423	0.0412	0.0391
GA	Jul	9	4,592,856	1,180,153	3,875,590	0.0454	0.0454	0.0426
GA	Jul	10	4,760,474	1,256,275	4,168,707	0.0471	0.0483	0.0459
GA	Jul	11	4,823,385	1,288,919	4,437,842	0.0477	0.0496	0.0488
GA	Jul	12	4,817,667	1,299,954	4,649,944	0.0476	0.0500	0.0512
GA	Jul	13	4,795,180	1,292,611	4,777,930	0.0474	0.0497	0.0526
GA	Jul	14	4,811,790	1,290,783	4,865,630	0.0476	0.0497	0.0535
GA	Jul	15	4,808,412	1,288,459	4,884,975	0.0475	0.0496	0.0537
GA	Jul	16	4,766,908	1,274,466	4,819,432	0.0471	0.0490	0.0530
GA	Jul	17	4,754,857	1,266,101	4,742,004	0.0470	0.0487	0.0522
GA	Jul	18	4,712,471	1,255,183	4,621,128	0.0466	0.0483	0.0508
GA	Jul	19	4,689,089	1,240,539	4,472,248	0.0464	0.0477	0.0492
GA	Jul	20	4,762,284	1,261,497	4,395,554	0.0471	0.0485	0.0484
GA	Jul	21	4,605,730	1,193,090	4,102,357	0.0455	0.0459	0.0451

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Jul	22	4,342,713	1,084,216	3,622,986	0.0429	0.0417	0.0399
GA	Jul	23	3,942,001	959,108	3,166,148	0.0390	0.0369	0.0348
GA	Aug	0	3,347,635	808,884	2,691,013	0.0334	0.0314	0.0300
GA	Aug	1	3,108,946	752,274	2,511,485	0.0311	0.0292	0.0280
GA	Aug	2	2,960,090	714,038	2,394,293	0.0296	0.0278	0.0267
GA	Aug	3	2,891,878	698,505	2,353,093	0.0289	0.0272	0.0262
GA	Aug	4	2,991,531	730,269	2,454,200	0.0299	0.0284	0.0273
GA	Aug	5	3,402,119	839,676	2,803,938	0.0340	0.0326	0.0312
GA	Aug	6	3,610,005	886,341	2,982,179	0.0361	0.0345	0.0332
GA	Aug	7	3,846,318	958,340	3,193,482	0.0384	0.0373	0.0356
GA	Aug	8	4,186,561	1,047,722	3,491,777	0.0418	0.0407	0.0389
GA	Aug	9	4,492,241	1,154,701	3,812,415	0.0449	0.0449	0.0425
GA	Aug	10	4,713,264	1,235,548	4,124,383	0.0471	0.0480	0.0460
GA	Aug	11	4,808,173	1,270,462	4,407,168	0.0480	0.0494	0.0491
GA	Aug	12	4,806,515	1,293,425	4,614,453	0.0480	0.0503	0.0514
GA	Aug	13	4,773,293	1,290,448	4,724,098	0.0477	0.0502	0.0526
GA	Aug	14	4,821,465	1,301,317	4,810,453	0.0482	0.0506	0.0536
GA	Aug	15	4,837,464	1,305,484	4,853,821	0.0483	0.0508	0.0541
GA	Aug	16	4,832,156	1,291,100	4,827,250	0.0483	0.0502	0.0538
GA	Aug	17	4,814,712	1,275,253	4,755,263	0.0481	0.0496	0.0530
GA	Aug	18	4,754,811	1,251,543	4,614,937	0.0475	0.0487	0.0514
GA	Aug	19	4,826,464	1,272,706	4,530,597	0.0482	0.0495	0.0505
GA	Aug	20	4,876,143	1,275,387	4,379,870	0.0487	0.0496	0.0488
GA	Aug	21	4,573,014	1,151,787	3,954,395	0.0457	0.0448	0.0441
GA	Aug	22	4,147,761	1,020,685	3,456,135	0.0414	0.0397	0.0385
GA	Aug	23	3,683,286	896,764	2,996,067	0.0368	0.0349	0.0334
GA	Sep	0	3,009,475	732,602	2,389,452	0.0333	0.0315	0.0311
GA	Sep	1	2,798,361	679,069	2,226,087	0.0310	0.0292	0.0289
GA	Sep	2	2,730,489	658,755	2,169,827	0.0302	0.0284	0.0282
GA	Sep	3	2,694,962	650,082	2,146,182	0.0299	0.0280	0.0279
GA	Sep	4	2,844,595	690,083	2,286,997	0.0315	0.0297	0.0297
GA	Sep	5	3,271,242	804,912	2,648,378	0.0362	0.0347	0.0344
GA	Sep	6	3,475,122	873,271	2,813,105	0.0385	0.0376	0.0366
GA	Sep	7	3,575,292	911,489	2,905,325	0.0396	0.0392	0.0378
GA	Sep	8	3,818,349	976,568	3,110,425	0.0423	0.0420	0.0404
GA	Sep	9	4,063,853	1,059,168	3,313,946	0.0450	0.0456	0.0431
GA	Sep	10	4,195,567	1,099,444	3,453,831	0.0465	0.0473	0.0449
GA	Sep	11	4,258,319	1,122,130	3,626,506	0.0472	0.0483	0.0471
GA	Sep	12	4,247,401	1,130,052	3,763,897	0.0471	0.0486	0.0489
GA	Sep	13	4,216,303	1,120,233	3,851,069	0.0467	0.0482	0.0501
GA	Sep	14	4,286,977	1,145,800	3,947,648	0.0475	0.0493	0.0513
GA	Sep	15	4,298,266	1,143,880	3,969,173	0.0476	0.0492	0.0516
GA	Sep	16	4,300,760	1,143,304	3,959,467	0.0476	0.0492	0.0515
GA	Sep	17	4,286,809	1,132,268	3,923,210	0.0475	0.0487	0.0510
GA	Sep	18	4,251,737	1,123,463	3,856,901	0.0471	0.0484	0.0501
GA	Sep	19	4,338,120	1,158,585	3,854,147	0.0481	0.0499	0.0501
GA	Sep	20	4,312,678	1,136,506	3,701,142	0.0478	0.0489	0.0481
GA	Sep	21	4,033,318	1,020,758	3,369,190	0.0447	0.0439	0.0438
GA	Sep	22	3,628,268	896,583	2,958,396	0.0402	0.0386	0.0385
GA	Sep	23	3,330,058	819,207	2,674,563	0.0369	0.0353	0.0348
GA	Oct	0	3,024,341	843,008	2,383,057	0.0348	0.0336	0.0331
GA	Oct	1	2,835,764	790,684	2,225,640	0.0327	0.0316	0.0309
GA	Oct	2	2,752,610	762,589	2,164,809	0.0317	0.0304	0.0301

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Oct	3	2,749,874	759,496	2,172,202	0.0317	0.0303	0.0302
GA	Oct	4	2,925,267	814,974	2,339,237	0.0337	0.0325	0.0325
GA	Oct	5	3,390,126	957,805	2,735,597	0.0391	0.0382	0.0380
GA	Oct	6	3,644,766	1,053,423	2,957,529	0.0420	0.0420	0.0411
GA	Oct	7	3,660,429	1,059,395	2,981,953	0.0422	0.0423	0.0414
GA	Oct	8	3,834,979	1,104,456	3,135,991	0.0442	0.0441	0.0435
GA	Oct	9	3,978,480	1,172,051	3,273,242	0.0458	0.0468	0.0454
GA	Oct	10	4,041,725	1,196,557	3,340,349	0.0466	0.0478	0.0464
GA	Oct	11	4,032,502	1,190,421	3,367,673	0.0465	0.0475	0.0468
GA	Oct	12	3,991,285	1,180,209	3,400,795	0.0460	0.0471	0.0472
GA	Oct	13	3,956,405	1,169,035	3,416,843	0.0456	0.0467	0.0474
GA	Oct	14	3,980,852	1,165,158	3,442,999	0.0459	0.0465	0.0478
GA	Oct	15	3,909,246	1,138,307	3,384,935	0.0450	0.0454	0.0470
GA	Oct	16	3,835,247	1,114,350	3,316,197	0.0442	0.0445	0.0460
GA	Oct	17	3,770,204	1,083,946	3,244,010	0.0434	0.0433	0.0450
GA	Oct	18	3,991,327	1,166,302	3,396,098	0.0460	0.0465	0.0471
GA	Oct	19	3,985,946	1,167,536	3,396,720	0.0459	0.0466	0.0472
GA	Oct	20	3,922,570	1,139,658	3,307,415	0.0452	0.0455	0.0459
GA	Oct	21	3,769,072	1,081,326	3,114,572	0.0434	0.0432	0.0432
GA	Oct	22	3,537,128	1,016,710	2,881,077	0.0408	0.0406	0.0400
GA	Oct	23	3,272,925	930,983	2,649,678	0.0377	0.0372	0.0368
GA	Nov	0	2,391,540	713,386	1,844,139	0.0363	0.0359	0.0358
GA	Nov	1	2,191,833	658,568	1,701,295	0.0333	0.0332	0.0330
GA	Nov	2	2,170,324	652,284	1,686,387	0.0330	0.0329	0.0327
GA	Nov	3	2,192,867	661,412	1,703,475	0.0333	0.0333	0.0330
GA	Nov	4	2,265,811	681,905	1,761,688	0.0344	0.0344	0.0342
GA	Nov	5	2,471,430	744,993	1,921,015	0.0376	0.0375	0.0373
GA	Nov	6	2,798,410	840,649	2,193,449	0.0425	0.0424	0.0425
GA	Nov	7	2,928,754	876,343	2,324,481	0.0445	0.0442	0.0451
GA	Nov	8	2,932,187	883,546	2,332,659	0.0446	0.0445	0.0452
GA	Nov	9	2,970,055	906,636	2,360,401	0.0451	0.0457	0.0458
GA	Nov	10	2,977,862	907,208	2,361,423	0.0453	0.0457	0.0458
GA	Nov	11	2,950,498	894,889	2,328,479	0.0448	0.0451	0.0452
GA	Nov	12	2,879,839	866,218	2,260,493	0.0438	0.0436	0.0438
GA	Nov	13	2,817,301	850,405	2,217,301	0.0428	0.0428	0.0430
GA	Nov	14	2,783,968	836,638	2,184,224	0.0423	0.0422	0.0424
GA	Nov	15	2,747,955	823,644	2,150,294	0.0418	0.0415	0.0417
GA	Nov	16	2,747,342	824,060	2,154,890	0.0418	0.0415	0.0418
GA	Nov	17	2,907,624	874,351	2,282,999	0.0442	0.0441	0.0443
GA	Nov	18	3,128,326	954,355	2,461,924	0.0475	0.0481	0.0477
GA	Nov	19	3,033,620	921,971	2,385,076	0.0461	0.0465	0.0463
GA	Nov	20	3,004,830	909,942	2,359,263	0.0457	0.0458	0.0458
GA	Nov	21	2,997,472	905,166	2,334,964	0.0456	0.0456	0.0453
GA	Nov	22	2,891,353	874,720	2,239,642	0.0439	0.0441	0.0434
GA	Nov	23	2,622,194	784,878	2,017,294	0.0398	0.0395	0.0391
GA	Dec	0	3,184,757	911,373	2,349,473	0.0374	0.0377	0.0372
GA	Dec	1	3,044,448	869,162	2,236,648	0.0358	0.0360	0.0354
GA	Dec	2	3,001,849	858,234	2,204,723	0.0353	0.0355	0.0349
GA	Dec	3	3,042,393	871,163	2,238,095	0.0357	0.0360	0.0354
GA	Dec	4	3,115,407	893,785	2,299,144	0.0366	0.0370	0.0364
GA	Dec	5	3,356,710	963,853	2,484,849	0.0394	0.0399	0.0393
GA	Dec	6	3,601,980	1,025,340	2,675,314	0.0423	0.0424	0.0424
GA	Dec	7	3,774,865	1,075,306	2,813,304	0.0443	0.0445	0.0445

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Dec	8	3,846,502	1,092,262	2,872,706	0.0452	0.0452	0.0455
GA	Dec	9	3,964,116	1,120,959	2,954,298	0.0466	0.0464	0.0468
GA	Dec	10	3,941,586	1,110,828	2,922,525	0.0463	0.0460	0.0463
GA	Dec	11	3,833,348	1,080,541	2,832,270	0.0450	0.0447	0.0448
GA	Dec	12	3,655,005	1,022,879	2,690,751	0.0429	0.0423	0.0426
GA	Dec	13	3,486,128	974,802	2,572,520	0.0409	0.0403	0.0407
GA	Dec	14	3,379,358	946,052	2,491,664	0.0397	0.0391	0.0394
GA	Dec	15	3,341,646	939,716	2,470,131	0.0393	0.0389	0.0391
GA	Dec	16	3,381,507	951,842	2,500,962	0.0397	0.0394	0.0396
GA	Dec	17	3,641,599	1,033,032	2,713,281	0.0428	0.0427	0.0430
GA	Dec	18	3,905,537	1,111,357	2,920,685	0.0459	0.0460	0.0462
GA	Dec	19	3,847,743	1,093,998	2,882,576	0.0452	0.0453	0.0456
GA	Dec	20	3,836,009	1,097,050	2,878,995	0.0451	0.0454	0.0456
GA	Dec	21	3,842,983	1,102,271	2,880,206	0.0451	0.0456	0.0456
GA	Dec	22	3,711,113	1,058,039	2,766,944	0.0436	0.0438	0.0438
GA	Dec	23	3,398,724	969,035	2,518,529	0.0399	0.0401	0.0399
KY	Jan	0	3,403,668	1,530,327	3,227,175	0.0385	0.0389	0.0388
KY	Jan	1	3,356,459	1,515,572	3,189,213	0.0380	0.0386	0.0383
KY	Jan	2	3,351,496	1,510,032	3,178,874	0.0379	0.0384	0.0382
KY	Jan	3	3,325,442	1,511,114	3,172,865	0.0376	0.0385	0.0381
KY	Jan	4	3,383,306	1,536,046	3,221,053	0.0383	0.0391	0.0387
KY	Jan	5	3,481,136	1,581,741	3,309,261	0.0394	0.0402	0.0398
KY	Jan	6	3,716,104	1,654,464	3,492,098	0.0420	0.0421	0.0420
KY	Jan	7	3,877,206	1,705,939	3,595,334	0.0439	0.0434	0.0432
KY	Jan	8	3,840,350	1,712,259	3,617,341	0.0434	0.0436	0.0435
KY	Jan	9	3,876,148	1,712,579	3,623,036	0.0439	0.0436	0.0436
KY	Jan	10	3,875,302	1,709,885	3,616,547	0.0438	0.0435	0.0435
KY	Jan	11	3,812,307	1,688,952	3,570,206	0.0431	0.0430	0.0429
KY	Jan	12	3,758,419	1,676,231	3,541,721	0.0425	0.0427	0.0426
KY	Jan	13	3,737,421	1,657,035	3,523,255	0.0423	0.0422	0.0424
KY	Jan	14	3,687,918	1,635,905	3,475,817	0.0417	0.0416	0.0418
KY	Jan	15	3,686,011	1,635,068	3,458,763	0.0417	0.0416	0.0416
KY	Jan	16	3,673,933	1,630,127	3,465,012	0.0416	0.0415	0.0417
KY	Jan	17	3,800,622	1,680,994	3,563,265	0.0430	0.0428	0.0428
KY	Jan	18	3,927,434	1,728,430	3,662,176	0.0444	0.0440	0.0440
KY	Jan	19	3,915,752	1,715,930	3,660,602	0.0443	0.0437	0.0440
KY	Jan	20	3,901,330	1,713,194	3,647,940	0.0441	0.0436	0.0439
KY	Jan	21	3,826,253	1,677,239	3,588,814	0.0433	0.0427	0.0431
KY	Jan	22	3,685,571	1,626,726	3,471,996	0.0417	0.0414	0.0417
KY	Jan	23	3,487,190	1,552,179	3,313,659	0.0395	0.0395	0.0398
KY	Feb	0	2,829,863	1,334,316	2,804,656	0.0387	0.0387	0.0388
KY	Feb	1	2,783,432	1,319,681	2,762,629	0.0381	0.0383	0.0383
KY	Feb	2	2,780,312	1,327,383	2,758,522	0.0380	0.0385	0.0382
KY	Feb	3	2,783,437	1,334,391	2,765,908	0.0381	0.0388	0.0383
KY	Feb	4	2,808,633	1,347,084	2,794,191	0.0384	0.0391	0.0387
KY	Feb	5	2,893,613	1,392,134	2,876,104	0.0396	0.0404	0.0398
KY	Feb	6	3,124,498	1,466,306	3,062,707	0.0427	0.0426	0.0424
KY	Feb	7	3,220,300	1,510,175	3,174,431	0.0440	0.0439	0.0440
KY	Feb	8	3,220,342	1,519,438	3,190,584	0.0440	0.0441	0.0442
KY	Feb	9	3,234,938	1,509,214	3,179,580	0.0442	0.0438	0.0440
KY	Feb	10	3,219,423	1,487,640	3,151,346	0.0440	0.0432	0.0436
KY	Feb	11	3,171,385	1,464,205	3,102,736	0.0434	0.0425	0.0430
KY	Feb	12	3,118,981	1,450,126	3,075,598	0.0426	0.0421	0.0426

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Feb	13	3,087,740	1,438,494	3,039,064	0.0422	0.0418	0.0421
KY	Feb	14	3,041,776	1,425,843	3,006,107	0.0416	0.0414	0.0416
KY	Feb	15	2,962,587	1,405,630	2,960,468	0.0405	0.0408	0.0410
KY	Feb	16	2,969,604	1,420,115	2,969,838	0.0406	0.0412	0.0411
KY	Feb	17	3,025,983	1,444,163	3,011,747	0.0414	0.0419	0.0417
KY	Feb	18	3,175,924	1,502,240	3,122,661	0.0434	0.0436	0.0432
KY	Feb	19	3,239,455	1,525,694	3,182,281	0.0443	0.0443	0.0441
KY	Feb	20	3,241,346	1,515,277	3,170,633	0.0443	0.0440	0.0439
KY	Feb	21	3,203,555	1,497,237	3,139,781	0.0438	0.0435	0.0435
KY	Feb	22	3,087,236	1,431,626	3,020,520	0.0422	0.0416	0.0418
KY	Feb	23	2,924,098	1,367,233	2,892,185	0.0400	0.0397	0.0401
KY	Mar	0	3,185,786	1,597,308	3,209,200	0.0385	0.0388	0.0388
KY	Mar	1	3,145,216	1,580,585	3,162,086	0.0380	0.0384	0.0382
KY	Mar	2	3,127,009	1,566,619	3,138,402	0.0378	0.0381	0.0379
KY	Mar	3	3,132,252	1,561,969	3,135,774	0.0379	0.0380	0.0379
KY	Mar	4	3,173,696	1,582,742	3,172,277	0.0384	0.0385	0.0383
KY	Mar	5	3,232,720	1,637,221	3,260,566	0.0391	0.0398	0.0394
KY	Mar	6	3,393,169	1,699,015	3,430,167	0.0410	0.0413	0.0414
KY	Mar	7	3,458,281	1,723,061	3,534,234	0.0418	0.0419	0.0427
KY	Mar	8	3,509,975	1,758,137	3,589,716	0.0424	0.0428	0.0434
KY	Mar	9	3,597,920	1,785,203	3,617,826	0.0435	0.0434	0.0437
KY	Mar	10	3,613,242	1,790,499	3,613,791	0.0437	0.0435	0.0436
KY	Mar	11	3,584,905	1,768,236	3,576,422	0.0433	0.0430	0.0432
KY	Mar	12	3,544,290	1,749,911	3,544,251	0.0428	0.0426	0.0428
KY	Mar	13	3,655,282	1,819,021	3,611,132	0.0442	0.0442	0.0436
KY	Mar	14	3,535,794	1,757,290	3,530,484	0.0427	0.0427	0.0426
KY	Mar	15	3,546,558	1,753,426	3,525,239	0.0429	0.0426	0.0426
KY	Mar	16	3,520,012	1,740,871	3,508,906	0.0425	0.0423	0.0424
KY	Mar	17	3,555,166	1,752,176	3,520,024	0.0430	0.0426	0.0425
KY	Mar	18	3,597,891	1,773,745	3,559,003	0.0435	0.0431	0.0430
KY	Mar	19	3,662,983	1,805,934	3,622,700	0.0443	0.0439	0.0438
KY	Mar	20	3,642,846	1,799,363	3,611,867	0.0440	0.0438	0.0436
KY	Mar	21	3,573,836	1,771,991	3,563,435	0.0432	0.0431	0.0430
KY	Mar	22	3,447,860	1,712,142	3,455,996	0.0417	0.0416	0.0417
KY	Mar	23	3,297,612	1,637,915	3,308,824	0.0399	0.0398	0.0400
KY	Apr	0	2,652,782	1,256,983	2,775,278	0.0366	0.0376	0.0372
KY	Apr	1	2,578,533	1,240,530	2,714,866	0.0355	0.0371	0.0364
KY	Apr	2	2,539,099	1,232,367	2,680,329	0.0350	0.0368	0.0360
KY	Apr	3	2,563,228	1,243,106	2,702,289	0.0353	0.0371	0.0363
KY	Apr	4	2,669,459	1,277,918	2,797,385	0.0368	0.0382	0.0375
KY	Apr	5	2,868,256	1,356,584	2,960,670	0.0395	0.0405	0.0397
KY	Apr	6	3,043,737	1,395,220	3,089,577	0.0420	0.0417	0.0414
KY	Apr	7	3,081,560	1,412,219	3,135,179	0.0425	0.0422	0.0421
KY	Apr	8	3,152,613	1,434,867	3,196,901	0.0435	0.0429	0.0429
KY	Apr	9	3,213,817	1,454,516	3,250,449	0.0443	0.0435	0.0436
KY	Apr	10	3,201,104	1,460,987	3,265,708	0.0441	0.0437	0.0438
KY	Apr	11	3,227,748	1,462,574	3,283,978	0.0445	0.0437	0.0441
KY	Apr	12	3,244,155	1,469,970	3,296,417	0.0447	0.0439	0.0442
KY	Apr	13	3,294,530	1,512,286	3,349,575	0.0454	0.0452	0.0449
KY	Apr	14	3,225,863	1,467,375	3,300,463	0.0445	0.0438	0.0443
KY	Apr	15	3,246,863	1,474,433	3,297,745	0.0448	0.0441	0.0442
KY	Apr	16	3,181,718	1,445,314	3,259,483	0.0439	0.0432	0.0437
KY	Apr	17	3,142,674	1,442,521	3,241,339	0.0433	0.0431	0.0435

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Apr	18	3,126,256	1,431,467	3,235,488	0.0431	0.0428	0.0434
KY	Apr	19	3,223,590	1,471,310	3,303,417	0.0444	0.0440	0.0443
KY	Apr	20	3,246,443	1,484,013	3,316,619	0.0447	0.0443	0.0445
KY	Apr	21	3,119,964	1,426,202	3,195,581	0.0430	0.0426	0.0429
KY	Apr	22	2,927,566	1,333,595	3,018,570	0.0404	0.0398	0.0405
KY	Apr	23	2,775,468	1,281,398	2,876,956	0.0383	0.0383	0.0386
KY	May	0	2,753,698	1,001,149	2,871,635	0.0358	0.0358	0.0372
KY	May	1	2,690,840	975,009	2,799,305	0.0350	0.0348	0.0363
KY	May	2	2,641,386	961,985	2,759,918	0.0343	0.0344	0.0358
KY	May	3	2,653,648	968,606	2,776,235	0.0345	0.0346	0.0360
KY	May	4	2,758,274	1,006,456	2,854,851	0.0358	0.0360	0.0370
KY	May	5	2,962,969	1,077,012	3,006,024	0.0385	0.0385	0.0390
KY	May	6	3,108,173	1,131,439	3,108,291	0.0404	0.0404	0.0403
KY	May	7	3,246,123	1,175,456	3,201,514	0.0422	0.0420	0.0415
KY	May	8	3,362,209	1,211,559	3,282,879	0.0437	0.0433	0.0426
KY	May	9	3,412,737	1,231,691	3,338,533	0.0443	0.0440	0.0433
KY	May	10	3,427,604	1,243,925	3,367,381	0.0445	0.0445	0.0437
KY	May	11	3,445,882	1,259,701	3,388,882	0.0448	0.0450	0.0440
KY	May	12	3,464,924	1,274,611	3,423,353	0.0450	0.0456	0.0444
KY	May	13	3,475,586	1,272,090	3,438,235	0.0451	0.0455	0.0446
KY	May	14	3,473,027	1,265,149	3,444,229	0.0451	0.0452	0.0447
KY	May	15	3,500,580	1,270,320	3,469,372	0.0455	0.0454	0.0450
KY	May	16	3,485,066	1,268,396	3,459,248	0.0453	0.0453	0.0449
KY	May	17	3,468,876	1,263,917	3,440,084	0.0451	0.0452	0.0446
KY	May	18	3,415,836	1,236,715	3,384,093	0.0444	0.0442	0.0439
KY	May	19	3,432,299	1,242,014	3,387,275	0.0446	0.0444	0.0439
KY	May	20	3,473,176	1,256,092	3,432,270	0.0451	0.0449	0.0445
KY	May	21	3,319,166	1,202,820	3,321,394	0.0431	0.0430	0.0431
KY	May	22	3,091,184	1,121,825	3,142,247	0.0402	0.0401	0.0408
KY	May	23	2,917,373	1,062,287	3,000,545	0.0379	0.0380	0.0389
KY	Jun	0	3,087,977	1,098,570	3,176,102	0.0362	0.0360	0.0371
KY	Jun	1	2,953,012	1,055,620	3,065,944	0.0346	0.0346	0.0358
KY	Jun	2	2,865,983	1,026,659	2,979,935	0.0336	0.0336	0.0348
KY	Jun	3	2,843,390	1,017,902	2,959,134	0.0333	0.0333	0.0346
KY	Jun	4	2,906,264	1,041,091	3,002,535	0.0341	0.0341	0.0351
KY	Jun	5	3,059,048	1,099,966	3,110,267	0.0359	0.0360	0.0363
KY	Jun	6	3,204,088	1,146,437	3,221,607	0.0376	0.0375	0.0376
KY	Jun	7	3,421,248	1,229,315	3,394,164	0.0401	0.0402	0.0397
KY	Jun	8	3,621,947	1,293,765	3,549,992	0.0425	0.0424	0.0415
KY	Jun	9	3,760,733	1,348,936	3,668,349	0.0441	0.0442	0.0429
KY	Jun	10	3,834,572	1,383,306	3,737,507	0.0450	0.0453	0.0437
KY	Jun	11	3,901,548	1,400,903	3,812,157	0.0457	0.0459	0.0445
KY	Jun	12	3,932,342	1,414,479	3,876,596	0.0461	0.0463	0.0453
KY	Jun	13	3,949,981	1,415,226	3,927,136	0.0463	0.0463	0.0459
KY	Jun	14	3,967,478	1,427,059	3,976,104	0.0465	0.0467	0.0465
KY	Jun	15	3,987,835	1,442,622	4,004,468	0.0468	0.0472	0.0468
KY	Jun	16	3,986,667	1,438,679	4,016,540	0.0467	0.0471	0.0469
KY	Jun	17	3,947,074	1,417,526	3,972,265	0.0463	0.0464	0.0464
KY	Jun	18	3,898,341	1,390,335	3,897,748	0.0457	0.0455	0.0455
KY	Jun	19	3,863,192	1,374,134	3,842,399	0.0453	0.0450	0.0449
KY	Jun	20	3,830,039	1,369,835	3,822,773	0.0449	0.0448	0.0447
KY	Jun	21	3,697,446	1,320,277	3,717,975	0.0433	0.0432	0.0434
KY	Jun	22	3,490,495	1,234,849	3,519,303	0.0409	0.0404	0.0411

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Jun	23	3,283,126	1,155,437	3,327,095	0.0385	0.0378	0.0389
KY	Jul	0	3,525,121	1,331,886	3,534,514	0.0380	0.0378	0.0369
KY	Jul	1	3,355,237	1,278,905	3,408,333	0.0361	0.0363	0.0356
KY	Jul	2	3,215,415	1,229,615	3,298,801	0.0346	0.0349	0.0345
KY	Jul	3	3,168,227	1,212,003	3,261,769	0.0341	0.0344	0.0341
KY	Jul	4	3,215,166	1,224,381	3,286,885	0.0346	0.0348	0.0343
KY	Jul	5	3,321,384	1,263,814	3,351,338	0.0358	0.0359	0.0350
KY	Jul	6	3,465,319	1,306,343	3,461,501	0.0373	0.0371	0.0362
KY	Jul	7	3,664,746	1,400,810	3,650,990	0.0395	0.0398	0.0381
KY	Jul	8	3,915,678	1,481,616	3,827,253	0.0422	0.0421	0.0400
KY	Jul	9	4,100,617	1,552,676	4,009,935	0.0442	0.0441	0.0419
KY	Jul	10	4,141,842	1,573,982	4,151,119	0.0446	0.0447	0.0434
KY	Jul	11	4,190,991	1,589,808	4,298,228	0.0451	0.0451	0.0449
KY	Jul	12	4,219,096	1,595,652	4,395,777	0.0454	0.0453	0.0459
KY	Jul	13	4,213,583	1,604,227	4,467,887	0.0454	0.0456	0.0467
KY	Jul	14	4,224,360	1,604,273	4,523,244	0.0455	0.0456	0.0473
KY	Jul	15	4,234,207	1,608,449	4,560,024	0.0456	0.0457	0.0476
KY	Jul	16	4,210,072	1,604,432	4,559,755	0.0453	0.0456	0.0476
KY	Jul	17	4,197,444	1,597,634	4,535,354	0.0452	0.0454	0.0474
KY	Jul	18	4,139,296	1,572,406	4,460,260	0.0446	0.0447	0.0466
KY	Jul	19	4,140,343	1,564,292	4,380,970	0.0446	0.0444	0.0458
KY	Jul	20	4,179,115	1,575,403	4,341,558	0.0450	0.0447	0.0454
KY	Jul	21	4,131,951	1,553,267	4,232,940	0.0445	0.0441	0.0442
KY	Jul	22	3,957,477	1,482,271	3,988,890	0.0426	0.0421	0.0417
KY	Jul	23	3,744,010	1,407,561	3,729,233	0.0403	0.0400	0.0390
KY	Aug	0	3,544,915	1,202,709	3,469,105	0.0367	0.0363	0.0368
KY	Aug	1	3,422,524	1,164,603	3,357,856	0.0355	0.0352	0.0356
KY	Aug	2	3,338,501	1,132,562	3,267,414	0.0346	0.0342	0.0347
KY	Aug	3	3,293,103	1,128,706	3,236,508	0.0341	0.0341	0.0343
KY	Aug	4	3,335,828	1,148,595	3,300,443	0.0346	0.0347	0.0350
KY	Aug	5	3,491,034	1,206,789	3,412,044	0.0362	0.0364	0.0362
KY	Aug	6	3,642,600	1,243,553	3,522,178	0.0377	0.0375	0.0374
KY	Aug	7	3,835,140	1,323,473	3,678,395	0.0397	0.0400	0.0390
KY	Aug	8	4,073,626	1,399,971	3,843,845	0.0422	0.0423	0.0408
KY	Aug	9	4,251,294	1,455,968	4,003,870	0.0441	0.0440	0.0425
KY	Aug	10	4,347,259	1,489,535	4,136,920	0.0450	0.0450	0.0439
KY	Aug	11	4,378,717	1,508,733	4,256,480	0.0454	0.0456	0.0452
KY	Aug	12	4,393,903	1,524,118	4,329,887	0.0455	0.0460	0.0460
KY	Aug	13	4,422,976	1,539,768	4,406,800	0.0458	0.0465	0.0468
KY	Aug	14	4,437,716	1,547,653	4,443,495	0.0460	0.0467	0.0472
KY	Aug	15	4,440,542	1,551,651	4,459,320	0.0460	0.0468	0.0473
KY	Aug	16	4,425,588	1,545,263	4,454,603	0.0459	0.0467	0.0473
KY	Aug	17	4,413,783	1,524,853	4,409,269	0.0457	0.0460	0.0468
KY	Aug	18	4,380,936	1,494,913	4,303,740	0.0454	0.0451	0.0457
KY	Aug	19	4,392,024	1,496,749	4,251,095	0.0455	0.0452	0.0451
KY	Aug	20	4,379,610	1,485,377	4,217,501	0.0454	0.0448	0.0448
KY	Aug	21	4,210,888	1,417,089	4,044,108	0.0436	0.0428	0.0429
KY	Aug	22	3,941,472	1,332,682	3,817,994	0.0408	0.0402	0.0405
KY	Aug	23	3,707,933	1,256,482	3,599,411	0.0384	0.0379	0.0382
KY	Sep	0	2,964,289	996,485	2,919,930	0.0361	0.0357	0.0362
KY	Sep	1	2,870,382	964,072	2,840,432	0.0349	0.0346	0.0352
KY	Sep	2	2,787,976	943,915	2,779,477	0.0339	0.0339	0.0345
KY	Sep	3	2,804,532	948,776	2,769,609	0.0341	0.0340	0.0343

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Sep	4	2,898,744	989,718	2,857,648	0.0353	0.0355	0.0354
KY	Sep	5	3,081,772	1,060,568	2,995,084	0.0375	0.0380	0.0371
KY	Sep	6	3,215,608	1,097,097	3,121,585	0.0391	0.0394	0.0387
KY	Sep	7	3,304,284	1,130,784	3,199,454	0.0402	0.0406	0.0397
KY	Sep	8	3,434,411	1,171,758	3,315,509	0.0418	0.0420	0.0411
KY	Sep	9	3,570,839	1,209,673	3,424,910	0.0434	0.0434	0.0425
KY	Sep	10	3,678,814	1,241,639	3,519,188	0.0448	0.0445	0.0436
KY	Sep	11	3,750,708	1,270,557	3,614,918	0.0456	0.0456	0.0448
KY	Sep	12	3,773,180	1,277,130	3,679,481	0.0459	0.0458	0.0456
KY	Sep	13	3,801,227	1,289,703	3,743,219	0.0462	0.0463	0.0464
KY	Sep	14	3,800,140	1,297,044	3,787,747	0.0462	0.0465	0.0470
KY	Sep	15	3,795,994	1,302,319	3,801,880	0.0462	0.0467	0.0471
KY	Sep	16	3,783,543	1,300,148	3,796,428	0.0460	0.0466	0.0471
KY	Sep	17	3,771,127	1,286,477	3,763,923	0.0459	0.0461	0.0467
KY	Sep	18	3,765,419	1,275,206	3,722,780	0.0458	0.0457	0.0462
KY	Sep	19	3,791,830	1,277,823	3,716,984	0.0461	0.0458	0.0461
KY	Sep	20	3,740,714	1,250,721	3,633,445	0.0455	0.0449	0.0451
KY	Sep	21	3,500,976	1,175,689	3,423,771	0.0426	0.0422	0.0425
KY	Sep	22	3,242,851	1,088,648	3,194,804	0.0395	0.0391	0.0396
KY	Sep	23	3,065,835	1,031,663	3,021,684	0.0373	0.0370	0.0375
KY	Oct	0	2,278,896	1,039,501	2,586,750	0.0366	0.0376	0.0376
KY	Oct	1	2,227,233	1,020,526	2,543,419	0.0358	0.0369	0.0370
KY	Oct	2	2,198,399	1,012,344	2,512,024	0.0354	0.0366	0.0365
KY	Oct	3	2,212,904	1,021,216	2,525,691	0.0356	0.0369	0.0367
KY	Oct	4	2,311,335	1,052,998	2,608,913	0.0372	0.0381	0.0379
KY	Oct	5	2,469,785	1,101,259	2,726,671	0.0397	0.0398	0.0397
KY	Oct	6	2,637,419	1,158,074	2,862,691	0.0424	0.0419	0.0416
KY	Oct	7	2,693,406	1,176,028	2,913,310	0.0433	0.0426	0.0424
KY	Oct	8	2,729,754	1,188,281	2,952,105	0.0439	0.0430	0.0429
KY	Oct	9	2,757,119	1,192,403	2,993,360	0.0443	0.0431	0.0435
KY	Oct	10	2,723,051	1,187,873	2,995,231	0.0438	0.0430	0.0436
KY	Oct	11	2,720,381	1,189,661	3,007,614	0.0437	0.0430	0.0437
KY	Oct	12	2,714,978	1,194,446	3,011,627	0.0437	0.0432	0.0438
KY	Oct	13	2,707,186	1,199,090	3,009,588	0.0435	0.0434	0.0438
KY	Oct	14	2,706,257	1,197,544	2,994,231	0.0435	0.0433	0.0436
KY	Oct	15	2,711,523	1,203,563	2,996,320	0.0436	0.0435	0.0436
KY	Oct	16	2,723,684	1,210,665	3,000,402	0.0438	0.0438	0.0436
KY	Oct	17	2,750,183	1,226,818	3,027,326	0.0442	0.0444	0.0440
KY	Oct	18	2,804,990	1,246,471	3,066,898	0.0451	0.0451	0.0446
KY	Oct	19	2,833,249	1,242,487	3,066,753	0.0456	0.0450	0.0446
KY	Oct	20	2,759,348	1,216,889	3,006,234	0.0444	0.0440	0.0437
KY	Oct	21	2,652,098	1,169,920	2,906,404	0.0426	0.0423	0.0423
KY	Oct	22	2,494,473	1,115,242	2,771,093	0.0401	0.0404	0.0403
KY	Oct	23	2,367,902	1,075,197	2,662,935	0.0381	0.0389	0.0387
KY	Nov	0	2,422,536	1,118,975	2,591,748	0.0379	0.0395	0.0391
KY	Nov	1	2,356,323	1,095,090	2,537,410	0.0369	0.0386	0.0383
KY	Nov	2	2,367,494	1,086,653	2,516,480	0.0370	0.0383	0.0380
KY	Nov	3	2,386,839	1,089,267	2,519,274	0.0373	0.0384	0.0380
KY	Nov	4	2,415,740	1,106,413	2,558,320	0.0378	0.0390	0.0386
KY	Nov	5	2,468,416	1,129,838	2,607,883	0.0386	0.0398	0.0393
KY	Nov	6	2,632,729	1,175,377	2,735,869	0.0412	0.0414	0.0413
KY	Nov	7	2,714,530	1,195,414	2,795,275	0.0425	0.0422	0.0422
KY	Nov	8	2,754,488	1,204,179	2,825,323	0.0431	0.0425	0.0426

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Nov	9	2,824,461	1,226,327	2,890,106	0.0442	0.0432	0.0436
KY	Nov	10	2,813,806	1,227,058	2,907,006	0.0440	0.0433	0.0438
KY	Nov	11	2,777,561	1,212,096	2,868,910	0.0434	0.0427	0.0433
KY	Nov	12	2,750,079	1,202,290	2,850,666	0.0430	0.0424	0.0430
KY	Nov	13	2,757,965	1,197,718	2,832,599	0.0431	0.0422	0.0427
KY	Nov	14	2,728,342	1,183,900	2,811,323	0.0427	0.0417	0.0424
KY	Nov	15	2,703,926	1,182,019	2,797,686	0.0423	0.0417	0.0422
KY	Nov	16	2,711,087	1,192,712	2,800,355	0.0424	0.0421	0.0422
KY	Nov	17	2,831,053	1,228,197	2,871,391	0.0443	0.0433	0.0433
KY	Nov	18	2,874,376	1,248,720	2,908,424	0.0450	0.0440	0.0439
KY	Nov	19	2,830,424	1,242,309	2,889,743	0.0443	0.0438	0.0436
KY	Nov	20	2,809,414	1,236,011	2,877,825	0.0439	0.0436	0.0434
KY	Nov	21	2,810,067	1,224,376	2,845,340	0.0439	0.0432	0.0429
KY	Nov	22	2,655,656	1,192,816	2,771,150	0.0415	0.0421	0.0418
KY	Nov	23	2,541,726	1,160,739	2,685,393	0.0398	0.0409	0.0405
KY	Dec	0	3,397,203	1,497,727	3,221,155	0.0384	0.0394	0.0395
KY	Dec	1	3,341,898	1,480,833	3,177,042	0.0378	0.0390	0.0390
KY	Dec	2	3,304,945	1,464,534	3,147,297	0.0374	0.0385	0.0386
KY	Dec	3	3,314,704	1,461,086	3,144,311	0.0375	0.0384	0.0386
KY	Dec	4	3,357,070	1,475,238	3,171,851	0.0380	0.0388	0.0389
KY	Dec	5	3,503,380	1,532,005	3,271,587	0.0396	0.0403	0.0402
KY	Dec	6	3,707,600	1,592,737	3,395,494	0.0419	0.0419	0.0417
KY	Dec	7	3,807,538	1,614,496	3,455,002	0.0431	0.0425	0.0424
KY	Dec	8	3,860,987	1,642,801	3,506,340	0.0437	0.0432	0.0430
KY	Dec	9	3,911,254	1,658,278	3,544,522	0.0442	0.0436	0.0435
KY	Dec	10	3,910,089	1,644,946	3,525,036	0.0442	0.0433	0.0433
KY	Dec	11	3,825,710	1,621,156	3,475,841	0.0433	0.0426	0.0427
KY	Dec	12	3,783,955	1,608,546	3,449,877	0.0428	0.0423	0.0423
KY	Dec	13	3,740,261	1,597,853	3,420,474	0.0423	0.0420	0.0420
KY	Dec	14	3,678,324	1,579,253	3,380,910	0.0416	0.0415	0.0415
KY	Dec	15	3,679,275	1,562,779	3,359,655	0.0416	0.0411	0.0412
KY	Dec	16	3,723,602	1,588,964	3,403,955	0.0421	0.0418	0.0418
KY	Dec	17	3,867,731	1,646,054	3,514,154	0.0437	0.0433	0.0431
KY	Dec	18	3,908,982	1,662,935	3,561,609	0.0442	0.0437	0.0437
KY	Dec	19	3,860,887	1,644,759	3,539,105	0.0437	0.0433	0.0434
KY	Dec	20	3,867,744	1,651,301	3,543,614	0.0437	0.0434	0.0435
KY	Dec	21	3,819,045	1,638,890	3,509,569	0.0432	0.0431	0.0431
KY	Dec	22	3,723,350	1,603,663	3,432,871	0.0421	0.0422	0.0421
KY	Dec	23	3,535,845	1,545,039	3,313,593	0.0400	0.0406	0.0407
MS	Jan	0	300,037	157,706	681,031	0.0374	0.0351	0.0364
MS	Jan	1	289,290	151,459	665,738	0.0360	0.0337	0.0356
MS	Jan	2	287,751	148,804	660,967	0.0358	0.0331	0.0354
MS	Jan	3	291,148	148,222	668,501	0.0362	0.0329	0.0358
MS	Jan	4	302,852	156,414	695,674	0.0377	0.0348	0.0372
MS	Jan	5	323,353	178,713	755,028	0.0403	0.0397	0.0404
MS	Jan	6	348,706	198,881	818,333	0.0434	0.0442	0.0438
MS	Jan	7	355,063	209,218	838,316	0.0442	0.0465	0.0448
MS	Jan	8	357,451	206,704	838,060	0.0445	0.0459	0.0448
MS	Jan	9	358,623	208,957	842,247	0.0447	0.0464	0.0451
MS	Jan	10	356,907	204,931	839,569	0.0444	0.0456	0.0449
MS	Jan	11	346,623	195,627	818,876	0.0432	0.0435	0.0438
MS	Jan	12	340,586	185,527	797,895	0.0424	0.0412	0.0427
MS	Jan	13	331,359	183,143	776,008	0.0413	0.0407	0.0415

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Jan	14	324,003	176,230	757,019	0.0403	0.0392	0.0405
MS	Jan	15	323,645	173,168	752,708	0.0403	0.0385	0.0403
MS	Jan	16	333,852	181,977	777,833	0.0416	0.0405	0.0416
MS	Jan	17	359,449	203,235	835,302	0.0448	0.0452	0.0447
MS	Jan	18	372,202	229,266	879,363	0.0463	0.0510	0.0470
MS	Jan	19	371,048	225,168	872,934	0.0462	0.0501	0.0467
MS	Jan	20	367,302	220,656	855,161	0.0457	0.0491	0.0457
MS	Jan	21	354,555	206,831	821,109	0.0441	0.0460	0.0439
MS	Jan	22	331,412	185,461	751,395	0.0413	0.0412	0.0402
MS	Jan	23	304,465	162,266	694,209	0.0379	0.0361	0.0371
MS	Feb	0	181,787	144,680	592,680	0.0348	0.0332	0.0350
MS	Feb	1	176,523	142,763	588,813	0.0338	0.0328	0.0348
MS	Feb	2	177,588	142,598	591,129	0.0340	0.0328	0.0349
MS	Feb	3	182,268	145,277	599,182	0.0349	0.0334	0.0354
MS	Feb	4	200,147	159,233	639,307	0.0383	0.0366	0.0378
MS	Feb	5	226,102	186,280	713,386	0.0433	0.0428	0.0422
MS	Feb	6	245,608	224,842	804,213	0.0470	0.0517	0.0475
MS	Feb	7	246,999	236,630	821,878	0.0473	0.0544	0.0486
MS	Feb	8	242,749	223,482	799,264	0.0465	0.0513	0.0472
MS	Feb	9	239,154	211,830	778,398	0.0458	0.0487	0.0460
MS	Feb	10	239,008	195,473	748,970	0.0458	0.0449	0.0443
MS	Feb	11	226,841	180,839	724,298	0.0434	0.0415	0.0428
MS	Feb	12	216,102	168,902	699,967	0.0414	0.0388	0.0414
MS	Feb	13	208,962	158,781	678,787	0.0400	0.0365	0.0401
MS	Feb	14	201,923	150,653	662,724	0.0387	0.0346	0.0392
MS	Feb	15	198,164	149,084	656,827	0.0379	0.0343	0.0388
MS	Feb	16	204,955	155,311	668,145	0.0392	0.0357	0.0395
MS	Feb	17	217,497	176,733	707,004	0.0416	0.0406	0.0418
MS	Feb	18	243,658	218,277	777,572	0.0466	0.0502	0.0460
MS	Feb	19	244,724	219,127	785,091	0.0468	0.0503	0.0464
MS	Feb	20	242,419	214,983	781,038	0.0464	0.0494	0.0462
MS	Feb	21	236,058	202,851	767,413	0.0452	0.0466	0.0454
MS	Feb	22	223,683	182,973	694,935	0.0428	0.0420	0.0411
MS	Feb	23	200,839	160,870	637,359	0.0384	0.0370	0.0377
MS	Mar	0	337,599	176,903	671,396	0.0379	0.0350	0.0344
MS	Mar	1	311,836	168,021	658,557	0.0350	0.0332	0.0337
MS	Mar	2	298,832	162,591	652,653	0.0336	0.0322	0.0334
MS	Mar	3	299,837	164,420	659,372	0.0337	0.0325	0.0338
MS	Mar	4	321,524	174,209	688,550	0.0361	0.0345	0.0353
MS	Mar	5	356,989	209,620	774,745	0.0401	0.0415	0.0397
MS	Mar	6	373,584	225,222	850,416	0.0420	0.0446	0.0435
MS	Mar	7	379,808	226,647	863,398	0.0427	0.0448	0.0442
MS	Mar	8	388,936	228,973	869,283	0.0437	0.0453	0.0445
MS	Mar	9	392,827	226,272	874,879	0.0441	0.0448	0.0448
MS	Mar	10	393,128	224,267	885,425	0.0441	0.0444	0.0453
MS	Mar	11	396,026	223,489	878,915	0.0445	0.0442	0.0450
MS	Mar	12	393,023	217,458	865,563	0.0441	0.0430	0.0443
MS	Mar	13	388,540	214,283	854,086	0.0436	0.0424	0.0437
MS	Mar	14	381,636	209,095	841,469	0.0429	0.0414	0.0431
MS	Mar	15	378,494	207,557	832,329	0.0425	0.0411	0.0426
MS	Mar	16	386,426	211,259	834,927	0.0434	0.0418	0.0428
MS	Mar	17	392,149	216,518	846,550	0.0440	0.0428	0.0433
MS	Mar	18	397,547	236,378	907,903	0.0446	0.0468	0.0465

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Mar	19	398,376	246,894	933,628	0.0447	0.0489	0.0478
MS	Mar	20	392,734	240,412	918,228	0.0441	0.0476	0.0470
MS	Mar	21	388,730	229,585	887,976	0.0437	0.0454	0.0455
MS	Mar	22	391,128	220,615	777,514	0.0439	0.0437	0.0398
MS	Mar	23	364,793	192,944	700,796	0.0410	0.0382	0.0359
MS	Apr	0	289,274	210,302	674,456	0.0341	0.0301	0.0313
MS	Apr	1	272,781	194,279	658,179	0.0321	0.0278	0.0306
MS	Apr	2	255,674	182,964	645,036	0.0301	0.0262	0.0299
MS	Apr	3	258,132	199,983	667,783	0.0304	0.0286	0.0310
MS	Apr	4	294,364	213,211	739,553	0.0347	0.0305	0.0343
MS	Apr	5	326,760	248,505	808,818	0.0385	0.0355	0.0376
MS	Apr	6	349,825	267,606	870,840	0.0412	0.0383	0.0404
MS	Apr	7	366,360	286,256	903,990	0.0432	0.0409	0.0420
MS	Apr	8	379,890	301,972	930,848	0.0447	0.0432	0.0432
MS	Apr	9	375,915	307,857	955,252	0.0443	0.0440	0.0443
MS	Apr	10	371,886	312,687	967,176	0.0438	0.0447	0.0449
MS	Apr	11	376,643	332,849	1,000,566	0.0444	0.0476	0.0465
MS	Apr	12	385,311	340,996	1,025,779	0.0454	0.0488	0.0476
MS	Apr	13	385,970	343,187	1,030,671	0.0455	0.0491	0.0479
MS	Apr	14	386,736	347,908	1,032,186	0.0456	0.0498	0.0479
MS	Apr	15	393,806	353,322	1,044,825	0.0464	0.0505	0.0485
MS	Apr	16	394,838	351,503	1,035,746	0.0465	0.0503	0.0481
MS	Apr	17	390,569	341,431	1,018,817	0.0460	0.0488	0.0473
MS	Apr	18	392,006	336,261	1,017,146	0.0462	0.0481	0.0472
MS	Apr	19	398,154	351,627	1,047,902	0.0469	0.0503	0.0487
MS	Apr	20	396,961	340,313	1,018,343	0.0468	0.0487	0.0473
MS	Apr	21	380,259	311,166	925,539	0.0448	0.0445	0.0430
MS	Apr	22	350,316	272,826	794,988	0.0413	0.0390	0.0369
MS	Apr	23	317,916	241,623	724,562	0.0374	0.0346	0.0336
MS	May	0	357,994	258,998	847,936	0.0306	0.0292	0.0320
MS	May	1	334,112	244,300	819,285	0.0285	0.0275	0.0309
MS	May	2	327,824	241,345	814,911	0.0280	0.0272	0.0308
MS	May	3	332,654	265,833	838,645	0.0284	0.0299	0.0317
MS	May	4	372,890	271,971	912,516	0.0318	0.0306	0.0344
MS	May	5	417,989	301,039	981,611	0.0357	0.0339	0.0370
MS	May	6	462,291	329,864	1,039,932	0.0395	0.0372	0.0393
MS	May	7	519,425	362,519	1,094,522	0.0443	0.0408	0.0413
MS	May	8	538,400	388,483	1,159,752	0.0460	0.0438	0.0438
MS	May	9	557,538	411,089	1,195,918	0.0476	0.0463	0.0451
MS	May	10	559,292	415,930	1,218,226	0.0477	0.0469	0.0460
MS	May	11	561,832	421,646	1,239,118	0.0480	0.0475	0.0468
MS	May	12	561,123	434,561	1,258,714	0.0479	0.0490	0.0475
MS	May	13	551,740	439,634	1,267,729	0.0471	0.0495	0.0478
MS	May	14	556,478	448,826	1,275,851	0.0475	0.0506	0.0482
MS	May	15	559,115	458,503	1,286,808	0.0477	0.0516	0.0486
MS	May	16	555,371	449,044	1,269,685	0.0474	0.0506	0.0479
MS	May	17	546,069	433,700	1,241,680	0.0466	0.0489	0.0469
MS	May	18	547,005	425,738	1,228,655	0.0467	0.0480	0.0464
MS	May	19	555,484	429,915	1,252,377	0.0474	0.0484	0.0473
MS	May	20	549,539	418,655	1,219,580	0.0469	0.0472	0.0460
MS	May	21	523,192	395,984	1,133,626	0.0447	0.0446	0.0428
MS	May	22	465,486	339,347	996,424	0.0397	0.0382	0.0376
MS	May	23	403,263	290,433	901,005	0.0344	0.0327	0.0340

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Jun	0	341,454	235,254	927,740	0.0291	0.0257	0.0287
MS	Jun	1	313,065	218,714	893,033	0.0267	0.0239	0.0276
MS	Jun	2	301,332	210,169	881,348	0.0257	0.0229	0.0272
MS	Jun	3	299,823	226,308	893,898	0.0256	0.0247	0.0276
MS	Jun	4	316,990	218,625	935,610	0.0270	0.0239	0.0289
MS	Jun	5	348,643	235,736	1,008,613	0.0297	0.0257	0.0312
MS	Jun	6	418,960	280,818	1,124,291	0.0357	0.0307	0.0348
MS	Jun	7	501,141	340,706	1,246,624	0.0428	0.0372	0.0385
MS	Jun	8	556,441	400,331	1,381,849	0.0475	0.0437	0.0427
MS	Jun	9	582,672	435,660	1,481,015	0.0497	0.0476	0.0458
MS	Jun	10	587,392	462,309	1,561,519	0.0501	0.0505	0.0483
MS	Jun	11	587,946	480,422	1,620,330	0.0502	0.0524	0.0501
MS	Jun	12	579,770	492,880	1,669,654	0.0495	0.0538	0.0516
MS	Jun	13	582,636	506,140	1,711,224	0.0497	0.0553	0.0529
MS	Jun	14	576,726	511,502	1,728,760	0.0492	0.0558	0.0534
MS	Jun	15	574,684	511,288	1,709,965	0.0490	0.0558	0.0529
MS	Jun	16	576,196	502,375	1,679,497	0.0492	0.0548	0.0519
MS	Jun	17	574,724	487,944	1,643,867	0.0490	0.0533	0.0508
MS	Jun	18	563,424	466,631	1,592,798	0.0481	0.0509	0.0492
MS	Jun	19	569,402	461,103	1,579,160	0.0486	0.0503	0.0488
MS	Jun	20	564,833	449,387	1,524,446	0.0482	0.0491	0.0471
MS	Jun	21	536,034	409,384	1,371,958	0.0457	0.0447	0.0424
MS	Jun	22	468,975	342,086	1,163,023	0.0400	0.0373	0.0359
MS	Jun	23	396,823	274,378	1,020,968	0.0339	0.0300	0.0316
MS	Jul	0	335,908	249,121	1,125,103	0.0314	0.0257	0.0286
MS	Jul	1	313,481	235,121	1,078,662	0.0293	0.0243	0.0274
MS	Jul	2	304,077	227,325	1,063,423	0.0284	0.0235	0.0270
MS	Jul	3	306,472	256,296	1,077,182	0.0286	0.0265	0.0274
MS	Jul	4	310,640	229,379	1,112,128	0.0290	0.0237	0.0283
MS	Jul	5	323,746	238,455	1,199,792	0.0303	0.0246	0.0305
MS	Jul	6	356,823	256,224	1,297,782	0.0334	0.0265	0.0330
MS	Jul	7	432,199	310,499	1,428,708	0.0404	0.0321	0.0363
MS	Jul	8	482,603	385,501	1,618,928	0.0451	0.0398	0.0411
MS	Jul	9	522,690	465,594	1,822,567	0.0489	0.0481	0.0463
MS	Jul	10	526,584	511,772	1,970,217	0.0492	0.0529	0.0501
MS	Jul	11	522,227	534,097	2,063,143	0.0488	0.0552	0.0524
MS	Jul	12	517,438	549,768	2,104,001	0.0484	0.0568	0.0535
MS	Jul	13	517,959	559,794	2,130,414	0.0484	0.0578	0.0541
MS	Jul	14	521,343	566,802	2,145,659	0.0487	0.0586	0.0545
MS	Jul	15	522,356	559,386	2,133,553	0.0488	0.0578	0.0542
MS	Jul	16	520,649	541,060	2,077,357	0.0487	0.0559	0.0528
MS	Jul	17	518,672	521,602	2,022,392	0.0485	0.0539	0.0514
MS	Jul	18	515,755	494,005	1,941,461	0.0482	0.0510	0.0493
MS	Jul	19	520,684	489,970	1,914,389	0.0487	0.0506	0.0486
MS	Jul	20	515,789	468,363	1,823,823	0.0482	0.0484	0.0463
MS	Jul	21	485,998	412,354	1,609,793	0.0454	0.0426	0.0409
MS	Jul	22	429,361	336,937	1,377,414	0.0401	0.0348	0.0350
MS	Jul	23	375,205	279,215	1,215,274	0.0351	0.0288	0.0309
MS	Aug	0	398,879	261,206	1,049,987	0.0326	0.0276	0.0293
MS	Aug	1	369,182	234,851	1,000,838	0.0301	0.0248	0.0280
MS	Aug	2	349,692	222,480	972,515	0.0286	0.0235	0.0272
MS	Aug	3	339,796	254,166	978,245	0.0277	0.0269	0.0273
MS	Aug	4	372,731	231,950	1,043,736	0.0304	0.0245	0.0292

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Aug	5	413,169	265,592	1,152,662	0.0337	0.0281	0.0322
MS	Aug	6	432,852	276,313	1,217,001	0.0353	0.0292	0.0340
MS	Aug	7	501,186	312,383	1,301,644	0.0409	0.0330	0.0364
MS	Aug	8	554,195	382,784	1,469,266	0.0452	0.0405	0.0411
MS	Aug	9	585,918	443,572	1,637,685	0.0478	0.0469	0.0458
MS	Aug	10	591,357	476,018	1,755,828	0.0483	0.0503	0.0491
MS	Aug	11	600,847	506,589	1,835,440	0.0491	0.0536	0.0513
MS	Aug	12	603,122	532,009	1,889,629	0.0492	0.0563	0.0528
MS	Aug	13	586,026	538,137	1,902,462	0.0478	0.0569	0.0532
MS	Aug	14	583,473	536,550	1,917,367	0.0476	0.0567	0.0536
MS	Aug	15	584,740	529,567	1,908,645	0.0477	0.0560	0.0533
MS	Aug	16	589,342	518,409	1,878,059	0.0481	0.0548	0.0525
MS	Aug	17	590,667	496,486	1,832,408	0.0482	0.0525	0.0512
MS	Aug	18	582,754	478,822	1,776,197	0.0476	0.0506	0.0496
MS	Aug	19	588,827	484,336	1,780,993	0.0481	0.0512	0.0498
MS	Aug	20	574,252	449,220	1,655,777	0.0469	0.0475	0.0463
MS	Aug	21	538,304	391,064	1,445,807	0.0439	0.0414	0.0404
MS	Aug	22	479,992	337,585	1,257,748	0.0392	0.0357	0.0351
MS	Aug	23	437,072	295,235	1,128,610	0.0357	0.0312	0.0315
MS	Sep	0	482,689	281,966	1,043,624	0.0362	0.0312	0.0323
MS	Sep	1	445,736	256,382	993,578	0.0335	0.0284	0.0308
MS	Sep	2	428,348	244,301	975,792	0.0322	0.0270	0.0302
MS	Sep	3	435,162	283,234	986,914	0.0327	0.0314	0.0306
MS	Sep	4	504,198	272,583	1,064,745	0.0379	0.0302	0.0330
MS	Sep	5	515,957	309,119	1,170,081	0.0387	0.0342	0.0363
MS	Sep	6	530,668	316,791	1,201,358	0.0398	0.0351	0.0372
MS	Sep	7	575,287	340,452	1,254,581	0.0432	0.0377	0.0389
MS	Sep	8	585,787	366,390	1,327,534	0.0440	0.0406	0.0411
MS	Sep	9	607,119	390,951	1,399,564	0.0456	0.0433	0.0434
MS	Sep	10	603,621	419,081	1,480,585	0.0453	0.0464	0.0459
MS	Sep	11	585,894	438,565	1,538,719	0.0440	0.0485	0.0477
MS	Sep	12	597,948	456,406	1,579,728	0.0449	0.0505	0.0490
MS	Sep	13	592,172	468,633	1,611,365	0.0445	0.0519	0.0499
MS	Sep	14	594,184	474,728	1,632,628	0.0446	0.0526	0.0506
MS	Sep	15	596,279	477,153	1,626,359	0.0448	0.0528	0.0504
MS	Sep	16	595,741	463,914	1,596,336	0.0447	0.0514	0.0495
MS	Sep	17	587,489	443,603	1,549,374	0.0441	0.0491	0.0480
MS	Sep	18	592,914	438,949	1,552,705	0.0445	0.0486	0.0481
MS	Sep	19	594,008	430,245	1,533,455	0.0446	0.0476	0.0475
MS	Sep	20	599,159	404,017	1,457,581	0.0450	0.0447	0.0452
MS	Sep	21	578,140	382,545	1,348,572	0.0434	0.0423	0.0418
MS	Sep	22	560,123	352,725	1,216,799	0.0421	0.0390	0.0377
MS	Sep	23	529,509	320,788	1,122,099	0.0398	0.0355	0.0348
MS	Oct	0	565,288	243,633	834,105	0.0362	0.0306	0.0343
MS	Oct	1	535,302	229,086	803,940	0.0343	0.0287	0.0331
MS	Oct	2	522,671	218,960	788,851	0.0335	0.0275	0.0324
MS	Oct	3	529,653	229,990	800,166	0.0339	0.0289	0.0329
MS	Oct	4	583,011	260,379	860,499	0.0374	0.0327	0.0354
MS	Oct	5	629,052	304,118	939,223	0.0403	0.0382	0.0386
MS	Oct	6	652,760	323,868	977,237	0.0418	0.0406	0.0402
MS	Oct	7	679,279	339,666	1,006,683	0.0435	0.0426	0.0414
MS	Oct	8	681,417	352,752	1,033,371	0.0437	0.0443	0.0425
MS	Oct	9	683,547	362,346	1,059,491	0.0438	0.0455	0.0436

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Oct	10	682,487	374,889	1,096,290	0.0437	0.0470	0.0451
MS	Oct	11	687,037	377,064	1,111,744	0.0440	0.0473	0.0457
MS	Oct	12	679,613	380,131	1,122,029	0.0435	0.0477	0.0461
MS	Oct	13	676,460	381,240	1,126,078	0.0433	0.0478	0.0463
MS	Oct	14	682,114	387,409	1,139,635	0.0437	0.0486	0.0469
MS	Oct	15	687,412	386,942	1,142,886	0.0440	0.0485	0.0470
MS	Oct	16	698,644	381,009	1,136,132	0.0448	0.0478	0.0467
MS	Oct	17	702,784	385,270	1,141,571	0.0450	0.0483	0.0469
MS	Oct	18	711,740	393,016	1,148,316	0.0456	0.0493	0.0472
MS	Oct	19	700,116	379,092	1,114,584	0.0449	0.0476	0.0458
MS	Oct	20	700,266	360,465	1,078,800	0.0449	0.0452	0.0444
MS	Oct	21	686,503	341,372	1,029,868	0.0440	0.0428	0.0423
MS	Oct	22	648,327	307,205	949,460	0.0415	0.0385	0.0390
MS	Oct	23	601,351	270,693	879,834	0.0385	0.0340	0.0362
MS	Nov	0	400,696	193,241	734,380	0.0332	0.0310	0.0359
MS	Nov	1	373,946	176,574	705,147	0.0310	0.0283	0.0345
MS	Nov	2	367,834	173,773	699,903	0.0305	0.0279	0.0342
MS	Nov	3	369,863	176,852	701,041	0.0307	0.0284	0.0343
MS	Nov	4	414,161	187,139	725,637	0.0344	0.0300	0.0355
MS	Nov	5	454,879	224,615	806,127	0.0377	0.0360	0.0394
MS	Nov	6	508,757	269,805	881,643	0.0422	0.0433	0.0431
MS	Nov	7	538,661	295,334	911,553	0.0447	0.0474	0.0446
MS	Nov	8	558,581	294,868	918,995	0.0463	0.0473	0.0449
MS	Nov	9	554,742	293,716	913,857	0.0460	0.0471	0.0447
MS	Nov	10	551,136	286,727	905,875	0.0457	0.0460	0.0443
MS	Nov	11	557,048	277,518	888,002	0.0462	0.0445	0.0434
MS	Nov	12	532,534	273,491	880,710	0.0442	0.0439	0.0431
MS	Nov	13	518,395	267,818	867,677	0.0430	0.0430	0.0424
MS	Nov	14	510,686	264,270	858,778	0.0424	0.0424	0.0420
MS	Nov	15	505,459	262,016	853,820	0.0419	0.0420	0.0417
MS	Nov	16	519,638	273,591	877,629	0.0431	0.0439	0.0429
MS	Nov	17	560,499	309,237	934,759	0.0465	0.0496	0.0457
MS	Nov	18	568,506	320,622	946,437	0.0472	0.0515	0.0463
MS	Nov	19	569,521	310,905	933,636	0.0472	0.0499	0.0456
MS	Nov	20	571,807	306,361	930,840	0.0474	0.0492	0.0455
MS	Nov	21	563,862	296,086	912,102	0.0468	0.0475	0.0446
MS	Nov	22	525,369	271,591	870,135	0.0436	0.0436	0.0425
MS	Nov	23	458,981	225,544	798,006	0.0381	0.0362	0.0390
MS	Dec	0	476,147	237,179	822,181	0.0354	0.0321	0.0360
MS	Dec	1	451,792	218,043	793,981	0.0335	0.0295	0.0347
MS	Dec	2	445,967	214,157	791,509	0.0331	0.0290	0.0346
MS	Dec	3	456,261	236,967	804,468	0.0339	0.0320	0.0352
MS	Dec	4	504,954	240,382	845,365	0.0375	0.0325	0.0370
MS	Dec	5	529,892	277,311	922,914	0.0393	0.0375	0.0404
MS	Dec	6	582,038	324,463	1,007,153	0.0432	0.0439	0.0441
MS	Dec	7	614,010	354,025	1,038,332	0.0456	0.0479	0.0454
MS	Dec	8	619,411	360,044	1,044,873	0.0460	0.0487	0.0457
MS	Dec	9	623,495	352,069	1,031,891	0.0463	0.0476	0.0452
MS	Dec	10	620,949	341,455	1,015,725	0.0461	0.0462	0.0444
MS	Dec	11	608,450	329,084	994,310	0.0452	0.0445	0.0435
MS	Dec	12	570,890	309,824	962,797	0.0424	0.0419	0.0421
MS	Dec	13	540,947	288,800	928,195	0.0402	0.0390	0.0406
MS	Dec	14	527,041	278,854	906,371	0.0391	0.0377	0.0397

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Dec	15	521,029	275,687	903,094	0.0387	0.0373	0.0395
MS	Dec	16	553,791	298,249	946,805	0.0411	0.0403	0.0414
MS	Dec	17	610,161	359,840	1,045,532	0.0453	0.0487	0.0458
MS	Dec	18	628,087	388,120	1,072,393	0.0466	0.0525	0.0469
MS	Dec	19	624,442	380,566	1,059,697	0.0464	0.0515	0.0464
MS	Dec	20	627,989	375,875	1,055,467	0.0466	0.0508	0.0462
MS	Dec	21	626,583	363,339	1,034,920	0.0465	0.0491	0.0453
MS	Dec	22	587,229	322,351	954,040	0.0436	0.0436	0.0417
MS	Dec	23	517,373	269,794	869,671	0.0384	0.0365	0.0381
NC	Jan	0	2,630,975	859,723	1,955,963	0.0350	0.0346	0.0350
NC	Jan	1	2,562,449	831,570	1,905,915	0.0341	0.0335	0.0341
NC	Jan	2	2,564,877	838,395	1,907,095	0.0341	0.0337	0.0341
NC	Jan	3	2,616,016	859,202	1,941,224	0.0348	0.0346	0.0347
NC	Jan	4	2,720,291	898,273	2,018,727	0.0362	0.0361	0.0361
NC	Jan	5	2,919,313	970,045	2,180,723	0.0389	0.0390	0.0390
NC	Jan	6	3,294,821	1,102,686	2,471,242	0.0439	0.0444	0.0442
NC	Jan	7	3,590,076	1,211,876	2,696,514	0.0478	0.0488	0.0482
NC	Jan	8	3,627,979	1,217,893	2,715,407	0.0483	0.0490	0.0486
NC	Jan	9	3,624,291	1,207,443	2,703,260	0.0482	0.0486	0.0484
NC	Jan	10	3,518,422	1,166,785	2,612,241	0.0468	0.0469	0.0467
NC	Jan	11	3,362,694	1,108,944	2,491,667	0.0448	0.0446	0.0446
NC	Jan	12	3,193,991	1,047,245	2,365,831	0.0425	0.0421	0.0423
NC	Jan	13	3,074,947	1,005,676	2,285,065	0.0409	0.0405	0.0409
NC	Jan	14	2,925,281	952,644	2,179,694	0.0389	0.0383	0.0390
NC	Jan	15	2,853,359	931,251	2,125,468	0.0380	0.0375	0.0380
NC	Jan	16	2,922,144	956,239	2,161,760	0.0389	0.0385	0.0387
NC	Jan	17	3,193,499	1,056,706	2,368,659	0.0425	0.0425	0.0424
NC	Jan	18	3,551,508	1,191,636	2,634,748	0.0473	0.0479	0.0471
NC	Jan	19	3,567,174	1,191,243	2,650,007	0.0475	0.0479	0.0474
NC	Jan	20	3,512,057	1,169,749	2,609,983	0.0467	0.0471	0.0467
NC	Jan	21	3,374,034	1,121,922	2,506,410	0.0449	0.0451	0.0448
NC	Jan	22	3,130,889	1,037,328	2,323,144	0.0417	0.0417	0.0416
NC	Jan	23	2,805,267	923,873	2,088,930	0.0373	0.0372	0.0374
NC	Feb	0	2,243,689	737,358	1,705,321	0.0358	0.0350	0.0355
NC	Feb	1	2,188,134	720,208	1,666,712	0.0349	0.0342	0.0347
NC	Feb	2	2,194,916	723,781	1,671,053	0.0350	0.0344	0.0348
NC	Feb	3	2,227,515	734,823	1,695,737	0.0356	0.0349	0.0353
NC	Feb	4	2,323,093	770,376	1,775,542	0.0371	0.0366	0.0369
NC	Feb	5	2,510,043	843,255	1,935,605	0.0401	0.0401	0.0403
NC	Feb	6	2,829,576	969,740	2,208,607	0.0452	0.0461	0.0460
NC	Feb	7	3,019,976	1,040,026	2,363,842	0.0482	0.0494	0.0492
NC	Feb	8	3,019,940	1,035,102	2,354,654	0.0482	0.0492	0.0490
NC	Feb	9	3,002,148	1,022,495	2,317,789	0.0479	0.0486	0.0482
NC	Feb	10	2,937,533	991,673	2,247,044	0.0469	0.0471	0.0468
NC	Feb	11	2,754,524	916,134	2,097,798	0.0440	0.0435	0.0436
NC	Feb	12	2,597,462	858,523	1,971,450	0.0415	0.0408	0.0410
NC	Feb	13	2,491,984	829,814	1,899,637	0.0398	0.0394	0.0395
NC	Feb	14	2,370,849	785,262	1,813,470	0.0379	0.0373	0.0377
NC	Feb	15	2,301,743	760,176	1,767,680	0.0368	0.0361	0.0368
NC	Feb	16	2,320,623	768,492	1,784,228	0.0371	0.0365	0.0371
NC	Feb	17	2,456,740	822,213	1,887,638	0.0392	0.0391	0.0393
NC	Feb	18	2,828,704	963,052	2,172,877	0.0452	0.0458	0.0452
NC	Feb	19	2,975,097	1,020,124	2,286,492	0.0475	0.0485	0.0476

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Feb	20	2,968,979	1,012,751	2,277,715	0.0474	0.0481	0.0474
NC	Feb	21	2,883,352	983,654	2,208,226	0.0460	0.0467	0.0459
NC	Feb	22	2,705,714	915,621	2,066,252	0.0432	0.0435	0.0430
NC	Feb	23	2,473,241	824,767	1,885,384	0.0395	0.0392	0.0392
NC	Mar	0	2,725,806	904,880	2,064,139	0.0356	0.0350	0.0353
NC	Mar	1	2,634,486	876,776	1,996,882	0.0344	0.0339	0.0341
NC	Mar	2	2,589,581	869,204	1,967,840	0.0338	0.0336	0.0336
NC	Mar	3	2,589,626	876,922	1,979,959	0.0338	0.0339	0.0338
NC	Mar	4	2,665,398	906,525	2,048,489	0.0348	0.0350	0.0350
NC	Mar	5	2,859,675	980,235	2,219,850	0.0374	0.0379	0.0379
NC	Mar	6	3,158,503	1,091,413	2,474,309	0.0413	0.0422	0.0423
NC	Mar	7	3,353,397	1,149,547	2,637,616	0.0438	0.0444	0.0451
NC	Mar	8	3,452,820	1,174,830	2,726,724	0.0451	0.0454	0.0466
NC	Mar	9	3,515,809	1,198,162	2,756,759	0.0460	0.0463	0.0471
NC	Mar	10	3,489,088	1,187,487	2,696,651	0.0456	0.0459	0.0461
NC	Mar	11	3,432,315	1,163,359	2,616,274	0.0449	0.0450	0.0447
NC	Mar	12	3,372,629	1,139,592	2,556,665	0.0441	0.0440	0.0437
NC	Mar	13	3,334,536	1,127,854	2,521,645	0.0436	0.0436	0.0431
NC	Mar	14	3,277,864	1,107,537	2,475,694	0.0428	0.0428	0.0423
NC	Mar	15	3,234,822	1,090,435	2,435,233	0.0423	0.0421	0.0416
NC	Mar	16	3,229,493	1,087,890	2,428,141	0.0422	0.0421	0.0415
NC	Mar	17	3,282,167	1,110,123	2,468,275	0.0429	0.0429	0.0422
NC	Mar	18	3,447,637	1,165,469	2,610,195	0.0451	0.0450	0.0446
NC	Mar	19	3,625,821	1,225,601	2,763,594	0.0474	0.0474	0.0472
NC	Mar	20	3,581,085	1,210,100	2,745,960	0.0468	0.0468	0.0469
NC	Mar	21	3,481,781	1,171,116	2,648,182	0.0455	0.0453	0.0452
NC	Mar	22	3,259,210	1,087,920	2,473,492	0.0426	0.0421	0.0423
NC	Mar	23	2,916,834	968,238	2,216,783	0.0381	0.0374	0.0379
NC	Apr	0	2,100,618	675,853	1,639,262	0.0325	0.0323	0.0320
NC	Apr	1	1,975,823	636,031	1,548,301	0.0306	0.0304	0.0302
NC	Apr	2	1,914,434	623,313	1,506,496	0.0297	0.0298	0.0294
NC	Apr	3	1,925,010	626,285	1,515,239	0.0298	0.0300	0.0296
NC	Apr	4	2,093,958	681,925	1,648,485	0.0324	0.0326	0.0322
NC	Apr	5	2,429,882	785,950	1,904,016	0.0376	0.0376	0.0372
NC	Apr	6	2,661,185	857,123	2,076,864	0.0412	0.0410	0.0405
NC	Apr	7	2,812,670	899,495	2,187,267	0.0436	0.0430	0.0427
NC	Apr	8	2,908,089	926,797	2,258,984	0.0451	0.0444	0.0441
NC	Apr	9	2,939,854	945,176	2,299,896	0.0455	0.0452	0.0449
NC	Apr	10	2,981,835	965,708	2,356,874	0.0462	0.0462	0.0460
NC	Apr	11	2,991,441	972,217	2,389,992	0.0463	0.0465	0.0466
NC	Apr	12	3,011,115	982,571	2,428,632	0.0467	0.0470	0.0474
NC	Apr	13	3,001,891	978,498	2,441,745	0.0465	0.0468	0.0476
NC	Apr	14	2,996,159	978,737	2,439,053	0.0464	0.0468	0.0476
NC	Apr	15	2,996,410	982,248	2,440,123	0.0464	0.0470	0.0476
NC	Apr	16	2,975,435	974,714	2,421,676	0.0461	0.0466	0.0473
NC	Apr	17	2,952,541	966,745	2,397,870	0.0457	0.0463	0.0468
NC	Apr	18	2,936,462	951,709	2,373,795	0.0455	0.0455	0.0463
NC	Apr	19	3,059,548	994,109	2,451,840	0.0474	0.0476	0.0478
NC	Apr	20	3,057,268	987,583	2,425,891	0.0474	0.0473	0.0473
NC	Apr	21	2,900,727	931,579	2,274,873	0.0449	0.0446	0.0444
NC	Apr	22	2,599,540	833,083	2,021,591	0.0403	0.0399	0.0394
NC	Apr	23	2,322,114	738,642	1,799,924	0.0360	0.0353	0.0351
NC	May	0	2,065,925	562,250	1,529,727	0.0311	0.0295	0.0303

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	May	1	1,942,880	529,629	1,440,259	0.0293	0.0278	0.0286
NC	May	2	1,874,541	512,022	1,394,864	0.0282	0.0269	0.0277
NC	May	3	1,876,529	516,720	1,403,648	0.0283	0.0271	0.0278
NC	May	4	2,033,834	569,058	1,526,099	0.0306	0.0299	0.0303
NC	May	5	2,331,128	665,142	1,746,123	0.0351	0.0349	0.0346
NC	May	6	2,601,795	743,433	1,943,820	0.0392	0.0390	0.0386
NC	May	7	2,723,097	780,487	2,035,283	0.0410	0.0409	0.0404
NC	May	8	2,890,108	833,200	2,168,760	0.0436	0.0437	0.0430
NC	May	9	3,015,858	873,553	2,275,028	0.0454	0.0458	0.0451
NC	May	10	3,099,776	903,719	2,352,058	0.0467	0.0474	0.0467
NC	May	11	3,155,782	929,798	2,414,664	0.0476	0.0488	0.0479
NC	May	12	3,220,459	954,022	2,489,769	0.0485	0.0501	0.0494
NC	May	13	3,225,509	957,339	2,512,222	0.0486	0.0502	0.0498
NC	May	14	3,227,364	958,813	2,522,483	0.0486	0.0503	0.0500
NC	May	15	3,255,755	963,573	2,536,475	0.0491	0.0506	0.0503
NC	May	16	3,262,086	956,245	2,534,920	0.0492	0.0502	0.0503
NC	May	17	3,223,841	933,698	2,496,255	0.0486	0.0490	0.0495
NC	May	18	3,135,372	900,144	2,415,281	0.0472	0.0472	0.0479
NC	May	19	3,151,605	908,334	2,416,369	0.0475	0.0477	0.0479
NC	May	20	3,186,474	913,399	2,408,969	0.0480	0.0479	0.0478
NC	May	21	2,981,839	846,832	2,219,083	0.0449	0.0444	0.0440
NC	May	22	2,577,084	718,668	1,912,726	0.0388	0.0377	0.0379
NC	May	23	2,304,233	630,612	1,710,740	0.0347	0.0331	0.0339
NC	Jun	0	2,698,752	744,271	2,043,707	0.0318	0.0301	0.0309
NC	Jun	1	2,479,228	667,633	1,881,847	0.0292	0.0270	0.0285
NC	Jun	2	2,323,403	617,724	1,770,006	0.0274	0.0250	0.0268
NC	Jun	3	2,277,608	607,874	1,737,010	0.0268	0.0246	0.0263
NC	Jun	4	2,387,746	643,693	1,813,473	0.0281	0.0261	0.0274
NC	Jun	5	2,573,317	709,718	1,948,011	0.0303	0.0287	0.0295
NC	Jun	6	2,838,747	793,658	2,134,912	0.0334	0.0321	0.0323
NC	Jun	7	3,166,072	892,709	2,373,823	0.0373	0.0361	0.0359
NC	Jun	8	3,524,626	1,007,912	2,641,944	0.0415	0.0408	0.0400
NC	Jun	9	3,843,069	1,123,200	2,904,535	0.0453	0.0455	0.0440
NC	Jun	10	4,043,416	1,198,420	3,104,571	0.0476	0.0485	0.0470
NC	Jun	11	4,192,670	1,256,435	3,262,160	0.0494	0.0509	0.0494
NC	Jun	12	4,258,502	1,278,050	3,373,191	0.0502	0.0517	0.0511
NC	Jun	13	4,289,051	1,290,971	3,453,047	0.0505	0.0523	0.0523
NC	Jun	14	4,321,317	1,305,932	3,504,898	0.0509	0.0529	0.0531
NC	Jun	15	4,349,451	1,313,942	3,524,878	0.0512	0.0532	0.0534
NC	Jun	16	4,341,649	1,311,642	3,510,840	0.0512	0.0531	0.0531
NC	Jun	17	4,304,106	1,291,874	3,467,981	0.0507	0.0523	0.0525
NC	Jun	18	4,175,661	1,237,434	3,336,184	0.0492	0.0501	0.0505
NC	Jun	19	4,056,076	1,198,189	3,201,002	0.0478	0.0485	0.0485
NC	Jun	20	4,064,283	1,205,448	3,172,571	0.0479	0.0488	0.0480
NC	Jun	21	3,832,571	1,129,651	2,951,417	0.0452	0.0457	0.0447
NC	Jun	22	3,463,424	1,007,586	2,635,046	0.0408	0.0408	0.0399
NC	Jun	23	3,067,572	870,502	2,317,749	0.0361	0.0352	0.0351
NC	Jul	0	3,354,173	921,685	2,530,425	0.0345	0.0333	0.0324
NC	Jul	1	3,102,787	854,676	2,351,750	0.0319	0.0309	0.0301
NC	Jul	2	2,911,773	802,741	2,215,003	0.0299	0.0290	0.0284
NC	Jul	3	2,825,326	780,292	2,152,351	0.0290	0.0282	0.0276
NC	Jul	4	2,907,343	814,431	2,214,240	0.0299	0.0294	0.0284
NC	Jul	5	3,128,868	880,781	2,379,883	0.0322	0.0318	0.0305

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Jul	6	3,364,298	932,557	2,556,208	0.0346	0.0337	0.0327
NC	Jul	7	3,727,524	1,033,747	2,842,468	0.0383	0.0374	0.0364
NC	Jul	8	4,083,493	1,137,915	3,140,889	0.0420	0.0411	0.0402
NC	Jul	9	4,380,317	1,234,238	3,405,321	0.0450	0.0446	0.0436
NC	Jul	10	4,570,924	1,300,164	3,598,940	0.0470	0.0470	0.0461
NC	Jul	11	4,666,649	1,338,728	3,767,945	0.0480	0.0484	0.0483
NC	Jul	12	4,717,837	1,369,012	3,906,870	0.0485	0.0495	0.0500
NC	Jul	13	4,730,905	1,384,309	4,007,760	0.0486	0.0500	0.0513
NC	Jul	14	4,739,704	1,389,410	4,057,834	0.0487	0.0502	0.0520
NC	Jul	15	4,742,237	1,396,672	4,071,903	0.0488	0.0505	0.0521
NC	Jul	16	4,731,546	1,388,003	4,056,107	0.0486	0.0502	0.0519
NC	Jul	17	4,705,403	1,376,275	4,011,432	0.0484	0.0497	0.0514
NC	Jul	18	4,599,800	1,327,134	3,874,506	0.0473	0.0480	0.0496
NC	Jul	19	4,539,753	1,297,041	3,759,845	0.0467	0.0469	0.0482
NC	Jul	20	4,506,297	1,291,594	3,683,093	0.0463	0.0467	0.0472
NC	Jul	21	4,373,391	1,238,584	3,488,460	0.0450	0.0448	0.0447
NC	Jul	22	4,124,519	1,150,002	3,189,787	0.0424	0.0416	0.0408
NC	Jul	23	3,739,934	1,028,356	2,823,010	0.0384	0.0372	0.0362
NC	Aug	0	3,147,274	820,311	2,369,555	0.0344	0.0320	0.0322
NC	Aug	1	2,939,408	758,945	2,222,246	0.0321	0.0296	0.0302
NC	Aug	2	2,778,657	716,182	2,106,431	0.0304	0.0279	0.0287
NC	Aug	3	2,714,267	702,973	2,062,647	0.0297	0.0274	0.0281
NC	Aug	4	2,809,982	738,251	2,138,949	0.0307	0.0288	0.0291
NC	Aug	5	3,106,915	821,031	2,364,730	0.0339	0.0320	0.0322
NC	Aug	6	3,271,595	868,994	2,488,143	0.0357	0.0338	0.0338
NC	Aug	7	3,520,512	951,753	2,682,675	0.0385	0.0371	0.0365
NC	Aug	8	3,832,243	1,058,899	2,947,079	0.0419	0.0412	0.0401
NC	Aug	9	4,044,942	1,136,586	3,170,537	0.0442	0.0443	0.0431
NC	Aug	10	4,236,026	1,210,737	3,383,136	0.0463	0.0472	0.0460
NC	Aug	11	4,374,045	1,265,673	3,583,654	0.0478	0.0493	0.0487
NC	Aug	12	4,448,054	1,306,663	3,732,151	0.0486	0.0509	0.0508
NC	Aug	13	4,463,954	1,316,993	3,801,307	0.0488	0.0513	0.0517
NC	Aug	14	4,466,890	1,324,169	3,826,912	0.0488	0.0516	0.0521
NC	Aug	15	4,474,224	1,330,615	3,838,517	0.0489	0.0518	0.0522
NC	Aug	16	4,480,697	1,330,857	3,833,061	0.0490	0.0518	0.0521
NC	Aug	17	4,464,415	1,317,485	3,798,214	0.0488	0.0513	0.0517
NC	Aug	18	4,368,273	1,262,744	3,657,788	0.0477	0.0492	0.0498
NC	Aug	19	4,299,971	1,233,117	3,569,848	0.0470	0.0480	0.0486
NC	Aug	20	4,242,454	1,203,933	3,464,344	0.0464	0.0469	0.0471
NC	Aug	21	4,010,663	1,115,907	3,162,517	0.0438	0.0435	0.0430
NC	Aug	22	3,678,946	996,483	2,804,548	0.0402	0.0388	0.0381
NC	Aug	23	3,345,819	883,969	2,512,733	0.0366	0.0344	0.0342
NC	Sep	0	2,594,163	751,815	2,013,200	0.0304	0.0301	0.0302
NC	Sep	1	2,425,818	708,706	1,894,572	0.0285	0.0283	0.0284
NC	Sep	2	2,320,656	677,824	1,816,379	0.0272	0.0271	0.0272
NC	Sep	3	2,292,901	670,975	1,796,988	0.0269	0.0268	0.0269
NC	Sep	4	2,464,312	720,190	1,924,097	0.0289	0.0288	0.0288
NC	Sep	5	2,876,553	852,274	2,226,771	0.0337	0.0341	0.0334
NC	Sep	6	3,213,128	941,390	2,470,322	0.0377	0.0376	0.0370
NC	Sep	7	3,400,320	993,645	2,607,715	0.0399	0.0397	0.0391
NC	Sep	8	3,637,976	1,062,104	2,793,098	0.0427	0.0425	0.0418
NC	Sep	9	3,861,830	1,127,816	2,971,071	0.0453	0.0451	0.0445
NC	Sep	10	4,036,881	1,186,609	3,135,700	0.0474	0.0474	0.0470

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Sep	11	4,130,342	1,220,631	3,234,052	0.0484	0.0488	0.0485
NC	Sep	12	4,199,576	1,251,593	3,323,592	0.0493	0.0500	0.0498
NC	Sep	13	4,224,482	1,261,381	3,372,396	0.0496	0.0504	0.0505
NC	Sep	14	4,231,071	1,259,360	3,385,954	0.0496	0.0504	0.0507
NC	Sep	15	4,242,472	1,264,312	3,402,050	0.0498	0.0505	0.0510
NC	Sep	16	4,244,232	1,264,242	3,391,946	0.0498	0.0505	0.0508
NC	Sep	17	4,226,775	1,248,945	3,359,088	0.0496	0.0499	0.0503
NC	Sep	18	4,208,856	1,232,865	3,330,576	0.0494	0.0493	0.0499
NC	Sep	19	4,225,962	1,238,465	3,338,028	0.0496	0.0495	0.0500
NC	Sep	20	4,094,679	1,183,723	3,191,573	0.0480	0.0473	0.0478
NC	Sep	21	3,815,098	1,090,161	2,934,209	0.0447	0.0436	0.0440
NC	Sep	22	3,343,293	951,941	2,565,452	0.0392	0.0381	0.0384
NC	Sep	23	2,943,063	850,713	2,267,230	0.0345	0.0340	0.0340
NC	Oct	0	2,424,400	812,600	1,926,201	0.0319	0.0316	0.0316
NC	Oct	1	2,285,677	772,232	1,823,035	0.0301	0.0300	0.0299
NC	Oct	2	2,220,651	756,793	1,776,132	0.0292	0.0294	0.0292
NC	Oct	3	2,243,688	767,340	1,795,867	0.0295	0.0298	0.0295
NC	Oct	4	2,450,879	845,015	1,956,573	0.0323	0.0329	0.0321
NC	Oct	5	2,859,392	977,580	2,263,350	0.0376	0.0380	0.0372
NC	Oct	6	3,217,818	1,085,582	2,540,167	0.0424	0.0422	0.0417
NC	Oct	7	3,307,214	1,105,589	2,607,134	0.0435	0.0430	0.0428
NC	Oct	8	3,428,397	1,152,865	2,706,103	0.0451	0.0448	0.0444
NC	Oct	9	3,491,653	1,178,585	2,770,212	0.0460	0.0458	0.0455
NC	Oct	10	3,517,217	1,192,605	2,811,151	0.0463	0.0464	0.0462
NC	Oct	11	3,538,950	1,204,998	2,843,030	0.0466	0.0469	0.0467
NC	Oct	12	3,529,712	1,200,971	2,855,779	0.0465	0.0467	0.0469
NC	Oct	13	3,527,575	1,200,801	2,875,571	0.0464	0.0467	0.0472
NC	Oct	14	3,525,571	1,199,032	2,881,917	0.0464	0.0466	0.0473
NC	Oct	15	3,538,115	1,202,132	2,881,056	0.0466	0.0467	0.0473
NC	Oct	16	3,553,556	1,212,512	2,890,076	0.0468	0.0472	0.0475
NC	Oct	17	3,586,460	1,224,221	2,909,629	0.0472	0.0476	0.0478
NC	Oct	18	3,663,611	1,253,981	2,972,033	0.0482	0.0488	0.0488
NC	Oct	19	3,614,898	1,228,106	2,918,644	0.0476	0.0478	0.0479
NC	Oct	20	3,513,638	1,183,174	2,811,865	0.0463	0.0460	0.0462
NC	Oct	21	3,333,450	1,108,298	2,637,286	0.0439	0.0431	0.0433
NC	Oct	22	2,956,146	975,213	2,338,054	0.0389	0.0379	0.0384
NC	Oct	23	2,636,184	875,188	2,089,871	0.0347	0.0340	0.0343
NC	Nov	0	2,547,217	879,719	2,011,827	0.0362	0.0360	0.0364
NC	Nov	1	2,459,319	846,721	1,942,672	0.0350	0.0346	0.0352
NC	Nov	2	2,433,618	843,768	1,921,253	0.0346	0.0345	0.0348
NC	Nov	3	2,450,746	855,500	1,934,662	0.0348	0.0350	0.0350
NC	Nov	4	2,567,117	900,472	2,028,517	0.0365	0.0368	0.0367
NC	Nov	5	2,792,642	987,481	2,215,227	0.0397	0.0404	0.0401
NC	Nov	6	3,069,432	1,077,264	2,433,311	0.0436	0.0440	0.0440
NC	Nov	7	3,211,209	1,120,156	2,539,068	0.0457	0.0458	0.0459
NC	Nov	8	3,243,790	1,116,948	2,541,021	0.0461	0.0456	0.0460
NC	Nov	9	3,234,097	1,116,443	2,523,217	0.0460	0.0456	0.0457
NC	Nov	10	3,188,140	1,105,415	2,484,544	0.0453	0.0452	0.0450
NC	Nov	11	3,080,695	1,065,180	2,401,616	0.0438	0.0435	0.0435
NC	Nov	12	2,949,281	1,023,692	2,302,453	0.0419	0.0418	0.0417
NC	Nov	13	2,858,735	997,869	2,238,957	0.0406	0.0408	0.0405
NC	Nov	14	2,788,593	969,690	2,185,558	0.0396	0.0396	0.0396
NC	Nov	15	2,756,208	961,551	2,162,884	0.0392	0.0393	0.0391

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Nov	16	2,842,698	986,636	2,233,334	0.0404	0.0403	0.0404
NC	Nov	17	3,113,777	1,094,330	2,440,223	0.0443	0.0447	0.0442
NC	Nov	18	3,299,571	1,163,945	2,585,335	0.0469	0.0476	0.0468
NC	Nov	19	3,281,261	1,143,162	2,573,396	0.0467	0.0467	0.0466
NC	Nov	20	3,266,244	1,130,250	2,562,040	0.0464	0.0462	0.0464
NC	Nov	21	3,181,852	1,105,473	2,499,861	0.0452	0.0452	0.0452
NC	Nov	22	2,999,763	1,039,345	2,358,610	0.0426	0.0425	0.0427
NC	Nov	23	2,719,459	938,347	2,139,422	0.0387	0.0383	0.0387
NC	Dec	0	2,786,311	952,086	2,137,402	0.0369	0.0360	0.0366
NC	Dec	1	2,688,299	918,583	2,066,058	0.0356	0.0348	0.0354
NC	Dec	2	2,652,627	910,901	2,041,385	0.0351	0.0345	0.0350
NC	Dec	3	2,681,579	924,596	2,064,035	0.0355	0.0350	0.0353
NC	Dec	4	2,793,097	973,712	2,151,528	0.0370	0.0368	0.0368
NC	Dec	5	2,978,587	1,039,056	2,299,246	0.0394	0.0393	0.0394
NC	Dec	6	3,255,765	1,138,815	2,527,471	0.0431	0.0431	0.0433
NC	Dec	7	3,468,637	1,222,783	2,697,743	0.0459	0.0463	0.0462
NC	Dec	8	3,528,746	1,244,532	2,735,466	0.0467	0.0471	0.0468
NC	Dec	9	3,499,852	1,231,070	2,705,546	0.0463	0.0466	0.0463
NC	Dec	10	3,402,765	1,194,282	2,627,210	0.0450	0.0452	0.0450
NC	Dec	11	3,273,673	1,144,185	2,526,301	0.0433	0.0433	0.0433
NC	Dec	12	3,116,777	1,085,434	2,401,454	0.0412	0.0411	0.0411
NC	Dec	13	2,996,242	1,044,492	2,311,719	0.0396	0.0395	0.0396
NC	Dec	14	2,905,118	1,018,633	2,243,181	0.0384	0.0385	0.0384
NC	Dec	15	2,862,458	1,005,003	2,213,736	0.0379	0.0380	0.0379
NC	Dec	16	2,998,333	1,041,875	2,319,069	0.0397	0.0394	0.0397
NC	Dec	17	3,345,572	1,177,991	2,596,998	0.0443	0.0446	0.0445
NC	Dec	18	3,540,109	1,274,586	2,749,103	0.0468	0.0482	0.0471
NC	Dec	19	3,530,539	1,245,967	2,739,450	0.0467	0.0471	0.0469
NC	Dec	20	3,508,778	1,235,613	2,725,026	0.0464	0.0467	0.0467
NC	Dec	21	3,456,701	1,218,913	2,673,450	0.0457	0.0461	0.0458
NC	Dec	22	3,313,726	1,158,670	2,550,455	0.0438	0.0438	0.0437
NC	Dec	23	3,000,663	1,031,342	2,305,464	0.0397	0.0390	0.0395
SC	Jan	0	1,194,843	480,648	1,247,487	0.0384	0.0386	0.0389
SC	Jan	1	1,181,062	468,835	1,223,955	0.0380	0.0377	0.0382
SC	Jan	2	1,178,324	465,076	1,215,074	0.0379	0.0374	0.0379
SC	Jan	3	1,185,185	465,533	1,218,379	0.0381	0.0374	0.0380
SC	Jan	4	1,203,617	473,274	1,235,149	0.0387	0.0380	0.0385
SC	Jan	5	1,244,456	491,415	1,270,561	0.0400	0.0395	0.0396
SC	Jan	6	1,345,325	534,230	1,358,260	0.0433	0.0429	0.0424
SC	Jan	7	1,417,318	570,794	1,441,179	0.0456	0.0459	0.0449
SC	Jan	8	1,416,853	576,272	1,455,985	0.0456	0.0463	0.0454
SC	Jan	9	1,415,176	572,561	1,446,396	0.0455	0.0460	0.0451
SC	Jan	10	1,397,177	570,131	1,436,696	0.0450	0.0458	0.0448
SC	Jan	11	1,360,857	555,144	1,405,593	0.0438	0.0446	0.0438
SC	Jan	12	1,301,336	525,161	1,352,206	0.0419	0.0422	0.0422
SC	Jan	13	1,250,536	498,742	1,308,808	0.0402	0.0401	0.0408
SC	Jan	14	1,223,591	483,833	1,281,905	0.0394	0.0389	0.0400
SC	Jan	15	1,207,238	471,171	1,257,847	0.0388	0.0379	0.0392
SC	Jan	16	1,219,228	474,017	1,265,489	0.0392	0.0381	0.0395
SC	Jan	17	1,277,592	499,120	1,316,601	0.0411	0.0401	0.0411
SC	Jan	18	1,386,046	555,815	1,414,662	0.0446	0.0447	0.0441
SC	Jan	19	1,395,284	566,893	1,429,707	0.0449	0.0455	0.0446
SC	Jan	20	1,388,573	564,996	1,426,484	0.0447	0.0454	0.0445

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Jan	21	1,353,844	553,482	1,405,199	0.0436	0.0445	0.0438
SC	Jan	22	1,301,954	530,961	1,362,865	0.0419	0.0427	0.0425
SC	Jan	23	1,236,633	499,336	1,294,592	0.0398	0.0401	0.0404
SC	Feb	0	1,041,655	453,992	1,137,929	0.0377	0.0378	0.0387
SC	Feb	1	1,023,879	441,068	1,114,670	0.0371	0.0367	0.0379
SC	Feb	2	1,025,675	442,264	1,115,322	0.0371	0.0368	0.0380
SC	Feb	3	1,041,433	448,073	1,123,781	0.0377	0.0373	0.0383
SC	Feb	4	1,064,963	460,399	1,142,344	0.0386	0.0383	0.0389
SC	Feb	5	1,113,818	481,647	1,189,091	0.0403	0.0401	0.0405
SC	Feb	6	1,204,046	520,862	1,267,530	0.0436	0.0433	0.0432
SC	Feb	7	1,269,465	556,447	1,338,662	0.0460	0.0463	0.0456
SC	Feb	8	1,271,254	558,690	1,347,296	0.0460	0.0465	0.0459
SC	Feb	9	1,261,215	551,623	1,325,078	0.0457	0.0459	0.0451
SC	Feb	10	1,258,014	548,546	1,307,257	0.0456	0.0456	0.0445
SC	Feb	11	1,213,058	533,420	1,273,502	0.0439	0.0444	0.0434
SC	Feb	12	1,157,145	509,539	1,232,702	0.0419	0.0424	0.0420
SC	Feb	13	1,115,616	489,378	1,196,676	0.0404	0.0407	0.0407
SC	Feb	14	1,083,985	473,997	1,174,255	0.0393	0.0394	0.0400
SC	Feb	15	1,069,355	465,111	1,159,918	0.0387	0.0387	0.0395
SC	Feb	16	1,083,211	467,600	1,165,528	0.0392	0.0389	0.0397
SC	Feb	17	1,113,435	482,842	1,193,396	0.0403	0.0402	0.0406
SC	Feb	18	1,195,180	515,881	1,256,756	0.0433	0.0429	0.0428
SC	Feb	19	1,237,637	538,211	1,291,252	0.0448	0.0448	0.0440
SC	Feb	20	1,228,729	535,559	1,283,159	0.0445	0.0445	0.0437
SC	Feb	21	1,220,471	532,359	1,276,459	0.0442	0.0443	0.0435
SC	Feb	22	1,194,620	523,226	1,257,240	0.0433	0.0435	0.0428
SC	Feb	23	1,128,305	491,626	1,202,526	0.0409	0.0409	0.0409
SC	Mar	0	1,147,569	507,527	1,208,175	0.0373	0.0369	0.0379
SC	Mar	1	1,110,411	488,536	1,170,163	0.0361	0.0355	0.0367
SC	Mar	2	1,106,133	482,100	1,160,443	0.0359	0.0351	0.0364
SC	Mar	3	1,117,730	484,035	1,164,246	0.0363	0.0352	0.0365
SC	Mar	4	1,134,897	488,530	1,175,239	0.0369	0.0355	0.0368
SC	Mar	5	1,177,436	506,209	1,223,198	0.0382	0.0368	0.0383
SC	Mar	6	1,259,703	551,851	1,318,478	0.0409	0.0401	0.0413
SC	Mar	7	1,331,476	588,096	1,389,787	0.0432	0.0428	0.0435
SC	Mar	8	1,346,676	607,086	1,416,752	0.0437	0.0442	0.0444
SC	Mar	9	1,363,068	610,741	1,424,503	0.0443	0.0444	0.0446
SC	Mar	10	1,362,102	613,492	1,412,867	0.0442	0.0446	0.0443
SC	Mar	11	1,348,072	608,769	1,397,146	0.0438	0.0443	0.0438
SC	Mar	12	1,331,944	603,304	1,378,584	0.0433	0.0439	0.0432
SC	Mar	13	1,324,281	598,146	1,363,276	0.0430	0.0435	0.0427
SC	Mar	14	1,308,840	587,857	1,346,240	0.0425	0.0428	0.0422
SC	Mar	15	1,299,894	581,352	1,334,578	0.0422	0.0423	0.0418
SC	Mar	16	1,311,716	586,865	1,342,143	0.0426	0.0427	0.0420
SC	Mar	17	1,327,170	594,508	1,355,504	0.0431	0.0432	0.0425
SC	Mar	18	1,360,944	609,339	1,389,484	0.0442	0.0443	0.0435
SC	Mar	19	1,403,774	632,070	1,434,512	0.0456	0.0460	0.0449
SC	Mar	20	1,404,116	635,255	1,438,786	0.0456	0.0462	0.0451
SC	Mar	21	1,378,675	627,017	1,419,091	0.0448	0.0456	0.0445
SC	Mar	22	1,327,543	607,815	1,381,745	0.0431	0.0442	0.0433
SC	Mar	23	1,201,867	548,195	1,274,399	0.0390	0.0399	0.0399
SC	Apr	0	1,133,885	466,873	1,159,489	0.0368	0.0358	0.0364
SC	Apr	1	1,098,489	445,533	1,126,493	0.0357	0.0341	0.0353

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Apr	2	1,074,450	434,469	1,105,970	0.0349	0.0333	0.0347
SC	Apr	3	1,067,571	432,836	1,101,070	0.0347	0.0332	0.0345
SC	Apr	4	1,094,306	440,836	1,117,672	0.0355	0.0338	0.0351
SC	Apr	5	1,171,162	473,005	1,179,856	0.0380	0.0362	0.0370
SC	Apr	6	1,258,502	523,651	1,267,925	0.0408	0.0401	0.0398
SC	Apr	7	1,294,607	547,925	1,302,811	0.0420	0.0420	0.0409
SC	Apr	8	1,328,850	566,276	1,332,824	0.0431	0.0434	0.0418
SC	Apr	9	1,359,580	580,188	1,362,251	0.0441	0.0445	0.0427
SC	Apr	10	1,371,543	583,066	1,386,790	0.0445	0.0447	0.0435
SC	Apr	11	1,368,109	583,729	1,407,762	0.0444	0.0447	0.0442
SC	Apr	12	1,374,089	588,721	1,424,583	0.0446	0.0451	0.0447
SC	Apr	13	1,361,595	583,547	1,420,912	0.0442	0.0447	0.0446
SC	Apr	14	1,367,002	588,115	1,443,671	0.0444	0.0451	0.0453
SC	Apr	15	1,369,994	591,700	1,455,560	0.0445	0.0453	0.0457
SC	Apr	16	1,379,249	593,261	1,463,247	0.0448	0.0455	0.0459
SC	Apr	17	1,375,841	592,628	1,462,644	0.0447	0.0454	0.0459
SC	Apr	18	1,362,699	588,327	1,449,990	0.0442	0.0451	0.0455
SC	Apr	19	1,380,346	594,549	1,460,011	0.0448	0.0456	0.0458
SC	Apr	20	1,384,434	598,346	1,458,963	0.0449	0.0458	0.0458
SC	Apr	21	1,358,113	591,722	1,423,692	0.0441	0.0453	0.0447
SC	Apr	22	1,282,401	557,662	1,334,871	0.0416	0.0427	0.0419
SC	Apr	23	1,191,759	504,735	1,232,157	0.0387	0.0387	0.0386
SC	May	0	1,228,688	516,553	1,383,850	0.0368	0.0355	0.0362
SC	May	1	1,201,855	500,262	1,352,550	0.0360	0.0344	0.0354
SC	May	2	1,185,694	491,051	1,336,057	0.0355	0.0338	0.0350
SC	May	3	1,169,177	487,170	1,324,226	0.0350	0.0335	0.0346
SC	May	4	1,189,532	495,280	1,341,690	0.0356	0.0341	0.0351
SC	May	5	1,259,593	523,755	1,406,545	0.0377	0.0360	0.0368
SC	May	6	1,333,625	569,197	1,491,985	0.0400	0.0391	0.0390
SC	May	7	1,359,691	589,010	1,529,045	0.0407	0.0405	0.0400
SC	May	8	1,406,248	612,485	1,576,795	0.0421	0.0421	0.0413
SC	May	9	1,444,207	638,558	1,625,268	0.0433	0.0439	0.0425
SC	May	10	1,462,974	653,634	1,672,791	0.0438	0.0450	0.0438
SC	May	11	1,477,568	659,991	1,710,819	0.0443	0.0454	0.0448
SC	May	12	1,490,383	665,928	1,737,149	0.0446	0.0458	0.0454
SC	May	13	1,497,507	669,215	1,752,602	0.0449	0.0460	0.0459
SC	May	14	1,503,844	671,032	1,763,879	0.0451	0.0461	0.0461
SC	May	15	1,516,709	673,616	1,774,779	0.0454	0.0463	0.0464
SC	May	16	1,523,324	674,286	1,778,700	0.0456	0.0464	0.0465
SC	May	17	1,515,986	671,958	1,772,017	0.0454	0.0462	0.0464
SC	May	18	1,493,820	660,267	1,748,196	0.0448	0.0454	0.0457
SC	May	19	1,484,653	652,972	1,733,108	0.0445	0.0449	0.0453
SC	May	20	1,503,697	661,029	1,732,271	0.0450	0.0455	0.0453
SC	May	21	1,471,313	651,703	1,672,660	0.0441	0.0448	0.0438
SC	May	22	1,373,862	602,536	1,553,626	0.0412	0.0414	0.0406
SC	May	23	1,285,784	549,346	1,453,778	0.0385	0.0378	0.0380
SC	Jun	0	1,317,160	534,747	1,418,600	0.0361	0.0350	0.0347
SC	Jun	1	1,254,115	504,239	1,360,666	0.0344	0.0330	0.0333
SC	Jun	2	1,218,081	490,965	1,327,523	0.0334	0.0321	0.0325
SC	Jun	3	1,196,077	481,911	1,308,651	0.0328	0.0315	0.0320
SC	Jun	4	1,201,291	483,865	1,307,341	0.0330	0.0316	0.0320
SC	Jun	5	1,244,751	500,138	1,339,899	0.0341	0.0327	0.0328
SC	Jun	6	1,313,605	529,260	1,394,558	0.0360	0.0346	0.0341

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Jun	7	1,388,136	570,681	1,480,296	0.0381	0.0373	0.0362
SC	Jun	8	1,513,695	627,740	1,604,495	0.0415	0.0410	0.0393
SC	Jun	9	1,594,676	669,173	1,708,432	0.0437	0.0438	0.0418
SC	Jun	10	1,650,250	702,690	1,831,365	0.0453	0.0459	0.0448
SC	Jun	11	1,688,649	720,117	1,930,073	0.0463	0.0471	0.0473
SC	Jun	12	1,715,234	734,256	1,998,193	0.0471	0.0480	0.0489
SC	Jun	13	1,728,158	739,791	2,029,002	0.0474	0.0484	0.0497
SC	Jun	14	1,733,573	740,392	2,036,326	0.0476	0.0484	0.0499
SC	Jun	15	1,731,234	738,786	2,032,064	0.0475	0.0483	0.0498
SC	Jun	16	1,727,326	737,522	2,027,165	0.0474	0.0482	0.0496
SC	Jun	17	1,714,522	733,951	2,011,417	0.0470	0.0480	0.0492
SC	Jun	18	1,694,167	725,702	1,990,211	0.0465	0.0474	0.0487
SC	Jun	19	1,658,889	709,176	1,932,339	0.0455	0.0464	0.0473
SC	Jun	20	1,663,468	706,596	1,888,845	0.0456	0.0462	0.0462
SC	Jun	21	1,612,342	690,122	1,779,653	0.0442	0.0451	0.0436
SC	Jun	22	1,505,012	643,357	1,614,139	0.0413	0.0421	0.0395
SC	Jun	23	1,390,672	579,803	1,493,083	0.0381	0.0379	0.0366
SC	Jul	0	1,550,861	647,375	1,621,672	0.0380	0.0379	0.0357
SC	Jul	1	1,485,649	606,974	1,557,981	0.0364	0.0355	0.0343
SC	Jul	2	1,435,894	577,435	1,512,180	0.0352	0.0338	0.0332
SC	Jul	3	1,406,613	563,617	1,489,064	0.0344	0.0330	0.0327
SC	Jul	4	1,393,604	552,854	1,472,430	0.0341	0.0324	0.0324
SC	Jul	5	1,427,729	562,174	1,495,141	0.0350	0.0329	0.0329
SC	Jul	6	1,483,276	581,958	1,528,722	0.0363	0.0341	0.0336
SC	Jul	7	1,553,204	624,180	1,617,557	0.0380	0.0365	0.0356
SC	Jul	8	1,669,386	685,118	1,746,634	0.0409	0.0401	0.0384
SC	Jul	9	1,780,560	744,007	1,914,618	0.0436	0.0436	0.0421
SC	Jul	10	1,841,166	780,080	2,059,147	0.0451	0.0457	0.0453
SC	Jul	11	1,871,650	797,506	2,160,641	0.0458	0.0467	0.0475
SC	Jul	12	1,885,097	804,057	2,215,621	0.0462	0.0471	0.0487
SC	Jul	13	1,893,481	804,660	2,247,460	0.0464	0.0471	0.0494
SC	Jul	14	1,880,848	802,907	2,250,524	0.0461	0.0470	0.0495
SC	Jul	15	1,871,265	802,725	2,253,254	0.0458	0.0470	0.0495
SC	Jul	16	1,874,544	803,356	2,251,591	0.0459	0.0470	0.0495
SC	Jul	17	1,864,347	800,267	2,238,259	0.0457	0.0468	0.0492
SC	Jul	18	1,841,150	793,304	2,202,195	0.0451	0.0464	0.0484
SC	Jul	19	1,817,323	777,456	2,137,212	0.0445	0.0455	0.0470
SC	Jul	20	1,825,395	776,122	2,056,405	0.0447	0.0454	0.0452
SC	Jul	21	1,806,089	766,607	1,942,184	0.0442	0.0449	0.0427
SC	Jul	22	1,745,295	737,081	1,813,537	0.0427	0.0431	0.0399
SC	Jul	23	1,633,411	690,428	1,704,282	0.0400	0.0404	0.0375
SC	Aug	0	1,438,903	564,220	1,495,896	0.0372	0.0362	0.0350
SC	Aug	1	1,371,260	533,223	1,434,370	0.0355	0.0342	0.0335
SC	Aug	2	1,314,516	510,277	1,387,397	0.0340	0.0327	0.0324
SC	Aug	3	1,292,699	501,939	1,371,174	0.0334	0.0322	0.0320
SC	Aug	4	1,315,716	507,934	1,381,607	0.0340	0.0326	0.0323
SC	Aug	5	1,409,065	544,067	1,448,169	0.0364	0.0349	0.0338
SC	Aug	6	1,484,951	578,736	1,510,958	0.0384	0.0371	0.0353
SC	Aug	7	1,510,405	596,475	1,565,906	0.0391	0.0383	0.0366
SC	Aug	8	1,583,021	630,367	1,655,106	0.0409	0.0404	0.0387
SC	Aug	9	1,667,201	673,589	1,798,684	0.0431	0.0432	0.0420
SC	Aug	10	1,721,623	702,425	1,936,111	0.0445	0.0451	0.0452
SC	Aug	11	1,762,679	721,381	2,040,296	0.0456	0.0463	0.0477

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Aug	12	1,787,421	735,211	2,090,912	0.0462	0.0472	0.0489
SC	Aug	13	1,793,621	740,812	2,115,282	0.0464	0.0475	0.0494
SC	Aug	14	1,793,187	740,506	2,117,739	0.0464	0.0475	0.0495
SC	Aug	15	1,805,171	745,541	2,123,103	0.0467	0.0478	0.0496
SC	Aug	16	1,807,683	746,813	2,121,240	0.0467	0.0479	0.0496
SC	Aug	17	1,797,020	739,242	2,103,452	0.0465	0.0474	0.0492
SC	Aug	18	1,772,300	727,860	2,068,105	0.0458	0.0467	0.0483
SC	Aug	19	1,755,499	718,248	2,025,562	0.0454	0.0461	0.0473
SC	Aug	20	1,748,648	715,426	1,965,235	0.0452	0.0459	0.0459
SC	Aug	21	1,689,776	690,266	1,822,903	0.0437	0.0443	0.0426
SC	Aug	22	1,578,938	640,743	1,664,935	0.0408	0.0411	0.0389
SC	Aug	23	1,475,430	586,544	1,546,164	0.0381	0.0376	0.0361
SC	Sep	0	1,267,171	489,865	1,287,184	0.0355	0.0347	0.0357
SC	Sep	1	1,214,880	466,986	1,245,487	0.0340	0.0330	0.0345
SC	Sep	2	1,179,221	452,666	1,218,077	0.0331	0.0320	0.0338
SC	Sep	3	1,166,196	446,962	1,205,510	0.0327	0.0316	0.0334
SC	Sep	4	1,193,111	456,933	1,221,705	0.0334	0.0323	0.0339
SC	Sep	5	1,298,674	501,016	1,299,352	0.0364	0.0355	0.0360
SC	Sep	6	1,395,952	546,074	1,378,585	0.0391	0.0386	0.0382
SC	Sep	7	1,399,227	551,691	1,397,508	0.0392	0.0390	0.0388
SC	Sep	8	1,484,456	586,479	1,473,117	0.0416	0.0415	0.0409
SC	Sep	9	1,551,745	619,554	1,550,128	0.0435	0.0438	0.0430
SC	Sep	10	1,607,397	642,136	1,608,375	0.0451	0.0454	0.0446
SC	Sep	11	1,641,868	654,374	1,654,612	0.0460	0.0463	0.0459
SC	Sep	12	1,656,163	663,988	1,683,369	0.0464	0.0470	0.0467
SC	Sep	13	1,664,480	668,709	1,698,407	0.0467	0.0473	0.0471
SC	Sep	14	1,667,461	671,110	1,704,850	0.0467	0.0475	0.0473
SC	Sep	15	1,665,656	670,852	1,701,846	0.0467	0.0475	0.0472
SC	Sep	16	1,671,289	672,480	1,697,383	0.0468	0.0476	0.0471
SC	Sep	17	1,663,662	668,885	1,691,010	0.0466	0.0473	0.0469
SC	Sep	18	1,656,238	662,424	1,678,966	0.0464	0.0469	0.0466
SC	Sep	19	1,665,481	663,287	1,673,145	0.0467	0.0469	0.0464
SC	Sep	20	1,639,488	655,455	1,639,684	0.0460	0.0464	0.0455
SC	Sep	21	1,561,295	625,954	1,561,141	0.0438	0.0443	0.0433
SC	Sep	22	1,439,682	571,244	1,443,309	0.0404	0.0404	0.0400
SC	Sep	23	1,328,878	522,474	1,345,189	0.0372	0.0370	0.0373
SC	Oct	0	1,083,438	432,962	1,077,489	0.0359	0.0355	0.0363
SC	Oct	1	1,045,716	411,972	1,041,266	0.0346	0.0338	0.0351
SC	Oct	2	1,036,821	405,198	1,029,069	0.0343	0.0332	0.0347
SC	Oct	3	1,041,711	404,777	1,026,238	0.0345	0.0332	0.0346
SC	Oct	4	1,087,634	424,511	1,063,636	0.0360	0.0348	0.0358
SC	Oct	5	1,188,034	464,658	1,138,266	0.0393	0.0381	0.0383
SC	Oct	6	1,264,169	506,142	1,202,115	0.0418	0.0415	0.0405
SC	Oct	7	1,281,158	514,592	1,225,918	0.0424	0.0422	0.0413
SC	Oct	8	1,327,321	532,210	1,264,589	0.0439	0.0436	0.0426
SC	Oct	9	1,352,740	543,750	1,289,224	0.0448	0.0446	0.0434
SC	Oct	10	1,362,337	555,102	1,312,226	0.0451	0.0455	0.0442
SC	Oct	11	1,356,707	556,753	1,327,909	0.0449	0.0456	0.0447
SC	Oct	12	1,354,978	556,010	1,344,829	0.0448	0.0456	0.0453
SC	Oct	13	1,350,576	555,834	1,350,789	0.0447	0.0456	0.0455
SC	Oct	14	1,347,416	554,676	1,351,650	0.0446	0.0455	0.0455
SC	Oct	15	1,342,470	552,929	1,352,179	0.0444	0.0453	0.0456
SC	Oct	16	1,346,603	553,976	1,354,292	0.0446	0.0454	0.0456

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Oct	17	1,349,409	551,984	1,350,493	0.0447	0.0452	0.0455
SC	Oct	18	1,351,247	548,130	1,346,388	0.0447	0.0449	0.0454
SC	Oct	19	1,350,041	549,817	1,335,542	0.0447	0.0451	0.0450
SC	Oct	20	1,339,271	544,543	1,310,248	0.0443	0.0446	0.0441
SC	Oct	21	1,312,079	532,082	1,273,823	0.0434	0.0436	0.0429
SC	Oct	22	1,215,755	494,039	1,195,535	0.0402	0.0405	0.0403
SC	Oct	23	1,126,056	454,256	1,119,629	0.0373	0.0372	0.0377
SC	Nov	0	1,142,879	465,804	1,092,879	0.0399	0.0397	0.0399
SC	Nov	1	1,121,516	454,090	1,069,293	0.0391	0.0387	0.0391
SC	Nov	2	1,107,818	445,707	1,056,930	0.0386	0.0380	0.0386
SC	Nov	3	1,112,215	448,817	1,060,109	0.0388	0.0382	0.0387
SC	Nov	4	1,117,929	452,879	1,068,293	0.0390	0.0386	0.0390
SC	Nov	5	1,155,180	470,750	1,105,723	0.0403	0.0401	0.0404
SC	Nov	6	1,214,771	493,858	1,148,648	0.0424	0.0421	0.0420
SC	Nov	7	1,238,138	509,024	1,183,112	0.0432	0.0434	0.0432
SC	Nov	8	1,229,883	505,155	1,180,162	0.0429	0.0430	0.0431
SC	Nov	9	1,239,623	505,179	1,179,357	0.0432	0.0430	0.0431
SC	Nov	10	1,229,433	501,538	1,163,431	0.0429	0.0427	0.0425
SC	Nov	11	1,218,899	498,788	1,159,807	0.0425	0.0425	0.0424
SC	Nov	12	1,205,021	493,462	1,152,594	0.0420	0.0420	0.0421
SC	Nov	13	1,190,767	485,270	1,136,787	0.0415	0.0413	0.0415
SC	Nov	14	1,173,108	478,959	1,124,147	0.0409	0.0408	0.0411
SC	Nov	15	1,168,764	477,481	1,121,535	0.0408	0.0407	0.0410
SC	Nov	16	1,166,053	478,332	1,126,451	0.0407	0.0408	0.0412
SC	Nov	17	1,217,287	499,460	1,166,260	0.0424	0.0426	0.0426
SC	Nov	18	1,260,433	520,571	1,201,570	0.0440	0.0444	0.0439
SC	Nov	19	1,261,010	520,195	1,196,676	0.0440	0.0443	0.0437
SC	Nov	20	1,256,921	518,826	1,192,076	0.0438	0.0442	0.0436
SC	Nov	21	1,247,080	517,189	1,187,202	0.0435	0.0441	0.0434
SC	Nov	22	1,227,629	508,506	1,169,284	0.0428	0.0433	0.0427
SC	Nov	23	1,175,485	486,920	1,126,987	0.0410	0.0415	0.0412
SC	Dec	0	1,356,270	556,321	1,309,476	0.0399	0.0399	0.0398
SC	Dec	1	1,332,499	540,268	1,279,485	0.0392	0.0387	0.0389
SC	Dec	2	1,324,618	536,330	1,275,732	0.0389	0.0384	0.0388
SC	Dec	3	1,330,924	538,908	1,284,514	0.0391	0.0386	0.0391
SC	Dec	4	1,335,158	545,819	1,296,880	0.0392	0.0391	0.0394
SC	Dec	5	1,385,906	565,695	1,340,759	0.0407	0.0405	0.0408
SC	Dec	6	1,436,829	586,536	1,387,329	0.0422	0.0420	0.0422
SC	Dec	7	1,488,961	611,648	1,440,753	0.0438	0.0438	0.0438
SC	Dec	8	1,491,509	613,176	1,444,956	0.0438	0.0440	0.0440
SC	Dec	9	1,501,425	618,516	1,447,916	0.0441	0.0443	0.0440
SC	Dec	10	1,484,685	610,879	1,431,441	0.0436	0.0438	0.0435
SC	Dec	11	1,459,697	593,638	1,395,938	0.0429	0.0426	0.0425
SC	Dec	12	1,423,246	578,669	1,365,957	0.0418	0.0415	0.0415
SC	Dec	13	1,391,851	570,939	1,345,091	0.0409	0.0409	0.0409
SC	Dec	14	1,352,161	557,078	1,319,068	0.0397	0.0399	0.0401
SC	Dec	15	1,344,643	551,497	1,312,670	0.0395	0.0395	0.0399
SC	Dec	16	1,369,024	559,569	1,333,589	0.0402	0.0401	0.0406
SC	Dec	17	1,449,587	595,765	1,398,917	0.0426	0.0427	0.0426
SC	Dec	18	1,493,742	621,423	1,438,833	0.0439	0.0445	0.0438
SC	Dec	19	1,473,502	611,050	1,427,712	0.0433	0.0438	0.0434
SC	Dec	20	1,479,504	608,223	1,424,664	0.0435	0.0436	0.0433
SC	Dec	21	1,475,680	608,049	1,421,202	0.0434	0.0436	0.0432

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Dec	22	1,450,119	597,906	1,401,208	0.0426	0.0429	0.0426
SC	Dec	23	1,391,087	573,310	1,351,539	0.0409	0.0411	0.0411
TN	Jan	0	2,280,657	1,090,246	2,060,661	0.0408	0.0412	0.0408
TN	Jan	1	2,276,680	1,086,084	2,055,798	0.0407	0.0410	0.0407
TN	Jan	2	2,272,794	1,084,755	2,049,805	0.0406	0.0409	0.0406
TN	Jan	3	2,283,587	1,086,794	2,055,875	0.0408	0.0410	0.0407
TN	Jan	4	2,315,278	1,097,078	2,085,158	0.0414	0.0414	0.0413
TN	Jan	5	2,354,985	1,117,772	2,125,268	0.0421	0.0422	0.0421
TN	Jan	6	2,377,419	1,130,729	2,160,310	0.0425	0.0427	0.0428
TN	Jan	7	2,379,741	1,134,700	2,158,578	0.0425	0.0428	0.0427
TN	Jan	8	2,385,006	1,131,469	2,152,929	0.0426	0.0427	0.0426
TN	Jan	9	2,382,917	1,123,629	2,142,415	0.0426	0.0424	0.0424
TN	Jan	10	2,365,473	1,117,013	2,124,072	0.0423	0.0422	0.0420
TN	Jan	11	2,327,368	1,103,862	2,103,953	0.0416	0.0417	0.0416
TN	Jan	12	2,316,863	1,091,178	2,093,020	0.0414	0.0412	0.0414
TN	Jan	13	2,309,096	1,078,383	2,078,746	0.0413	0.0407	0.0411
TN	Jan	14	2,299,661	1,075,824	2,074,755	0.0411	0.0406	0.0411
TN	Jan	15	2,321,027	1,088,345	2,097,187	0.0415	0.0411	0.0415
TN	Jan	16	2,343,037	1,095,908	2,109,557	0.0419	0.0414	0.0418
TN	Jan	17	2,367,599	1,107,163	2,131,849	0.0423	0.0418	0.0422
TN	Jan	18	2,380,012	1,121,715	2,145,891	0.0425	0.0423	0.0425
TN	Jan	19	2,370,033	1,119,519	2,140,261	0.0424	0.0423	0.0424
TN	Jan	20	2,365,048	1,117,332	2,136,469	0.0423	0.0422	0.0423
TN	Jan	21	2,342,389	1,110,766	2,116,629	0.0419	0.0419	0.0419
TN	Jan	22	2,292,432	1,097,607	2,075,794	0.0410	0.0414	0.0411
TN	Jan	23	2,253,488	1,082,843	2,042,235	0.0403	0.0409	0.0404
TN	Feb	0	2,045,561	1,036,193	1,974,208	0.0411	0.0413	0.0409
TN	Feb	1	2,037,112	1,028,755	1,964,950	0.0409	0.0410	0.0407
TN	Feb	2	2,036,584	1,027,141	1,965,731	0.0409	0.0409	0.0407
TN	Feb	3	2,051,386	1,033,416	1,976,667	0.0412	0.0412	0.0410
TN	Feb	4	2,081,945	1,043,732	2,001,259	0.0418	0.0416	0.0415
TN	Feb	5	2,119,150	1,058,631	2,035,996	0.0426	0.0422	0.0422
TN	Feb	6	2,129,069	1,067,771	2,052,247	0.0428	0.0425	0.0425
TN	Feb	7	2,110,861	1,062,664	2,046,802	0.0424	0.0423	0.0424
TN	Feb	8	2,121,686	1,063,805	2,048,373	0.0426	0.0424	0.0424
TN	Feb	9	2,098,143	1,055,196	2,045,894	0.0422	0.0420	0.0424
TN	Feb	10	2,075,935	1,049,309	2,035,769	0.0417	0.0418	0.0422
TN	Feb	11	2,068,315	1,047,712	2,029,719	0.0416	0.0417	0.0421
TN	Feb	12	2,054,168	1,044,777	2,018,542	0.0413	0.0416	0.0418
TN	Feb	13	2,034,932	1,038,578	2,002,914	0.0409	0.0414	0.0415
TN	Feb	14	2,011,399	1,030,459	1,985,070	0.0404	0.0410	0.0411
TN	Feb	15	2,002,182	1,029,651	1,978,422	0.0402	0.0410	0.0410
TN	Feb	16	2,025,350	1,034,663	1,991,100	0.0407	0.0412	0.0413
TN	Feb	17	2,061,721	1,046,012	2,017,429	0.0414	0.0417	0.0418
TN	Feb	18	2,100,734	1,054,346	2,024,956	0.0422	0.0420	0.0420
TN	Feb	19	2,107,282	1,051,903	2,019,594	0.0423	0.0419	0.0418
TN	Feb	20	2,118,880	1,052,061	2,023,781	0.0426	0.0419	0.0419
TN	Feb	21	2,113,523	1,053,535	2,023,349	0.0425	0.0420	0.0419
TN	Feb	22	2,087,880	1,052,103	2,006,920	0.0419	0.0419	0.0416
TN	Feb	23	2,079,170	1,048,811	1,999,179	0.0418	0.0418	0.0414
TN	Mar	0	2,180,326	1,137,957	2,190,242	0.0405	0.0410	0.0407
TN	Mar	1	2,156,648	1,130,759	2,174,875	0.0400	0.0407	0.0404
TN	Mar	2	2,137,773	1,126,441	2,164,468	0.0397	0.0405	0.0403

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Mar	3	2,142,861	1,124,783	2,171,287	0.0398	0.0405	0.0404
TN	Mar	4	2,165,441	1,134,289	2,194,430	0.0402	0.0408	0.0408
TN	Mar	5	2,210,240	1,150,811	2,235,294	0.0410	0.0414	0.0416
TN	Mar	6	2,247,318	1,174,062	2,289,372	0.0417	0.0423	0.0426
TN	Mar	7	2,237,563	1,174,836	2,285,107	0.0415	0.0423	0.0425
TN	Mar	8	2,250,433	1,170,688	2,270,641	0.0418	0.0421	0.0422
TN	Mar	9	2,278,430	1,175,946	2,286,604	0.0423	0.0423	0.0425
TN	Mar	10	2,288,113	1,178,902	2,294,721	0.0425	0.0424	0.0427
TN	Mar	11	2,291,351	1,179,668	2,283,107	0.0425	0.0425	0.0425
TN	Mar	12	2,290,673	1,174,183	2,272,685	0.0425	0.0423	0.0423
TN	Mar	13	2,286,454	1,166,158	2,256,742	0.0424	0.0420	0.0420
TN	Mar	14	2,280,776	1,163,689	2,246,497	0.0423	0.0419	0.0418
TN	Mar	15	2,284,314	1,161,581	2,249,873	0.0424	0.0418	0.0418
TN	Mar	16	2,285,313	1,160,340	2,250,387	0.0424	0.0418	0.0418
TN	Mar	17	2,287,641	1,162,243	2,248,851	0.0425	0.0418	0.0418
TN	Mar	18	2,312,247	1,170,061	2,262,283	0.0429	0.0421	0.0421
TN	Mar	19	2,314,670	1,170,576	2,259,844	0.0430	0.0421	0.0420
TN	Mar	20	2,302,073	1,165,324	2,253,878	0.0427	0.0419	0.0419
TN	Mar	21	2,274,016	1,161,954	2,248,913	0.0422	0.0418	0.0418
TN	Mar	22	2,209,224	1,140,592	2,203,141	0.0410	0.0410	0.0410
TN	Mar	23	2,174,554	1,130,438	2,180,161	0.0404	0.0407	0.0405
TN	Apr	0	2,044,749	1,061,543	2,070,830	0.0381	0.0394	0.0386
TN	Apr	1	2,005,156	1,046,422	2,036,645	0.0374	0.0388	0.0379
TN	Apr	2	2,004,324	1,041,500	2,026,268	0.0374	0.0387	0.0378
TN	Apr	3	2,045,372	1,055,392	2,058,094	0.0381	0.0392	0.0383
TN	Apr	4	2,141,951	1,088,750	2,135,048	0.0399	0.0404	0.0398
TN	Apr	5	2,226,460	1,118,523	2,198,103	0.0415	0.0415	0.0410
TN	Apr	6	2,233,453	1,121,488	2,209,347	0.0416	0.0416	0.0412
TN	Apr	7	2,264,203	1,131,645	2,229,844	0.0422	0.0420	0.0415
TN	Apr	8	2,284,079	1,138,038	2,249,554	0.0426	0.0422	0.0419
TN	Apr	9	2,297,398	1,139,610	2,272,535	0.0428	0.0423	0.0423
TN	Apr	10	2,312,291	1,140,698	2,298,553	0.0431	0.0423	0.0428
TN	Apr	11	2,309,811	1,138,665	2,307,521	0.0431	0.0423	0.0430
TN	Apr	12	2,310,818	1,140,028	2,311,347	0.0431	0.0423	0.0431
TN	Apr	13	2,310,720	1,146,265	2,329,188	0.0431	0.0425	0.0434
TN	Apr	14	2,309,927	1,147,491	2,336,905	0.0431	0.0426	0.0435
TN	Apr	15	2,310,604	1,149,649	2,341,989	0.0431	0.0427	0.0436
TN	Apr	16	2,311,508	1,155,848	2,347,038	0.0431	0.0429	0.0437
TN	Apr	17	2,311,177	1,158,728	2,342,439	0.0431	0.0430	0.0436
TN	Apr	18	2,333,502	1,167,531	2,352,881	0.0435	0.0433	0.0438
TN	Apr	19	2,346,118	1,165,574	2,352,994	0.0437	0.0433	0.0438
TN	Apr	20	2,337,132	1,158,848	2,321,872	0.0436	0.0430	0.0433
TN	Apr	21	2,274,011	1,136,940	2,237,857	0.0424	0.0422	0.0417
TN	Apr	22	2,188,145	1,109,353	2,174,202	0.0408	0.0412	0.0405
TN	Apr	23	2,122,615	1,085,586	2,127,949	0.0396	0.0403	0.0396
TN	May	0	2,097,390	1,044,045	2,183,067	0.0390	0.0398	0.0394
TN	May	1	2,059,125	1,025,383	2,145,941	0.0383	0.0391	0.0387
TN	May	2	2,044,200	1,012,178	2,124,933	0.0380	0.0386	0.0384
TN	May	3	2,062,636	1,018,551	2,141,667	0.0383	0.0389	0.0387
TN	May	4	2,107,827	1,041,643	2,184,093	0.0392	0.0397	0.0394
TN	May	5	2,168,969	1,065,468	2,238,029	0.0403	0.0406	0.0404
TN	May	6	2,178,130	1,073,329	2,252,855	0.0405	0.0409	0.0407
TN	May	7	2,223,555	1,085,827	2,276,424	0.0413	0.0414	0.0411

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	May	8	2,291,831	1,109,084	2,334,809	0.0426	0.0423	0.0421
TN	May	9	2,304,353	1,112,287	2,352,677	0.0428	0.0424	0.0425
TN	May	10	2,316,864	1,119,631	2,371,950	0.0431	0.0427	0.0428
TN	May	11	2,330,777	1,130,585	2,396,929	0.0433	0.0431	0.0433
TN	May	12	2,332,930	1,125,359	2,400,531	0.0434	0.0429	0.0433
TN	May	13	2,349,411	1,137,190	2,423,689	0.0437	0.0434	0.0438
TN	May	14	2,344,893	1,131,685	2,422,228	0.0436	0.0432	0.0437
TN	May	15	2,333,830	1,124,888	2,407,856	0.0434	0.0429	0.0435
TN	May	16	2,337,173	1,127,827	2,408,655	0.0434	0.0430	0.0435
TN	May	17	2,324,409	1,124,076	2,389,619	0.0432	0.0429	0.0431
TN	May	18	2,328,213	1,121,883	2,381,990	0.0433	0.0428	0.0430
TN	May	19	2,350,543	1,121,297	2,389,039	0.0437	0.0428	0.0431
TN	May	20	2,332,491	1,118,215	2,372,526	0.0434	0.0427	0.0428
TN	May	21	2,250,042	1,094,437	2,304,079	0.0418	0.0418	0.0416
TN	May	22	2,181,192	1,080,175	2,264,001	0.0405	0.0412	0.0409
TN	May	23	2,142,259	1,066,553	2,229,848	0.0398	0.0407	0.0403
TN	Jun	0	2,246,844	1,163,244	2,348,629	0.0387	0.0402	0.0390
TN	Jun	1	2,157,024	1,116,780	2,254,251	0.0371	0.0386	0.0374
TN	Jun	2	2,114,606	1,091,410	2,206,758	0.0364	0.0377	0.0367
TN	Jun	3	2,122,681	1,090,934	2,209,308	0.0365	0.0377	0.0367
TN	Jun	4	2,166,926	1,110,534	2,256,363	0.0373	0.0383	0.0375
TN	Jun	5	2,197,182	1,121,043	2,280,986	0.0378	0.0387	0.0379
TN	Jun	6	2,245,908	1,133,255	2,321,132	0.0387	0.0391	0.0386
TN	Jun	7	2,380,289	1,182,770	2,422,629	0.0410	0.0408	0.0402
TN	Jun	8	2,475,740	1,222,110	2,519,902	0.0426	0.0422	0.0419
TN	Jun	9	2,521,948	1,243,308	2,580,303	0.0434	0.0429	0.0429
TN	Jun	10	2,540,649	1,252,511	2,616,466	0.0437	0.0432	0.0435
TN	Jun	11	2,556,532	1,258,730	2,639,054	0.0440	0.0435	0.0438
TN	Jun	12	2,551,271	1,259,623	2,658,926	0.0439	0.0435	0.0442
TN	Jun	13	2,556,432	1,260,605	2,690,570	0.0440	0.0435	0.0447
TN	Jun	14	2,568,395	1,257,352	2,701,819	0.0442	0.0434	0.0449
TN	Jun	15	2,571,738	1,261,886	2,709,178	0.0443	0.0436	0.0450
TN	Jun	16	2,571,247	1,259,730	2,695,121	0.0443	0.0435	0.0448
TN	Jun	17	2,567,684	1,258,082	2,681,601	0.0442	0.0434	0.0445
TN	Jun	18	2,563,903	1,254,680	2,663,559	0.0441	0.0433	0.0442
TN	Jun	19	2,570,639	1,256,567	2,651,315	0.0443	0.0434	0.0440
TN	Jun	20	2,557,808	1,252,991	2,621,719	0.0440	0.0433	0.0435
TN	Jun	21	2,502,736	1,237,210	2,547,606	0.0431	0.0427	0.0423
TN	Jun	22	2,415,922	1,215,513	2,484,921	0.0416	0.0420	0.0413
TN	Jun	23	2,359,788	1,199,917	2,443,012	0.0406	0.0414	0.0406
TN	Jul	0	2,483,790	1,202,492	2,513,570	0.0396	0.0405	0.0385
TN	Jul	1	2,399,485	1,184,193	2,454,175	0.0383	0.0399	0.0376
TN	Jul	2	2,342,566	1,162,167	2,402,688	0.0374	0.0391	0.0368
TN	Jul	3	2,351,902	1,159,517	2,402,184	0.0375	0.0391	0.0368
TN	Jul	4	2,394,141	1,167,605	2,428,316	0.0382	0.0393	0.0372
TN	Jul	5	2,405,527	1,170,775	2,445,342	0.0384	0.0394	0.0375
TN	Jul	6	2,475,120	1,185,236	2,494,763	0.0395	0.0399	0.0382
TN	Jul	7	2,594,352	1,225,183	2,593,504	0.0414	0.0413	0.0397
TN	Jul	8	2,665,212	1,241,348	2,664,052	0.0425	0.0418	0.0408
TN	Jul	9	2,717,800	1,258,136	2,754,759	0.0433	0.0424	0.0422
TN	Jul	10	2,735,468	1,268,759	2,858,838	0.0436	0.0427	0.0438
TN	Jul	11	2,736,509	1,272,416	2,925,505	0.0436	0.0429	0.0448
TN	Jul	12	2,733,200	1,278,347	2,972,783	0.0436	0.0431	0.0456

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Jul	13	2,721,767	1,271,801	2,979,932	0.0434	0.0428	0.0457
TN	Jul	14	2,725,109	1,273,232	2,983,227	0.0435	0.0429	0.0457
TN	Jul	15	2,727,026	1,274,190	2,979,882	0.0435	0.0429	0.0457
TN	Jul	16	2,728,768	1,277,405	2,969,560	0.0435	0.0430	0.0455
TN	Jul	17	2,730,777	1,275,804	2,938,302	0.0435	0.0430	0.0450
TN	Jul	18	2,730,727	1,275,132	2,908,965	0.0435	0.0430	0.0446
TN	Jul	19	2,734,862	1,273,353	2,885,817	0.0436	0.0429	0.0442
TN	Jul	20	2,724,414	1,269,790	2,824,939	0.0434	0.0428	0.0433
TN	Jul	21	2,682,158	1,261,150	2,709,560	0.0428	0.0425	0.0415
TN	Jul	22	2,609,134	1,237,889	2,605,099	0.0416	0.0417	0.0399
TN	Jul	23	2,566,458	1,219,764	2,564,354	0.0409	0.0411	0.0393
TN	Aug	0	2,589,072	1,244,659	2,571,778	0.0400	0.0406	0.0391
TN	Aug	1	2,482,005	1,213,802	2,491,469	0.0383	0.0396	0.0378
TN	Aug	2	2,412,655	1,190,281	2,433,679	0.0373	0.0388	0.0370
TN	Aug	3	2,415,732	1,186,501	2,431,309	0.0373	0.0387	0.0369
TN	Aug	4	2,517,052	1,216,870	2,509,643	0.0389	0.0397	0.0381
TN	Aug	5	2,560,068	1,236,898	2,557,754	0.0395	0.0403	0.0388
TN	Aug	6	2,573,052	1,239,009	2,559,716	0.0397	0.0404	0.0389
TN	Aug	7	2,687,855	1,273,323	2,636,910	0.0415	0.0415	0.0400
TN	Aug	8	2,751,791	1,288,132	2,706,827	0.0425	0.0420	0.0411
TN	Aug	9	2,785,826	1,297,919	2,766,035	0.0430	0.0423	0.0420
TN	Aug	10	2,794,196	1,305,843	2,842,356	0.0432	0.0426	0.0432
TN	Aug	11	2,796,816	1,311,987	2,907,571	0.0432	0.0428	0.0442
TN	Aug	12	2,807,974	1,318,004	2,952,191	0.0434	0.0430	0.0448
TN	Aug	13	2,808,826	1,320,679	2,973,811	0.0434	0.0431	0.0452
TN	Aug	14	2,811,072	1,322,692	2,980,643	0.0434	0.0431	0.0453
TN	Aug	15	2,811,713	1,323,530	2,985,965	0.0434	0.0432	0.0453
TN	Aug	16	2,814,605	1,319,242	2,961,149	0.0435	0.0430	0.0450
TN	Aug	17	2,809,050	1,314,222	2,946,849	0.0434	0.0429	0.0448
TN	Aug	18	2,811,343	1,310,855	2,921,085	0.0434	0.0428	0.0444
TN	Aug	19	2,822,940	1,309,436	2,898,504	0.0436	0.0427	0.0440
TN	Aug	20	2,791,507	1,300,921	2,825,941	0.0431	0.0424	0.0429
TN	Aug	21	2,746,217	1,286,560	2,726,683	0.0424	0.0420	0.0414
TN	Aug	22	2,687,580	1,269,256	2,648,952	0.0415	0.0414	0.0402
TN	Aug	23	2,643,644	1,255,684	2,607,394	0.0408	0.0410	0.0396
TN	Sep	0	2,100,256	994,602	2,062,966	0.0379	0.0395	0.0380
TN	Sep	1	2,047,482	972,290	2,009,555	0.0370	0.0386	0.0370
TN	Sep	2	2,011,459	948,849	1,968,782	0.0363	0.0376	0.0363
TN	Sep	3	2,022,730	952,560	1,976,847	0.0365	0.0378	0.0364
TN	Sep	4	2,110,465	985,460	2,053,490	0.0381	0.0391	0.0378
TN	Sep	5	2,217,288	1,025,173	2,144,343	0.0400	0.0407	0.0395
TN	Sep	6	2,208,307	1,025,125	2,148,584	0.0399	0.0407	0.0396
TN	Sep	7	2,272,117	1,042,945	2,204,052	0.0410	0.0414	0.0406
TN	Sep	8	2,353,309	1,065,925	2,273,730	0.0425	0.0423	0.0419
TN	Sep	9	2,390,600	1,078,517	2,315,077	0.0432	0.0428	0.0427
TN	Sep	10	2,415,712	1,082,908	2,333,874	0.0436	0.0430	0.0430
TN	Sep	11	2,422,511	1,085,326	2,366,086	0.0438	0.0431	0.0436
TN	Sep	12	2,432,854	1,088,395	2,393,500	0.0439	0.0432	0.0441
TN	Sep	13	2,438,961	1,094,403	2,426,071	0.0441	0.0434	0.0447
TN	Sep	14	2,442,999	1,091,969	2,454,300	0.0441	0.0433	0.0452
TN	Sep	15	2,449,388	1,092,741	2,462,484	0.0442	0.0434	0.0454
TN	Sep	16	2,450,695	1,096,504	2,469,534	0.0443	0.0435	0.0455
TN	Sep	17	2,452,366	1,099,411	2,453,851	0.0443	0.0436	0.0452

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Sep	18	2,479,684	1,100,837	2,448,194	0.0448	0.0437	0.0451
TN	Sep	19	2,479,355	1,098,149	2,427,647	0.0448	0.0436	0.0447
TN	Sep	20	2,436,004	1,083,302	2,338,680	0.0440	0.0430	0.0431
TN	Sep	21	2,329,020	1,057,042	2,243,274	0.0421	0.0419	0.0413
TN	Sep	22	2,234,964	1,032,337	2,174,590	0.0404	0.0410	0.0401
TN	Sep	23	2,165,417	1,008,946	2,117,775	0.0391	0.0400	0.0390
TN	Oct	0	2,139,772	882,922	1,778,041	0.0390	0.0395	0.0393
TN	Oct	1	2,091,048	864,540	1,731,779	0.0381	0.0387	0.0383
TN	Oct	2	2,071,604	853,095	1,712,494	0.0378	0.0381	0.0379
TN	Oct	3	2,110,192	863,463	1,734,343	0.0385	0.0386	0.0383
TN	Oct	4	2,186,854	888,082	1,786,906	0.0399	0.0397	0.0395
TN	Oct	5	2,268,051	920,636	1,849,494	0.0414	0.0412	0.0409
TN	Oct	6	2,246,949	918,115	1,842,517	0.0410	0.0411	0.0407
TN	Oct	7	2,305,963	935,475	1,879,680	0.0421	0.0418	0.0416
TN	Oct	8	2,334,590	941,996	1,900,013	0.0426	0.0421	0.0420
TN	Oct	9	2,348,131	947,167	1,918,210	0.0428	0.0424	0.0424
TN	Oct	10	2,352,830	948,748	1,926,088	0.0429	0.0424	0.0426
TN	Oct	11	2,360,530	954,116	1,943,405	0.0431	0.0427	0.0430
TN	Oct	12	2,359,928	953,643	1,946,378	0.0431	0.0426	0.0430
TN	Oct	13	2,355,481	954,978	1,952,041	0.0430	0.0427	0.0432
TN	Oct	14	2,352,945	958,397	1,962,268	0.0429	0.0429	0.0434
TN	Oct	15	2,367,845	963,646	1,970,641	0.0432	0.0431	0.0436
TN	Oct	16	2,372,944	965,803	1,972,460	0.0433	0.0432	0.0436
TN	Oct	17	2,384,097	969,314	1,980,106	0.0435	0.0433	0.0438
TN	Oct	18	2,383,452	969,581	1,980,602	0.0435	0.0434	0.0438
TN	Oct	19	2,371,349	964,505	1,964,370	0.0433	0.0431	0.0434
TN	Oct	20	2,343,180	959,852	1,926,794	0.0427	0.0429	0.0426
TN	Oct	21	2,303,770	951,687	1,902,263	0.0420	0.0426	0.0421
TN	Oct	22	2,227,075	926,290	1,857,672	0.0406	0.0414	0.0411
TN	Oct	23	2,177,392	905,891	1,818,658	0.0397	0.0405	0.0402
TN	Nov	0	2,122,166	939,253	1,824,730	0.0404	0.0409	0.0408
TN	Nov	1	2,103,234	928,523	1,808,506	0.0401	0.0405	0.0405
TN	Nov	2	2,081,677	922,513	1,796,588	0.0397	0.0402	0.0402
TN	Nov	3	2,091,184	924,630	1,801,275	0.0399	0.0403	0.0403
TN	Nov	4	2,140,977	939,754	1,834,880	0.0408	0.0410	0.0410
TN	Nov	5	2,185,224	954,192	1,874,290	0.0416	0.0416	0.0419
TN	Nov	6	2,215,954	968,937	1,904,312	0.0422	0.0422	0.0426
TN	Nov	7	2,199,361	966,143	1,890,767	0.0419	0.0421	0.0423
TN	Nov	8	2,240,555	976,082	1,906,513	0.0427	0.0425	0.0426
TN	Nov	9	2,235,377	969,674	1,896,398	0.0426	0.0423	0.0424
TN	Nov	10	2,228,033	963,362	1,886,306	0.0425	0.0420	0.0422
TN	Nov	11	2,201,933	954,595	1,868,083	0.0420	0.0416	0.0418
TN	Nov	12	2,186,268	952,154	1,856,347	0.0417	0.0415	0.0415
TN	Nov	13	2,173,193	948,302	1,846,796	0.0414	0.0413	0.0413
TN	Nov	14	2,169,805	946,823	1,845,494	0.0414	0.0413	0.0413
TN	Nov	15	2,173,733	947,154	1,849,851	0.0414	0.0413	0.0414
TN	Nov	16	2,214,871	958,831	1,871,799	0.0422	0.0418	0.0419
TN	Nov	17	2,276,241	979,171	1,907,962	0.0434	0.0427	0.0427
TN	Nov	18	2,264,239	983,901	1,905,184	0.0431	0.0429	0.0426
TN	Nov	19	2,252,067	981,371	1,900,588	0.0429	0.0428	0.0425
TN	Nov	20	2,236,975	974,822	1,890,883	0.0426	0.0425	0.0423
TN	Nov	21	2,206,086	967,213	1,874,494	0.0420	0.0422	0.0419
TN	Nov	22	2,150,907	951,900	1,840,745	0.0410	0.0415	0.0412

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Nov	23	2,123,724	941,780	1,821,462	0.0405	0.0411	0.0407
TN	Dec	0	2,375,447	1,040,346	1,966,374	0.0404	0.0410	0.0405
TN	Dec	1	2,368,124	1,038,608	1,961,291	0.0403	0.0410	0.0404
TN	Dec	2	2,365,244	1,040,760	1,962,485	0.0403	0.0411	0.0404
TN	Dec	3	2,374,892	1,039,526	1,967,265	0.0404	0.0410	0.0405
TN	Dec	4	2,400,829	1,049,395	1,987,220	0.0409	0.0414	0.0409
TN	Dec	5	2,444,720	1,061,600	2,019,991	0.0416	0.0419	0.0416
TN	Dec	6	2,479,036	1,073,879	2,059,962	0.0422	0.0424	0.0424
TN	Dec	7	2,454,089	1,064,469	2,052,942	0.0418	0.0420	0.0423
TN	Dec	8	2,506,996	1,084,025	2,073,253	0.0427	0.0428	0.0427
TN	Dec	9	2,493,623	1,074,369	2,057,139	0.0424	0.0424	0.0424
TN	Dec	10	2,468,993	1,059,911	2,031,806	0.0420	0.0418	0.0419
TN	Dec	11	2,443,688	1,052,604	2,013,783	0.0416	0.0415	0.0415
TN	Dec	12	2,432,161	1,043,185	2,000,237	0.0414	0.0411	0.0412
TN	Dec	13	2,412,745	1,034,056	1,982,778	0.0411	0.0408	0.0409
TN	Dec	14	2,387,833	1,027,022	1,967,780	0.0406	0.0405	0.0405
TN	Dec	15	2,410,985	1,029,460	1,979,718	0.0410	0.0406	0.0408
TN	Dec	16	2,485,741	1,047,783	2,034,725	0.0423	0.0413	0.0419
TN	Dec	17	2,530,101	1,068,450	2,087,328	0.0431	0.0421	0.0430
TN	Dec	18	2,524,339	1,079,512	2,098,589	0.0430	0.0426	0.0432
TN	Dec	19	2,513,226	1,082,453	2,092,628	0.0428	0.0427	0.0431
TN	Dec	20	2,511,044	1,079,600	2,081,736	0.0427	0.0426	0.0429
TN	Dec	21	2,499,871	1,073,275	2,053,754	0.0426	0.0423	0.0423
TN	Dec	22	2,456,046	1,060,522	2,012,941	0.0418	0.0418	0.0415
TN	Dec	23	2,410,321	1,047,159	1,982,293	0.0410	0.0413	0.0408
VA	Jan	0	1,469,978	510,941	1,363,411	0.0382	0.0368	0.0382
VA	Jan	1	1,413,972	489,263	1,318,879	0.0368	0.0352	0.0369
VA	Jan	2	1,394,261	477,993	1,299,882	0.0362	0.0344	0.0364
VA	Jan	3	1,397,937	478,827	1,303,996	0.0363	0.0345	0.0365
VA	Jan	4	1,416,371	486,582	1,324,620	0.0368	0.0350	0.0371
VA	Jan	5	1,487,816	517,463	1,389,246	0.0387	0.0373	0.0389
VA	Jan	6	1,623,644	579,686	1,510,446	0.0422	0.0418	0.0423
VA	Jan	7	1,715,251	625,847	1,590,037	0.0446	0.0451	0.0445
VA	Jan	8	1,722,037	632,495	1,599,147	0.0448	0.0456	0.0448
VA	Jan	9	1,720,004	632,290	1,597,612	0.0447	0.0455	0.0447
VA	Jan	10	1,706,659	626,351	1,584,494	0.0444	0.0451	0.0444
VA	Jan	11	1,689,686	619,991	1,567,420	0.0439	0.0447	0.0439
VA	Jan	12	1,658,244	607,065	1,538,644	0.0431	0.0437	0.0431
VA	Jan	13	1,625,083	594,625	1,510,414	0.0422	0.0428	0.0423
VA	Jan	14	1,569,117	572,708	1,464,270	0.0408	0.0412	0.0410
VA	Jan	15	1,555,639	568,031	1,453,720	0.0404	0.0409	0.0407
VA	Jan	16	1,587,985	579,215	1,480,877	0.0413	0.0417	0.0414
VA	Jan	17	1,695,410	621,520	1,572,071	0.0441	0.0448	0.0440
VA	Jan	18	1,738,629	643,076	1,610,889	0.0452	0.0463	0.0451
VA	Jan	19	1,730,939	638,860	1,599,981	0.0450	0.0460	0.0448
VA	Jan	20	1,708,932	629,991	1,578,255	0.0444	0.0454	0.0442
VA	Jan	21	1,687,903	621,447	1,553,653	0.0439	0.0448	0.0435
VA	Jan	22	1,616,851	584,859	1,491,201	0.0420	0.0421	0.0417
VA	Jan	23	1,542,767	544,940	1,423,800	0.0401	0.0392	0.0399
VA	Feb	0	1,368,690	469,483	1,181,951	0.0378	0.0369	0.0377
VA	Feb	1	1,336,875	456,681	1,154,602	0.0369	0.0359	0.0369
VA	Feb	2	1,322,779	451,116	1,147,582	0.0365	0.0355	0.0366
VA	Feb	3	1,333,836	458,129	1,164,392	0.0368	0.0361	0.0372

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Feb	4	1,361,878	471,759	1,192,234	0.0376	0.0371	0.0381
VA	Feb	5	1,421,122	494,336	1,243,585	0.0392	0.0389	0.0397
VA	Feb	6	1,530,749	542,251	1,336,999	0.0422	0.0427	0.0427
VA	Feb	7	1,602,705	572,795	1,400,421	0.0442	0.0451	0.0447
VA	Feb	8	1,613,145	574,906	1,405,919	0.0445	0.0452	0.0449
VA	Feb	9	1,615,977	574,927	1,401,863	0.0446	0.0452	0.0448
VA	Feb	10	1,607,668	568,840	1,386,028	0.0444	0.0448	0.0443
VA	Feb	11	1,584,820	559,052	1,360,943	0.0437	0.0440	0.0435
VA	Feb	12	1,549,939	544,312	1,333,674	0.0428	0.0428	0.0426
VA	Feb	13	1,525,397	535,758	1,314,055	0.0421	0.0422	0.0420
VA	Feb	14	1,499,947	524,061	1,291,568	0.0414	0.0412	0.0412
VA	Feb	15	1,484,587	518,692	1,278,640	0.0410	0.0408	0.0408
VA	Feb	16	1,491,150	520,331	1,284,022	0.0411	0.0409	0.0410
VA	Feb	17	1,545,105	540,830	1,325,078	0.0426	0.0426	0.0423
VA	Feb	18	1,617,388	572,189	1,387,502	0.0446	0.0450	0.0443
VA	Feb	19	1,624,248	576,665	1,395,102	0.0448	0.0454	0.0445
VA	Feb	20	1,615,343	571,246	1,385,202	0.0446	0.0450	0.0442
VA	Feb	21	1,594,985	563,656	1,368,972	0.0440	0.0444	0.0437
VA	Feb	22	1,536,741	541,001	1,321,964	0.0424	0.0426	0.0422
VA	Feb	23	1,461,207	504,963	1,256,551	0.0403	0.0397	0.0401
VA	Mar	0	1,279,376	439,049	1,063,062	0.0371	0.0365	0.0374
VA	Mar	1	1,233,249	418,530	1,024,957	0.0358	0.0348	0.0360
VA	Mar	2	1,207,911	410,251	1,007,598	0.0350	0.0341	0.0354
VA	Mar	3	1,216,260	412,516	1,018,161	0.0353	0.0343	0.0358
VA	Mar	4	1,240,030	421,138	1,037,719	0.0360	0.0351	0.0365
VA	Mar	5	1,327,489	457,104	1,111,007	0.0385	0.0380	0.0391
VA	Mar	6	1,444,267	501,981	1,200,290	0.0419	0.0418	0.0422
VA	Mar	7	1,498,835	523,135	1,248,898	0.0435	0.0435	0.0439
VA	Mar	8	1,518,411	534,023	1,265,340	0.0440	0.0444	0.0445
VA	Mar	9	1,530,914	537,909	1,269,390	0.0444	0.0448	0.0446
VA	Mar	10	1,534,346	538,245	1,265,708	0.0445	0.0448	0.0445
VA	Mar	11	1,541,252	542,417	1,260,104	0.0447	0.0451	0.0443
VA	Mar	12	1,534,861	536,853	1,247,994	0.0445	0.0447	0.0439
VA	Mar	13	1,521,261	531,616	1,236,573	0.0441	0.0442	0.0435
VA	Mar	14	1,481,449	518,802	1,207,868	0.0429	0.0432	0.0425
VA	Mar	15	1,464,895	510,978	1,198,302	0.0425	0.0425	0.0421
VA	Mar	16	1,464,553	510,115	1,204,163	0.0425	0.0425	0.0423
VA	Mar	17	1,482,592	517,774	1,220,188	0.0430	0.0431	0.0429
VA	Mar	18	1,532,009	537,788	1,260,929	0.0444	0.0448	0.0443
VA	Mar	19	1,561,784	551,019	1,280,662	0.0453	0.0459	0.0450
VA	Mar	20	1,544,567	544,288	1,264,308	0.0448	0.0453	0.0444
VA	Mar	21	1,518,580	536,290	1,240,768	0.0440	0.0446	0.0436
VA	Mar	22	1,446,590	507,931	1,186,577	0.0419	0.0423	0.0417
VA	Mar	23	1,367,554	474,384	1,124,567	0.0396	0.0395	0.0395
VA	Apr	0	1,240,716	406,440	987,895	0.0369	0.0347	0.0357
VA	Apr	1	1,213,794	397,410	965,908	0.0361	0.0339	0.0349
VA	Apr	2	1,200,095	393,264	957,266	0.0357	0.0335	0.0346
VA	Apr	3	1,203,851	394,822	962,158	0.0358	0.0337	0.0348
VA	Apr	4	1,244,120	413,841	998,655	0.0370	0.0353	0.0361
VA	Apr	5	1,339,178	457,128	1,077,834	0.0398	0.0390	0.0390
VA	Apr	6	1,395,573	483,859	1,128,950	0.0415	0.0413	0.0408
VA	Apr	7	1,426,154	497,975	1,159,394	0.0424	0.0425	0.0419
VA	Apr	8	1,444,940	506,658	1,176,576	0.0429	0.0432	0.0426

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Apr	9	1,476,162	522,122	1,206,938	0.0439	0.0445	0.0437
VA	Apr	10	1,486,502	529,550	1,234,909	0.0442	0.0452	0.0447
VA	Apr	11	1,493,336	533,666	1,254,458	0.0444	0.0455	0.0454
VA	Apr	12	1,492,266	533,296	1,259,077	0.0443	0.0455	0.0456
VA	Apr	13	1,485,756	533,147	1,258,882	0.0441	0.0455	0.0455
VA	Apr	14	1,473,870	527,614	1,248,261	0.0438	0.0450	0.0452
VA	Apr	15	1,476,587	528,575	1,241,334	0.0439	0.0451	0.0449
VA	Apr	16	1,470,082	525,736	1,230,503	0.0437	0.0448	0.0445
VA	Apr	17	1,466,249	523,085	1,219,327	0.0436	0.0446	0.0441
VA	Apr	18	1,462,774	521,639	1,217,577	0.0435	0.0445	0.0441
VA	Apr	19	1,509,568	541,326	1,258,536	0.0448	0.0462	0.0455
VA	Apr	20	1,501,750	536,426	1,250,026	0.0446	0.0457	0.0452
VA	Apr	21	1,463,454	514,150	1,200,114	0.0435	0.0438	0.0434
VA	Apr	22	1,381,127	468,961	1,102,738	0.0410	0.0400	0.0399
VA	Apr	23	1,310,475	435,052	1,042,101	0.0389	0.0371	0.0377
VA	May	0	1,034,088	374,835	945,590	0.0344	0.0336	0.0347
VA	May	1	960,760	346,845	890,073	0.0320	0.0311	0.0327
VA	May	2	932,997	334,289	866,886	0.0310	0.0300	0.0318
VA	May	3	950,186	340,260	881,082	0.0316	0.0305	0.0323
VA	May	4	1,027,900	371,481	942,158	0.0342	0.0333	0.0346
VA	May	5	1,162,255	425,470	1,047,649	0.0387	0.0381	0.0385
VA	May	6	1,245,261	458,944	1,111,770	0.0414	0.0411	0.0408
VA	May	7	1,285,665	479,791	1,152,941	0.0428	0.0430	0.0423
VA	May	8	1,333,772	496,349	1,194,430	0.0444	0.0445	0.0438
VA	May	9	1,361,141	508,109	1,221,558	0.0453	0.0455	0.0448
VA	May	10	1,365,884	510,428	1,226,515	0.0454	0.0457	0.0450
VA	May	11	1,371,925	511,465	1,227,741	0.0456	0.0458	0.0451
VA	May	12	1,371,310	512,607	1,233,486	0.0456	0.0459	0.0453
VA	May	13	1,370,472	514,400	1,242,210	0.0456	0.0461	0.0456
VA	May	14	1,364,316	509,992	1,242,288	0.0454	0.0457	0.0456
VA	May	15	1,369,912	514,563	1,250,824	0.0456	0.0461	0.0459
VA	May	16	1,370,996	514,114	1,249,905	0.0456	0.0461	0.0459
VA	May	17	1,378,307	514,779	1,251,148	0.0459	0.0461	0.0459
VA	May	18	1,366,028	510,451	1,232,663	0.0454	0.0458	0.0453
VA	May	19	1,378,988	517,473	1,242,266	0.0459	0.0464	0.0456
VA	May	20	1,380,676	521,775	1,245,211	0.0459	0.0468	0.0457
VA	May	21	1,309,293	493,845	1,183,239	0.0436	0.0443	0.0434
VA	May	22	1,218,862	452,909	1,110,801	0.0405	0.0406	0.0408
VA	May	23	1,147,769	421,967	1,048,606	0.0382	0.0378	0.0385
VA	Jun	0	1,397,495	443,092	1,235,263	0.0346	0.0334	0.0341
VA	Jun	1	1,327,255	410,390	1,162,803	0.0328	0.0309	0.0321
VA	Jun	2	1,278,550	386,745	1,114,453	0.0316	0.0291	0.0308
VA	Jun	3	1,271,890	382,365	1,108,061	0.0315	0.0288	0.0306
VA	Jun	4	1,310,627	397,290	1,146,548	0.0324	0.0299	0.0317
VA	Jun	5	1,398,242	435,155	1,228,045	0.0346	0.0328	0.0339
VA	Jun	6	1,495,866	471,389	1,306,937	0.0370	0.0355	0.0361
VA	Jun	7	1,600,863	513,334	1,404,233	0.0396	0.0387	0.0388
VA	Jun	8	1,700,518	554,536	1,496,298	0.0421	0.0418	0.0413
VA	Jun	9	1,790,807	591,290	1,586,098	0.0443	0.0445	0.0438
VA	Jun	10	1,848,522	614,171	1,656,220	0.0457	0.0463	0.0457
VA	Jun	11	1,887,068	631,219	1,710,038	0.0467	0.0476	0.0472
VA	Jun	12	1,906,968	641,883	1,749,832	0.0472	0.0484	0.0483
VA	Jun	13	1,923,519	648,826	1,770,567	0.0476	0.0489	0.0489

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Jun	14	1,927,468	651,916	1,778,766	0.0477	0.0491	0.0491
VA	Jun	15	1,931,654	656,225	1,783,908	0.0478	0.0494	0.0493
VA	Jun	16	1,925,274	656,042	1,781,177	0.0476	0.0494	0.0492
VA	Jun	17	1,910,579	651,675	1,754,851	0.0473	0.0491	0.0485
VA	Jun	18	1,880,003	639,257	1,708,902	0.0465	0.0482	0.0472
VA	Jun	19	1,867,546	629,573	1,676,621	0.0462	0.0474	0.0463
VA	Jun	20	1,853,464	625,447	1,654,206	0.0458	0.0471	0.0457
VA	Jun	21	1,784,928	596,774	1,570,992	0.0441	0.0450	0.0434
VA	Jun	22	1,674,345	547,840	1,465,449	0.0414	0.0413	0.0405
VA	Jun	23	1,540,774	496,982	1,357,686	0.0381	0.0374	0.0375
VA	Jul	0	1,738,779	538,400	1,560,424	0.0372	0.0359	0.0359
VA	Jul	1	1,625,367	498,365	1,459,915	0.0348	0.0332	0.0336
VA	Jul	2	1,551,236	468,148	1,386,096	0.0332	0.0312	0.0319
VA	Jul	3	1,538,408	459,996	1,372,485	0.0329	0.0306	0.0316
VA	Jul	4	1,576,187	474,633	1,412,899	0.0337	0.0316	0.0325
VA	Jul	5	1,639,540	503,238	1,481,939	0.0351	0.0335	0.0341
VA	Jul	6	1,693,447	523,681	1,528,950	0.0362	0.0349	0.0352
VA	Jul	7	1,804,205	564,995	1,625,548	0.0386	0.0376	0.0374
VA	Jul	8	1,921,147	614,906	1,740,732	0.0411	0.0410	0.0401
VA	Jul	9	2,047,059	662,993	1,870,471	0.0438	0.0442	0.0430
VA	Jul	10	2,113,607	692,843	1,969,526	0.0452	0.0462	0.0453
VA	Jul	11	2,156,850	710,646	2,034,113	0.0461	0.0473	0.0468
VA	Jul	12	2,169,969	717,075	2,085,421	0.0464	0.0478	0.0480
VA	Jul	13	2,184,131	727,002	2,112,606	0.0467	0.0484	0.0486
VA	Jul	14	2,175,525	725,200	2,114,597	0.0465	0.0483	0.0487
VA	Jul	15	2,174,896	722,663	2,118,194	0.0465	0.0481	0.0487
VA	Jul	16	2,166,576	721,456	2,117,406	0.0464	0.0481	0.0487
VA	Jul	17	2,153,812	713,979	2,093,281	0.0461	0.0476	0.0482
VA	Jul	18	2,127,855	699,628	2,034,501	0.0455	0.0466	0.0468
VA	Jul	19	2,118,827	691,020	2,000,297	0.0453	0.0460	0.0460
VA	Jul	20	2,119,353	690,686	1,973,226	0.0453	0.0460	0.0454
VA	Jul	21	2,068,277	667,743	1,883,303	0.0442	0.0445	0.0433
VA	Jul	22	1,985,229	629,328	1,783,692	0.0425	0.0419	0.0411
VA	Jul	23	1,892,348	591,962	1,690,742	0.0405	0.0394	0.0389
VA	Aug	0	1,869,122	566,252	1,611,217	0.0383	0.0366	0.0368
VA	Aug	1	1,770,023	530,040	1,525,329	0.0363	0.0343	0.0348
VA	Aug	2	1,691,266	500,687	1,455,173	0.0346	0.0324	0.0332
VA	Aug	3	1,675,446	495,600	1,440,022	0.0343	0.0320	0.0329
VA	Aug	4	1,709,086	504,668	1,474,981	0.0350	0.0326	0.0337
VA	Aug	5	1,811,968	548,687	1,565,972	0.0371	0.0355	0.0358
VA	Aug	6	1,864,223	570,743	1,610,359	0.0382	0.0369	0.0368
VA	Aug	7	1,927,147	597,885	1,667,208	0.0395	0.0386	0.0381
VA	Aug	8	2,026,347	640,451	1,762,032	0.0415	0.0414	0.0402
VA	Aug	9	2,132,365	683,465	1,882,225	0.0437	0.0442	0.0430
VA	Aug	10	2,189,968	708,981	1,970,167	0.0449	0.0458	0.0450
VA	Aug	11	2,214,024	722,887	2,038,314	0.0453	0.0467	0.0465
VA	Aug	12	2,228,353	729,285	2,087,813	0.0456	0.0471	0.0477
VA	Aug	13	2,239,713	735,915	2,114,598	0.0459	0.0476	0.0483
VA	Aug	14	2,233,013	735,928	2,118,959	0.0457	0.0476	0.0484
VA	Aug	15	2,240,896	741,005	2,127,267	0.0459	0.0479	0.0486
VA	Aug	16	2,232,515	735,891	2,112,344	0.0457	0.0476	0.0482
VA	Aug	17	2,219,245	728,152	2,083,159	0.0455	0.0471	0.0476
VA	Aug	18	2,179,915	709,548	2,013,656	0.0446	0.0459	0.0460

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Aug	19	2,176,270	705,356	1,980,929	0.0446	0.0456	0.0452
VA	Aug	20	2,149,798	695,186	1,924,909	0.0440	0.0449	0.0439
VA	Aug	21	2,089,053	663,648	1,820,277	0.0428	0.0429	0.0416
VA	Aug	22	2,009,321	625,344	1,739,811	0.0412	0.0404	0.0397
VA	Aug	23	1,945,406	597,840	1,675,872	0.0398	0.0386	0.0383
VA	Sep	0	1,441,293	453,438	1,191,408	0.0374	0.0356	0.0368
VA	Sep	1	1,373,736	430,714	1,140,404	0.0356	0.0338	0.0352
VA	Sep	2	1,331,167	413,971	1,102,235	0.0345	0.0325	0.0340
VA	Sep	3	1,333,267	413,374	1,102,619	0.0346	0.0325	0.0340
VA	Sep	4	1,389,343	431,321	1,145,949	0.0360	0.0339	0.0354
VA	Sep	5	1,494,999	480,393	1,237,255	0.0388	0.0377	0.0382
VA	Sep	6	1,529,036	498,769	1,269,575	0.0396	0.0392	0.0392
VA	Sep	7	1,560,168	514,607	1,301,916	0.0404	0.0404	0.0402
VA	Sep	8	1,611,696	533,108	1,347,058	0.0418	0.0419	0.0416
VA	Sep	9	1,674,599	559,003	1,401,255	0.0434	0.0439	0.0433
VA	Sep	10	1,701,371	572,026	1,432,931	0.0441	0.0449	0.0442
VA	Sep	11	1,724,516	582,023	1,456,658	0.0447	0.0457	0.0450
VA	Sep	12	1,734,545	588,564	1,475,368	0.0450	0.0462	0.0455
VA	Sep	13	1,746,074	596,034	1,493,022	0.0453	0.0468	0.0461
VA	Sep	14	1,745,378	595,458	1,499,485	0.0452	0.0467	0.0463
VA	Sep	15	1,760,129	600,202	1,512,952	0.0456	0.0471	0.0467
VA	Sep	16	1,750,973	597,119	1,505,446	0.0454	0.0469	0.0465
VA	Sep	17	1,739,990	590,786	1,485,986	0.0451	0.0464	0.0459
VA	Sep	18	1,733,578	585,300	1,466,840	0.0449	0.0460	0.0453
VA	Sep	19	1,748,668	592,387	1,472,470	0.0453	0.0465	0.0455
VA	Sep	20	1,715,018	577,989	1,438,203	0.0445	0.0454	0.0444
VA	Sep	21	1,645,660	547,575	1,369,655	0.0427	0.0430	0.0423
VA	Sep	22	1,581,120	508,940	1,303,840	0.0410	0.0400	0.0403
VA	Sep	23	1,509,011	474,525	1,240,731	0.0391	0.0373	0.0383
VA	Oct	0	1,221,781	405,730	1,026,446	0.0361	0.0342	0.0360
VA	Oct	1	1,166,433	387,319	990,460	0.0344	0.0327	0.0347
VA	Oct	2	1,140,794	378,566	972,622	0.0337	0.0319	0.0341
VA	Oct	3	1,160,122	384,134	985,395	0.0343	0.0324	0.0345
VA	Oct	4	1,242,765	415,598	1,043,253	0.0367	0.0351	0.0366
VA	Oct	5	1,356,444	468,870	1,134,250	0.0400	0.0396	0.0397
VA	Oct	6	1,415,398	497,074	1,180,074	0.0418	0.0419	0.0414
VA	Oct	7	1,442,788	511,947	1,202,382	0.0426	0.0432	0.0421
VA	Oct	8	1,464,098	519,804	1,221,570	0.0432	0.0439	0.0428
VA	Oct	9	1,484,481	527,100	1,236,826	0.0438	0.0445	0.0433
VA	Oct	10	1,493,670	529,323	1,257,436	0.0441	0.0447	0.0441
VA	Oct	11	1,500,217	533,391	1,272,612	0.0443	0.0450	0.0446
VA	Oct	12	1,506,866	535,891	1,283,639	0.0445	0.0452	0.0450
VA	Oct	13	1,503,493	534,275	1,278,132	0.0444	0.0451	0.0448
VA	Oct	14	1,489,453	530,463	1,269,255	0.0440	0.0448	0.0445
VA	Oct	15	1,504,898	533,922	1,276,238	0.0444	0.0451	0.0447
VA	Oct	16	1,505,924	534,017	1,280,487	0.0445	0.0451	0.0449
VA	Oct	17	1,534,643	545,454	1,297,310	0.0453	0.0460	0.0455
VA	Oct	18	1,547,227	551,891	1,307,433	0.0457	0.0466	0.0458
VA	Oct	19	1,544,313	551,759	1,300,798	0.0456	0.0466	0.0456
VA	Oct	20	1,517,573	541,240	1,270,167	0.0448	0.0457	0.0445
VA	Oct	21	1,456,750	517,452	1,214,843	0.0430	0.0437	0.0426
VA	Oct	22	1,371,855	474,149	1,145,336	0.0405	0.0400	0.0401
VA	Oct	23	1,298,679	440,807	1,090,117	0.0383	0.0372	0.0382

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Nov	0	1,346,748	459,200	1,150,618	0.0380	0.0370	0.0385
VA	Nov	1	1,284,143	434,306	1,101,450	0.0362	0.0350	0.0369
VA	Nov	2	1,265,761	425,988	1,084,782	0.0357	0.0343	0.0363
VA	Nov	3	1,288,920	432,073	1,100,391	0.0363	0.0348	0.0368
VA	Nov	4	1,316,994	441,875	1,119,993	0.0371	0.0356	0.0375
VA	Nov	5	1,403,047	481,014	1,188,526	0.0396	0.0387	0.0398
VA	Nov	6	1,488,053	522,859	1,254,477	0.0419	0.0421	0.0420
VA	Nov	7	1,532,338	546,440	1,289,619	0.0432	0.0440	0.0432
VA	Nov	8	1,545,741	552,814	1,299,845	0.0436	0.0445	0.0435
VA	Nov	9	1,564,025	557,509	1,310,789	0.0441	0.0449	0.0439
VA	Nov	10	1,561,776	553,622	1,308,086	0.0440	0.0446	0.0438
VA	Nov	11	1,547,040	546,267	1,289,361	0.0436	0.0440	0.0431
VA	Nov	12	1,529,504	537,425	1,273,837	0.0431	0.0433	0.0426
VA	Nov	13	1,504,168	525,938	1,258,230	0.0424	0.0423	0.0421
VA	Nov	14	1,475,387	513,798	1,237,805	0.0416	0.0414	0.0414
VA	Nov	15	1,470,236	510,335	1,232,782	0.0414	0.0411	0.0412
VA	Nov	16	1,502,506	527,752	1,259,292	0.0424	0.0425	0.0421
VA	Nov	17	1,579,638	563,577	1,327,338	0.0445	0.0454	0.0444
VA	Nov	18	1,608,098	580,411	1,350,672	0.0453	0.0467	0.0452
VA	Nov	19	1,605,564	576,425	1,346,058	0.0453	0.0464	0.0450
VA	Nov	20	1,585,664	565,149	1,330,345	0.0447	0.0455	0.0445
VA	Nov	21	1,553,960	551,946	1,304,971	0.0438	0.0444	0.0437
VA	Nov	22	1,486,684	523,280	1,255,853	0.0419	0.0421	0.0420
VA	Nov	23	1,427,128	493,496	1,211,354	0.0402	0.0397	0.0405
VA	Dec	0	1,752,992	596,011	1,430,870	0.0391	0.0385	0.0391
VA	Dec	1	1,660,775	560,462	1,364,181	0.0370	0.0362	0.0373
VA	Dec	2	1,630,683	546,098	1,343,121	0.0364	0.0353	0.0367
VA	Dec	3	1,634,996	547,799	1,345,334	0.0365	0.0354	0.0368
VA	Dec	4	1,672,277	561,026	1,369,551	0.0373	0.0362	0.0374
VA	Dec	5	1,772,406	599,408	1,442,270	0.0395	0.0387	0.0394
VA	Dec	6	1,879,874	642,755	1,527,259	0.0419	0.0415	0.0417
VA	Dec	7	1,939,570	673,122	1,587,201	0.0433	0.0435	0.0434
VA	Dec	8	1,959,012	686,691	1,608,093	0.0437	0.0444	0.0440
VA	Dec	9	1,959,083	686,457	1,601,157	0.0437	0.0444	0.0438
VA	Dec	10	1,944,859	677,174	1,588,688	0.0434	0.0438	0.0434
VA	Dec	11	1,923,095	666,093	1,560,100	0.0429	0.0430	0.0426
VA	Dec	12	1,894,389	652,835	1,534,593	0.0422	0.0422	0.0419
VA	Dec	13	1,877,733	644,574	1,516,367	0.0419	0.0416	0.0414
VA	Dec	14	1,854,241	632,723	1,496,169	0.0414	0.0409	0.0409
VA	Dec	15	1,838,390	628,026	1,488,006	0.0410	0.0406	0.0407
VA	Dec	16	1,884,334	647,311	1,531,248	0.0420	0.0418	0.0419
VA	Dec	17	1,995,799	703,152	1,639,545	0.0445	0.0454	0.0448
VA	Dec	18	2,008,396	712,884	1,651,185	0.0448	0.0461	0.0451
VA	Dec	19	2,013,772	712,139	1,648,060	0.0449	0.0460	0.0450
VA	Dec	20	2,005,900	709,037	1,637,546	0.0447	0.0458	0.0448
VA	Dec	21	1,986,146	698,568	1,620,807	0.0443	0.0451	0.0443
VA	Dec	22	1,912,307	663,003	1,556,698	0.0426	0.0428	0.0426
VA	Dec	23	1,838,374	629,883	1,495,088	0.0410	0.0407	0.0409
WV	Jan	0	3,586,286	1,489,559	2,975,721	0.0370	0.0354	0.0376
WV	Jan	1	3,506,867	1,439,034	2,901,910	0.0362	0.0342	0.0367
WV	Jan	2	3,468,517	1,422,624	2,875,801	0.0358	0.0338	0.0364
WV	Jan	3	3,456,105	1,415,775	2,856,734	0.0357	0.0337	0.0361
WV	Jan	4	3,502,022	1,434,796	2,891,945	0.0361	0.0341	0.0366

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Jan	5	3,645,809	1,500,327	2,992,132	0.0376	0.0357	0.0378
WV	Jan	6	3,977,151	1,680,028	3,228,492	0.0410	0.0400	0.0408
WV	Jan	7	4,251,989	1,855,463	3,430,492	0.0439	0.0441	0.0434
WV	Jan	8	4,343,136	1,912,455	3,491,370	0.0448	0.0455	0.0441
WV	Jan	9	4,389,086	1,921,035	3,505,236	0.0453	0.0457	0.0443
WV	Jan	10	4,387,288	1,926,571	3,506,307	0.0453	0.0458	0.0443
WV	Jan	11	4,320,628	1,903,047	3,476,671	0.0446	0.0453	0.0440
WV	Jan	12	4,272,325	1,877,152	3,446,545	0.0441	0.0446	0.0436
WV	Jan	13	4,221,505	1,850,243	3,412,924	0.0435	0.0440	0.0432
WV	Jan	14	4,148,881	1,813,653	3,372,611	0.0428	0.0431	0.0426
WV	Jan	15	4,095,634	1,785,330	3,341,710	0.0422	0.0425	0.0423
WV	Jan	16	4,105,341	1,806,571	3,373,654	0.0423	0.0430	0.0427
WV	Jan	17	4,229,481	1,883,758	3,468,947	0.0436	0.0448	0.0439
WV	Jan	18	4,370,183	1,989,261	3,580,114	0.0451	0.0473	0.0453
WV	Jan	19	4,362,026	1,974,348	3,566,426	0.0450	0.0470	0.0451
WV	Jan	20	4,346,352	1,956,219	3,543,898	0.0448	0.0465	0.0448
WV	Jan	21	4,244,400	1,891,439	3,463,041	0.0438	0.0450	0.0438
WV	Jan	22	3,991,991	1,741,388	3,298,390	0.0412	0.0414	0.0417
WV	Jan	23	3,721,790	1,574,365	3,091,779	0.0384	0.0374	0.0391
WV	Feb	0	3,083,613	1,471,681	2,904,706	0.0376	0.0366	0.0385
WV	Feb	1	2,996,658	1,415,433	2,826,998	0.0365	0.0352	0.0375
WV	Feb	2	2,971,783	1,396,334	2,800,408	0.0362	0.0347	0.0372
WV	Feb	3	2,969,671	1,393,637	2,789,493	0.0362	0.0346	0.0370
WV	Feb	4	3,011,920	1,416,134	2,824,109	0.0367	0.0352	0.0375
WV	Feb	5	3,169,650	1,499,630	2,941,708	0.0386	0.0373	0.0390
WV	Feb	6	3,437,383	1,658,982	3,134,188	0.0419	0.0412	0.0416
WV	Feb	7	3,590,158	1,781,802	3,264,536	0.0437	0.0443	0.0433
WV	Feb	8	3,638,972	1,819,065	3,304,548	0.0443	0.0452	0.0438
WV	Feb	9	3,662,841	1,826,984	3,305,017	0.0446	0.0454	0.0439
WV	Feb	10	3,666,484	1,830,416	3,314,530	0.0446	0.0455	0.0440
WV	Feb	11	3,614,578	1,797,916	3,279,293	0.0440	0.0447	0.0435
WV	Feb	12	3,551,743	1,769,981	3,245,013	0.0433	0.0440	0.0431
WV	Feb	13	3,512,984	1,741,132	3,209,913	0.0428	0.0433	0.0426
WV	Feb	14	3,463,896	1,701,745	3,168,050	0.0422	0.0423	0.0420
WV	Feb	15	3,405,978	1,672,774	3,134,443	0.0415	0.0416	0.0416
WV	Feb	16	3,424,571	1,683,824	3,153,904	0.0417	0.0418	0.0418
WV	Feb	17	3,504,989	1,720,579	3,208,870	0.0427	0.0428	0.0426
WV	Feb	18	3,641,381	1,821,793	3,323,895	0.0443	0.0453	0.0441
WV	Feb	19	3,697,271	1,853,339	3,351,977	0.0450	0.0461	0.0445
WV	Feb	20	3,691,280	1,845,789	3,343,727	0.0449	0.0459	0.0444
WV	Feb	21	3,637,796	1,810,063	3,298,193	0.0443	0.0450	0.0438
WV	Feb	22	3,507,924	1,724,596	3,199,695	0.0427	0.0429	0.0425
WV	Feb	23	3,266,332	1,582,764	3,036,081	0.0398	0.0393	0.0403
WV	Mar	0	2,956,020	1,403,742	2,803,600	0.0368	0.0356	0.0376
WV	Mar	1	2,849,280	1,343,894	2,709,083	0.0355	0.0341	0.0363
WV	Mar	2	2,796,725	1,326,060	2,681,699	0.0348	0.0336	0.0359
WV	Mar	3	2,788,370	1,318,662	2,669,770	0.0347	0.0334	0.0358
WV	Mar	4	2,845,587	1,343,066	2,714,269	0.0355	0.0340	0.0364
WV	Mar	5	3,023,839	1,436,532	2,855,425	0.0377	0.0364	0.0382
WV	Mar	6	3,303,618	1,588,719	3,066,327	0.0412	0.0403	0.0411
WV	Mar	7	3,469,616	1,694,879	3,201,030	0.0432	0.0430	0.0429
WV	Mar	8	3,550,028	1,755,713	3,274,699	0.0442	0.0445	0.0439
WV	Mar	9	3,613,065	1,799,740	3,322,001	0.0450	0.0456	0.0445

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Mar	10	3,645,075	1,823,212	3,347,426	0.0454	0.0462	0.0448
WV	Mar	11	3,638,241	1,826,686	3,338,051	0.0453	0.0463	0.0447
WV	Mar	12	3,597,759	1,798,797	3,303,456	0.0448	0.0456	0.0442
WV	Mar	13	3,537,428	1,759,681	3,263,295	0.0441	0.0446	0.0437
WV	Mar	14	3,467,033	1,718,721	3,211,202	0.0432	0.0436	0.0430
WV	Mar	15	3,401,963	1,684,003	3,167,015	0.0424	0.0427	0.0424
WV	Mar	16	3,412,637	1,694,361	3,168,540	0.0425	0.0430	0.0424
WV	Mar	17	3,455,603	1,720,419	3,204,943	0.0431	0.0436	0.0429
WV	Mar	18	3,581,695	1,787,495	3,295,887	0.0446	0.0453	0.0441
WV	Mar	19	3,690,924	1,873,467	3,387,225	0.0460	0.0475	0.0454
WV	Mar	20	3,663,641	1,851,403	3,357,474	0.0456	0.0469	0.0450
WV	Mar	21	3,566,306	1,788,110	3,284,756	0.0444	0.0453	0.0440
WV	Mar	22	3,338,283	1,639,235	3,118,799	0.0416	0.0416	0.0418
WV	Mar	23	3,072,820	1,472,966	2,909,247	0.0383	0.0373	0.0390
WV	Apr	0	2,516,974	1,212,084	2,347,023	0.0341	0.0333	0.0357
WV	Apr	1	2,431,013	1,171,024	2,278,118	0.0330	0.0322	0.0346
WV	Apr	2	2,409,717	1,163,540	2,265,763	0.0327	0.0320	0.0345
WV	Apr	3	2,428,017	1,162,503	2,268,626	0.0329	0.0320	0.0345
WV	Apr	4	2,527,131	1,198,798	2,337,792	0.0343	0.0330	0.0355
WV	Apr	5	2,799,484	1,334,513	2,534,850	0.0379	0.0367	0.0385
WV	Apr	6	3,057,971	1,486,151	2,713,532	0.0415	0.0409	0.0413
WV	Apr	7	3,205,894	1,584,380	2,827,670	0.0435	0.0436	0.0430
WV	Apr	8	3,300,511	1,645,098	2,910,730	0.0447	0.0453	0.0443
WV	Apr	9	3,371,940	1,689,883	2,966,807	0.0457	0.0465	0.0451
WV	Apr	10	3,407,597	1,711,419	2,989,164	0.0462	0.0471	0.0454
WV	Apr	11	3,391,609	1,708,707	2,984,424	0.0460	0.0470	0.0454
WV	Apr	12	3,393,566	1,707,990	2,980,706	0.0460	0.0470	0.0453
WV	Apr	13	3,381,808	1,705,171	2,966,171	0.0458	0.0469	0.0451
WV	Apr	14	3,346,414	1,681,908	2,943,156	0.0454	0.0463	0.0448
WV	Apr	15	3,320,437	1,669,943	2,930,846	0.0450	0.0459	0.0446
WV	Apr	16	3,275,077	1,634,232	2,894,929	0.0444	0.0450	0.0440
WV	Apr	17	3,259,107	1,612,599	2,877,690	0.0442	0.0444	0.0438
WV	Apr	18	3,283,364	1,626,920	2,896,021	0.0445	0.0448	0.0440
WV	Apr	19	3,374,748	1,679,820	2,960,309	0.0457	0.0462	0.0450
WV	Apr	20	3,395,888	1,686,318	2,971,513	0.0460	0.0464	0.0452
WV	Apr	21	3,223,879	1,569,046	2,830,404	0.0437	0.0432	0.0430
WV	Apr	22	2,950,082	1,417,057	2,626,803	0.0400	0.0390	0.0399
WV	Apr	23	2,719,084	1,295,703	2,465,436	0.0369	0.0356	0.0375
WV	May	0	2,707,290	1,020,566	2,559,576	0.0348	0.0344	0.0359
WV	May	1	2,628,441	981,055	2,496,649	0.0338	0.0330	0.0350
WV	May	2	2,587,332	968,612	2,461,722	0.0333	0.0326	0.0345
WV	May	3	2,617,594	974,162	2,480,275	0.0337	0.0328	0.0347
WV	May	4	2,750,964	1,031,270	2,582,779	0.0354	0.0347	0.0362
WV	May	5	2,988,524	1,130,152	2,756,540	0.0384	0.0381	0.0386
WV	May	6	3,208,377	1,224,083	2,921,207	0.0413	0.0412	0.0409
WV	May	7	3,338,313	1,294,564	3,033,967	0.0429	0.0436	0.0425
WV	May	8	3,457,856	1,335,852	3,123,813	0.0445	0.0450	0.0438
WV	May	9	3,536,570	1,355,206	3,186,053	0.0455	0.0456	0.0446
WV	May	10	3,554,063	1,368,494	3,217,968	0.0457	0.0461	0.0451
WV	May	11	3,535,694	1,366,110	3,211,219	0.0455	0.0460	0.0450
WV	May	12	3,524,564	1,368,190	3,212,666	0.0453	0.0461	0.0450
WV	May	13	3,498,012	1,345,225	3,177,331	0.0450	0.0453	0.0445
WV	May	14	3,510,508	1,343,687	3,182,755	0.0452	0.0452	0.0446

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	May	15	3,525,475	1,352,447	3,194,660	0.0453	0.0455	0.0447
WV	May	16	3,513,171	1,347,149	3,192,495	0.0452	0.0454	0.0447
WV	May	17	3,479,267	1,337,554	3,171,058	0.0447	0.0450	0.0444
WV	May	18	3,454,200	1,327,411	3,155,351	0.0444	0.0447	0.0442
WV	May	19	3,484,602	1,333,989	3,175,696	0.0448	0.0449	0.0445
WV	May	20	3,520,461	1,351,418	3,203,979	0.0453	0.0455	0.0449
WV	May	21	3,372,448	1,282,601	3,095,328	0.0434	0.0432	0.0434
WV	May	22	3,102,337	1,176,136	2,894,819	0.0399	0.0396	0.0405
WV	May	23	2,854,686	1,084,922	2,702,630	0.0367	0.0365	0.0379
WV	Jun	0	2,843,469	1,152,973	2,753,778	0.0349	0.0346	0.0360
WV	Jun	1	2,726,373	1,097,574	2,644,370	0.0335	0.0330	0.0346
WV	Jun	2	2,618,664	1,060,356	2,559,837	0.0322	0.0319	0.0335
WV	Jun	3	2,597,860	1,051,368	2,533,191	0.0319	0.0316	0.0331
WV	Jun	4	2,650,707	1,077,889	2,586,631	0.0325	0.0324	0.0338
WV	Jun	5	2,771,076	1,132,722	2,701,065	0.0340	0.0340	0.0353
WV	Jun	6	2,984,091	1,222,075	2,883,981	0.0366	0.0367	0.0377
WV	Jun	7	3,229,224	1,322,822	3,084,170	0.0396	0.0397	0.0403
WV	Jun	8	3,444,511	1,409,967	3,236,957	0.0423	0.0424	0.0423
WV	Jun	9	3,595,116	1,481,520	3,356,516	0.0441	0.0445	0.0439
WV	Jun	10	3,701,838	1,522,116	3,437,688	0.0455	0.0457	0.0449
WV	Jun	11	3,781,442	1,559,595	3,509,835	0.0464	0.0469	0.0459
WV	Jun	12	3,814,628	1,572,730	3,544,776	0.0468	0.0473	0.0463
WV	Jun	13	3,809,153	1,569,311	3,547,716	0.0468	0.0472	0.0464
WV	Jun	14	3,830,303	1,577,459	3,555,127	0.0470	0.0474	0.0465
WV	Jun	15	3,815,668	1,575,585	3,551,631	0.0469	0.0473	0.0464
WV	Jun	16	3,837,647	1,579,964	3,551,755	0.0471	0.0475	0.0464
WV	Jun	17	3,827,331	1,575,908	3,531,529	0.0470	0.0474	0.0462
WV	Jun	18	3,824,669	1,565,305	3,516,672	0.0470	0.0470	0.0460
WV	Jun	19	3,801,976	1,544,178	3,485,066	0.0467	0.0464	0.0456
WV	Jun	20	3,822,383	1,539,705	3,488,072	0.0469	0.0463	0.0456
WV	Jun	21	3,664,460	1,482,015	3,378,299	0.0450	0.0445	0.0442
WV	Jun	22	3,386,760	1,371,539	3,154,797	0.0416	0.0412	0.0412
WV	Jun	23	3,064,083	1,236,755	2,901,197	0.0376	0.0372	0.0379
WV	Jul	0	3,397,815	1,351,534	3,196,171	0.0366	0.0364	0.0375
WV	Jul	1	3,252,067	1,299,799	3,091,026	0.0351	0.0350	0.0362
WV	Jul	2	3,152,459	1,262,576	3,015,795	0.0340	0.0340	0.0353
WV	Jul	3	3,119,567	1,235,049	2,974,803	0.0336	0.0332	0.0349
WV	Jul	4	3,158,978	1,252,745	3,002,539	0.0341	0.0337	0.0352
WV	Jul	5	3,265,984	1,287,349	3,083,114	0.0352	0.0346	0.0361
WV	Jul	6	3,412,627	1,355,566	3,185,911	0.0368	0.0365	0.0373
WV	Jul	7	3,645,945	1,461,311	3,383,432	0.0393	0.0393	0.0397
WV	Jul	8	3,886,415	1,556,538	3,554,072	0.0419	0.0419	0.0417
WV	Jul	9	4,070,545	1,628,778	3,697,547	0.0439	0.0438	0.0433
WV	Jul	10	4,174,422	1,678,715	3,794,163	0.0450	0.0452	0.0445
WV	Jul	11	4,216,840	1,699,266	3,824,864	0.0455	0.0457	0.0448
WV	Jul	12	4,232,083	1,703,997	3,847,949	0.0456	0.0458	0.0451
WV	Jul	13	4,263,637	1,717,091	3,878,062	0.0460	0.0462	0.0455
WV	Jul	14	4,284,548	1,730,452	3,898,551	0.0462	0.0465	0.0457
WV	Jul	15	4,266,411	1,726,522	3,886,680	0.0460	0.0464	0.0456
WV	Jul	16	4,310,280	1,737,883	3,907,327	0.0465	0.0467	0.0458
WV	Jul	17	4,298,259	1,735,019	3,893,392	0.0464	0.0467	0.0456
WV	Jul	18	4,270,704	1,721,917	3,863,670	0.0461	0.0463	0.0453
WV	Jul	19	4,206,882	1,698,798	3,807,381	0.0454	0.0457	0.0446

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Jul	20	4,216,411	1,688,204	3,813,857	0.0455	0.0454	0.0447
WV	Jul	21	4,109,330	1,642,771	3,750,329	0.0443	0.0442	0.0440
WV	Jul	22	3,903,083	1,561,544	3,595,662	0.0421	0.0420	0.0421
WV	Jul	23	3,606,254	1,441,272	3,376,472	0.0389	0.0388	0.0396
WV	Aug	0	3,321,408	1,267,632	2,979,735	0.0366	0.0363	0.0372
WV	Aug	1	3,224,037	1,227,882	2,906,303	0.0355	0.0352	0.0363
WV	Aug	2	3,103,798	1,189,181	2,830,579	0.0342	0.0340	0.0354
WV	Aug	3	3,051,056	1,172,137	2,796,757	0.0336	0.0336	0.0349
WV	Aug	4	3,109,025	1,198,934	2,839,560	0.0343	0.0343	0.0355
WV	Aug	5	3,234,711	1,244,919	2,938,801	0.0356	0.0356	0.0367
WV	Aug	6	3,386,692	1,300,705	3,035,359	0.0373	0.0372	0.0379
WV	Aug	7	3,619,032	1,373,365	3,196,950	0.0399	0.0393	0.0399
WV	Aug	8	3,824,375	1,440,371	3,341,468	0.0421	0.0412	0.0418
WV	Aug	9	3,964,546	1,502,325	3,460,676	0.0437	0.0430	0.0432
WV	Aug	10	4,066,747	1,556,919	3,560,168	0.0448	0.0446	0.0445
WV	Aug	11	4,133,222	1,603,039	3,636,996	0.0455	0.0459	0.0454
WV	Aug	12	4,179,451	1,629,659	3,682,605	0.0460	0.0467	0.0460
WV	Aug	13	4,172,028	1,631,044	3,676,060	0.0460	0.0467	0.0459
WV	Aug	14	4,196,846	1,633,652	3,676,364	0.0462	0.0468	0.0459
WV	Aug	15	4,220,257	1,640,023	3,673,741	0.0465	0.0470	0.0459
WV	Aug	16	4,232,450	1,645,270	3,673,424	0.0466	0.0471	0.0459
WV	Aug	17	4,197,859	1,626,913	3,644,753	0.0462	0.0466	0.0455
WV	Aug	18	4,141,932	1,602,043	3,596,560	0.0456	0.0459	0.0449
WV	Aug	19	4,134,746	1,594,540	3,571,720	0.0456	0.0457	0.0446
WV	Aug	20	4,130,351	1,592,291	3,563,911	0.0455	0.0456	0.0445
WV	Aug	21	3,947,237	1,514,010	3,435,941	0.0435	0.0433	0.0429
WV	Aug	22	3,726,104	1,424,841	3,255,475	0.0411	0.0408	0.0407
WV	Aug	23	3,449,532	1,316,101	3,051,240	0.0380	0.0377	0.0381
WV	Sep	0	2,641,922	1,070,453	2,419,773	0.0348	0.0343	0.0360
WV	Sep	1	2,558,375	1,038,903	2,359,312	0.0337	0.0333	0.0351
WV	Sep	2	2,525,429	1,021,458	2,318,669	0.0332	0.0327	0.0345
WV	Sep	3	2,494,438	1,014,077	2,312,561	0.0328	0.0325	0.0344
WV	Sep	4	2,593,714	1,052,523	2,391,523	0.0341	0.0337	0.0356
WV	Sep	5	2,844,069	1,151,502	2,555,935	0.0374	0.0369	0.0380
WV	Sep	6	3,000,826	1,220,351	2,652,239	0.0395	0.0391	0.0395
WV	Sep	7	3,099,292	1,263,999	2,726,877	0.0408	0.0405	0.0406
WV	Sep	8	3,231,758	1,305,316	2,807,726	0.0425	0.0418	0.0418
WV	Sep	9	3,326,189	1,353,136	2,888,422	0.0438	0.0433	0.0430
WV	Sep	10	3,395,390	1,396,807	2,948,903	0.0447	0.0447	0.0439
WV	Sep	11	3,461,605	1,424,919	3,005,414	0.0456	0.0456	0.0447
WV	Sep	12	3,479,595	1,446,803	3,034,151	0.0458	0.0463	0.0452
WV	Sep	13	3,511,704	1,462,581	3,063,096	0.0462	0.0468	0.0456
WV	Sep	14	3,506,242	1,468,555	3,073,539	0.0461	0.0470	0.0457
WV	Sep	15	3,500,360	1,476,395	3,080,994	0.0461	0.0473	0.0459
WV	Sep	16	3,524,947	1,488,834	3,098,448	0.0464	0.0477	0.0461
WV	Sep	17	3,498,796	1,464,378	3,071,309	0.0460	0.0469	0.0457
WV	Sep	18	3,502,274	1,446,004	3,054,264	0.0461	0.0463	0.0455
WV	Sep	19	3,532,304	1,451,761	3,067,918	0.0465	0.0465	0.0457
WV	Sep	20	3,487,174	1,426,238	3,027,826	0.0459	0.0457	0.0451
WV	Sep	21	3,315,771	1,350,538	2,900,224	0.0436	0.0433	0.0432
WV	Sep	22	3,104,899	1,265,740	2,753,717	0.0409	0.0405	0.0410
WV	Sep	23	2,844,727	1,159,438	2,572,096	0.0374	0.0371	0.0383
WV	Oct	0	3,026,493	1,406,807	2,717,153	0.0357	0.0343	0.0368

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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Oct	1	2,928,313	1,362,009	2,645,418	0.0345	0.0332	0.0358
WV	Oct	2	2,887,608	1,346,647	2,616,803	0.0341	0.0328	0.0354
WV	Oct	3	2,899,205	1,346,799	2,623,332	0.0342	0.0328	0.0355
WV	Oct	4	3,028,647	1,402,439	2,719,299	0.0357	0.0342	0.0368
WV	Oct	5	3,313,783	1,552,023	2,912,582	0.0391	0.0379	0.0394
WV	Oct	6	3,542,744	1,690,580	3,076,942	0.0418	0.0412	0.0417
WV	Oct	7	3,665,917	1,759,230	3,168,877	0.0432	0.0429	0.0429
WV	Oct	8	3,751,272	1,825,970	3,226,123	0.0442	0.0445	0.0437
WV	Oct	9	3,805,809	1,846,873	3,244,787	0.0449	0.0450	0.0439
WV	Oct	10	3,813,050	1,856,289	3,258,150	0.0450	0.0453	0.0441
WV	Oct	11	3,839,575	1,862,838	3,272,732	0.0453	0.0454	0.0443
WV	Oct	12	3,823,911	1,866,040	3,275,905	0.0451	0.0455	0.0444
WV	Oct	13	3,780,486	1,857,643	3,259,377	0.0446	0.0453	0.0441
WV	Oct	14	3,746,790	1,831,179	3,231,209	0.0442	0.0447	0.0438
WV	Oct	15	3,727,943	1,828,023	3,227,163	0.0440	0.0446	0.0437
WV	Oct	16	3,714,988	1,836,090	3,224,183	0.0438	0.0448	0.0437
WV	Oct	17	3,766,728	1,869,558	3,258,145	0.0444	0.0456	0.0441
WV	Oct	18	3,868,885	1,944,068	3,329,026	0.0456	0.0474	0.0451
WV	Oct	19	3,861,941	1,933,684	3,323,673	0.0456	0.0472	0.0450
WV	Oct	20	3,823,490	1,885,927	3,284,109	0.0451	0.0460	0.0445
WV	Oct	21	3,631,118	1,768,538	3,154,327	0.0428	0.0431	0.0427
WV	Oct	22	3,378,765	1,625,898	2,983,326	0.0399	0.0397	0.0404
WV	Oct	23	3,148,807	1,494,091	2,821,278	0.0371	0.0364	0.0382
WV	Nov	0	3,117,338	1,470,760	2,731,864	0.0363	0.0352	0.0374
WV	Nov	1	3,016,171	1,412,455	2,657,397	0.0351	0.0338	0.0364
WV	Nov	2	2,979,990	1,392,134	2,626,885	0.0347	0.0333	0.0360
WV	Nov	3	2,989,420	1,396,337	2,632,487	0.0348	0.0334	0.0360
WV	Nov	4	3,019,868	1,411,782	2,655,631	0.0352	0.0338	0.0364
WV	Nov	5	3,177,773	1,493,500	2,774,932	0.0370	0.0357	0.0380
WV	Nov	6	3,495,104	1,683,124	2,987,267	0.0407	0.0403	0.0409
WV	Nov	7	3,726,505	1,833,926	3,148,278	0.0434	0.0439	0.0431
WV	Nov	8	3,834,074	1,904,575	3,220,382	0.0447	0.0456	0.0441
WV	Nov	9	3,865,251	1,914,186	3,236,778	0.0450	0.0458	0.0443
WV	Nov	10	3,883,450	1,921,247	3,236,826	0.0452	0.0460	0.0443
WV	Nov	11	3,839,198	1,891,371	3,204,364	0.0447	0.0453	0.0439
WV	Nov	12	3,778,574	1,843,919	3,161,839	0.0440	0.0441	0.0433
WV	Nov	13	3,710,360	1,814,446	3,123,297	0.0432	0.0434	0.0428
WV	Nov	14	3,656,231	1,784,789	3,092,715	0.0426	0.0427	0.0424
WV	Nov	15	3,629,587	1,773,938	3,084,549	0.0423	0.0424	0.0422
WV	Nov	16	3,660,121	1,791,718	3,109,393	0.0426	0.0429	0.0426
WV	Nov	17	3,836,771	1,897,202	3,228,241	0.0447	0.0454	0.0442
WV	Nov	18	3,952,885	1,979,057	3,314,698	0.0461	0.0474	0.0454
WV	Nov	19	3,924,541	1,964,754	3,300,521	0.0457	0.0470	0.0452
WV	Nov	20	3,909,736	1,952,816	3,283,265	0.0456	0.0467	0.0450
WV	Nov	21	3,832,696	1,902,314	3,230,112	0.0447	0.0455	0.0442
WV	Nov	22	3,601,756	1,754,154	3,069,819	0.0420	0.0420	0.0420
WV	Nov	23	3,389,068	1,611,143	2,913,834	0.0395	0.0385	0.0399
WV	Dec	0	3,404,522	1,601,479	3,011,458	0.0371	0.0360	0.0380
WV	Dec	1	3,286,612	1,533,057	2,921,867	0.0358	0.0345	0.0369
WV	Dec	2	3,232,262	1,508,155	2,877,148	0.0352	0.0339	0.0363
WV	Dec	3	3,210,231	1,505,642	2,868,508	0.0350	0.0338	0.0362
WV	Dec	4	3,264,787	1,533,576	2,908,406	0.0355	0.0345	0.0367
WV	Dec	5	3,420,375	1,609,406	3,007,631	0.0372	0.0362	0.0380

Actual 2002 State Level Monthly-Diurnal Profiles
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			Actual Reported Values [2002]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Dec	6	3,697,969	1,783,014	3,198,789	0.0403	0.0401	0.0404
WV	Dec	7	3,924,210	1,918,829	3,358,948	0.0427	0.0431	0.0424
WV	Dec	8	4,042,205	1,994,642	3,450,461	0.0440	0.0448	0.0436
WV	Dec	9	4,111,049	2,035,320	3,500,334	0.0448	0.0458	0.0442
WV	Dec	10	4,110,585	2,027,310	3,489,849	0.0448	0.0456	0.0441
WV	Dec	11	4,076,404	1,993,840	3,471,311	0.0444	0.0448	0.0438
WV	Dec	12	4,046,861	1,954,975	3,438,541	0.0441	0.0439	0.0434
WV	Dec	13	4,004,867	1,922,444	3,406,151	0.0436	0.0432	0.0430
WV	Dec	14	3,921,172	1,869,324	3,345,903	0.0427	0.0420	0.0422
WV	Dec	15	3,855,417	1,834,963	3,315,226	0.0420	0.0413	0.0419
WV	Dec	16	3,888,660	1,878,029	3,354,174	0.0423	0.0422	0.0424
WV	Dec	17	4,109,097	2,037,631	3,503,434	0.0447	0.0458	0.0442
WV	Dec	18	4,209,514	2,117,544	3,578,429	0.0458	0.0476	0.0452
WV	Dec	19	4,199,396	2,097,840	3,575,421	0.0457	0.0472	0.0451
WV	Dec	20	4,161,050	2,067,815	3,544,693	0.0453	0.0465	0.0448
WV	Dec	21	4,115,588	2,029,959	3,509,552	0.0448	0.0456	0.0443
WV	Dec	22	3,928,733	1,904,833	3,383,567	0.0428	0.0428	0.0427
WV	Dec	23	3,629,250	1,722,821	3,174,446	0.0395	0.0387	0.0401

Average 2000-2004 State Level Monthly Profiles
CEM-Based Distribution

		Average Values [2000-2004]					
		SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	01	96,930,269	35,587,650	106,607,722	0.0891	0.0906	0.0841
AL	02	89,299,276	31,712,573	92,320,799	0.0821	0.0807	0.0728
AL	03	97,977,033	34,625,029	99,742,940	0.0901	0.0881	0.0787
AL	04	88,243,177	32,334,269	100,129,509	0.0811	0.0823	0.0790
AL	05	89,962,666	32,627,766	112,967,968	0.0827	0.0830	0.0891
AL	06	87,102,237	31,193,299	111,088,721	0.0801	0.0794	0.0876
AL	07	91,587,444	32,073,978	120,110,609	0.0842	0.0816	0.0947
AL	08	90,517,064	32,282,799	119,715,397	0.0832	0.0822	0.0944
AL	09	86,093,933	30,205,186	108,873,196	0.0792	0.0769	0.0859
AL	10	94,862,824	34,337,900	104,619,520	0.0872	0.0874	0.0825
AL	11	85,540,251	32,415,917	91,045,088	0.0787	0.0825	0.0718
AL	12	89,344,392	33,549,632	100,769,555	0.0822	0.0854	0.0795
FL	01	116,011,253	62,989,958	198,751,048	0.0858	0.0875	0.0831
FL	02	93,958,786	50,831,818	164,949,702	0.0695	0.0706	0.0690
FL	03	111,505,553	60,285,972	196,705,697	0.0824	0.0838	0.0822
FL	04	107,015,438	59,071,792	195,338,204	0.0791	0.0821	0.0817
FL	05	118,589,361	61,811,604	207,803,996	0.0877	0.0859	0.0869
FL	06	116,068,987	59,801,640	202,716,214	0.0858	0.0831	0.0848
FL	07	123,868,749	62,500,169	212,478,437	0.0916	0.0868	0.0888
FL	08	125,384,940	64,572,843	214,637,218	0.0927	0.0897	0.0897
FL	09	113,080,789	59,913,723	206,712,956	0.0836	0.0832	0.0864
FL	10	109,960,828	61,551,310	206,924,170	0.0813	0.0855	0.0865
FL	11	101,781,383	55,861,718	186,984,665	0.0752	0.0776	0.0782
FL	12	115,588,740	60,566,444	197,592,133	0.0854	0.0841	0.0826
GA	01	111,381,833	35,300,170	101,578,866	0.0899	0.1020	0.0843
GA	02	98,896,327	30,678,660	86,718,335	0.0798	0.0887	0.0720
GA	03	106,485,284	33,079,065	92,242,973	0.0859	0.0956	0.0765
GA	04	102,974,144	30,008,861	103,324,610	0.0831	0.0867	0.0857
GA	05	105,293,816	25,969,027	106,952,596	0.0850	0.0751	0.0888
GA	06	102,271,647	24,738,987	106,006,251	0.0825	0.0715	0.0880
GA	07	108,957,317	26,952,614	120,877,914	0.0879	0.0779	0.1003
GA	08	108,752,336	26,639,752	120,190,489	0.0878	0.0770	0.0997
GA	09	97,918,725	23,487,485	104,072,746	0.0790	0.0679	0.0864
GA	10	101,536,528	30,369,446	96,452,757	0.0819	0.0878	0.0800
GA	11	93,759,865	28,223,403	78,439,851	0.0757	0.0816	0.0651
GA	12	101,006,607	30,570,535	88,223,873	0.0815	0.0883	0.0732
KY	01	114,451,110	50,961,629	103,156,727	0.0911	0.1020	0.0862
KY	02	99,582,190	45,260,425	92,691,929	0.0793	0.0906	0.0774
KY	03	106,411,998	49,574,474	102,526,546	0.0847	0.0993	0.0857
KY	04	101,118,302	45,106,138	100,653,753	0.0805	0.0903	0.0841
KY	05	104,021,647	37,580,055	99,546,365	0.0828	0.0752	0.0832
KY	06	105,872,032	34,128,995	97,828,149	0.0843	0.0683	0.0817
KY	07	108,881,756	35,056,185	107,192,042	0.0867	0.0702	0.0896
KY	08	104,798,920	34,486,336	105,469,064	0.0835	0.0690	0.0881
KY	09	100,167,234	31,953,387	96,012,045	0.0798	0.0640	0.0802
KY	10	103,383,830	43,615,561	97,660,979	0.0823	0.0873	0.0816
KY	11	101,028,279	44,613,743	94,343,813	0.0804	0.0893	0.0788
KY	12	106,076,566	47,126,961	99,865,268	0.0845	0.0944	0.0834
MS	01	26,002,429	14,959,002	50,082,518	0.0941	0.0940	0.0871
MS	02	21,206,233	11,880,358	40,471,183	0.0768	0.0747	0.0704
MS	03	25,528,343	13,158,285	47,129,522	0.0924	0.0827	0.0819

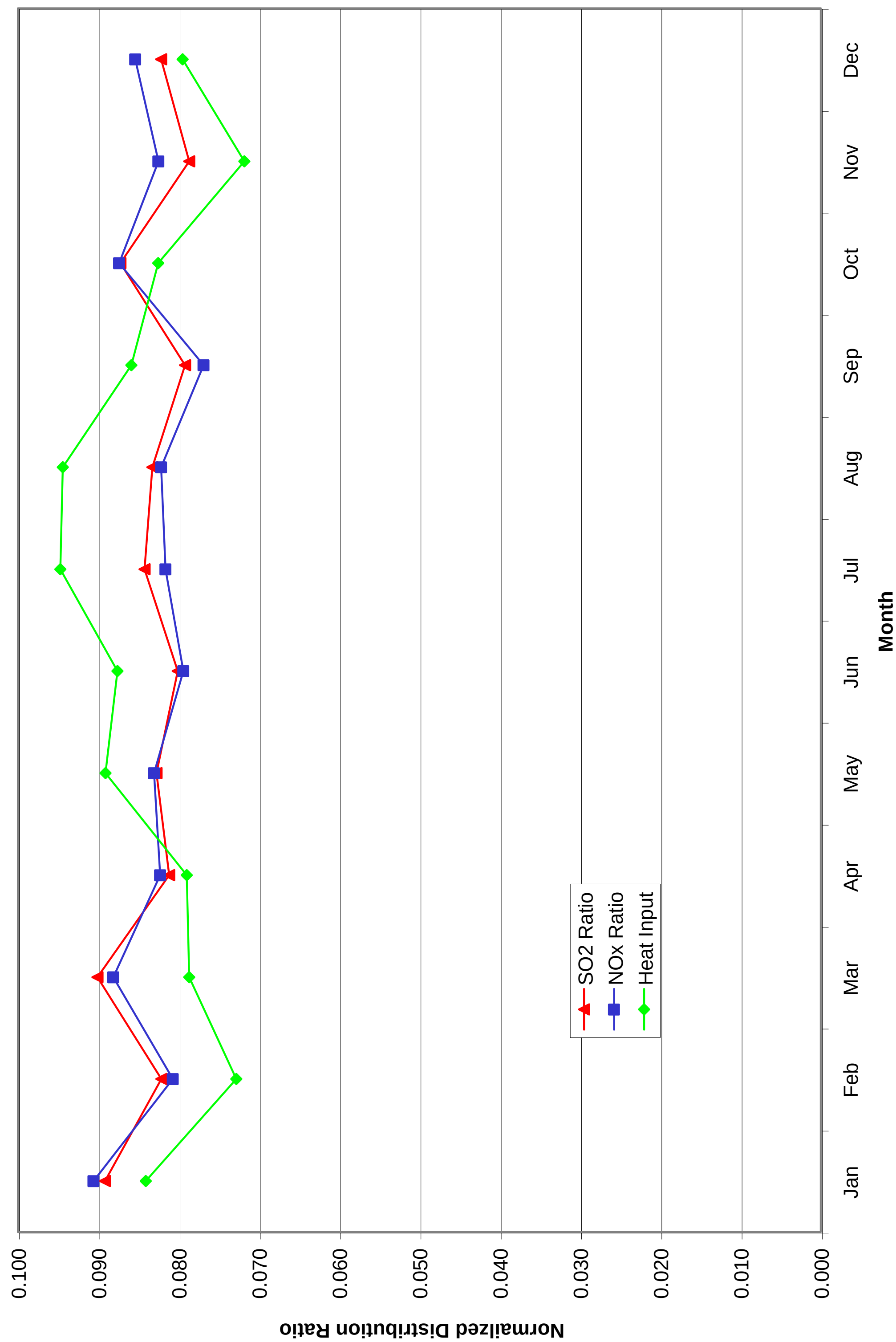
Average 2000-2004 State Level Monthly Profiles
CEM-Based Distribution

		Average Values [2000-2004]					
		SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	04	21,273,756	12,214,212	46,195,711	0.0770	0.0768	0.0803
MS	05	22,125,071	11,792,392	50,436,986	0.0801	0.0741	0.0877
MS	06	20,491,237	12,047,012	48,840,874	0.0742	0.0757	0.0849
MS	07	21,656,323	13,520,807	58,072,028	0.0784	0.0850	0.1010
MS	08	23,098,376	13,834,360	56,814,327	0.0836	0.0870	0.0988
MS	09	20,523,293	12,077,193	46,707,196	0.0743	0.0759	0.0812
MS	10	24,275,175	13,614,844	43,907,379	0.0879	0.0856	0.0763
MS	11	24,222,077	14,399,213	41,359,918	0.0877	0.0905	0.0719
MS	12	25,787,873	15,593,701	45,087,695	0.0934	0.0980	0.0784
NC	01	97,331,884	37,053,636	92,254,907	0.0866	0.0983	0.0883
NC	02	87,137,443	31,305,996	77,220,069	0.0775	0.0831	0.0739
NC	03	97,833,212	33,620,839	82,323,264	0.0871	0.0892	0.0788
NC	04	92,583,583	31,510,173	82,114,199	0.0824	0.0836	0.0786
NC	05	93,010,611	30,993,014	92,701,935	0.0828	0.0822	0.0887
NC	06	89,783,619	27,981,850	86,656,380	0.0799	0.0742	0.0829
NC	07	96,373,472	29,656,314	95,664,904	0.0858	0.0787	0.0915
NC	08	98,109,730	30,628,115	98,103,529	0.0873	0.0813	0.0939
NC	09	90,309,848	27,225,566	84,456,086	0.0804	0.0722	0.0808
NC	10	93,077,269	31,140,223	83,355,612	0.0828	0.0826	0.0798
NC	11	89,955,025	29,977,442	72,940,892	0.0800	0.0795	0.0698
NC	12	98,265,370	35,793,481	97,185,382	0.0874	0.0950	0.0930
SC	01	43,721,987	18,432,548	49,580,491	0.0868	0.0916	0.0808
SC	02	38,541,035	16,084,499	43,227,327	0.0765	0.0800	0.0705
SC	03	41,798,931	16,863,740	48,271,000	0.0830	0.0838	0.0787
SC	04	39,311,540	16,302,473	46,550,374	0.0780	0.0810	0.0759
SC	05	41,348,611	18,341,342	57,954,394	0.0821	0.0912	0.0945
SC	06	40,997,908	16,485,083	55,608,346	0.0814	0.0820	0.0907
SC	07	43,867,411	17,240,809	58,741,824	0.0871	0.0857	0.0958
SC	08	44,651,381	17,110,102	58,644,588	0.0886	0.0851	0.0956
SC	09	40,323,039	15,481,066	50,978,159	0.0800	0.0770	0.0831
SC	10	42,560,796	16,101,822	48,087,082	0.0845	0.0800	0.0784
SC	11	42,129,900	15,649,579	44,762,435	0.0836	0.0778	0.0730
SC	12	44,617,469	17,064,833	50,887,170	0.0885	0.0848	0.0830
TN	01	71,608,169	32,463,649	70,543,984	0.0891	0.0918	0.0878
TN	02	63,447,099	28,516,971	57,807,903	0.0790	0.0806	0.0719
TN	03	70,285,032	30,789,323	62,978,124	0.0875	0.0870	0.0784
TN	04	67,115,103	29,544,149	62,263,948	0.0836	0.0835	0.0775
TN	05	67,604,846	30,239,993	73,924,640	0.0842	0.0855	0.0920
TN	06	64,995,186	27,570,520	69,983,255	0.0809	0.0779	0.0871
TN	07	69,115,263	28,472,467	75,627,607	0.0860	0.0805	0.0941
TN	08	68,203,771	27,938,018	75,482,963	0.0849	0.0790	0.0939
TN	09	64,028,005	26,223,217	66,657,640	0.0797	0.0741	0.0830
TN	10	67,207,741	30,302,087	63,600,104	0.0837	0.0857	0.0792
TN	11	64,351,135	30,025,154	60,930,714	0.0801	0.0849	0.0758
TN	12	65,304,428	31,613,217	63,691,363	0.0813	0.0894	0.0793
VA	01	48,819,916	19,354,669	61,201,527	0.0903	0.0899	0.0845
VA	02	42,459,207	16,120,688	50,059,887	0.0786	0.0749	0.0692
VA	03	46,445,863	17,609,976	52,456,475	0.0860	0.0818	0.0725
VA	04	45,434,640	16,978,258	55,638,983	0.0841	0.0789	0.0769
VA	05	44,510,048	20,277,218	70,273,499	0.0824	0.0942	0.0971
VA	06	44,336,821	18,643,880	65,152,697	0.0820	0.0866	0.0900

Average 2000-2004 State Level Monthly Profiles
CEM-Based Distribution

		Average Values [2000-2004]					
		SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	07	47,115,998	18,686,032	71,852,733	0.0872	0.0868	0.0993
VA	08	47,071,668	19,614,203	74,982,624	0.0871	0.0911	0.1036
VA	09	41,488,618	16,595,117	60,690,737	0.0768	0.0771	0.0838
VA	10	41,835,028	16,195,498	49,286,979	0.0774	0.0752	0.0681
VA	11	43,194,175	16,478,500	52,422,881	0.0799	0.0766	0.0724
VA	12	47,668,957	18,685,461	59,876,938	0.0882	0.0868	0.0827
WV	01	111,875,900	52,042,851	92,757,729	0.0894	0.0974	0.0850
WV	02	101,345,095	47,532,002	84,725,694	0.0810	0.0889	0.0776
WV	03	110,021,992	50,082,217	92,337,571	0.0879	0.0937	0.0846
WV	04	104,297,369	47,902,177	89,453,424	0.0833	0.0896	0.0820
WV	05	104,359,859	41,624,694	92,539,479	0.0834	0.0779	0.0848
WV	06	99,762,595	36,857,627	88,460,783	0.0797	0.0690	0.0810
WV	07	103,652,169	39,048,341	94,718,439	0.0828	0.0731	0.0868
WV	08	105,240,948	37,751,302	96,769,225	0.0841	0.0706	0.0887
WV	09	100,547,899	36,230,294	91,003,310	0.0803	0.0678	0.0834
WV	10	104,134,189	47,928,604	90,978,471	0.0832	0.0897	0.0834
WV	11	101,789,220	48,091,022	87,501,683	0.0813	0.0900	0.0802
WV	12	104,764,255	49,305,966	90,235,248	0.0837	0.0923	0.0827

Appendix F
Average 2000-2004 Alabama Monthly Profiles
CEM-Based Distribution



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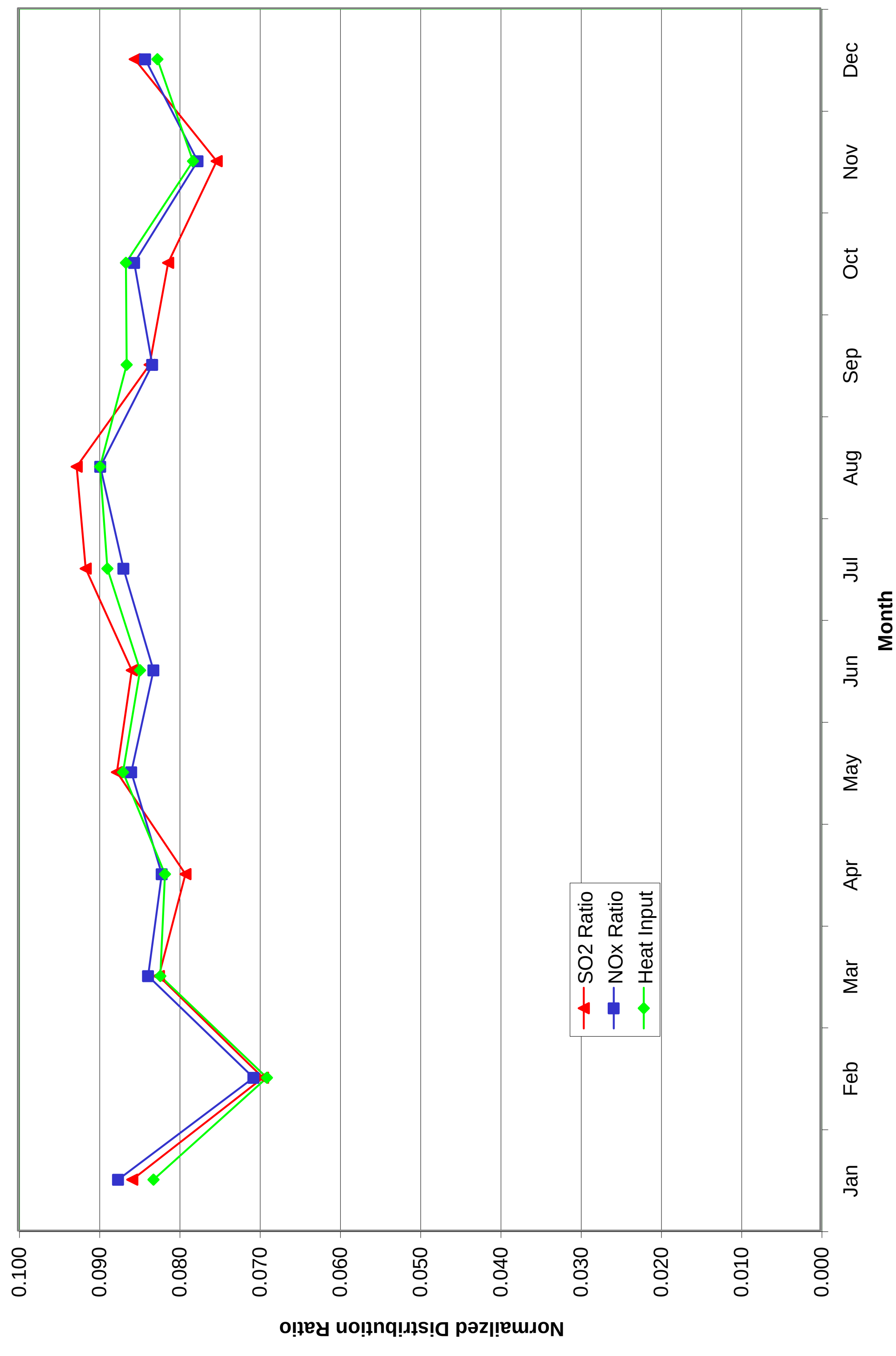
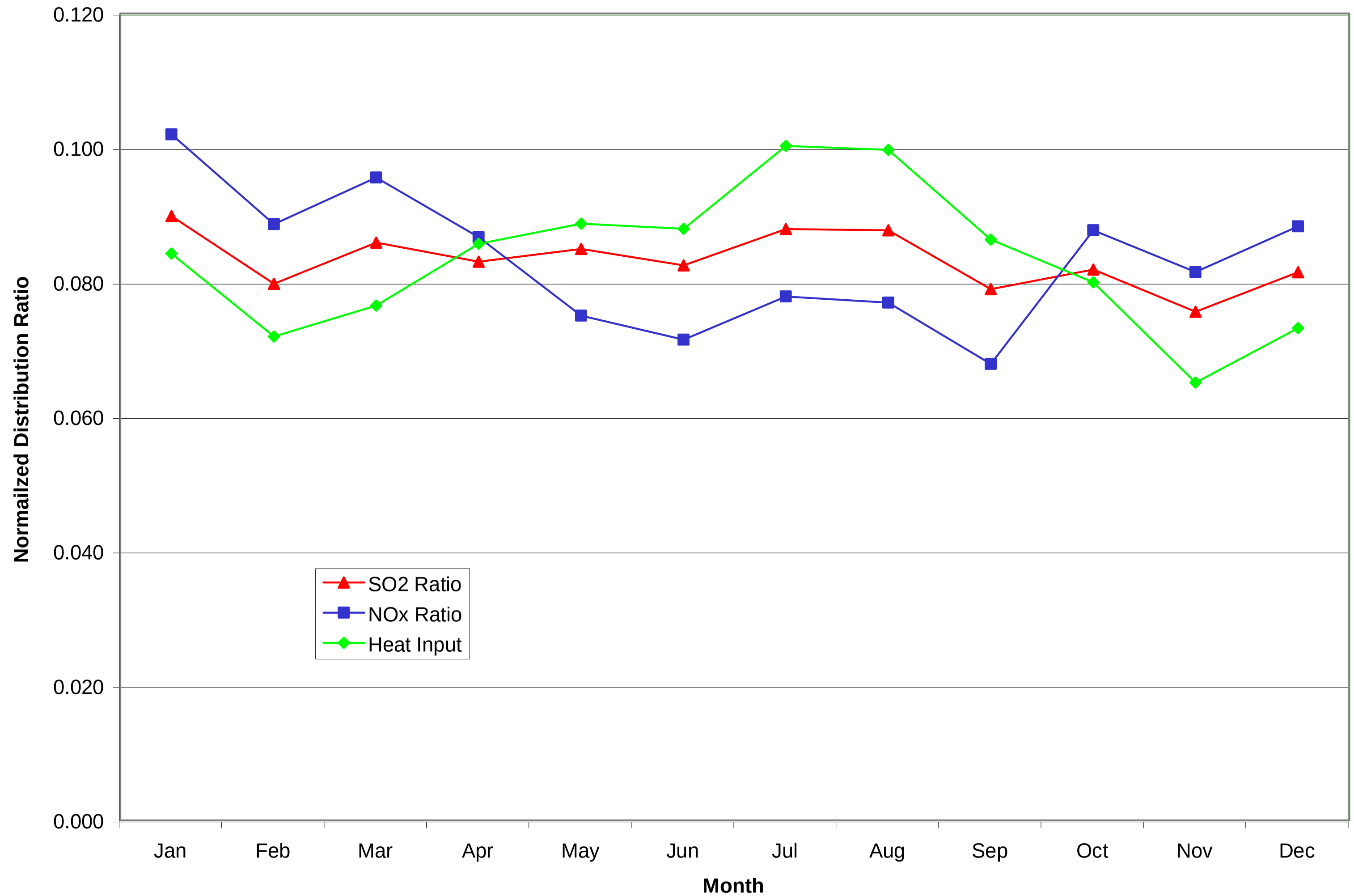
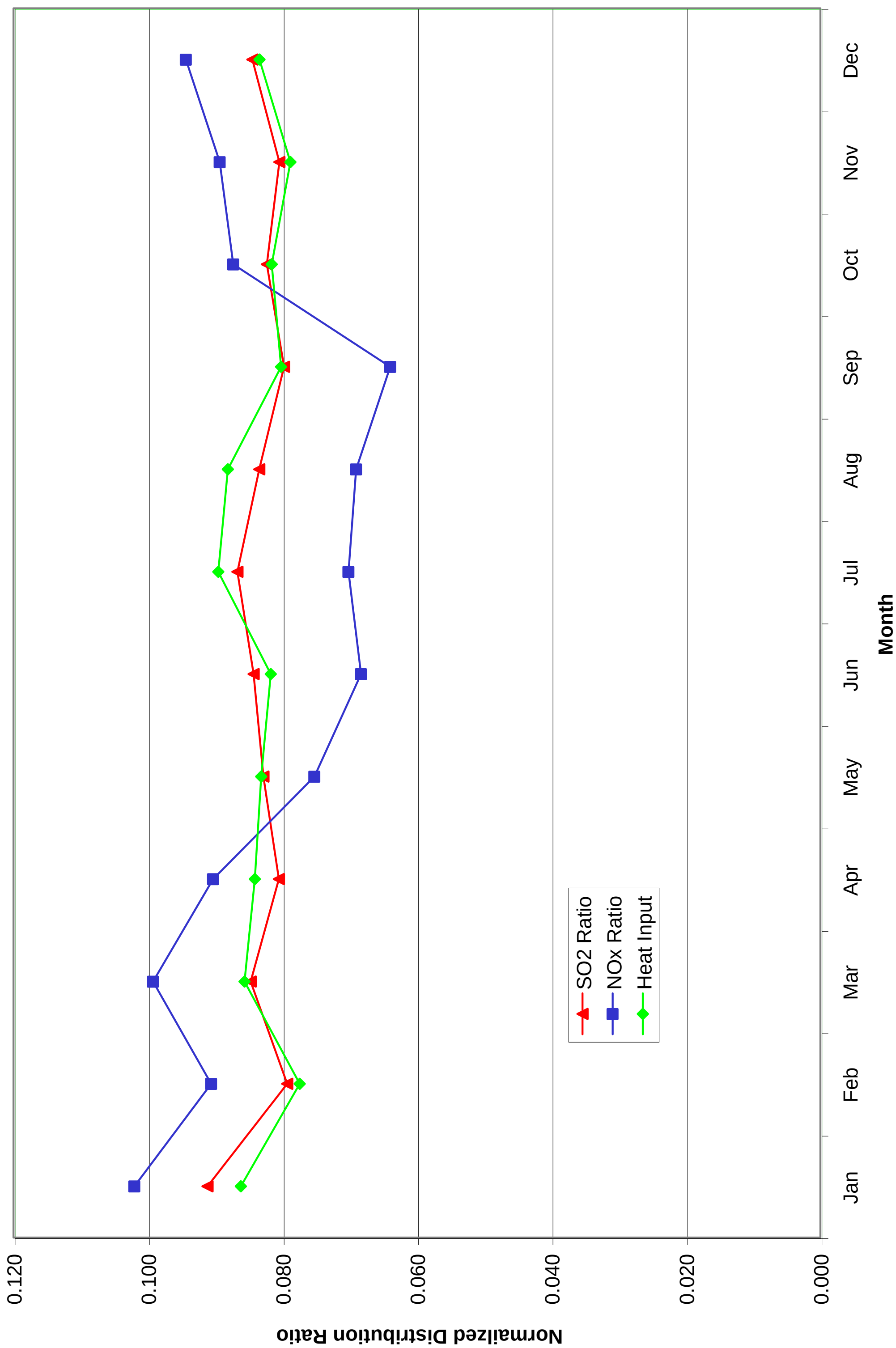
Appendix F
Average 2000-2004 Florida Monthly Profiles
CEM-Based Distribution



Appendix F
Average 2000-2004 Georgia Monthly Profiles
CEM-Based Distribution



Appendix F
Average 2000-2004 Kentucky Monthly Profiles
CEM-Based Distribution



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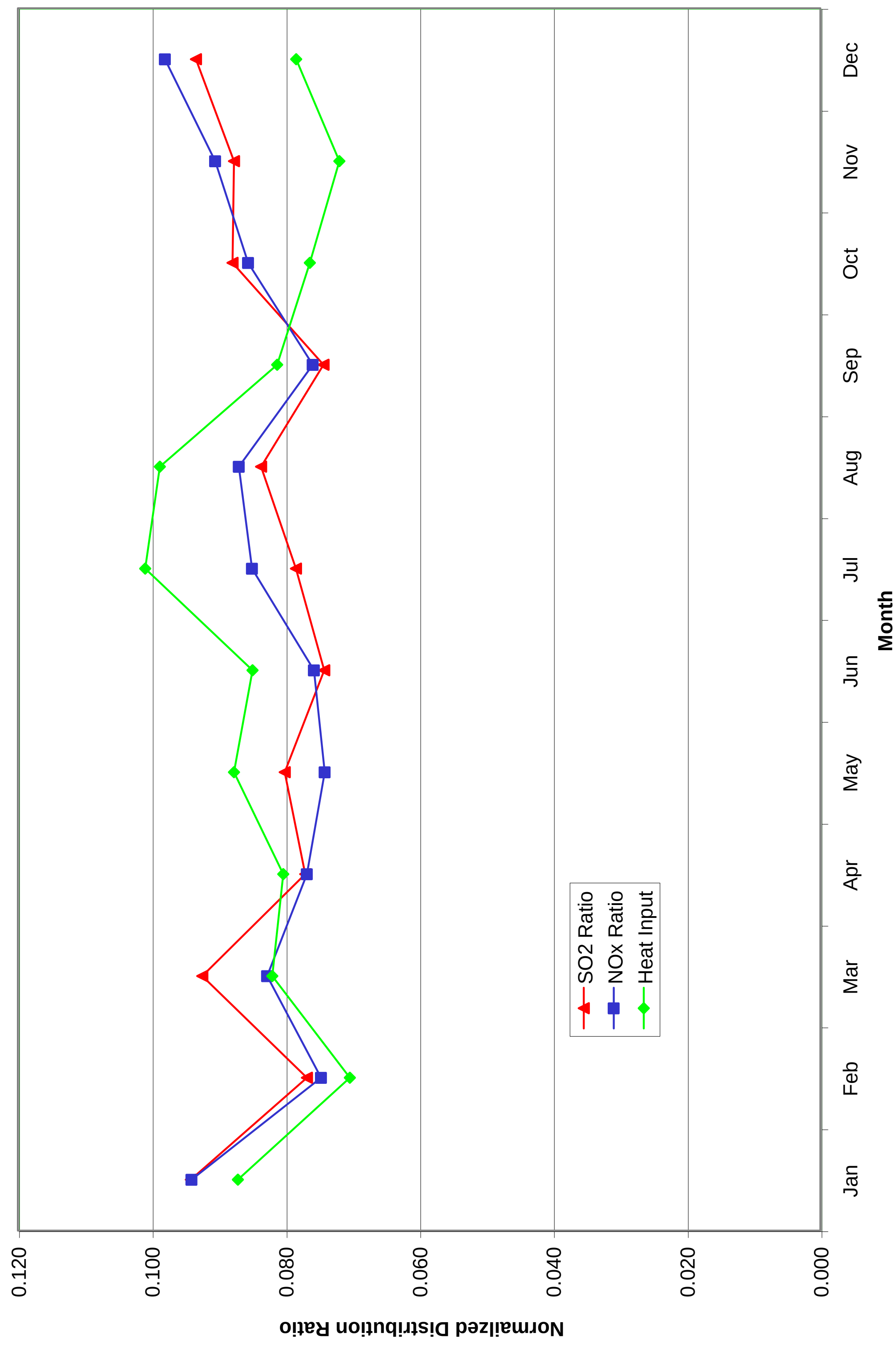
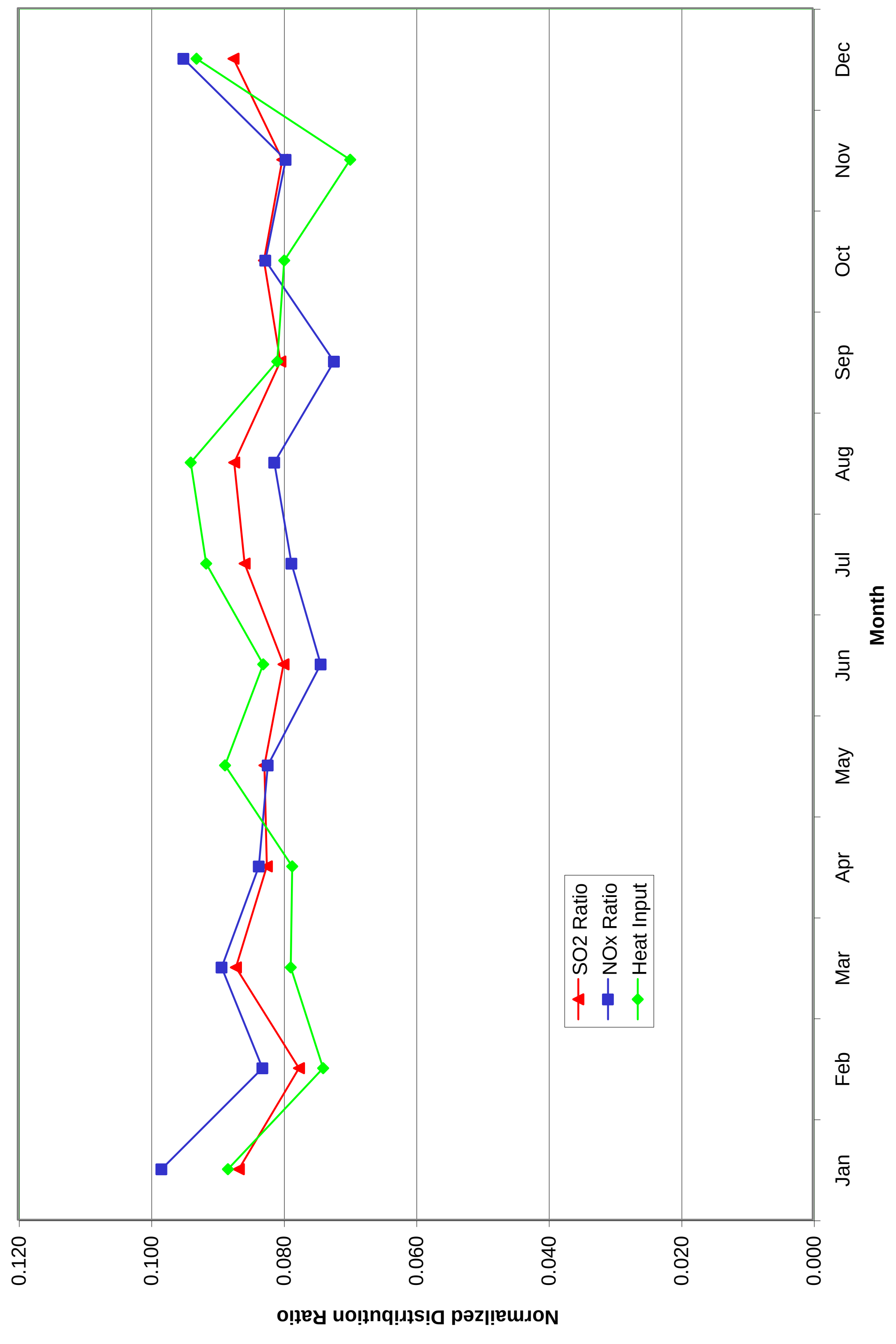
Appendix F
Average 2000-2004 Mississippi Monthly Profiles
CEM-Based Distribution




Appendix F
Average 2000-2004 North Carolina Monthly Profiles
CEM-Based Distribution
Normailzed Distribution Ratio
0.120
0.100
0.080
0.060
0.040
0.020
0.000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
SO2 Ratio
NOx Ratio
Heat Input

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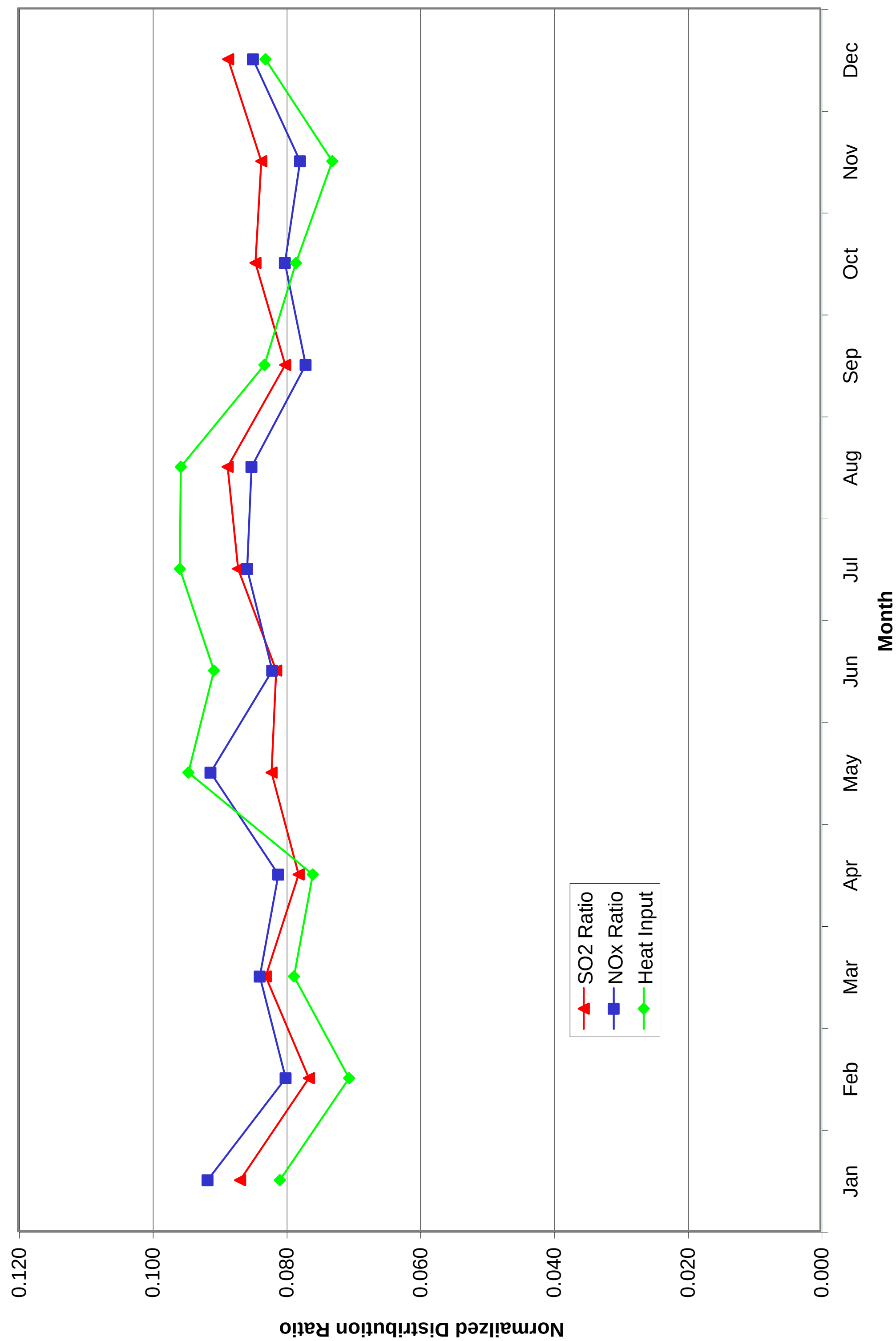
Appendix F
Average 2000-2004 South Carolina Monthly Profiles
CEM-Based Distribution



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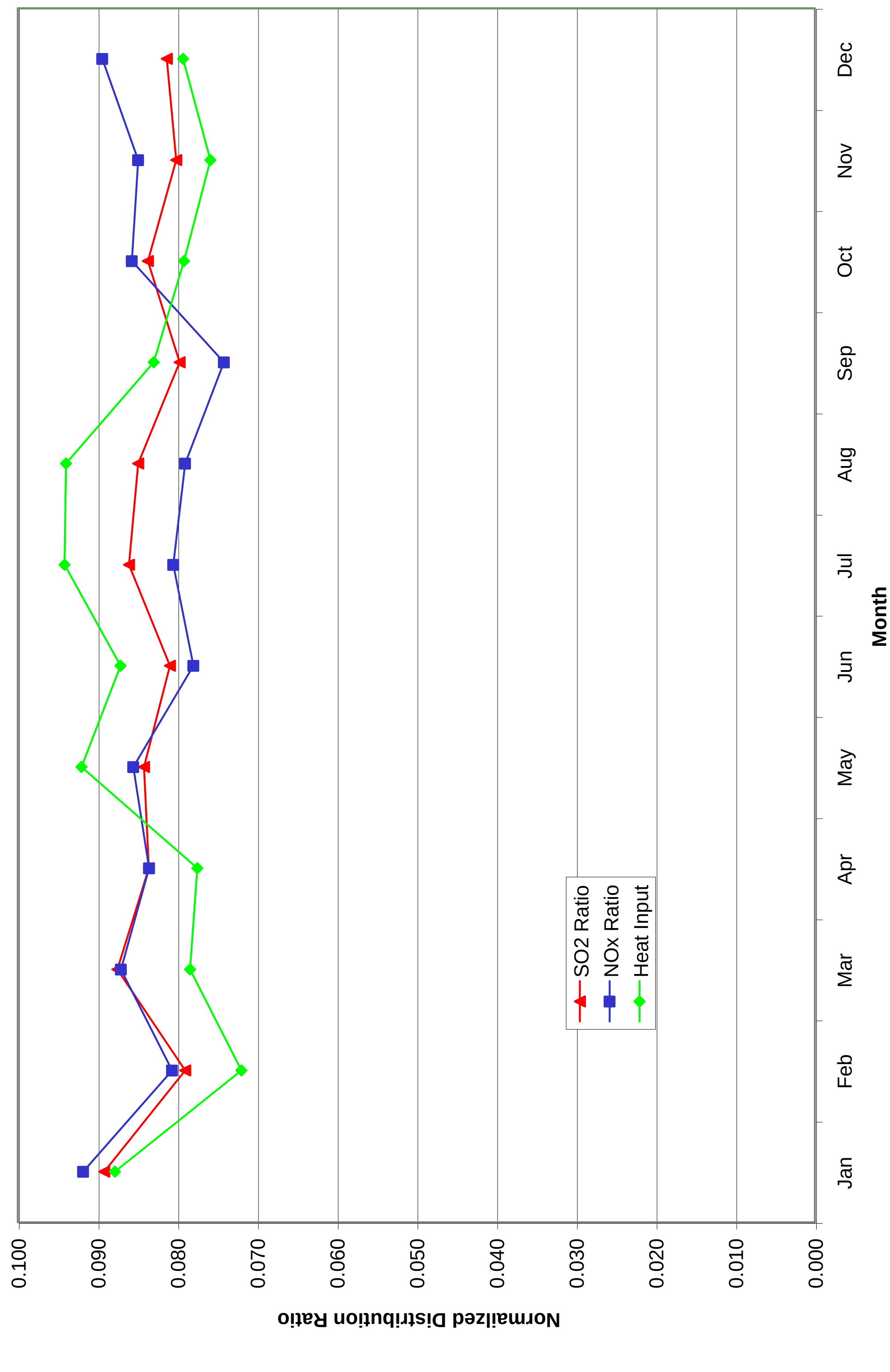
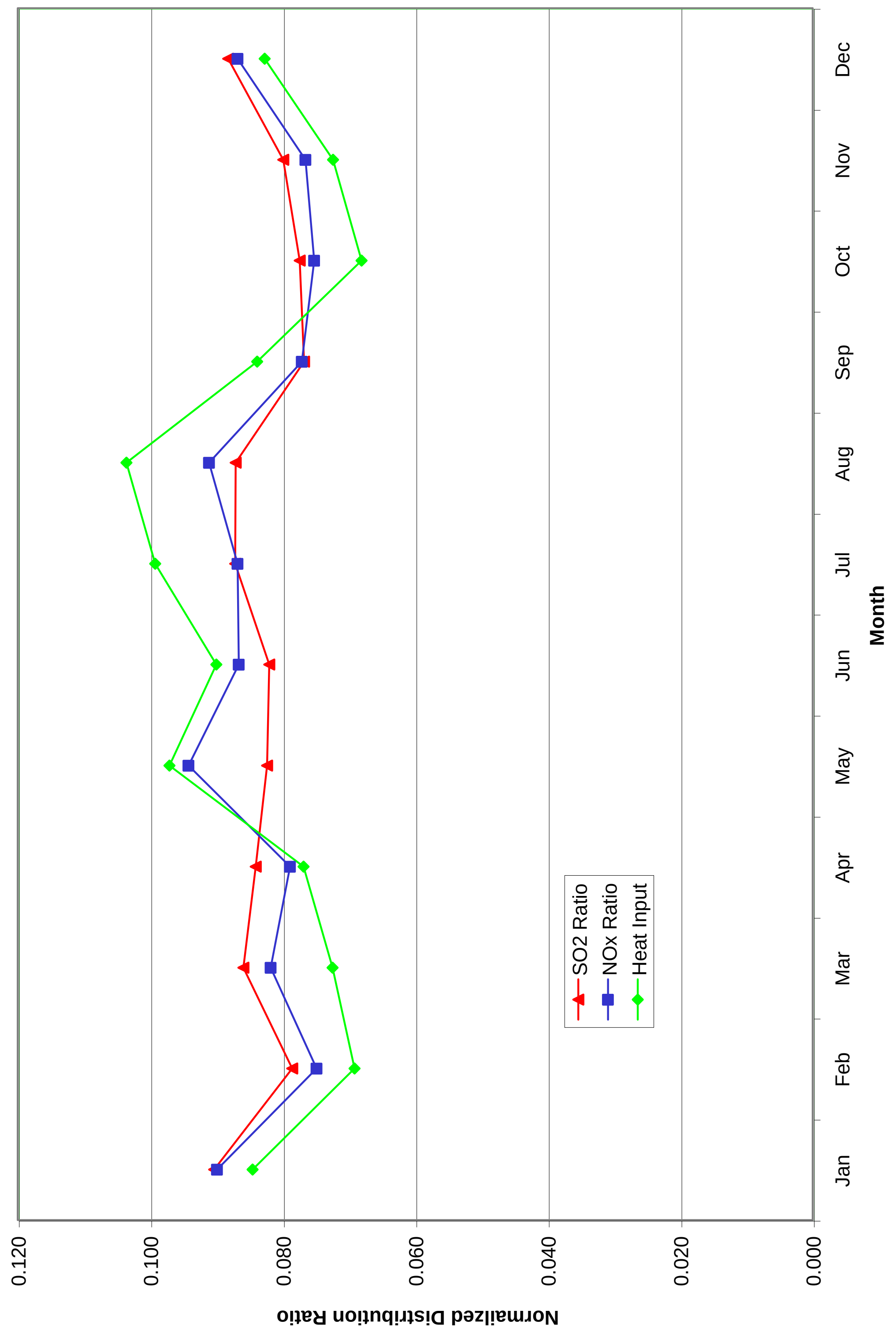
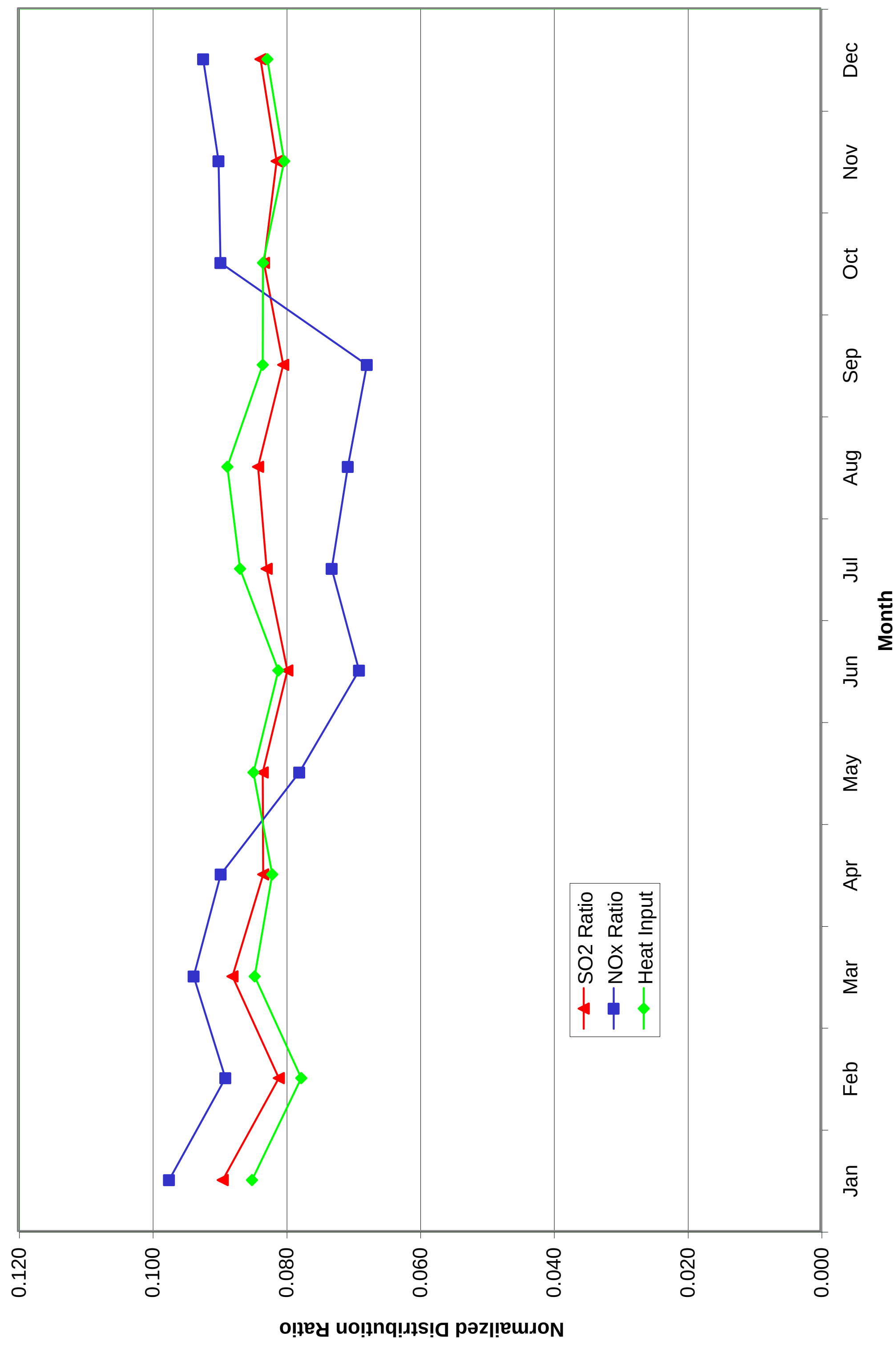
Appendix F
Average 2000-2004 Tennessee Monthly Profiles
CEM-Based Distribution



Appendix F
Average 2000-2004 Virginia Monthly Profiles
CEM-Based Distribution



Appendix F
Average 2000-2004 West Virginia Monthly Profiles
CEM-Based Distribution



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Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Jan	Sun	11,973,393	4,292,483	12,150,601	0.1235	0.1206	0.1140
AL	Jan	Mon	12,374,833	4,518,105	13,660,275	0.1277	0.1270	0.1281
AL	Jan	Tue	15,759,152	5,811,809	17,855,568	0.1626	0.1633	0.1675
AL	Jan	Wed	15,817,025	5,904,760	18,056,233	0.1632	0.1659	0.1694
AL	Jan	Thu	15,848,565	5,912,905	17,883,602	0.1635	0.1662	0.1678
AL	Jan	Fri	12,652,920	4,622,646	14,110,073	0.1305	0.1299	0.1324
AL	Jan	Sat	12,504,382	4,524,941	12,891,370	0.1290	0.1271	0.1209
AL	Feb	Sun	12,465,714	4,378,603	11,982,100	0.1396	0.1381	0.1298
AL	Feb	Mon	12,648,797	4,566,922	13,683,022	0.1416	0.1440	0.1482
AL	Feb	Tue	13,055,528	4,650,784	13,916,803	0.1462	0.1467	0.1507
AL	Feb	Wed	12,952,638	4,624,268	13,892,291	0.1450	0.1458	0.1505
AL	Feb	Thu	13,064,253	4,654,235	13,656,975	0.1463	0.1468	0.1479
AL	Feb	Fri	12,605,617	4,453,161	13,144,836	0.1412	0.1404	0.1424
AL	Feb	Sat	12,506,729	4,384,600	12,044,772	0.1401	0.1383	0.1305
AL	Mar	Sun	15,136,907	5,425,946	15,180,521	0.1545	0.1567	0.1522
AL	Mar	Mon	12,807,193	4,585,951	14,006,813	0.1307	0.1324	0.1404
AL	Mar	Tue	12,944,714	4,570,137	13,805,523	0.1321	0.1320	0.1384
AL	Mar	Wed	12,999,541	4,537,373	13,259,394	0.1327	0.1310	0.1329
AL	Mar	Thu	12,873,383	4,506,075	12,778,477	0.1314	0.1301	0.1281
AL	Mar	Fri	15,661,836	5,503,590	15,357,680	0.1599	0.1589	0.1540
AL	Mar	Sat	15,553,458	5,495,957	15,354,531	0.1587	0.1587	0.1539
AL	Apr	Sun	11,332,686	4,123,907	12,698,306	0.1284	0.1275	0.1268
AL	Apr	Mon	14,709,426	5,394,905	16,813,048	0.1667	0.1668	0.1679
AL	Apr	Tue	14,964,648	5,500,081	17,133,697	0.1696	0.1701	0.1711
AL	Apr	Wed	11,974,199	4,381,431	13,657,561	0.1357	0.1355	0.1364
AL	Apr	Thu	11,841,341	4,392,824	13,582,578	0.1342	0.1359	0.1357
AL	Apr	Fri	11,589,435	4,252,648	13,155,951	0.1313	0.1315	0.1314
AL	Apr	Sat	11,831,443	4,288,474	13,088,368	0.1341	0.1326	0.1307
AL	May	Sun	11,290,254	3,924,702	13,059,831	0.1255	0.1203	0.1156
AL	May	Mon	11,516,514	4,115,730	14,403,677	0.1280	0.1261	0.1275
AL	May	Tue	11,730,957	4,236,978	14,784,483	0.1304	0.1299	0.1309
AL	May	Wed	14,812,058	5,491,479	18,961,819	0.1646	0.1683	0.1679
AL	May	Thu	14,475,031	5,429,397	18,685,109	0.1609	0.1664	0.1654
AL	May	Fri	14,613,756	5,349,841	19,086,178	0.1624	0.1640	0.1690
AL	May	Sat	11,524,096	4,079,639	13,986,871	0.1281	0.1250	0.1238
AL	Jun	Sun	13,957,660	4,981,619	17,448,833	0.1602	0.1597	0.1571
AL	Jun	Mon	11,633,110	4,294,059	14,994,420	0.1336	0.1377	0.1350
AL	Jun	Tue	11,576,426	4,230,898	15,073,323	0.1329	0.1356	0.1357
AL	Jun	Wed	11,663,562	4,201,231	15,347,162	0.1339	0.1347	0.1382
AL	Jun	Thu	12,000,645	4,240,320	15,246,768	0.1378	0.1359	0.1372
AL	Jun	Fri	11,905,820	4,190,850	15,112,838	0.1367	0.1344	0.1360
AL	Jun	Sat	14,365,013	5,054,322	17,865,378	0.1649	0.1620	0.1608
AL	Jul	Sun	11,478,359	4,030,395	14,872,793	0.1253	0.1257	0.1238
AL	Jul	Mon	14,896,744	5,353,452	19,661,377	0.1627	0.1669	0.1637
AL	Jul	Tue	14,892,334	5,240,213	19,673,860	0.1626	0.1634	0.1638
AL	Jul	Wed	14,865,558	5,188,296	19,695,559	0.1623	0.1618	0.1640
AL	Jul	Thu	12,025,777	4,112,950	15,522,479	0.1313	0.1282	0.1292
AL	Jul	Fri	11,771,513	4,111,362	15,390,421	0.1285	0.1282	0.1281
AL	Jul	Sat	11,657,160	4,037,311	15,294,119	0.1273	0.1259	0.1273
AL	Aug	Sun	11,088,782	3,913,833	14,625,355	0.1225	0.1212	0.1222
AL	Aug	Mon	11,442,122	4,181,420	15,548,602	0.1264	0.1295	0.1299
AL	Aug	Tue	11,752,571	4,201,299	15,748,722	0.1298	0.1301	0.1316
AL	Aug	Wed	11,940,710	4,288,501	15,898,971	0.1319	0.1328	0.1328
AL	Aug	Thu	15,014,026	5,347,097	19,862,773	0.1659	0.1656	0.1659
AL	Aug	Fri	14,892,207	5,266,987	19,530,653	0.1645	0.1632	0.1631
AL	Aug	Sat	14,386,647	5,083,661	18,500,321	0.1589	0.1575	0.1545
AL	Sep	Sun	13,885,652	4,820,670	16,659,869	0.1613	0.1596	0.1530

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Sep	Mon	14,141,995	5,038,855	18,062,372	0.1643	0.1668	0.1659
AL	Sep	Tue	11,484,404	4,082,649	14,962,763	0.1334	0.1352	0.1374
AL	Sep	Wed	11,524,522	4,022,576	15,083,427	0.1339	0.1332	0.1385
AL	Sep	Thu	11,685,702	4,046,346	15,167,290	0.1357	0.1340	0.1393
AL	Sep	Fri	11,811,386	4,173,863	15,058,953	0.1372	0.1382	0.1383
AL	Sep	Sat	11,560,273	4,020,226	13,878,522	0.1343	0.1331	0.1275
AL	Oct	Sun	11,811,377	4,289,943	12,293,195	0.1245	0.1249	0.1175
AL	Oct	Mon	12,332,346	4,513,994	13,800,627	0.1300	0.1315	0.1319
AL	Oct	Tue	15,474,221	5,650,161	18,121,815	0.1631	0.1645	0.1732
AL	Oct	Wed	15,551,242	5,595,423	17,461,781	0.1639	0.1630	0.1669
AL	Oct	Thu	15,534,833	5,592,238	17,160,242	0.1638	0.1629	0.1640
AL	Oct	Fri	12,155,982	4,367,495	13,056,737	0.1281	0.1272	0.1248
AL	Oct	Sat	12,002,823	4,328,644	12,725,123	0.1265	0.1261	0.1216
AL	Nov	Sun	10,950,379	4,115,386	11,183,830	0.1280	0.1270	0.1228
AL	Nov	Mon	11,507,720	4,411,521	12,990,319	0.1345	0.1361	0.1427
AL	Nov	Tue	11,720,227	4,422,309	12,908,336	0.1370	0.1364	0.1418
AL	Nov	Wed	11,739,397	4,445,575	12,902,505	0.1372	0.1371	0.1417
AL	Nov	Thu	11,403,389	4,330,306	12,158,977	0.1333	0.1336	0.1335
AL	Nov	Fri	14,207,798	5,352,146	14,393,969	0.1661	0.1651	0.1581
AL	Nov	Sat	14,011,340	5,338,674	14,507,152	0.1638	0.1647	0.1593
AL	Dec	Sun	14,259,735	5,291,444	15,673,882	0.1596	0.1577	0.1555
AL	Dec	Mon	14,521,256	5,449,977	16,243,296	0.1625	0.1624	0.1612
AL	Dec	Tue	14,337,889	5,387,676	16,636,483	0.1605	0.1606	0.1651
AL	Dec	Wed	11,519,363	4,344,609	13,758,100	0.1289	0.1295	0.1365
AL	Dec	Thu	11,537,461	4,339,002	13,205,960	0.1291	0.1293	0.1311
AL	Dec	Fri	11,518,162	4,387,499	12,641,479	0.1289	0.1308	0.1254
AL	Dec	Sat	11,650,526	4,349,426	12,610,355	0.1304	0.1296	0.1251
FL	Jan	Sun	13,052,230	7,160,414	23,398,263	0.1125	0.1137	0.1177
FL	Jan	Mon	14,866,982	7,996,928	25,194,145	0.1282	0.1270	0.1268
FL	Jan	Tue	18,966,078	10,294,960	31,932,987	0.1635	0.1634	0.1607
FL	Jan	Wed	20,016,132	10,819,976	32,850,433	0.1725	0.1718	0.1653
FL	Jan	Thu	19,295,311	10,472,703	32,116,708	0.1663	0.1663	0.1616
FL	Jan	Fri	15,354,992	8,522,403	27,688,357	0.1324	0.1353	0.1393
FL	Jan	Sat	14,459,528	7,722,574	25,570,155	0.1246	0.1226	0.1287
FL	Feb	Sun	12,328,843	6,678,620	22,095,068	0.1312	0.1314	0.1340
FL	Feb	Mon	13,274,623	7,208,897	22,824,084	0.1413	0.1418	0.1384
FL	Feb	Tue	13,693,951	7,472,016	23,752,507	0.1457	0.1470	0.1440
FL	Feb	Wed	13,836,434	7,526,378	24,260,947	0.1473	0.1481	0.1471
FL	Feb	Thu	14,626,146	7,756,851	24,978,352	0.1557	0.1526	0.1514
FL	Feb	Fri	13,387,771	7,250,124	24,015,119	0.1425	0.1426	0.1456
FL	Feb	Sat	12,811,018	6,938,932	23,023,625	0.1363	0.1365	0.1396
FL	Mar	Sun	16,314,717	8,834,739	28,930,182	0.1463	0.1465	0.1471
FL	Mar	Mon	14,145,402	7,894,516	25,499,466	0.1269	0.1310	0.1296
FL	Mar	Tue	15,509,617	8,218,394	26,796,918	0.1391	0.1363	0.1362
FL	Mar	Wed	14,681,727	7,998,106	26,192,929	0.1317	0.1327	0.1332
FL	Mar	Thu	15,079,501	8,032,083	26,337,928	0.1352	0.1332	0.1339
FL	Mar	Fri	18,299,777	9,808,680	32,297,624	0.1641	0.1627	0.1642
FL	Mar	Sat	17,474,812	9,499,456	30,650,650	0.1567	0.1576	0.1558
FL	Apr	Sun	13,180,026	7,253,618	24,850,878	0.1232	0.1228	0.1272
FL	Apr	Mon	18,541,655	10,196,466	33,323,177	0.1733	0.1726	0.1706
FL	Apr	Tue	18,213,655	10,190,833	33,629,986	0.1702	0.1725	0.1722
FL	Apr	Wed	14,605,188	7,968,116	26,091,761	0.1365	0.1349	0.1336
FL	Apr	Thu	14,526,273	7,984,231	25,923,235	0.1357	0.1352	0.1327
FL	Apr	Fri	14,280,951	7,906,375	26,138,199	0.1334	0.1338	0.1338
FL	Apr	Sat	13,667,690	7,572,152	25,380,968	0.1277	0.1282	0.1299
FL	May	Sun	14,357,464	7,485,459	25,863,896	0.1211	0.1211	0.1245
FL	May	Mon	15,154,083	7,956,981	26,787,554	0.1278	0.1287	0.1289

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	May	Tue	15,455,197	8,087,887	26,870,989	0.1303	0.1308	0.1293
FL	May	Wed	19,503,288	10,111,972	33,711,442	0.1645	0.1636	0.1622
FL	May	Thu	19,515,243	10,161,786	34,071,726	0.1646	0.1644	0.1640
FL	May	Fri	19,586,389	10,147,265	33,901,927	0.1652	0.1642	0.1631
FL	May	Sat	15,017,697	7,860,254	26,596,461	0.1266	0.1272	0.1280
FL	Jun	Sun	18,310,691	9,452,183	32,537,086	0.1578	0.1581	0.1605
FL	Jun	Mon	15,781,319	8,161,348	27,330,779	0.1360	0.1365	0.1348
FL	Jun	Tue	15,960,643	8,221,474	27,459,697	0.1375	0.1375	0.1355
FL	Jun	Wed	16,100,778	8,299,845	27,869,080	0.1387	0.1388	0.1375
FL	Jun	Thu	15,570,508	8,114,098	27,364,774	0.1341	0.1357	0.1350
FL	Jun	Fri	15,525,917	7,973,482	27,062,460	0.1338	0.1333	0.1335
FL	Jun	Sat	18,819,132	9,579,210	33,092,339	0.1621	0.1602	0.1632
FL	Jul	Sun	14,708,203	7,575,148	26,405,051	0.1187	0.1212	0.1243
FL	Jul	Mon	20,178,197	10,115,348	34,663,034	0.1629	0.1618	0.1631
FL	Jul	Tue	20,451,635	10,271,409	34,820,771	0.1651	0.1643	0.1639
FL	Jul	Wed	20,493,877	10,275,526	34,553,648	0.1654	0.1644	0.1626
FL	Jul	Thu	16,472,099	8,264,690	27,655,517	0.1330	0.1322	0.1302
FL	Jul	Fri	16,330,885	8,240,365	27,757,755	0.1318	0.1318	0.1306
FL	Jul	Sat	15,233,852	7,757,683	26,622,660	0.1230	0.1241	0.1253
FL	Aug	Sun	14,832,430	7,770,298	26,355,005	0.1183	0.1203	0.1228
FL	Aug	Mon	16,289,567	8,415,375	27,921,417	0.1299	0.1303	0.1301
FL	Aug	Tue	16,409,009	8,464,979	27,982,337	0.1309	0.1311	0.1304
FL	Aug	Wed	16,599,763	8,412,726	27,839,040	0.1324	0.1303	0.1297
FL	Aug	Thu	21,190,840	10,674,830	35,352,991	0.1690	0.1653	0.1647
FL	Aug	Fri	20,753,135	10,663,040	35,280,658	0.1655	0.1651	0.1644
FL	Aug	Sat	19,310,195	10,171,594	33,905,771	0.1540	0.1575	0.1580
FL	Sep	Sun	17,407,168	9,327,229	33,090,745	0.1539	0.1557	0.1601
FL	Sep	Mon	18,951,071	10,063,106	34,697,245	0.1676	0.1680	0.1679
FL	Sep	Tue	15,814,547	8,275,493	28,027,452	0.1399	0.1381	0.1356
FL	Sep	Wed	15,592,813	8,221,478	28,140,157	0.1379	0.1372	0.1361
FL	Sep	Thu	15,256,995	8,137,970	28,067,153	0.1349	0.1358	0.1358
FL	Sep	Fri	15,323,186	8,044,147	27,681,511	0.1355	0.1343	0.1339
FL	Sep	Sat	14,735,009	7,844,300	27,008,693	0.1303	0.1309	0.1307
FL	Oct	Sun	13,398,285	7,549,892	25,661,085	0.1218	0.1227	0.1240
FL	Oct	Mon	14,202,904	7,990,788	27,002,819	0.1292	0.1298	0.1305
FL	Oct	Tue	18,096,168	9,983,295	34,056,575	0.1646	0.1622	0.1646
FL	Oct	Wed	17,946,866	10,125,375	33,672,517	0.1632	0.1645	0.1627
FL	Oct	Thu	18,294,441	10,176,870	33,532,221	0.1664	0.1653	0.1621
FL	Oct	Fri	14,378,959	8,087,989	26,782,353	0.1308	0.1314	0.1294
FL	Oct	Sat	13,643,205	7,637,100	26,216,601	0.1241	0.1241	0.1267
FL	Nov	Sun	12,425,949	6,985,756	23,514,454	0.1221	0.1251	0.1258
FL	Nov	Mon	13,791,110	7,588,195	25,610,183	0.1355	0.1358	0.1370
FL	Nov	Tue	14,159,503	7,809,700	26,113,365	0.1391	0.1398	0.1397
FL	Nov	Wed	14,370,209	7,842,655	25,876,805	0.1412	0.1404	0.1384
FL	Nov	Thu	13,592,948	7,519,473	24,826,599	0.1336	0.1346	0.1328
FL	Nov	Fri	16,684,484	9,125,303	30,670,840	0.1639	0.1634	0.1640
FL	Nov	Sat	16,757,179	8,990,636	30,372,419	0.1646	0.1609	0.1624
FL	Dec	Sun	18,192,578	9,580,007	31,795,817	0.1574	0.1582	0.1609
FL	Dec	Mon	18,247,650	9,703,301	31,978,285	0.1579	0.1602	0.1618
FL	Dec	Tue	18,262,323	9,595,586	31,915,018	0.1580	0.1584	0.1615
FL	Dec	Wed	14,947,606	7,892,737	25,962,148	0.1293	0.1303	0.1314
FL	Dec	Thu	15,731,535	8,249,796	26,206,079	0.1361	0.1362	0.1326
FL	Dec	Fri	15,220,061	7,809,988	25,012,084	0.1317	0.1289	0.1266
FL	Dec	Sat	14,986,986	7,735,028	24,722,702	0.1297	0.1277	0.1251
GA	Jan	Sun	13,124,248	4,020,218	11,305,425	0.1178	0.1139	0.1113
GA	Jan	Mon	14,360,931	4,512,619	12,504,023	0.1289	0.1278	0.1231
GA	Jan	Tue	18,524,178	5,840,250	16,704,047	0.1663	0.1654	0.1644

Average 2000-2004 State Level Monthly-Day of Week Profiles
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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Jan	Wed	18,483,995	5,950,256	17,283,608	0.1660	0.1686	0.1701
GA	Jan	Thu	17,872,716	5,819,388	16,862,298	0.1605	0.1649	0.1660
GA	Jan	Fri	14,637,093	4,697,899	14,218,196	0.1314	0.1331	0.1400
GA	Jan	Sat	14,378,672	4,459,541	12,701,268	0.1291	0.1263	0.1250
GA	Feb	Sun	13,382,988	3,957,671	10,524,683	0.1353	0.1290	0.1214
GA	Feb	Mon	14,770,265	4,523,997	12,942,006	0.1494	0.1475	0.1492
GA	Feb	Tue	14,508,558	4,595,940	13,154,535	0.1467	0.1498	0.1517
GA	Feb	Wed	14,470,656	4,563,033	13,554,721	0.1463	0.1487	0.1563
GA	Feb	Thu	14,407,456	4,600,185	13,771,393	0.1457	0.1499	0.1588
GA	Feb	Fri	13,742,723	4,340,244	11,899,583	0.1390	0.1415	0.1372
GA	Feb	Sat	13,613,681	4,097,591	10,871,415	0.1377	0.1336	0.1254
GA	Mar	Sun	15,495,089	4,641,883	12,167,666	0.1455	0.1403	0.1319
GA	Mar	Mon	14,334,901	4,513,847	13,362,335	0.1346	0.1365	0.1449
GA	Mar	Tue	14,420,895	4,532,750	13,463,600	0.1354	0.1370	0.1460
GA	Mar	Wed	14,170,345	4,489,531	13,057,182	0.1331	0.1357	0.1416
GA	Mar	Thu	14,004,649	4,446,853	12,249,119	0.1315	0.1344	0.1328
GA	Mar	Fri	17,177,952	5,357,920	14,842,639	0.1613	0.1620	0.1609
GA	Mar	Sat	16,881,455	5,096,281	13,100,433	0.1585	0.1541	0.1420
GA	Apr	Sun	12,693,095	3,672,253	11,719,631	0.1233	0.1224	0.1134
GA	Apr	Mon	17,251,251	5,137,684	18,011,935	0.1675	0.1712	0.1743
GA	Apr	Tue	17,584,479	5,057,585	18,208,078	0.1708	0.1685	0.1762
GA	Apr	Wed	13,945,269	4,029,330	14,482,773	0.1354	0.1343	0.1402
GA	Apr	Thu	14,088,286	4,141,433	14,549,349	0.1368	0.1380	0.1408
GA	Apr	Fri	13,898,987	4,014,958	13,810,855	0.1350	0.1338	0.1337
GA	Apr	Sat	13,512,776	3,955,619	12,541,990	0.1312	0.1318	0.1214
GA	May	Sun	12,906,496	2,943,453	11,988,411	0.1226	0.1133	0.1121
GA	May	Mon	13,439,964	3,255,041	13,325,027	0.1276	0.1253	0.1246
GA	May	Tue	13,342,706	3,443,206	13,496,507	0.1267	0.1326	0.1262
GA	May	Wed	16,859,064	4,405,016	17,702,345	0.1601	0.1696	0.1655
GA	May	Thu	17,404,134	4,394,630	18,689,800	0.1653	0.1692	0.1747
GA	May	Fri	17,637,771	4,321,631	18,223,384	0.1675	0.1664	0.1704
GA	May	Sat	13,703,682	3,206,049	13,527,121	0.1301	0.1235	0.1265
GA	Jun	Sun	16,235,802	3,781,890	16,311,536	0.1588	0.1529	0.1539
GA	Jun	Mon	13,881,743	3,266,998	14,225,348	0.1357	0.1321	0.1342
GA	Jun	Tue	13,809,085	3,372,791	14,673,939	0.1350	0.1363	0.1384
GA	Jun	Wed	13,979,459	3,424,713	15,005,533	0.1367	0.1384	0.1416
GA	Jun	Thu	14,048,031	3,487,248	14,772,625	0.1374	0.1410	0.1394
GA	Jun	Fri	13,653,375	3,370,860	14,100,835	0.1335	0.1363	0.1330
GA	Jun	Sat	16,664,151	4,034,487	16,916,436	0.1629	0.1631	0.1596
GA	Jul	Sun	13,493,095	3,379,960	14,451,977	0.1238	0.1254	0.1196
GA	Jul	Mon	17,801,210	4,556,344	19,924,880	0.1634	0.1691	0.1648
GA	Jul	Tue	17,736,601	4,396,225	19,892,108	0.1628	0.1631	0.1646
GA	Jul	Wed	17,688,477	4,396,005	20,106,026	0.1623	0.1631	0.1663
GA	Jul	Thu	14,116,591	3,450,943	16,084,166	0.1296	0.1280	0.1331
GA	Jul	Fri	14,202,897	3,403,815	15,676,086	0.1304	0.1263	0.1297
GA	Jul	Sat	13,918,446	3,369,321	14,742,670	0.1277	0.1250	0.1220
GA	Aug	Sun	13,460,815	3,033,642	13,996,540	0.1238	0.1139	0.1165
GA	Aug	Mon	14,006,159	3,327,578	15,676,687	0.1288	0.1249	0.1304
GA	Aug	Tue	13,931,609	3,456,530	16,030,001	0.1281	0.1298	0.1334
GA	Aug	Wed	14,283,637	3,631,066	15,723,552	0.1313	0.1363	0.1308
GA	Aug	Thu	17,975,152	4,576,805	19,839,720	0.1653	0.1718	0.1651
GA	Aug	Fri	17,749,354	4,363,885	20,001,135	0.1632	0.1638	0.1664
GA	Aug	Sat	17,345,611	4,250,247	18,922,855	0.1595	0.1595	0.1574
GA	Sep	Sun	15,448,171	3,602,062	15,157,438	0.1578	0.1534	0.1456
GA	Sep	Mon	16,414,338	3,876,193	17,459,170	0.1676	0.1650	0.1678
GA	Sep	Tue	13,131,984	3,099,912	14,117,735	0.1341	0.1320	0.1357
GA	Sep	Wed	13,320,417	3,165,578	14,440,389	0.1360	0.1348	0.1388

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Sep	Thu	13,516,677	3,288,041	14,927,333	0.1380	0.1400	0.1434
GA	Sep	Fri	13,444,163	3,378,753	15,048,148	0.1373	0.1439	0.1446
GA	Sep	Sat	12,642,974	3,076,945	12,922,533	0.1291	0.1310	0.1242
GA	Oct	Sun	12,221,190	3,547,451	10,953,557	0.1204	0.1168	0.1136
GA	Oct	Mon	13,361,673	4,095,621	12,885,298	0.1316	0.1349	0.1336
GA	Oct	Tue	16,938,579	5,190,094	16,406,795	0.1668	0.1709	0.1701
GA	Oct	Wed	16,923,596	5,106,862	16,895,152	0.1667	0.1682	0.1752
GA	Oct	Thu	16,501,991	4,995,042	16,151,355	0.1625	0.1645	0.1675
GA	Oct	Fri	13,305,028	3,870,352	12,036,350	0.1310	0.1274	0.1248
GA	Oct	Sat	12,284,472	3,564,025	11,124,250	0.1210	0.1174	0.1153
GA	Nov	Sun	11,646,313	3,389,419	8,962,157	0.1242	0.1201	0.1143
GA	Nov	Mon	13,073,222	3,945,534	11,430,721	0.1394	0.1398	0.1457
GA	Nov	Tue	13,191,844	3,986,329	11,603,064	0.1407	0.1412	0.1479
GA	Nov	Wed	12,998,499	4,054,567	11,677,317	0.1386	0.1437	0.1489
GA	Nov	Thu	12,454,620	3,848,249	10,562,184	0.1328	0.1363	0.1347
GA	Nov	Fri	15,290,213	4,579,302	12,324,022	0.1631	0.1623	0.1571
GA	Nov	Sat	15,105,153	4,420,003	11,880,385	0.1611	0.1566	0.1515
GA	Dec	Sun	15,270,476	4,619,508	12,878,140	0.1512	0.1511	0.1460
GA	Dec	Mon	16,620,084	5,058,485	14,687,554	0.1645	0.1655	0.1665
GA	Dec	Tue	16,351,400	4,949,393	14,751,688	0.1619	0.1619	0.1672
GA	Dec	Wed	13,562,340	4,109,788	12,508,459	0.1343	0.1344	0.1418
GA	Dec	Thu	13,153,577	4,029,058	11,982,882	0.1302	0.1318	0.1358
GA	Dec	Fri	13,076,436	3,969,867	11,132,791	0.1295	0.1299	0.1262
GA	Dec	Sat	12,972,294	3,834,436	10,282,360	0.1284	0.1254	0.1165
KY	Jan	Sun	13,951,350	6,324,291	12,340,439	0.1219	0.1241	0.1196
KY	Jan	Mon	14,648,386	6,568,474	13,191,315	0.1280	0.1289	0.1279
KY	Jan	Tue	18,754,926	8,319,015	16,806,905	0.1639	0.1632	0.1629
KY	Jan	Wed	18,737,070	8,302,139	16,702,204	0.1637	0.1629	0.1619
KY	Jan	Thu	18,617,927	8,274,249	17,253,825	0.1627	0.1624	0.1673
KY	Jan	Fri	14,989,539	6,674,316	13,836,584	0.1310	0.1310	0.1341
KY	Jan	Sat	14,751,911	6,499,145	13,025,455	0.1289	0.1275	0.1263
KY	Feb	Sun	13,614,024	6,109,118	12,294,809	0.1367	0.1350	0.1326
KY	Feb	Mon	14,397,395	6,582,725	13,387,654	0.1446	0.1454	0.1444
KY	Feb	Tue	14,555,978	6,610,627	13,801,950	0.1462	0.1461	0.1489
KY	Feb	Wed	14,329,132	6,724,437	14,007,595	0.1439	0.1486	0.1511
KY	Feb	Thu	14,616,707	6,568,675	13,427,712	0.1468	0.1451	0.1449
KY	Feb	Fri	14,205,033	6,385,449	12,975,468	0.1426	0.1411	0.1400
KY	Feb	Sat	13,863,920	6,279,393	12,796,740	0.1392	0.1387	0.1381
KY	Mar	Sun	16,154,103	7,633,026	15,634,188	0.1518	0.1540	0.1525
KY	Mar	Mon	13,697,223	6,340,694	13,810,745	0.1287	0.1279	0.1347
KY	Mar	Tue	14,077,465	6,505,076	13,891,463	0.1323	0.1312	0.1355
KY	Mar	Wed	14,152,624	6,445,515	13,294,931	0.1330	0.1300	0.1297
KY	Mar	Thu	14,228,900	6,555,563	13,351,220	0.1337	0.1322	0.1302
KY	Mar	Fri	17,604,219	8,283,732	16,713,671	0.1654	0.1671	0.1630
KY	Mar	Sat	16,497,463	7,810,869	15,830,328	0.1550	0.1576	0.1544
KY	Apr	Sun	12,664,919	5,692,491	12,300,015	0.1252	0.1262	0.1222
KY	Apr	Mon	16,959,493	7,671,569	17,098,033	0.1677	0.1701	0.1699
KY	Apr	Tue	17,071,625	7,772,987	17,448,992	0.1688	0.1723	0.1734
KY	Apr	Wed	13,857,201	6,101,485	13,777,709	0.1370	0.1353	0.1369
KY	Apr	Thu	13,903,554	6,065,542	13,876,852	0.1375	0.1345	0.1379
KY	Apr	Fri	13,716,257	5,951,503	13,472,483	0.1356	0.1319	0.1338
KY	Apr	Sat	12,945,254	5,850,563	12,679,669	0.1280	0.1297	0.1260
KY	May	Sun	12,456,298	4,367,716	11,712,119	0.1197	0.1162	0.1177
KY	May	Mon	13,110,103	4,772,353	12,765,025	0.1260	0.1270	0.1282
KY	May	Tue	13,515,816	5,059,816	13,131,188	0.1299	0.1346	0.1319
KY	May	Wed	17,039,088	6,330,032	16,401,532	0.1638	0.1684	0.1648
KY	May	Thu	17,180,451	6,257,493	16,428,566	0.1652	0.1665	0.1650

Average 2000-2004 State Level Monthly-Day of Week Profiles
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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	May	Fri	17,730,036	6,198,671	16,780,192	0.1704	0.1649	0.1686
KY	May	Sat	12,989,855	4,593,973	12,327,744	0.1249	0.1222	0.1238
KY	Jun	Sun	16,427,192	5,214,046	14,825,059	0.1552	0.1528	0.1515
KY	Jun	Mon	14,418,433	4,609,315	13,524,297	0.1362	0.1351	0.1382
KY	Jun	Tue	14,716,957	4,703,306	13,812,994	0.1390	0.1378	0.1412
KY	Jun	Wed	14,946,201	4,688,060	13,762,886	0.1412	0.1374	0.1407
KY	Jun	Thu	14,520,946	4,780,070	13,478,982	0.1372	0.1401	0.1378
KY	Jun	Fri	14,372,136	4,691,043	13,090,249	0.1358	0.1375	0.1338
KY	Jun	Sat	16,470,166	5,443,154	15,333,682	0.1556	0.1595	0.1567
KY	Jul	Sun	13,244,569	4,448,178	13,049,965	0.1216	0.1269	0.1217
KY	Jul	Mon	17,797,803	5,939,637	17,936,410	0.1635	0.1694	0.1673
KY	Jul	Tue	18,024,388	5,840,628	17,786,205	0.1655	0.1666	0.1659
KY	Jul	Wed	18,006,476	5,728,943	17,730,534	0.1654	0.1634	0.1654
KY	Jul	Thu	14,180,922	4,403,898	13,941,707	0.1302	0.1256	0.1301
KY	Jul	Fri	14,046,649	4,359,457	13,625,059	0.1290	0.1244	0.1271
KY	Jul	Sat	13,580,950	4,335,445	13,122,163	0.1247	0.1237	0.1224
KY	Aug	Sun	12,657,699	3,968,906	12,321,196	0.1208	0.1151	0.1168
KY	Aug	Mon	13,431,315	4,290,811	13,998,056	0.1282	0.1244	0.1327
KY	Aug	Tue	13,951,503	4,490,599	13,738,219	0.1331	0.1302	0.1303
KY	Aug	Wed	14,027,682	4,722,032	13,908,301	0.1339	0.1369	0.1319
KY	Aug	Thu	17,490,094	5,971,600	17,868,881	0.1669	0.1732	0.1694
KY	Aug	Fri	17,069,499	5,736,578	17,711,338	0.1629	0.1663	0.1679
KY	Aug	Sat	16,171,129	5,305,811	15,923,072	0.1543	0.1539	0.1510
KY	Sep	Sun	15,560,753	5,159,716	14,794,644	0.1553	0.1615	0.1541
KY	Sep	Mon	16,691,163	5,314,459	16,076,578	0.1666	0.1663	0.1674
KY	Sep	Tue	13,588,051	4,280,822	13,252,975	0.1357	0.1340	0.1380
KY	Sep	Wed	13,648,570	4,327,920	13,280,817	0.1363	0.1354	0.1383
KY	Sep	Thu	13,835,926	4,291,753	13,183,716	0.1381	0.1343	0.1373
KY	Sep	Fri	13,884,049	4,410,151	13,162,399	0.1386	0.1380	0.1371
KY	Sep	Sat	12,958,721	4,168,565	12,260,916	0.1294	0.1305	0.1277
KY	Oct	Sun	12,141,431	5,354,039	11,492,581	0.1174	0.1228	0.1177
KY	Oct	Mon	13,299,820	5,652,234	12,677,771	0.1286	0.1296	0.1298
KY	Oct	Tue	17,100,418	7,229,922	16,388,261	0.1654	0.1658	0.1678
KY	Oct	Wed	17,118,965	7,190,218	16,425,518	0.1656	0.1649	0.1682
KY	Oct	Thu	17,274,935	7,151,119	16,036,970	0.1671	0.1640	0.1642
KY	Oct	Fri	13,765,153	5,621,152	12,698,452	0.1331	0.1289	0.1300
KY	Oct	Sat	12,683,108	5,416,877	11,941,426	0.1227	0.1242	0.1223
KY	Nov	Sun	12,888,034	5,689,531	11,479,068	0.1276	0.1275	0.1217
KY	Nov	Mon	13,827,750	6,033,281	12,998,049	0.1369	0.1352	0.1378
KY	Nov	Tue	14,027,391	6,156,558	13,280,129	0.1388	0.1380	0.1408
KY	Nov	Wed	13,817,947	6,111,620	13,092,157	0.1368	0.1370	0.1388
KY	Nov	Thu	13,433,079	6,044,717	12,858,995	0.1330	0.1355	0.1363
KY	Nov	Fri	16,819,649	7,428,344	15,553,025	0.1665	0.1665	0.1649
KY	Nov	Sat	16,214,428	7,149,693	15,082,390	0.1605	0.1603	0.1599
KY	Dec	Sun	16,266,536	7,260,701	15,042,094	0.1533	0.1541	0.1506
KY	Dec	Mon	17,099,626	7,535,136	16,334,542	0.1612	0.1599	0.1636
KY	Dec	Tue	17,351,671	7,571,480	16,257,812	0.1636	0.1607	0.1628
KY	Dec	Wed	14,124,157	6,354,861	13,497,177	0.1332	0.1348	0.1352
KY	Dec	Thu	13,901,436	6,145,481	13,098,858	0.1311	0.1304	0.1312
KY	Dec	Fri	13,867,147	6,193,877	13,039,149	0.1307	0.1314	0.1306
KY	Dec	Sat	13,465,992	6,065,424	12,595,635	0.1269	0.1287	0.1261
MS	Jan	Sun	2,934,027	1,547,031	5,070,324	0.1128	0.1034	0.1012
MS	Jan	Mon	3,211,301	1,796,701	6,005,754	0.1235	0.1201	0.1199
MS	Jan	Tue	4,376,210	2,575,555	8,503,271	0.1683	0.1722	0.1698
MS	Jan	Wed	4,447,777	2,510,206	8,647,532	0.1711	0.1678	0.1727
MS	Jan	Thu	4,254,311	2,482,838	8,660,945	0.1636	0.1660	0.1729
MS	Jan	Fri	3,387,442	2,084,011	7,203,543	0.1303	0.1393	0.1438

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Jan	Sat	3,391,361	1,962,660	5,991,150	0.1304	0.1312	0.1196
MS	Feb	Sun	2,865,707	1,539,649	4,982,124	0.1351	0.1296	0.1231
MS	Feb	Mon	3,045,835	1,706,390	5,818,853	0.1436	0.1436	0.1438
MS	Feb	Tue	2,946,366	1,680,065	6,058,331	0.1389	0.1414	0.1497
MS	Feb	Wed	3,050,683	1,748,835	6,271,216	0.1439	0.1472	0.1550
MS	Feb	Thu	3,152,909	1,772,814	6,454,138	0.1487	0.1492	0.1595
MS	Feb	Fri	3,183,084	1,721,498	5,634,487	0.1501	0.1449	0.1392
MS	Feb	Sat	2,961,648	1,711,108	5,252,034	0.1397	0.1440	0.1298
MS	Mar	Sun	3,536,374	1,770,341	6,574,596	0.1385	0.1345	0.1395
MS	Mar	Mon	3,354,673	1,837,396	6,523,294	0.1314	0.1396	0.1384
MS	Mar	Tue	3,739,452	1,994,948	6,723,534	0.1465	0.1516	0.1427
MS	Mar	Wed	3,656,975	1,879,896	6,472,039	0.1433	0.1429	0.1373
MS	Mar	Thu	3,519,508	1,781,031	6,253,976	0.1379	0.1354	0.1327
MS	Mar	Fri	3,858,765	1,999,341	7,488,276	0.1512	0.1519	0.1589
MS	Mar	Sat	3,862,595	1,895,332	7,093,809	0.1513	0.1440	0.1505
MS	Apr	Sun	2,802,706	1,550,523	5,068,596	0.1317	0.1269	0.1097
MS	Apr	Mon	3,522,340	2,054,745	7,897,071	0.1656	0.1682	0.1709
MS	Apr	Tue	3,368,315	2,015,573	8,579,047	0.1583	0.1650	0.1857
MS	Apr	Wed	2,960,970	1,712,096	6,675,080	0.1392	0.1402	0.1445
MS	Apr	Thu	2,955,704	1,732,620	6,321,601	0.1389	0.1419	0.1368
MS	Apr	Fri	2,856,821	1,592,191	6,260,019	0.1343	0.1304	0.1355
MS	Apr	Sat	2,806,900	1,556,465	5,394,296	0.1319	0.1274	0.1168
MS	May	Sun	2,590,337	1,347,670	5,761,467	0.1171	0.1143	0.1142
MS	May	Mon	2,821,631	1,516,133	6,688,091	0.1275	0.1286	0.1326
MS	May	Tue	2,953,516	1,581,490	6,734,189	0.1335	0.1341	0.1335
MS	May	Wed	3,823,573	1,935,958	8,214,151	0.1728	0.1642	0.1629
MS	May	Thu	3,670,372	1,965,880	8,388,543	0.1659	0.1667	0.1663
MS	May	Fri	3,371,461	1,934,087	8,483,172	0.1524	0.1640	0.1682
MS	May	Sat	2,894,182	1,511,175	6,167,372	0.1308	0.1281	0.1223
MS	Jun	Sun	3,218,591	1,902,886	7,575,004	0.1571	0.1580	0.1551
MS	Jun	Mon	2,697,806	1,679,401	6,841,996	0.1317	0.1394	0.1401
MS	Jun	Tue	2,719,988	1,611,625	6,613,821	0.1327	0.1338	0.1354
MS	Jun	Wed	2,755,870	1,631,480	6,712,697	0.1345	0.1354	0.1374
MS	Jun	Thu	2,845,794	1,626,021	6,661,510	0.1389	0.1350	0.1364
MS	Jun	Fri	2,829,302	1,593,911	6,637,388	0.1381	0.1323	0.1359
MS	Jun	Sat	3,423,886	2,001,689	7,798,457	0.1671	0.1662	0.1597
MS	Jul	Sun	2,788,663	1,638,489	6,251,771	0.1288	0.1212	0.1077
MS	Jul	Mon	3,405,599	2,237,694	10,224,933	0.1573	0.1655	0.1761
MS	Jul	Tue	3,448,674	2,189,589	10,177,932	0.1592	0.1619	0.1753
MS	Jul	Wed	3,388,723	2,140,674	9,734,319	0.1565	0.1583	0.1676
MS	Jul	Thu	2,919,688	1,811,222	7,636,333	0.1348	0.1340	0.1315
MS	Jul	Fri	2,896,864	1,779,411	7,423,708	0.1338	0.1316	0.1278
MS	Jul	Sat	2,808,112	1,723,730	6,623,033	0.1297	0.1275	0.1140
MS	Aug	Sun	2,895,411	1,656,512	6,714,526	0.1254	0.1197	0.1182
MS	Aug	Mon	3,074,029	1,814,139	7,573,903	0.1331	0.1311	0.1333
MS	Aug	Tue	3,086,467	1,808,880	7,702,160	0.1336	0.1308	0.1356
MS	Aug	Wed	3,109,788	1,837,416	7,519,726	0.1346	0.1328	0.1324
MS	Aug	Thu	3,776,028	2,353,215	9,748,609	0.1635	0.1701	0.1716
MS	Aug	Fri	3,614,761	2,215,018	9,221,906	0.1565	0.1601	0.1623
MS	Aug	Sat	3,541,892	2,149,180	8,333,496	0.1533	0.1554	0.1467
MS	Sep	Sun	3,076,179	1,765,446	6,702,748	0.1499	0.1462	0.1435
MS	Sep	Mon	3,399,174	2,143,898	8,513,746	0.1656	0.1775	0.1823
MS	Sep	Tue	2,799,490	1,690,307	6,329,646	0.1364	0.1400	0.1355
MS	Sep	Wed	2,884,057	1,655,046	6,522,357	0.1405	0.1370	0.1396
MS	Sep	Thu	2,754,512	1,559,383	6,174,835	0.1342	0.1291	0.1322
MS	Sep	Fri	2,827,643	1,681,841	6,652,181	0.1378	0.1393	0.1424
MS	Sep	Sat	2,782,238	1,581,271	5,811,684	0.1356	0.1309	0.1244

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Oct	Sun	3,278,945	1,583,575	5,127,382	0.1351	0.1163	0.1168
MS	Oct	Mon	3,248,925	1,854,673	5,569,888	0.1338	0.1362	0.1269
MS	Oct	Tue	3,990,653	2,290,719	7,468,788	0.1644	0.1683	0.1701
MS	Oct	Wed	3,843,403	2,259,117	7,721,640	0.1583	0.1659	0.1759
MS	Oct	Thu	3,738,950	2,254,009	6,989,380	0.1540	0.1656	0.1592
MS	Oct	Fri	3,057,451	1,786,361	5,631,502	0.1259	0.1312	0.1283
MS	Oct	Sat	3,116,847	1,586,390	5,398,799	0.1284	0.1165	0.1230
MS	Nov	Sun	2,968,150	1,518,472	4,817,704	0.1225	0.1055	0.1165
MS	Nov	Mon	3,277,374	2,027,572	6,000,382	0.1353	0.1408	0.1451
MS	Nov	Tue	3,430,763	2,101,835	6,096,504	0.1416	0.1460	0.1474
MS	Nov	Wed	3,723,161	2,303,904	6,077,856	0.1537	0.1600	0.1470
MS	Nov	Thu	3,320,974	1,859,539	5,420,987	0.1371	0.1291	0.1311
MS	Nov	Fri	3,670,295	2,220,336	6,568,420	0.1515	0.1542	0.1588
MS	Nov	Sat	3,831,361	2,367,555	6,378,066	0.1582	0.1644	0.1542
MS	Dec	Sun	4,165,179	2,346,770	6,260,737	0.1615	0.1505	0.1389
MS	Dec	Mon	3,980,279	2,569,066	8,105,561	0.1543	0.1648	0.1798
MS	Dec	Tue	3,854,472	2,566,199	7,311,023	0.1495	0.1646	0.1622
MS	Dec	Wed	3,359,960	2,132,483	6,471,988	0.1303	0.1368	0.1435
MS	Dec	Thu	3,395,266	2,018,285	5,948,199	0.1317	0.1294	0.1319
MS	Dec	Fri	3,506,671	2,023,650	5,728,721	0.1360	0.1298	0.1271
MS	Dec	Sat	3,526,047	1,937,249	5,261,466	0.1367	0.1242	0.1167
NC	Jan	Sun	11,560,761	4,249,277	9,886,708	0.1188	0.1147	0.1072
NC	Jan	Mon	12,574,135	4,827,083	11,673,165	0.1292	0.1303	0.1265
NC	Jan	Tue	15,914,366	5,976,859	14,437,971	0.1635	0.1613	0.1565
NC	Jan	Wed	16,265,175	6,180,766	16,052,916	0.1671	0.1668	0.1740
NC	Jan	Thu	15,906,990	6,067,725	15,819,307	0.1634	0.1638	0.1715
NC	Jan	Fri	12,722,270	5,026,049	13,149,759	0.1307	0.1356	0.1425
NC	Jan	Sat	12,388,186	4,725,877	11,235,081	0.1273	0.1275	0.1218
NC	Feb	Sun	11,253,673	3,991,235	9,863,838	0.1291	0.1275	0.1277
NC	Feb	Mon	13,019,558	4,745,266	12,077,127	0.1494	0.1516	0.1564
NC	Feb	Tue	13,131,342	4,727,808	11,411,117	0.1507	0.1510	0.1478
NC	Feb	Wed	12,697,796	4,649,147	11,442,703	0.1457	0.1485	0.1482
NC	Feb	Thu	12,755,297	4,761,010	12,182,443	0.1464	0.1521	0.1578
NC	Feb	Fri	12,543,945	4,351,743	10,497,224	0.1440	0.1390	0.1359
NC	Feb	Sat	11,735,833	4,079,787	9,745,618	0.1347	0.1303	0.1262
NC	Mar	Sun	13,215,914	4,396,336	10,507,879	0.1351	0.1308	0.1276
NC	Mar	Mon	13,109,591	4,680,045	12,123,509	0.1340	0.1392	0.1473
NC	Mar	Tue	13,489,418	4,803,912	12,457,110	0.1379	0.1429	0.1513
NC	Mar	Wed	13,251,851	4,629,968	11,247,320	0.1355	0.1377	0.1366
NC	Mar	Thu	13,003,971	4,452,547	10,611,013	0.1329	0.1324	0.1289
NC	Mar	Fri	16,099,512	5,471,485	13,239,143	0.1646	0.1627	0.1608
NC	Mar	Sat	15,662,956	5,186,547	12,137,290	0.1601	0.1543	0.1474
NC	Apr	Sun	10,365,527	3,419,497	8,537,340	0.1120	0.1085	0.1040
NC	Apr	Mon	15,778,590	5,363,049	14,204,953	0.1704	0.1702	0.1730
NC	Apr	Tue	16,016,035	5,633,374	15,421,565	0.1730	0.1788	0.1878
NC	Apr	Wed	12,837,940	4,348,243	11,661,251	0.1387	0.1380	0.1420
NC	Apr	Thu	13,058,838	4,448,763	11,453,508	0.1410	0.1412	0.1395
NC	Apr	Fri	12,672,336	4,394,180	11,092,891	0.1369	0.1395	0.1351
NC	Apr	Sat	11,854,316	3,903,067	9,742,692	0.1280	0.1239	0.1186
NC	May	Sun	10,567,915	3,460,975	10,014,907	0.1136	0.1117	0.1080
NC	May	Mon	11,380,064	3,829,182	11,589,806	0.1224	0.1235	0.1250
NC	May	Tue	11,927,341	4,012,583	12,246,904	0.1282	0.1295	0.1321
NC	May	Wed	15,656,917	5,171,053	15,443,752	0.1683	0.1668	0.1666
NC	May	Thu	15,919,175	5,248,882	15,559,076	0.1712	0.1694	0.1678
NC	May	Fri	15,768,764	5,307,036	15,945,613	0.1695	0.1712	0.1720
NC	May	Sat	11,790,435	3,963,302	11,901,876	0.1268	0.1279	0.1284
NC	Jun	Sun	13,367,053	4,138,287	12,252,759	0.1489	0.1479	0.1414

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Jun	Mon	11,979,927	3,818,428	11,743,113	0.1334	0.1365	0.1355
NC	Jun	Tue	12,240,369	3,803,148	12,035,557	0.1363	0.1359	0.1389
NC	Jun	Wed	12,709,046	3,888,576	12,455,794	0.1416	0.1390	0.1437
NC	Jun	Thu	12,725,711	4,055,491	12,717,286	0.1417	0.1449	0.1468
NC	Jun	Fri	12,229,854	3,828,431	12,054,275	0.1362	0.1368	0.1391
NC	Jun	Sat	14,531,658	4,449,489	13,397,596	0.1619	0.1590	0.1546
NC	Jul	Sun	11,246,431	3,418,516	10,641,975	0.1167	0.1153	0.1112
NC	Jul	Mon	15,651,357	4,989,285	16,150,177	0.1624	0.1682	0.1688
NC	Jul	Tue	16,108,173	5,103,743	16,759,522	0.1671	0.1721	0.1752
NC	Jul	Wed	16,579,960	5,132,330	16,715,137	0.1720	0.1731	0.1747
NC	Jul	Thu	12,670,597	3,862,163	12,537,462	0.1315	0.1302	0.1311
NC	Jul	Fri	12,278,284	3,696,064	12,009,448	0.1274	0.1246	0.1255
NC	Jul	Sat	11,838,669	3,454,214	10,851,183	0.1228	0.1165	0.1134
NC	Aug	Sun	11,479,244	3,358,626	10,736,719	0.1170	0.1097	0.1094
NC	Aug	Mon	12,629,747	3,877,004	12,763,508	0.1287	0.1266	0.1301
NC	Aug	Tue	12,812,427	4,063,792	13,237,499	0.1306	0.1327	0.1349
NC	Aug	Wed	13,012,606	4,137,501	13,383,854	0.1326	0.1351	0.1364
NC	Aug	Thu	16,525,562	5,294,573	17,020,078	0.1684	0.1729	0.1735
NC	Aug	Fri	16,384,752	5,213,137	16,625,089	0.1670	0.1702	0.1695
NC	Aug	Sat	15,265,391	4,683,482	14,336,782	0.1556	0.1529	0.1461
NC	Sep	Sun	13,712,599	4,074,212	12,514,877	0.1518	0.1496	0.1482
NC	Sep	Mon	15,128,207	4,601,799	14,184,006	0.1675	0.1690	0.1679
NC	Sep	Tue	12,446,519	3,728,527	11,630,920	0.1378	0.1369	0.1377
NC	Sep	Wed	12,427,864	3,750,678	12,093,798	0.1376	0.1378	0.1432
NC	Sep	Thu	12,665,249	3,791,337	12,075,466	0.1402	0.1393	0.1430
NC	Sep	Fri	12,425,087	3,827,947	11,780,541	0.1376	0.1406	0.1395
NC	Sep	Sat	11,504,324	3,451,066	10,176,479	0.1274	0.1268	0.1205
NC	Oct	Sun	9,926,001	3,347,481	9,219,235	0.1066	0.1075	0.1106
NC	Oct	Mon	12,000,192	4,004,111	10,100,002	0.1289	0.1286	0.1212
NC	Oct	Tue	15,724,365	5,416,992	14,901,932	0.1689	0.1740	0.1788
NC	Oct	Wed	15,819,491	5,289,407	14,324,894	0.1700	0.1699	0.1719
NC	Oct	Thu	15,750,876	5,302,371	13,678,768	0.1692	0.1703	0.1641
NC	Oct	Fri	12,372,634	4,029,992	10,848,320	0.1329	0.1294	0.1301
NC	Oct	Sat	11,483,709	3,749,869	10,282,460	0.1234	0.1204	0.1234
NC	Nov	Sun	10,023,278	3,222,274	7,792,129	0.1114	0.1075	0.1068
NC	Nov	Mon	12,447,300	4,137,529	9,964,986	0.1384	0.1380	0.1366
NC	Nov	Tue	12,881,077	4,292,782	10,453,683	0.1432	0.1432	0.1433
NC	Nov	Wed	12,916,994	4,383,358	10,645,915	0.1436	0.1462	0.1460
NC	Nov	Thu	12,385,728	4,224,955	10,610,434	0.1377	0.1409	0.1455
NC	Nov	Fri	15,167,077	5,089,774	12,499,202	0.1686	0.1698	0.1714
NC	Nov	Sat	14,133,571	4,626,771	10,974,544	0.1571	0.1543	0.1505
NC	Dec	Sun	14,791,350	5,258,122	13,326,998	0.1505	0.1469	0.1371
NC	Dec	Mon	16,237,678	5,826,236	15,406,573	0.1652	0.1628	0.1585
NC	Dec	Tue	16,315,997	5,957,529	16,703,694	0.1660	0.1664	0.1719
NC	Dec	Wed	12,963,222	4,805,957	13,540,009	0.1319	0.1343	0.1393
NC	Dec	Thu	12,777,627	4,841,250	14,031,890	0.1300	0.1353	0.1444
NC	Dec	Fri	12,568,143	4,666,300	12,869,912	0.1279	0.1304	0.1324
NC	Dec	Sat	12,611,354	4,438,087	11,306,307	0.1283	0.1240	0.1163
SC	Jan	Sun	5,286,611	2,299,193	5,931,799	0.1209	0.1247	0.1196
SC	Jan	Mon	5,518,504	2,268,103	6,449,806	0.1262	0.1230	0.1301
SC	Jan	Tue	7,105,148	2,913,672	8,059,401	0.1625	0.1581	0.1626
SC	Jan	Wed	7,212,795	2,960,524	7,936,264	0.1650	0.1606	0.1601
SC	Jan	Thu	7,225,322	3,082,517	8,272,676	0.1653	0.1672	0.1669
SC	Jan	Fri	5,801,117	2,484,678	6,705,029	0.1327	0.1348	0.1352
SC	Jan	Sat	5,572,491	2,423,861	6,225,516	0.1275	0.1315	0.1256
SC	Feb	Sun	5,294,051	2,161,161	5,744,847	0.1374	0.1344	0.1329
SC	Feb	Mon	5,615,000	2,312,931	6,373,437	0.1457	0.1438	0.1474

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Feb	Tue	5,605,890	2,374,050	6,441,940	0.1455	0.1476	0.1490
SC	Feb	Wed	5,521,102	2,343,140	6,387,296	0.1433	0.1457	0.1478
SC	Feb	Thu	5,670,915	2,389,128	6,494,850	0.1471	0.1485	0.1502
SC	Feb	Fri	5,519,594	2,264,999	6,018,260	0.1432	0.1408	0.1392
SC	Feb	Sat	5,314,483	2,239,090	5,766,696	0.1379	0.1392	0.1334
SC	Mar	Sun	6,243,777	2,481,381	6,574,279	0.1494	0.1471	0.1362
SC	Mar	Mon	5,571,915	2,290,581	6,793,033	0.1333	0.1358	0.1407
SC	Mar	Tue	5,614,590	2,298,253	7,164,458	0.1343	0.1363	0.1484
SC	Mar	Wed	5,581,053	2,241,721	6,668,461	0.1335	0.1329	0.1381
SC	Mar	Thu	5,493,948	2,242,960	6,140,967	0.1314	0.1330	0.1272
SC	Mar	Fri	6,744,831	2,705,745	7,629,740	0.1614	0.1604	0.1581
SC	Mar	Sat	6,548,817	2,603,100	7,300,062	0.1567	0.1544	0.1512
SC	Apr	Sun	4,866,897	2,025,673	5,514,502	0.1238	0.1243	0.1185
SC	Apr	Mon	6,582,528	2,761,303	7,892,285	0.1674	0.1694	0.1695
SC	Apr	Tue	6,553,751	2,764,562	7,577,646	0.1667	0.1696	0.1628
SC	Apr	Wed	5,420,705	2,235,667	6,541,198	0.1379	0.1371	0.1405
SC	Apr	Thu	5,434,929	2,229,200	6,735,259	0.1383	0.1367	0.1447
SC	Apr	Fri	5,360,997	2,172,034	6,328,859	0.1364	0.1332	0.1360
SC	Apr	Sat	5,091,734	2,114,032	5,960,624	0.1295	0.1297	0.1280
SC	May	Sun	4,956,438	2,200,048	6,729,759	0.1199	0.1200	0.1161
SC	May	Mon	5,224,306	2,306,267	7,328,601	0.1263	0.1257	0.1265
SC	May	Tue	5,372,448	2,355,685	7,528,493	0.1299	0.1284	0.1299
SC	May	Wed	6,740,001	2,976,890	9,452,710	0.1630	0.1623	0.1631
SC	May	Thu	6,940,903	3,066,999	9,693,933	0.1679	0.1672	0.1673
SC	May	Fri	6,854,306	3,105,902	9,864,722	0.1658	0.1693	0.1702
SC	May	Sat	5,260,209	2,329,552	7,356,176	0.1272	0.1270	0.1269
SC	Jun	Sun	6,383,589	2,577,662	8,188,890	0.1557	0.1564	0.1473
SC	Jun	Mon	5,372,449	2,221,814	7,396,371	0.1310	0.1348	0.1330
SC	Jun	Tue	5,536,697	2,198,447	7,589,704	0.1350	0.1334	0.1365
SC	Jun	Wed	5,581,008	2,243,382	7,845,895	0.1361	0.1361	0.1411
SC	Jun	Thu	5,597,302	2,280,841	7,803,034	0.1365	0.1384	0.1403
SC	Jun	Fri	5,633,901	2,247,249	7,688,499	0.1374	0.1363	0.1383
SC	Jun	Sat	6,892,963	2,715,688	9,095,953	0.1681	0.1647	0.1636
SC	Jul	Sun	5,413,887	2,117,128	7,170,967	0.1234	0.1228	0.1221
SC	Jul	Mon	7,085,887	2,816,784	9,552,726	0.1615	0.1634	0.1626
SC	Jul	Tue	7,204,088	2,859,286	9,856,055	0.1642	0.1658	0.1678
SC	Jul	Wed	7,243,156	2,903,936	9,808,396	0.1651	0.1684	0.1670
SC	Jul	Thu	5,771,911	2,239,458	7,676,462	0.1316	0.1299	0.1307
SC	Jul	Fri	5,688,169	2,228,514	7,570,468	0.1297	0.1293	0.1289
SC	Jul	Sat	5,460,312	2,075,704	7,106,750	0.1245	0.1204	0.1210
SC	Aug	Sun	5,482,755	2,037,311	7,317,015	0.1228	0.1191	0.1248
SC	Aug	Mon	5,756,711	2,192,128	7,666,671	0.1289	0.1281	0.1307
SC	Aug	Tue	5,812,452	2,179,431	7,552,200	0.1302	0.1274	0.1288
SC	Aug	Wed	5,847,602	2,245,012	7,592,610	0.1310	0.1312	0.1295
SC	Aug	Thu	7,349,689	2,913,385	9,792,236	0.1646	0.1703	0.1670
SC	Aug	Fri	7,338,728	2,861,283	9,655,335	0.1644	0.1672	0.1646
SC	Aug	Sat	7,063,443	2,681,552	9,068,522	0.1582	0.1567	0.1546
SC	Sep	Sun	6,339,672	2,424,941	7,471,183	0.1572	0.1566	0.1466
SC	Sep	Mon	6,787,257	2,657,781	8,685,323	0.1683	0.1717	0.1704
SC	Sep	Tue	5,388,827	2,077,370	7,061,264	0.1336	0.1342	0.1385
SC	Sep	Wed	5,472,142	2,087,907	7,133,322	0.1357	0.1349	0.1399
SC	Sep	Thu	5,569,864	2,100,333	7,160,117	0.1381	0.1357	0.1405
SC	Sep	Fri	5,483,049	2,110,868	7,101,504	0.1360	0.1364	0.1393
SC	Sep	Sat	5,282,229	2,021,866	6,365,447	0.1310	0.1306	0.1249
SC	Oct	Sun	5,151,806	1,929,694	5,751,902	0.1210	0.1198	0.1196
SC	Oct	Mon	5,549,253	2,115,276	6,066,443	0.1304	0.1314	0.1262
SC	Oct	Tue	6,997,266	2,674,898	7,877,912	0.1644	0.1661	0.1638

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Oct	Wed	6,894,938	2,655,754	8,340,717	0.1620	0.1649	0.1735
SC	Oct	Thu	6,986,528	2,639,916	7,522,795	0.1642	0.1640	0.1564
SC	Oct	Fri	5,491,463	2,044,827	6,110,234	0.1290	0.1270	0.1271
SC	Oct	Sat	5,489,541	2,041,458	6,417,078	0.1290	0.1268	0.1334
SC	Nov	Sun	5,303,068	1,987,453	5,023,639	0.1259	0.1270	0.1122
SC	Nov	Mon	5,595,362	2,093,756	6,380,031	0.1328	0.1338	0.1425
SC	Nov	Tue	5,920,911	2,160,967	6,713,867	0.1405	0.1381	0.1500
SC	Nov	Wed	5,810,872	2,172,297	6,727,295	0.1379	0.1388	0.1503
SC	Nov	Thu	5,716,637	2,122,812	6,301,654	0.1357	0.1356	0.1408
SC	Nov	Fri	6,991,739	2,559,269	7,160,715	0.1660	0.1635	0.1600
SC	Nov	Sat	6,791,311	2,553,023	6,455,234	0.1612	0.1631	0.1442
SC	Dec	Sun	7,036,662	2,681,721	7,352,493	0.1577	0.1571	0.1445
SC	Dec	Mon	7,256,042	2,832,586	9,388,765	0.1626	0.1660	0.1845
SC	Dec	Tue	7,256,788	2,771,868	8,759,465	0.1626	0.1624	0.1721
SC	Dec	Wed	5,797,730	2,196,236	6,716,005	0.1299	0.1287	0.1320
SC	Dec	Thu	5,798,886	2,203,624	6,558,441	0.1300	0.1291	0.1289
SC	Dec	Fri	5,699,841	2,175,738	6,092,912	0.1277	0.1275	0.1197
SC	Dec	Sat	5,771,520	2,203,060	6,019,090	0.1294	0.1291	0.1183
TN	Jan	Sun	9,099,686	4,091,623	7,860,007	0.1271	0.1260	0.1114
TN	Jan	Mon	9,350,839	4,087,116	8,986,290	0.1306	0.1259	0.1274
TN	Jan	Tue	11,592,830	5,207,451	11,639,003	0.1619	0.1604	0.1650
TN	Jan	Wed	11,485,493	5,331,473	11,741,383	0.1604	0.1642	0.1664
TN	Jan	Thu	11,505,996	5,297,978	12,272,227	0.1607	0.1632	0.1740
TN	Jan	Fri	9,376,798	4,287,250	9,623,665	0.1309	0.1321	0.1364
TN	Jan	Sat	9,196,527	4,160,758	8,421,408	0.1284	0.1282	0.1194
TN	Feb	Sun	8,800,773	3,967,147	7,600,561	0.1387	0.1391	0.1315
TN	Feb	Mon	9,159,306	4,100,701	8,568,313	0.1444	0.1438	0.1482
TN	Feb	Tue	9,247,034	4,127,780	8,596,687	0.1457	0.1447	0.1487
TN	Feb	Wed	9,117,262	4,204,190	8,935,096	0.1437	0.1474	0.1546
TN	Feb	Thu	9,052,507	4,072,547	8,333,834	0.1427	0.1428	0.1442
TN	Feb	Fri	9,083,992	4,056,706	7,977,179	0.1432	0.1423	0.1380
TN	Feb	Sat	8,986,225	3,987,899	7,796,234	0.1416	0.1398	0.1349
TN	Mar	Sun	10,966,197	4,760,105	9,351,965	0.1560	0.1546	0.1485
TN	Mar	Mon	9,143,307	3,993,837	8,990,902	0.1301	0.1297	0.1428
TN	Mar	Tue	9,182,937	4,060,570	8,406,031	0.1307	0.1319	0.1335
TN	Mar	Wed	9,185,207	4,030,563	8,357,946	0.1307	0.1309	0.1327
TN	Mar	Thu	9,231,709	4,035,004	8,255,316	0.1313	0.1311	0.1311
TN	Mar	Fri	11,389,629	5,003,488	10,084,990	0.1620	0.1625	0.1601
TN	Mar	Sat	11,186,046	4,905,757	9,530,974	0.1592	0.1593	0.1513
TN	Apr	Sun	8,560,160	3,801,188	7,498,187	0.1275	0.1287	0.1204
TN	Apr	Mon	11,203,790	4,969,527	10,454,039	0.1669	0.1682	0.1679
TN	Apr	Tue	11,446,890	5,015,504	10,762,527	0.1706	0.1698	0.1729
TN	Apr	Wed	8,997,027	3,972,060	8,745,116	0.1341	0.1344	0.1405
TN	Apr	Thu	9,067,307	3,974,330	8,751,285	0.1351	0.1345	0.1406
TN	Apr	Fri	8,946,817	3,889,910	8,149,838	0.1333	0.1317	0.1309
TN	Apr	Sat	8,893,112	3,921,629	7,902,956	0.1325	0.1327	0.1269
TN	May	Sun	8,403,065	3,567,755	8,320,215	0.1243	0.1180	0.1125
TN	May	Mon	8,539,591	3,716,083	9,348,867	0.1263	0.1229	0.1265
TN	May	Tue	8,817,207	3,898,796	9,335,224	0.1304	0.1289	0.1263
TN	May	Wed	11,087,808	4,969,226	12,093,631	0.1640	0.1643	0.1636
TN	May	Thu	10,990,628	5,056,791	12,579,593	0.1626	0.1672	0.1702
TN	May	Fri	11,052,801	5,165,825	12,864,637	0.1635	0.1708	0.1740
TN	May	Sat	8,713,746	3,865,517	9,382,473	0.1289	0.1278	0.1269
TN	Jun	Sun	10,393,098	4,533,967	11,156,081	0.1599	0.1644	0.1594
TN	Jun	Mon	8,711,697	3,725,581	9,783,408	0.1340	0.1351	0.1398
TN	Jun	Tue	8,741,729	3,627,897	9,459,498	0.1345	0.1316	0.1352
TN	Jun	Wed	8,766,721	3,631,756	9,539,806	0.1349	0.1317	0.1363

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Jun	Thu	8,848,458	3,742,830	9,620,040	0.1361	0.1358	0.1375
TN	Jun	Fri	8,762,875	3,790,104	9,262,557	0.1348	0.1375	0.1324
TN	Jun	Sat	10,770,608	4,518,386	11,161,866	0.1657	0.1639	0.1595
TN	Jul	Sun	8,894,036	3,579,627	9,352,175	0.1287	0.1257	0.1237
TN	Jul	Mon	11,252,738	4,697,567	12,710,610	0.1628	0.1650	0.1681
TN	Jul	Tue	11,137,713	4,767,180	12,778,672	0.1611	0.1674	0.1690
TN	Jul	Wed	11,200,250	4,781,047	12,540,421	0.1621	0.1679	0.1658
TN	Jul	Thu	8,854,548	3,652,058	9,565,743	0.1281	0.1283	0.1265
TN	Jul	Fri	8,854,281	3,501,416	9,340,928	0.1281	0.1230	0.1235
TN	Jul	Sat	8,921,698	3,493,570	9,339,060	0.1291	0.1227	0.1235
TN	Aug	Sun	8,473,075	3,359,083	8,744,330	0.1242	0.1202	0.1158
TN	Aug	Mon	8,749,130	3,521,647	9,755,649	0.1283	0.1261	0.1292
TN	Aug	Tue	8,913,755	3,615,783	9,963,585	0.1307	0.1294	0.1320
TN	Aug	Wed	8,964,350	3,725,019	9,943,413	0.1314	0.1333	0.1317
TN	Aug	Thu	11,193,413	4,717,520	12,762,471	0.1641	0.1689	0.1691
TN	Aug	Fri	10,997,095	4,615,603	12,369,001	0.1612	0.1652	0.1639
TN	Aug	Sat	10,912,952	4,383,365	11,944,515	0.1600	0.1569	0.1582
TN	Sep	Sun	10,404,619	4,343,533	10,196,585	0.1625	0.1656	0.1530
TN	Sep	Mon	10,676,388	4,428,210	11,176,536	0.1667	0.1689	0.1677
TN	Sep	Tue	8,551,785	3,567,888	9,085,899	0.1336	0.1361	0.1363
TN	Sep	Wed	8,498,673	3,440,180	9,105,219	0.1327	0.1312	0.1366
TN	Sep	Thu	8,615,031	3,408,390	9,133,138	0.1346	0.1300	0.1370
TN	Sep	Fri	8,756,376	3,556,133	9,246,219	0.1368	0.1356	0.1387
TN	Sep	Sat	8,525,133	3,478,882	8,714,045	0.1331	0.1327	0.1307
TN	Oct	Sun	8,531,840	3,835,755	7,772,483	0.1269	0.1266	0.1222
TN	Oct	Mon	8,892,684	3,950,484	8,309,721	0.1323	0.1304	0.1307
TN	Oct	Tue	10,917,649	4,858,337	10,314,372	0.1624	0.1603	0.1622
TN	Oct	Wed	10,773,156	4,936,690	10,827,798	0.1603	0.1629	0.1702
TN	Oct	Thu	10,901,265	4,951,409	10,418,961	0.1622	0.1634	0.1638
TN	Oct	Fri	8,672,179	3,928,690	8,161,391	0.1290	0.1297	0.1283
TN	Oct	Sat	8,518,967	3,840,721	7,795,377	0.1268	0.1267	0.1226
TN	Nov	Sun	8,241,119	3,919,519	7,683,311	0.1281	0.1305	0.1261
TN	Nov	Mon	8,660,832	4,016,217	8,330,173	0.1346	0.1338	0.1367
TN	Nov	Tue	8,692,746	4,018,035	8,354,128	0.1351	0.1338	0.1371
TN	Nov	Wed	8,831,053	4,072,301	8,375,377	0.1372	0.1356	0.1375
TN	Nov	Thu	8,819,830	4,107,426	8,125,227	0.1371	0.1368	0.1334
TN	Nov	Fri	10,672,438	4,930,921	10,247,631	0.1658	0.1642	0.1682
TN	Nov	Sat	10,433,116	4,960,736	9,814,868	0.1621	0.1652	0.1611
TN	Dec	Sun	10,493,511	5,080,387	9,970,039	0.1607	0.1607	0.1565
TN	Dec	Mon	10,472,176	5,047,077	10,091,372	0.1604	0.1597	0.1584
TN	Dec	Tue	10,364,186	5,053,370	10,218,924	0.1587	0.1598	0.1604
TN	Dec	Wed	8,430,160	4,133,341	8,447,439	0.1291	0.1307	0.1326
TN	Dec	Thu	8,400,272	4,064,361	8,215,987	0.1286	0.1286	0.1290
TN	Dec	Fri	8,538,944	4,171,606	8,609,539	0.1308	0.1320	0.1352
TN	Dec	Sat	8,605,180	4,063,075	8,138,063	0.1318	0.1285	0.1278
VA	Jan	Sun	5,811,765	2,316,017	7,616,300	0.1190	0.1197	0.1244
VA	Jan	Mon	6,211,403	2,485,527	7,917,891	0.1272	0.1284	0.1294
VA	Jan	Tue	7,940,198	3,138,739	9,712,340	0.1626	0.1622	0.1587
VA	Jan	Wed	8,024,931	3,204,521	10,072,675	0.1644	0.1656	0.1646
VA	Jan	Thu	8,113,493	3,186,724	9,926,427	0.1662	0.1646	0.1622
VA	Jan	Fri	6,460,028	2,592,834	8,413,562	0.1323	0.1340	0.1375
VA	Jan	Sat	6,258,098	2,430,307	7,542,331	0.1282	0.1256	0.1232
VA	Feb	Sun	5,807,914	2,167,826	6,825,013	0.1368	0.1345	0.1363
VA	Feb	Mon	6,350,995	2,452,208	7,696,337	0.1496	0.1521	0.1537
VA	Feb	Tue	6,219,530	2,418,822	7,435,721	0.1465	0.1500	0.1485
VA	Feb	Wed	6,140,607	2,358,956	7,187,303	0.1446	0.1463	0.1436
VA	Feb	Thu	6,247,503	2,395,843	7,595,661	0.1471	0.1486	0.1517

Average 2000-2004 State Level Monthly-Day of Week Profiles
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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Feb	Fri	5,958,249	2,218,883	6,858,750	0.1403	0.1376	0.1370
VA	Feb	Sat	5,734,408	2,108,150	6,461,103	0.1351	0.1308	0.1291
VA	Mar	Sun	6,546,714	2,460,961	7,210,271	0.1410	0.1397	0.1375
VA	Mar	Mon	6,199,479	2,422,357	7,382,697	0.1335	0.1376	0.1407
VA	Mar	Tue	6,467,668	2,472,571	7,695,216	0.1393	0.1404	0.1467
VA	Mar	Wed	6,285,724	2,391,185	7,319,783	0.1353	0.1358	0.1395
VA	Mar	Thu	6,219,394	2,338,411	6,727,654	0.1339	0.1328	0.1283
VA	Mar	Fri	7,586,557	2,841,834	8,251,167	0.1633	0.1614	0.1573
VA	Mar	Sat	7,140,328	2,682,658	7,869,685	0.1537	0.1523	0.1500
VA	Apr	Sun	5,372,630	1,885,933	5,689,911	0.1182	0.1111	0.1023
VA	Apr	Mon	7,705,227	2,927,979	9,715,459	0.1696	0.1725	0.1746
VA	Apr	Tue	7,721,008	3,004,679	10,378,295	0.1699	0.1770	0.1865
VA	Apr	Wed	6,305,442	2,407,495	8,290,264	0.1388	0.1418	0.1490
VA	Apr	Thu	6,439,621	2,426,647	8,198,125	0.1417	0.1429	0.1473
VA	Apr	Fri	6,095,372	2,276,176	7,413,038	0.1342	0.1341	0.1332
VA	Apr	Sat	5,795,340	2,049,349	5,953,890	0.1276	0.1207	0.1070
VA	May	Sun	5,016,098	2,303,849	8,186,499	0.1127	0.1136	0.1165
VA	May	Mon	5,618,443	2,483,055	9,338,456	0.1262	0.1225	0.1329
VA	May	Tue	5,887,808	2,662,709	9,429,232	0.1323	0.1313	0.1342
VA	May	Wed	7,492,377	3,701,360	11,942,285	0.1683	0.1825	0.1699
VA	May	Thu	7,331,220	3,231,990	10,860,283	0.1647	0.1594	0.1545
VA	May	Fri	7,617,544	3,513,772	11,906,835	0.1711	0.1733	0.1694
VA	May	Sat	5,546,558	2,380,483	8,609,908	0.1246	0.1174	0.1225
VA	Jun	Sun	6,513,553	2,944,360	8,979,026	0.1469	0.1579	0.1378
VA	Jun	Mon	5,944,473	2,397,677	8,636,259	0.1341	0.1286	0.1326
VA	Jun	Tue	6,003,344	2,404,199	9,085,917	0.1354	0.1290	0.1395
VA	Jun	Wed	6,290,346	2,771,395	9,628,014	0.1419	0.1486	0.1478
VA	Jun	Thu	6,247,335	2,822,810	9,834,003	0.1409	0.1514	0.1509
VA	Jun	Fri	6,138,069	2,382,480	8,912,624	0.1384	0.1278	0.1368
VA	Jun	Sat	7,199,701	2,920,958	10,076,854	0.1624	0.1567	0.1547
VA	Jul	Sun	5,503,862	2,224,650	8,312,789	0.1168	0.1191	0.1157
VA	Jul	Mon	7,633,800	3,278,534	12,325,491	0.1620	0.1755	0.1715
VA	Jul	Tue	7,823,761	3,126,318	12,341,767	0.1661	0.1673	0.1718
VA	Jul	Wed	7,952,170	3,092,320	12,102,055	0.1688	0.1655	0.1684
VA	Jul	Thu	6,287,319	2,419,804	9,400,829	0.1334	0.1295	0.1308
VA	Jul	Fri	6,140,261	2,380,424	9,079,155	0.1303	0.1274	0.1264
VA	Jul	Sat	5,774,825	2,163,984	8,290,648	0.1226	0.1158	0.1154
VA	Aug	Sun	5,448,930	2,097,174	8,196,327	0.1158	0.1069	0.1093
VA	Aug	Mon	6,139,944	2,465,314	9,840,814	0.1304	0.1257	0.1312
VA	Aug	Tue	6,193,758	2,612,080	10,136,460	0.1316	0.1332	0.1352
VA	Aug	Wed	6,186,308	2,620,372	9,968,553	0.1314	0.1336	0.1329
VA	Aug	Thu	7,809,322	3,289,728	12,666,064	0.1659	0.1677	0.1689
VA	Aug	Fri	7,865,395	3,581,866	13,016,442	0.1671	0.1826	0.1736
VA	Aug	Sat	7,428,011	2,947,669	11,157,963	0.1578	0.1503	0.1488
VA	Sep	Sun	6,177,672	2,488,478	8,731,469	0.1489	0.1500	0.1439
VA	Sep	Mon	7,109,030	2,890,060	10,904,947	0.1713	0.1742	0.1797
VA	Sep	Tue	5,928,175	2,381,555	8,626,984	0.1429	0.1435	0.1421
VA	Sep	Wed	5,932,703	2,271,312	8,613,889	0.1430	0.1369	0.1419
VA	Sep	Thu	5,889,653	2,273,535	8,570,257	0.1420	0.1370	0.1412
VA	Sep	Fri	5,437,800	2,220,372	7,955,577	0.1311	0.1338	0.1311
VA	Sep	Sat	5,013,585	2,069,804	7,287,614	0.1208	0.1247	0.1201
VA	Oct	Sun	4,771,469	1,784,307	5,367,161	0.1141	0.1102	0.1089
VA	Oct	Mon	5,414,776	2,165,936	6,569,238	0.1294	0.1337	0.1333
VA	Oct	Tue	7,072,886	2,772,936	8,419,584	0.1691	0.1712	0.1708
VA	Oct	Wed	7,030,678	2,680,581	8,274,150	0.1681	0.1655	0.1679
VA	Oct	Thu	6,960,514	2,691,664	8,339,010	0.1664	0.1662	0.1692
VA	Oct	Fri	5,531,903	2,160,818	6,476,213	0.1322	0.1334	0.1314

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Oct	Sat	5,052,803	1,939,255	5,841,623	0.1208	0.1197	0.1185
VA	Nov	Sun	4,951,164	1,817,900	5,508,618	0.1146	0.1103	0.1051
VA	Nov	Mon	5,894,107	2,288,508	7,448,643	0.1365	0.1389	0.1421
VA	Nov	Tue	6,154,674	2,395,715	8,186,811	0.1425	0.1454	0.1562
VA	Nov	Wed	6,258,978	2,403,829	7,844,902	0.1449	0.1459	0.1496
VA	Nov	Thu	5,847,652	2,232,942	7,199,537	0.1354	0.1355	0.1373
VA	Nov	Fri	7,594,341	2,888,008	8,967,164	0.1758	0.1753	0.1711
VA	Nov	Sat	6,493,259	2,451,598	7,267,207	0.1503	0.1488	0.1386
VA	Dec	Sun	7,487,546	2,806,711	8,422,661	0.1571	0.1502	0.1407
VA	Dec	Mon	7,706,240	3,188,365	11,274,103	0.1617	0.1706	0.1883
VA	Dec	Tue	7,650,735	2,999,800	9,868,823	0.1605	0.1605	0.1648
VA	Dec	Wed	6,147,705	2,394,021	7,657,538	0.1290	0.1281	0.1279
VA	Dec	Thu	6,246,331	2,471,379	7,814,089	0.1310	0.1323	0.1305
VA	Dec	Fri	6,214,437	2,470,674	7,691,748	0.1304	0.1322	0.1285
VA	Dec	Sat	6,215,963	2,354,510	7,147,977	0.1304	0.1260	0.1194
WV	Jan	Sun	13,100,315	5,799,646	10,867,329	0.1171	0.1114	0.1172
WV	Jan	Mon	14,362,750	6,742,714	12,003,777	0.1284	0.1296	0.1294
WV	Jan	Tue	18,380,394	8,731,334	15,294,185	0.1643	0.1678	0.1649
WV	Jan	Wed	18,649,891	8,753,658	15,342,028	0.1667	0.1682	0.1654
WV	Jan	Thu	18,460,881	8,670,949	15,363,013	0.1650	0.1666	0.1656
WV	Jan	Fri	14,751,419	6,880,007	12,181,754	0.1319	0.1322	0.1313
WV	Jan	Sat	14,170,249	6,464,543	11,705,645	0.1267	0.1242	0.1262
WV	Feb	Sun	13,515,091	6,243,479	11,396,913	0.1334	0.1314	0.1345
WV	Feb	Mon	14,644,850	6,934,137	12,277,541	0.1445	0.1459	0.1449
WV	Feb	Tue	14,828,460	6,946,924	12,430,932	0.1463	0.1462	0.1467
WV	Feb	Wed	14,759,293	6,959,149	12,305,147	0.1456	0.1464	0.1452
WV	Feb	Thu	14,609,084	6,915,589	12,214,470	0.1442	0.1455	0.1442
WV	Feb	Fri	14,583,419	6,820,286	12,151,113	0.1439	0.1435	0.1434
WV	Feb	Sat	14,404,898	6,712,438	11,949,578	0.1421	0.1412	0.1410
WV	Mar	Sun	16,122,515	7,236,109	13,753,265	0.1465	0.1445	0.1489
WV	Mar	Mon	14,519,230	6,825,535	12,576,681	0.1320	0.1363	0.1362
WV	Mar	Tue	14,710,069	6,798,174	12,342,614	0.1337	0.1357	0.1337
WV	Mar	Wed	14,856,321	6,663,871	12,085,672	0.1350	0.1331	0.1309
WV	Mar	Thu	14,806,603	6,772,985	12,285,137	0.1346	0.1352	0.1330
WV	Mar	Fri	17,926,131	8,136,390	14,944,895	0.1629	0.1625	0.1619
WV	Mar	Sat	17,081,123	7,649,154	14,349,306	0.1553	0.1527	0.1554
WV	Apr	Sun	12,659,911	5,616,755	10,711,173	0.1214	0.1173	0.1197
WV	Apr	Mon	17,613,006	8,128,426	15,122,209	0.1689	0.1697	0.1691
WV	Apr	Tue	17,929,618	8,331,690	15,445,939	0.1719	0.1739	0.1727
WV	Apr	Wed	14,445,569	6,673,004	12,480,197	0.1385	0.1393	0.1395
WV	Apr	Thu	14,237,092	6,681,897	12,404,167	0.1365	0.1395	0.1387
WV	Apr	Fri	13,967,495	6,422,716	11,926,943	0.1339	0.1341	0.1333
WV	Apr	Sat	13,444,678	6,047,689	11,362,797	0.1289	0.1263	0.1270
WV	May	Sun	11,759,655	4,646,889	10,863,241	0.1127	0.1116	0.1174
WV	May	Mon	13,257,241	5,319,864	11,860,681	0.1270	0.1278	0.1282
WV	May	Tue	14,019,375	5,696,886	12,212,949	0.1343	0.1369	0.1320
WV	May	Wed	17,425,095	7,041,737	15,343,080	0.1670	0.1692	0.1658
WV	May	Thu	17,510,110	7,006,274	15,483,728	0.1678	0.1683	0.1673
WV	May	Fri	17,612,584	6,869,355	15,321,354	0.1688	0.1650	0.1656
WV	May	Sat	12,775,798	5,043,687	11,454,445	0.1224	0.1212	0.1238
WV	Jun	Sun	14,957,872	5,513,227	13,450,208	0.1499	0.1496	0.1520
WV	Jun	Mon	13,487,078	4,966,344	12,093,706	0.1352	0.1347	0.1367
WV	Jun	Tue	13,810,046	4,924,808	12,328,120	0.1384	0.1336	0.1394
WV	Jun	Wed	14,035,209	5,019,365	12,246,507	0.1407	0.1362	0.1384
WV	Jun	Thu	13,971,661	5,248,525	12,289,497	0.1400	0.1424	0.1389
WV	Jun	Fri	13,647,530	5,202,625	11,944,391	0.1368	0.1412	0.1350
WV	Jun	Sat	15,853,200	5,982,734	14,108,354	0.1589	0.1623	0.1595

Average 2000-2004 State Level Monthly-Day of Week Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Day of Week	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Jul	Sun	12,579,090	4,859,371	11,483,663	0.1214	0.1244	0.1212
WV	Jul	Mon	16,922,966	6,628,216	15,654,385	0.1633	0.1697	0.1653
WV	Jul	Tue	16,829,969	6,510,534	15,642,798	0.1624	0.1667	0.1652
WV	Jul	Wed	16,922,109	6,356,022	15,616,084	0.1633	0.1628	0.1649
WV	Jul	Thu	13,767,564	4,995,695	12,445,189	0.1328	0.1279	0.1314
WV	Jul	Fri	13,765,831	4,996,420	12,282,163	0.1328	0.1280	0.1297
WV	Jul	Sat	12,864,639	4,702,083	11,594,157	0.1241	0.1204	0.1224
WV	Aug	Sun	12,420,738	4,243,325	11,548,441	0.1180	0.1124	0.1193
WV	Aug	Mon	13,711,685	4,876,761	12,698,726	0.1303	0.1292	0.1312
WV	Aug	Tue	13,802,245	4,932,803	12,778,560	0.1311	0.1307	0.1321
WV	Aug	Wed	13,982,519	5,203,299	12,734,042	0.1329	0.1378	0.1316
WV	Aug	Thu	17,526,678	6,525,344	16,118,431	0.1665	0.1729	0.1666
WV	Aug	Fri	17,375,999	6,269,445	16,109,397	0.1651	0.1661	0.1665
WV	Aug	Sat	16,421,084	5,700,325	14,781,627	0.1560	0.1510	0.1528
WV	Sep	Sun	15,387,791	5,583,374	14,178,712	0.1530	0.1541	0.1558
WV	Sep	Mon	16,479,807	5,987,538	15,060,884	0.1639	0.1653	0.1655
WV	Sep	Tue	13,653,144	4,977,030	12,477,507	0.1358	0.1374	0.1371
WV	Sep	Wed	13,978,860	4,854,370	12,357,544	0.1390	0.1340	0.1358
WV	Sep	Thu	13,844,610	4,851,874	12,422,717	0.1377	0.1339	0.1365
WV	Sep	Fri	13,973,475	5,127,295	12,521,330	0.1390	0.1415	0.1376
WV	Sep	Sat	13,230,214	4,848,814	11,984,616	0.1316	0.1338	0.1317
WV	Oct	Sun	11,795,713	5,328,806	10,519,418	0.1133	0.1112	0.1156
WV	Oct	Mon	13,506,437	6,360,933	11,820,770	0.1297	0.1327	0.1299
WV	Oct	Tue	17,397,758	8,030,289	15,157,209	0.1671	0.1675	0.1666
WV	Oct	Wed	17,332,497	7,975,342	15,086,415	0.1664	0.1664	0.1658
WV	Oct	Thu	17,546,866	8,115,257	15,238,555	0.1685	0.1693	0.1675
WV	Oct	Fri	14,025,759	6,395,999	11,980,650	0.1347	0.1334	0.1317
WV	Oct	Sat	12,529,159	5,721,977	11,175,454	0.1203	0.1194	0.1228
WV	Nov	Sun	12,129,792	5,619,696	10,631,285	0.1192	0.1169	0.1215
WV	Nov	Mon	13,864,511	6,604,163	11,913,288	0.1362	0.1373	0.1361
WV	Nov	Tue	14,354,084	6,781,122	12,170,429	0.1410	0.1410	0.1391
WV	Nov	Wed	14,405,997	6,847,447	12,275,110	0.1415	0.1424	0.1403
WV	Nov	Thu	13,730,088	6,400,457	11,689,312	0.1349	0.1331	0.1336
WV	Nov	Fri	17,117,867	8,198,832	14,796,047	0.1682	0.1705	0.1691
WV	Nov	Sat	16,186,882	7,639,304	14,026,213	0.1590	0.1589	0.1603
WV	Dec	Sun	15,617,799	7,200,553	13,529,804	0.1491	0.1460	0.1499
WV	Dec	Mon	16,601,004	7,918,361	14,743,758	0.1585	0.1606	0.1634
WV	Dec	Tue	17,036,342	8,066,876	14,717,030	0.1626	0.1636	0.1631
WV	Dec	Wed	13,898,570	6,561,202	11,840,873	0.1327	0.1331	0.1312
WV	Dec	Thu	14,069,657	6,626,904	11,884,163	0.1343	0.1344	0.1317
WV	Dec	Fri	14,040,201	6,649,697	12,003,729	0.1340	0.1349	0.1330
WV	Dec	Sat	13,500,681	6,282,373	11,515,891	0.1289	0.1274	0.1276

Average 2000-2004 State Level Monthly-Diurnal Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Jan	0	3,832,622	1,392,784	4,120,769	0.0395	0.0391	0.0387
AL	Jan	1	3,809,746	1,388,794	4,104,496	0.0393	0.0390	0.0385
AL	Jan	2	3,837,326	1,409,897	4,181,432	0.0396	0.0396	0.0392
AL	Jan	3	3,872,244	1,416,932	4,244,428	0.0399	0.0398	0.0398
AL	Jan	4	3,954,578	1,442,167	4,360,856	0.0408	0.0405	0.0409
AL	Jan	5	4,058,942	1,485,648	4,575,472	0.0419	0.0417	0.0429
AL	Jan	6	4,146,714	1,523,527	4,732,549	0.0428	0.0428	0.0444
AL	Jan	7	4,144,066	1,535,797	4,686,268	0.0428	0.0432	0.0440
AL	Jan	8	4,154,152	1,527,650	4,662,311	0.0429	0.0429	0.0437
AL	Jan	9	4,197,324	1,541,262	4,646,238	0.0433	0.0433	0.0436
AL	Jan	10	4,144,211	1,536,368	4,568,193	0.0428	0.0432	0.0429
AL	Jan	11	4,106,061	1,520,068	4,516,912	0.0424	0.0427	0.0424
AL	Jan	12	4,072,688	1,502,952	4,430,110	0.0420	0.0422	0.0416
AL	Jan	13	4,004,292	1,471,843	4,338,987	0.0413	0.0414	0.0407
AL	Jan	14	3,946,062	1,451,861	4,298,092	0.0407	0.0408	0.0403
AL	Jan	15	3,949,273	1,448,804	4,285,043	0.0407	0.0407	0.0402
AL	Jan	16	4,004,065	1,472,030	4,367,663	0.0413	0.0414	0.0410
AL	Jan	17	4,121,578	1,522,913	4,569,818	0.0425	0.0428	0.0429
AL	Jan	18	4,163,180	1,529,167	4,629,152	0.0430	0.0430	0.0434
AL	Jan	19	4,136,097	1,515,161	4,571,459	0.0427	0.0426	0.0429
AL	Jan	20	4,145,700	1,519,543	4,577,690	0.0428	0.0427	0.0429
AL	Jan	21	4,125,600	1,511,622	4,521,593	0.0426	0.0425	0.0424
AL	Jan	22	4,060,942	1,489,296	4,386,027	0.0419	0.0418	0.0411
AL	Jan	23	3,942,804	1,431,564	4,232,162	0.0407	0.0402	0.0397
AL	Feb	0	3,533,625	1,253,887	3,594,975	0.0396	0.0395	0.0389
AL	Feb	1	3,487,513	1,236,149	3,548,210	0.0391	0.0390	0.0384
AL	Feb	2	3,483,693	1,239,510	3,560,034	0.0390	0.0391	0.0386
AL	Feb	3	3,539,241	1,250,195	3,664,698	0.0396	0.0394	0.0397
AL	Feb	4	3,650,176	1,285,888	3,808,325	0.0409	0.0405	0.0413
AL	Feb	5	3,760,946	1,330,454	3,964,089	0.0421	0.0420	0.0429
AL	Feb	6	3,838,201	1,371,166	4,116,946	0.0430	0.0432	0.0446
AL	Feb	7	3,850,449	1,374,094	4,099,473	0.0431	0.0433	0.0444
AL	Feb	8	3,807,644	1,369,131	4,026,312	0.0426	0.0432	0.0436
AL	Feb	9	3,827,781	1,366,508	3,973,960	0.0429	0.0431	0.0430
AL	Feb	10	3,820,790	1,350,468	3,939,317	0.0428	0.0426	0.0427
AL	Feb	11	3,818,017	1,344,208	3,929,298	0.0428	0.0424	0.0426
AL	Feb	12	3,763,616	1,323,974	3,862,170	0.0421	0.0417	0.0418
AL	Feb	13	3,716,580	1,308,905	3,794,748	0.0416	0.0413	0.0411
AL	Feb	14	3,707,376	1,308,841	3,783,297	0.0415	0.0413	0.0410
AL	Feb	15	3,713,519	1,309,785	3,785,935	0.0416	0.0413	0.0410
AL	Feb	16	3,731,767	1,322,800	3,814,771	0.0418	0.0417	0.0413
AL	Feb	17	3,785,828	1,346,395	3,931,720	0.0424	0.0425	0.0426
AL	Feb	18	3,834,263	1,369,480	4,038,456	0.0429	0.0432	0.0437
AL	Feb	19	3,809,317	1,368,459	4,006,765	0.0427	0.0432	0.0434
AL	Feb	20	3,786,113	1,353,892	3,910,013	0.0424	0.0427	0.0424
AL	Feb	21	3,751,734	1,341,345	3,839,564	0.0420	0.0423	0.0416
AL	Feb	22	3,693,699	1,314,805	3,718,028	0.0414	0.0415	0.0403
AL	Feb	23	3,587,387	1,272,233	3,609,697	0.0402	0.0401	0.0391
AL	Mar	0	3,884,884	1,355,573	3,822,870	0.0397	0.0392	0.0383
AL	Mar	1	3,827,542	1,337,086	3,777,070	0.0391	0.0386	0.0379
AL	Mar	2	3,820,846	1,339,596	3,789,362	0.0390	0.0387	0.0380
AL	Mar	3	3,841,024	1,348,644	3,826,479	0.0392	0.0389	0.0384
AL	Mar	4	3,914,521	1,377,239	3,929,343	0.0400	0.0398	0.0394

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Mar	5	4,054,316	1,429,153	4,139,114	0.0414	0.0413	0.0415
AL	Mar	6	4,127,528	1,459,314	4,262,823	0.0421	0.0421	0.0427
AL	Mar	7	4,154,653	1,464,376	4,233,137	0.0424	0.0423	0.0424
AL	Mar	8	4,166,633	1,472,592	4,261,932	0.0425	0.0425	0.0427
AL	Mar	9	4,189,848	1,479,971	4,271,323	0.0428	0.0427	0.0428
AL	Mar	10	4,174,285	1,483,811	4,268,181	0.0426	0.0429	0.0428
AL	Mar	11	4,156,507	1,476,068	4,254,967	0.0424	0.0426	0.0427
AL	Mar	12	4,131,520	1,474,033	4,274,598	0.0422	0.0426	0.0429
AL	Mar	13	4,108,706	1,462,540	4,246,704	0.0419	0.0422	0.0426
AL	Mar	14	4,119,333	1,465,494	4,271,940	0.0420	0.0423	0.0428
AL	Mar	15	4,126,074	1,464,845	4,267,467	0.0421	0.0423	0.0428
AL	Mar	16	4,137,700	1,475,522	4,249,552	0.0422	0.0426	0.0426
AL	Mar	17	4,147,480	1,475,701	4,253,733	0.0423	0.0426	0.0426
AL	Mar	18	4,223,743	1,507,052	4,402,908	0.0431	0.0435	0.0441
AL	Mar	19	4,226,663	1,498,418	4,412,192	0.0431	0.0433	0.0442
AL	Mar	20	4,196,460	1,486,812	4,339,197	0.0428	0.0429	0.0435
AL	Mar	21	4,162,035	1,464,285	4,182,939	0.0425	0.0423	0.0419
AL	Mar	22	4,112,232	1,437,662	4,070,175	0.0420	0.0415	0.0408
AL	Mar	23	3,972,501	1,389,240	3,934,933	0.0405	0.0401	0.0395
AL	Apr	0	3,363,198	1,217,532	3,698,549	0.0381	0.0377	0.0369
AL	Apr	1	3,318,487	1,226,840	3,676,330	0.0376	0.0379	0.0367
AL	Apr	2	3,313,384	1,224,253	3,669,911	0.0375	0.0379	0.0367
AL	Apr	3	3,402,206	1,231,546	3,742,732	0.0386	0.0381	0.0374
AL	Apr	4	3,575,530	1,295,380	3,944,154	0.0405	0.0401	0.0394
AL	Apr	5	3,685,748	1,349,191	4,131,717	0.0418	0.0417	0.0413
AL	Apr	6	3,715,609	1,373,011	4,187,547	0.0421	0.0425	0.0418
AL	Apr	7	3,740,649	1,360,712	4,144,855	0.0424	0.0421	0.0414
AL	Apr	8	3,782,629	1,381,548	4,157,764	0.0429	0.0427	0.0415
AL	Apr	9	3,818,629	1,386,461	4,271,958	0.0433	0.0429	0.0427
AL	Apr	10	3,809,084	1,397,435	4,356,611	0.0432	0.0432	0.0435
AL	Apr	11	3,802,578	1,393,134	4,406,377	0.0431	0.0431	0.0440
AL	Apr	12	3,771,988	1,384,184	4,419,719	0.0427	0.0428	0.0441
AL	Apr	13	3,779,174	1,386,794	4,441,381	0.0428	0.0429	0.0444
AL	Apr	14	3,782,737	1,396,661	4,457,323	0.0429	0.0432	0.0445
AL	Apr	15	3,775,005	1,406,020	4,451,082	0.0428	0.0435	0.0445
AL	Apr	16	3,781,714	1,398,764	4,427,061	0.0429	0.0433	0.0442
AL	Apr	17	3,791,836	1,397,385	4,412,649	0.0430	0.0432	0.0441
AL	Apr	18	3,815,899	1,409,963	4,458,379	0.0432	0.0436	0.0445
AL	Apr	19	3,827,202	1,415,440	4,450,921	0.0434	0.0438	0.0445
AL	Apr	20	3,781,426	1,386,890	4,338,012	0.0429	0.0429	0.0433
AL	Apr	21	3,714,250	1,353,685	4,167,295	0.0421	0.0419	0.0416
AL	Apr	22	3,598,737	1,302,914	3,919,037	0.0408	0.0403	0.0391
AL	Apr	23	3,495,479	1,258,528	3,798,145	0.0396	0.0389	0.0379
AL	May	0	3,336,544	1,204,200	3,957,971	0.0371	0.0369	0.0350
AL	May	1	3,235,207	1,167,840	3,853,580	0.0360	0.0358	0.0341
AL	May	2	3,187,798	1,149,355	3,800,179	0.0354	0.0352	0.0336
AL	May	3	3,278,716	1,172,350	3,874,610	0.0364	0.0359	0.0343
AL	May	4	3,481,698	1,252,805	4,061,025	0.0387	0.0384	0.0359
AL	May	5	3,618,028	1,304,064	4,242,931	0.0402	0.0400	0.0376
AL	May	6	3,711,280	1,326,707	4,405,290	0.0413	0.0407	0.0390
AL	May	7	3,807,688	1,357,099	4,593,502	0.0423	0.0416	0.0407
AL	May	8	3,910,037	1,415,728	4,809,122	0.0435	0.0434	0.0426
AL	May	9	3,945,371	1,432,231	4,937,386	0.0439	0.0439	0.0437

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	May	10	3,959,804	1,444,770	5,078,134	0.0440	0.0443	0.0450
AL	May	11	3,984,853	1,463,785	5,187,569	0.0443	0.0449	0.0459
AL	May	12	3,967,316	1,463,002	5,269,665	0.0441	0.0448	0.0466
AL	May	13	3,969,347	1,469,503	5,321,405	0.0441	0.0450	0.0471
AL	May	14	3,973,176	1,470,089	5,352,352	0.0442	0.0451	0.0474
AL	May	15	3,983,688	1,477,372	5,362,174	0.0443	0.0453	0.0475
AL	May	16	3,969,189	1,447,344	5,261,688	0.0441	0.0444	0.0466
AL	May	17	3,947,675	1,438,262	5,195,482	0.0439	0.0441	0.0460
AL	May	18	3,917,508	1,433,101	5,143,555	0.0435	0.0439	0.0455
AL	May	19	3,942,531	1,451,739	5,163,763	0.0438	0.0445	0.0457
AL	May	20	3,882,556	1,399,938	4,962,672	0.0432	0.0429	0.0439
AL	May	21	3,786,170	1,355,129	4,694,712	0.0421	0.0415	0.0416
AL	May	22	3,658,659	1,283,668	4,334,298	0.0407	0.0393	0.0384
AL	May	23	3,507,827	1,247,687	4,104,904	0.0390	0.0382	0.0363
AL	Jun	0	3,249,457	1,135,350	3,889,416	0.0373	0.0364	0.0350
AL	Jun	1	3,118,010	1,100,797	3,794,112	0.0358	0.0353	0.0342
AL	Jun	2	3,046,926	1,081,031	3,725,689	0.0350	0.0347	0.0335
AL	Jun	3	3,089,289	1,101,845	3,763,688	0.0355	0.0353	0.0339
AL	Jun	4	3,204,111	1,144,934	3,887,662	0.0368	0.0367	0.0350
AL	Jun	5	3,301,357	1,176,830	4,024,403	0.0379	0.0377	0.0362
AL	Jun	6	3,481,535	1,232,393	4,204,486	0.0400	0.0395	0.0378
AL	Jun	7	3,640,010	1,283,636	4,365,599	0.0418	0.0412	0.0393
AL	Jun	8	3,786,169	1,336,261	4,591,409	0.0435	0.0428	0.0413
AL	Jun	9	3,849,169	1,379,354	4,872,063	0.0442	0.0442	0.0439
AL	Jun	10	3,886,151	1,407,767	5,049,662	0.0446	0.0451	0.0455
AL	Jun	11	3,899,135	1,415,593	5,234,525	0.0448	0.0454	0.0471
AL	Jun	12	3,882,514	1,420,588	5,337,089	0.0446	0.0455	0.0480
AL	Jun	13	3,883,981	1,422,434	5,350,779	0.0446	0.0456	0.0482
AL	Jun	14	3,891,077	1,426,441	5,325,650	0.0447	0.0457	0.0479
AL	Jun	15	3,904,160	1,429,269	5,326,230	0.0448	0.0458	0.0479
AL	Jun	16	3,890,967	1,416,563	5,294,467	0.0447	0.0454	0.0477
AL	Jun	17	3,874,046	1,403,488	5,238,057	0.0445	0.0450	0.0472
AL	Jun	18	3,836,617	1,382,313	5,100,573	0.0440	0.0443	0.0459
AL	Jun	19	3,862,525	1,391,041	5,060,286	0.0443	0.0446	0.0456
AL	Jun	20	3,825,675	1,372,354	4,862,221	0.0439	0.0440	0.0438
AL	Jun	21	3,727,151	1,307,044	4,537,952	0.0428	0.0419	0.0408
AL	Jun	22	3,561,423	1,241,753	4,216,643	0.0409	0.0398	0.0380
AL	Jun	23	3,410,779	1,184,219	4,036,059	0.0392	0.0380	0.0363
AL	Jul	0	3,439,331	1,179,646	4,241,206	0.0376	0.0368	0.0353
AL	Jul	1	3,292,043	1,133,656	4,108,549	0.0359	0.0353	0.0342
AL	Jul	2	3,221,553	1,112,403	4,048,567	0.0352	0.0347	0.0337
AL	Jul	3	3,230,938	1,117,015	4,055,211	0.0353	0.0348	0.0338
AL	Jul	4	3,344,145	1,162,812	4,150,241	0.0365	0.0363	0.0346
AL	Jul	5	3,442,485	1,205,619	4,325,308	0.0376	0.0376	0.0360
AL	Jul	6	3,597,919	1,249,932	4,517,342	0.0393	0.0390	0.0376
AL	Jul	7	3,770,680	1,304,482	4,741,948	0.0412	0.0407	0.0395
AL	Jul	8	3,936,064	1,383,541	5,014,602	0.0430	0.0431	0.0417
AL	Jul	9	4,035,072	1,412,474	5,258,624	0.0441	0.0440	0.0438
AL	Jul	10	4,098,677	1,460,627	5,438,453	0.0448	0.0455	0.0453
AL	Jul	11	4,121,751	1,454,293	5,604,370	0.0450	0.0453	0.0467
AL	Jul	12	4,101,025	1,452,552	5,705,407	0.0448	0.0453	0.0475
AL	Jul	13	4,091,145	1,450,657	5,736,411	0.0447	0.0452	0.0478
AL	Jul	14	4,102,687	1,458,381	5,760,754	0.0448	0.0455	0.0480

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Jul	15	4,105,831	1,456,744	5,744,619	0.0448	0.0454	0.0478
AL	Jul	16	4,088,730	1,450,875	5,678,442	0.0446	0.0452	0.0473
AL	Jul	17	4,074,377	1,441,938	5,602,017	0.0445	0.0450	0.0466
AL	Jul	18	4,046,811	1,425,856	5,503,034	0.0442	0.0445	0.0458
AL	Jul	19	4,057,207	1,423,649	5,489,189	0.0443	0.0444	0.0457
AL	Jul	20	4,028,869	1,408,944	5,276,923	0.0440	0.0439	0.0439
AL	Jul	21	3,939,185	1,370,873	4,966,147	0.0430	0.0427	0.0413
AL	Jul	22	3,785,688	1,311,615	4,694,013	0.0413	0.0409	0.0391
AL	Jul	23	3,635,231	1,245,395	4,449,233	0.0397	0.0388	0.0370
AL	Aug	0	3,431,253	1,193,699	4,186,623	0.0379	0.0370	0.0350
AL	Aug	1	3,307,883	1,150,053	4,077,525	0.0365	0.0356	0.0341
AL	Aug	2	3,256,822	1,131,091	4,013,306	0.0360	0.0350	0.0335
AL	Aug	3	3,292,935	1,152,962	4,042,147	0.0364	0.0357	0.0338
AL	Aug	4	3,449,798	1,209,426	4,215,379	0.0381	0.0375	0.0352
AL	Aug	5	3,566,895	1,267,176	4,383,240	0.0394	0.0393	0.0366
AL	Aug	6	3,626,514	1,287,197	4,519,263	0.0401	0.0399	0.0378
AL	Aug	7	3,741,028	1,342,638	4,671,194	0.0413	0.0416	0.0390
AL	Aug	8	3,880,563	1,370,276	4,978,193	0.0429	0.0424	0.0416
AL	Aug	9	3,941,442	1,414,788	5,234,978	0.0435	0.0438	0.0437
AL	Aug	10	3,984,075	1,443,741	5,472,107	0.0440	0.0447	0.0457
AL	Aug	11	4,011,170	1,441,002	5,610,521	0.0443	0.0446	0.0469
AL	Aug	12	4,004,862	1,446,340	5,680,752	0.0442	0.0448	0.0475
AL	Aug	13	4,006,916	1,450,309	5,728,806	0.0443	0.0449	0.0479
AL	Aug	14	4,021,532	1,463,125	5,750,748	0.0444	0.0453	0.0480
AL	Aug	15	4,022,793	1,463,121	5,756,612	0.0444	0.0453	0.0481
AL	Aug	16	4,011,804	1,453,868	5,709,595	0.0443	0.0450	0.0477
AL	Aug	17	3,999,859	1,440,569	5,615,593	0.0442	0.0446	0.0469
AL	Aug	18	3,976,679	1,429,307	5,552,926	0.0439	0.0443	0.0464
AL	Aug	19	3,970,599	1,424,331	5,462,287	0.0439	0.0441	0.0456
AL	Aug	20	3,924,918	1,403,283	5,238,962	0.0434	0.0435	0.0438
AL	Aug	21	3,834,050	1,360,582	4,909,036	0.0424	0.0421	0.0410
AL	Aug	22	3,681,304	1,297,182	4,559,770	0.0407	0.0402	0.0381
AL	Aug	23	3,571,373	1,246,733	4,345,837	0.0395	0.0386	0.0363
AL	Sep	0	3,173,133	1,087,802	3,726,533	0.0369	0.0360	0.0342
AL	Sep	1	3,085,837	1,064,028	3,661,167	0.0358	0.0352	0.0336
AL	Sep	2	3,044,225	1,051,232	3,623,321	0.0354	0.0348	0.0333
AL	Sep	3	3,087,917	1,065,342	3,658,420	0.0359	0.0353	0.0336
AL	Sep	4	3,281,892	1,134,947	3,853,372	0.0381	0.0376	0.0354
AL	Sep	5	3,449,316	1,197,293	4,077,599	0.0401	0.0396	0.0375
AL	Sep	6	3,491,093	1,228,696	4,209,757	0.0405	0.0407	0.0387
AL	Sep	7	3,589,499	1,273,314	4,339,749	0.0417	0.0422	0.0399
AL	Sep	8	3,693,656	1,295,401	4,516,642	0.0429	0.0429	0.0415
AL	Sep	9	3,753,630	1,326,750	4,705,712	0.0436	0.0439	0.0432
AL	Sep	10	3,793,897	1,344,080	4,868,926	0.0441	0.0445	0.0447
AL	Sep	11	3,814,789	1,353,910	5,047,015	0.0443	0.0448	0.0464
AL	Sep	12	3,810,937	1,364,922	5,157,180	0.0443	0.0452	0.0474
AL	Sep	13	3,824,476	1,365,307	5,211,391	0.0444	0.0452	0.0479
AL	Sep	14	3,842,311	1,367,787	5,278,551	0.0446	0.0453	0.0485
AL	Sep	15	3,855,155	1,369,353	5,279,121	0.0448	0.0453	0.0485
AL	Sep	16	3,842,896	1,364,140	5,244,513	0.0446	0.0452	0.0482
AL	Sep	17	3,840,388	1,358,817	5,199,308	0.0446	0.0450	0.0478
AL	Sep	18	3,852,451	1,366,889	5,177,795	0.0447	0.0453	0.0476
AL	Sep	19	3,838,056	1,349,035	5,040,981	0.0446	0.0447	0.0463

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Sep	20	3,766,174	1,308,138	4,762,991	0.0437	0.0433	0.0437
AL	Sep	21	3,627,576	1,252,788	4,357,940	0.0421	0.0415	0.0400
AL	Sep	22	3,439,979	1,184,709	4,038,063	0.0400	0.0392	0.0371
AL	Sep	23	3,294,649	1,130,504	3,837,152	0.0383	0.0374	0.0352
AL	Oct	0	3,632,590	1,292,415	3,716,299	0.0383	0.0376	0.0355
AL	Oct	1	3,566,773	1,275,337	3,658,994	0.0376	0.0371	0.0350
AL	Oct	2	3,550,154	1,272,032	3,645,593	0.0374	0.0370	0.0348
AL	Oct	3	3,622,818	1,298,930	3,715,279	0.0382	0.0378	0.0355
AL	Oct	4	3,816,443	1,361,689	3,908,601	0.0402	0.0397	0.0374
AL	Oct	5	3,964,777	1,422,147	4,179,281	0.0418	0.0414	0.0399
AL	Oct	6	3,982,938	1,464,711	4,302,262	0.0420	0.0427	0.0411
AL	Oct	7	4,034,829	1,454,472	4,405,035	0.0425	0.0424	0.0421
AL	Oct	8	4,084,350	1,473,771	4,493,838	0.0431	0.0429	0.0430
AL	Oct	9	4,092,334	1,486,378	4,588,066	0.0431	0.0433	0.0439
AL	Oct	10	4,100,833	1,486,998	4,657,813	0.0432	0.0433	0.0445
AL	Oct	11	4,103,409	1,494,434	4,731,151	0.0433	0.0435	0.0452
AL	Oct	12	4,077,261	1,489,692	4,761,539	0.0430	0.0434	0.0455
AL	Oct	13	4,076,784	1,493,384	4,753,105	0.0430	0.0435	0.0454
AL	Oct	14	4,084,027	1,496,244	4,759,557	0.0431	0.0436	0.0455
AL	Oct	15	4,091,111	1,496,627	4,745,431	0.0431	0.0436	0.0454
AL	Oct	16	4,091,084	1,497,434	4,756,253	0.0431	0.0436	0.0455
AL	Oct	17	4,105,544	1,502,049	4,805,118	0.0433	0.0437	0.0459
AL	Oct	18	4,104,966	1,503,458	4,764,255	0.0433	0.0438	0.0455
AL	Oct	19	4,083,456	1,487,218	4,657,595	0.0430	0.0433	0.0445
AL	Oct	20	4,048,426	1,465,206	4,506,250	0.0427	0.0427	0.0431
AL	Oct	21	3,970,419	1,423,742	4,241,227	0.0419	0.0415	0.0405
AL	Oct	22	3,842,465	1,371,164	4,022,655	0.0405	0.0399	0.0385
AL	Oct	23	3,735,034	1,328,366	3,844,323	0.0394	0.0387	0.0367
AL	Nov	0	3,267,264	1,247,402	3,299,233	0.0382	0.0385	0.0362
AL	Nov	1	3,204,439	1,212,764	3,235,759	0.0375	0.0374	0.0355
AL	Nov	2	3,181,765	1,213,704	3,237,355	0.0372	0.0374	0.0356
AL	Nov	3	3,208,275	1,219,805	3,277,901	0.0375	0.0376	0.0360
AL	Nov	4	3,317,965	1,255,332	3,402,159	0.0388	0.0387	0.0374
AL	Nov	5	3,500,997	1,321,240	3,633,182	0.0409	0.0408	0.0399
AL	Nov	6	3,617,744	1,374,822	3,878,759	0.0423	0.0424	0.0426
AL	Nov	7	3,651,716	1,383,616	3,949,207	0.0427	0.0427	0.0434
AL	Nov	8	3,686,742	1,392,750	3,957,532	0.0431	0.0430	0.0435
AL	Nov	9	3,724,441	1,400,877	3,976,990	0.0435	0.0432	0.0437
AL	Nov	10	3,704,353	1,400,083	4,019,889	0.0433	0.0432	0.0442
AL	Nov	11	3,692,782	1,403,186	4,057,061	0.0432	0.0433	0.0446
AL	Nov	12	3,676,420	1,393,003	4,030,364	0.0430	0.0430	0.0443
AL	Nov	13	3,651,783	1,382,082	3,955,983	0.0427	0.0426	0.0435
AL	Nov	14	3,639,470	1,380,674	3,934,235	0.0425	0.0426	0.0432
AL	Nov	15	3,642,229	1,376,339	3,903,518	0.0426	0.0425	0.0429
AL	Nov	16	3,692,761	1,394,692	4,019,062	0.0432	0.0430	0.0441
AL	Nov	17	3,760,549	1,423,722	4,162,605	0.0440	0.0439	0.0457
AL	Nov	18	3,753,211	1,429,019	4,186,038	0.0439	0.0441	0.0460
AL	Nov	19	3,721,778	1,413,776	4,135,212	0.0435	0.0436	0.0454
AL	Nov	20	3,695,216	1,400,293	4,002,565	0.0432	0.0432	0.0440
AL	Nov	21	3,641,056	1,376,237	3,826,538	0.0426	0.0425	0.0420
AL	Nov	22	3,521,606	1,332,335	3,575,679	0.0412	0.0411	0.0393
AL	Nov	23	3,385,691	1,288,165	3,388,264	0.0396	0.0397	0.0372
AL	Dec	0	3,528,822	1,323,984	3,877,301	0.0395	0.0395	0.0385

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
AL	Dec	1	3,455,700	1,299,710	3,812,929	0.0387	0.0387	0.0378
AL	Dec	2	3,450,663	1,302,222	3,812,469	0.0386	0.0388	0.0378
AL	Dec	3	3,486,042	1,312,140	3,842,898	0.0390	0.0391	0.0381
AL	Dec	4	3,561,526	1,351,413	4,009,684	0.0399	0.0403	0.0398
AL	Dec	5	3,691,291	1,392,356	4,216,662	0.0413	0.0415	0.0418
AL	Dec	6	3,808,679	1,436,242	4,391,288	0.0426	0.0428	0.0436
AL	Dec	7	3,849,370	1,442,553	4,426,423	0.0431	0.0430	0.0439
AL	Dec	8	3,867,228	1,445,250	4,389,009	0.0433	0.0431	0.0436
AL	Dec	9	3,873,293	1,445,929	4,341,531	0.0434	0.0431	0.0431
AL	Dec	10	3,843,700	1,432,897	4,312,111	0.0430	0.0427	0.0428
AL	Dec	11	3,800,122	1,418,517	4,254,327	0.0425	0.0423	0.0422
AL	Dec	12	3,736,547	1,406,341	4,191,604	0.0418	0.0419	0.0416
AL	Dec	13	3,659,619	1,369,323	4,092,232	0.0410	0.0408	0.0406
AL	Dec	14	3,606,430	1,356,548	4,069,143	0.0404	0.0404	0.0404
AL	Dec	15	3,631,611	1,368,864	4,116,419	0.0406	0.0408	0.0408
AL	Dec	16	3,728,053	1,404,849	4,283,856	0.0417	0.0419	0.0425
AL	Dec	17	3,878,777	1,456,685	4,475,306	0.0434	0.0434	0.0444
AL	Dec	18	3,906,726	1,466,262	4,507,942	0.0437	0.0437	0.0447
AL	Dec	19	3,875,131	1,458,101	4,452,005	0.0434	0.0435	0.0442
AL	Dec	20	3,876,365	1,452,244	4,397,504	0.0434	0.0433	0.0436
AL	Dec	21	3,858,933	1,444,312	4,325,152	0.0432	0.0431	0.0429
AL	Dec	22	3,755,148	1,402,934	4,153,973	0.0420	0.0418	0.0412
AL	Dec	23	3,614,616	1,359,957	4,017,788	0.0405	0.0405	0.0399
FL	Jan	0	4,092,917	2,105,649	6,987,856	0.0353	0.0334	0.0352
FL	Jan	1	3,987,160	2,035,874	6,898,903	0.0344	0.0323	0.0347
FL	Jan	2	3,969,797	2,031,934	6,906,056	0.0342	0.0323	0.0347
FL	Jan	3	4,002,571	2,069,592	7,035,278	0.0345	0.0329	0.0354
FL	Jan	4	4,117,388	2,174,218	7,449,461	0.0355	0.0345	0.0375
FL	Jan	5	4,479,652	2,396,830	8,148,718	0.0386	0.0381	0.0410
FL	Jan	6	5,174,782	2,828,553	9,183,615	0.0446	0.0449	0.0462
FL	Jan	7	5,717,909	3,155,634	9,845,442	0.0493	0.0501	0.0495
FL	Jan	8	5,760,945	3,192,267	9,911,845	0.0497	0.0507	0.0499
FL	Jan	9	5,596,442	3,102,531	9,574,243	0.0482	0.0493	0.0482
FL	Jan	10	5,355,908	2,964,195	9,053,718	0.0462	0.0471	0.0456
FL	Jan	11	5,051,096	2,824,581	8,500,073	0.0435	0.0448	0.0428
FL	Jan	12	4,807,243	2,611,433	8,065,116	0.0414	0.0415	0.0406
FL	Jan	13	4,557,208	2,478,633	7,746,587	0.0393	0.0393	0.0390
FL	Jan	14	4,348,649	2,364,071	7,449,604	0.0375	0.0375	0.0375
FL	Jan	15	4,286,664	2,327,446	7,356,274	0.0370	0.0369	0.0370
FL	Jan	16	4,385,028	2,374,163	7,524,846	0.0378	0.0377	0.0379
FL	Jan	17	4,858,385	2,645,810	8,268,667	0.0419	0.0420	0.0416
FL	Jan	18	5,704,399	3,160,866	9,468,763	0.0492	0.0502	0.0476
FL	Jan	19	5,743,463	3,241,746	9,613,610	0.0495	0.0515	0.0484
FL	Jan	20	5,498,856	3,078,322	9,308,547	0.0474	0.0489	0.0468
FL	Jan	21	5,177,963	2,871,307	8,801,908	0.0446	0.0456	0.0443
FL	Jan	22	4,908,336	2,630,830	8,167,507	0.0423	0.0418	0.0411
FL	Jan	23	4,428,492	2,323,474	7,484,412	0.0382	0.0369	0.0377
FL	Feb	0	2,843,907	1,468,930	5,312,973	0.0303	0.0289	0.0322
FL	Feb	1	2,672,347	1,391,877	5,132,938	0.0284	0.0274	0.0311
FL	Feb	2	2,564,226	1,347,543	5,007,986	0.0273	0.0265	0.0304
FL	Feb	3	2,550,645	1,347,706	5,022,651	0.0271	0.0265	0.0304
FL	Feb	4	2,603,632	1,390,611	5,195,066	0.0277	0.0274	0.0315
FL	Feb	5	2,897,018	1,552,695	5,719,031	0.0308	0.0305	0.0347

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Feb	6	3,602,560	1,982,073	6,872,933	0.0383	0.0390	0.0417
FL	Feb	7	4,201,272	2,325,930	7,680,764	0.0447	0.0458	0.0466
FL	Feb	8	4,367,138	2,395,477	7,781,623	0.0465	0.0471	0.0472
FL	Feb	9	4,422,900	2,420,472	7,732,427	0.0471	0.0476	0.0469
FL	Feb	10	4,458,881	2,438,577	7,562,420	0.0475	0.0480	0.0458
FL	Feb	11	4,389,493	2,382,402	7,340,385	0.0467	0.0469	0.0445
FL	Feb	12	4,330,015	2,364,939	7,272,402	0.0461	0.0465	0.0441
FL	Feb	13	4,300,811	2,352,445	7,230,408	0.0458	0.0463	0.0438
FL	Feb	14	4,221,312	2,306,854	7,170,989	0.0449	0.0454	0.0435
FL	Feb	15	4,241,059	2,317,603	7,204,323	0.0451	0.0456	0.0437
FL	Feb	16	4,321,957	2,348,475	7,310,653	0.0460	0.0462	0.0443
FL	Feb	17	4,502,792	2,432,169	7,559,804	0.0479	0.0478	0.0458
FL	Feb	18	5,064,768	2,734,325	8,339,846	0.0539	0.0538	0.0506
FL	Feb	19	5,226,395	2,858,688	8,591,004	0.0556	0.0562	0.0521
FL	Feb	20	4,798,063	2,604,697	8,044,823	0.0511	0.0512	0.0488
FL	Feb	21	4,284,859	2,310,862	7,344,108	0.0456	0.0455	0.0445
FL	Feb	22	3,831,661	2,044,379	6,628,589	0.0408	0.0402	0.0402
FL	Feb	23	3,261,076	1,712,086	5,891,556	0.0347	0.0337	0.0357
FL	Mar	0	3,393,482	1,746,949	6,158,635	0.0304	0.0290	0.0313
FL	Mar	1	3,131,030	1,597,082	5,893,284	0.0281	0.0265	0.0300
FL	Mar	2	2,986,263	1,516,235	5,703,128	0.0268	0.0252	0.0290
FL	Mar	3	2,920,560	1,485,480	5,624,453	0.0262	0.0246	0.0286
FL	Mar	4	2,941,877	1,503,977	5,664,936	0.0264	0.0249	0.0288
FL	Mar	5	3,156,463	1,628,630	6,037,441	0.0283	0.0270	0.0307
FL	Mar	6	3,688,413	1,962,560	6,934,659	0.0331	0.0326	0.0353
FL	Mar	7	4,174,443	2,233,007	7,530,457	0.0374	0.0370	0.0383
FL	Mar	8	4,565,073	2,460,491	7,929,663	0.0409	0.0408	0.0403
FL	Mar	9	4,955,768	2,720,368	8,407,702	0.0444	0.0451	0.0427
FL	Mar	10	5,238,317	2,887,913	8,870,979	0.0470	0.0479	0.0451
FL	Mar	11	5,370,699	2,987,753	9,202,544	0.0482	0.0496	0.0468
FL	Mar	12	5,518,223	3,054,007	9,575,664	0.0495	0.0507	0.0487
FL	Mar	13	5,592,032	3,102,973	9,797,330	0.0502	0.0515	0.0498
FL	Mar	14	5,614,340	3,120,407	9,897,194	0.0504	0.0518	0.0503
FL	Mar	15	5,691,689	3,156,307	9,993,214	0.0510	0.0524	0.0508
FL	Mar	16	5,707,207	3,157,176	10,043,000	0.0512	0.0524	0.0511
FL	Mar	17	5,690,130	3,132,464	9,975,039	0.0510	0.0520	0.0507
FL	Mar	18	5,807,055	3,182,134	10,094,726	0.0521	0.0528	0.0513
FL	Mar	19	6,060,481	3,342,494	10,376,991	0.0544	0.0554	0.0528
FL	Mar	20	5,685,976	3,099,357	9,729,690	0.0510	0.0514	0.0495
FL	Mar	21	5,106,809	2,729,404	8,718,323	0.0458	0.0453	0.0443
FL	Mar	22	4,546,936	2,410,497	7,700,628	0.0408	0.0400	0.0391
FL	Mar	23	3,962,286	2,068,307	6,846,020	0.0355	0.0343	0.0348
FL	Apr	0	3,073,473	1,596,832	5,818,515	0.0287	0.0270	0.0298
FL	Apr	1	2,830,568	1,464,614	5,507,523	0.0265	0.0248	0.0282
FL	Apr	2	2,712,866	1,401,941	5,353,106	0.0254	0.0237	0.0274
FL	Apr	3	2,687,715	1,398,112	5,341,580	0.0251	0.0237	0.0273
FL	Apr	4	2,884,533	1,512,851	5,606,259	0.0270	0.0256	0.0287
FL	Apr	5	3,377,502	1,808,189	6,324,646	0.0316	0.0306	0.0324
FL	Apr	6	3,701,542	2,024,027	6,883,043	0.0346	0.0343	0.0352
FL	Apr	7	4,029,897	2,189,545	7,308,193	0.0377	0.0371	0.0374
FL	Apr	8	4,435,204	2,429,739	7,846,588	0.0414	0.0411	0.0402
FL	Apr	9	4,800,755	2,669,166	8,433,318	0.0449	0.0452	0.0432
FL	Apr	10	5,003,384	2,806,647	8,951,308	0.0468	0.0475	0.0458

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Apr	11	5,202,417	2,944,645	9,493,938	0.0486	0.0498	0.0486
FL	Apr	12	5,375,267	3,054,496	9,838,364	0.0502	0.0517	0.0504
FL	Apr	13	5,540,550	3,155,947	10,110,799	0.0518	0.0534	0.0518
FL	Apr	14	5,669,250	3,235,350	10,270,190	0.0530	0.0548	0.0526
FL	Apr	15	5,758,423	3,296,338	10,401,429	0.0538	0.0558	0.0532
FL	Apr	16	5,747,345	3,273,691	10,406,169	0.0537	0.0554	0.0533
FL	Apr	17	5,636,021	3,182,448	10,224,599	0.0527	0.0539	0.0523
FL	Apr	18	5,499,025	3,076,297	9,966,284	0.0514	0.0521	0.0510
FL	Apr	19	5,565,173	3,123,280	10,085,034	0.0520	0.0529	0.0516
FL	Apr	20	5,249,717	2,916,414	9,379,352	0.0491	0.0494	0.0480
FL	Apr	21	4,676,711	2,548,574	8,349,346	0.0437	0.0431	0.0427
FL	Apr	22	4,085,358	2,156,831	7,180,264	0.0382	0.0365	0.0368
FL	Apr	23	3,472,742	1,805,817	6,258,356	0.0325	0.0306	0.0320
FL	May	0	3,326,795	1,616,442	6,064,855	0.0281	0.0262	0.0292
FL	May	1	3,039,934	1,466,219	5,722,859	0.0256	0.0237	0.0275
FL	May	2	2,875,087	1,383,514	5,511,885	0.0242	0.0224	0.0265
FL	May	3	2,805,215	1,349,812	5,436,296	0.0237	0.0218	0.0262
FL	May	4	2,925,111	1,419,558	5,587,227	0.0247	0.0230	0.0269
FL	May	5	3,310,211	1,647,323	6,084,579	0.0279	0.0267	0.0293
FL	May	6	3,613,515	1,829,481	6,474,592	0.0305	0.0296	0.0312
FL	May	7	4,112,896	2,091,150	7,118,987	0.0347	0.0338	0.0343
FL	May	8	4,723,020	2,464,573	8,082,604	0.0398	0.0399	0.0389
FL	May	9	5,299,044	2,811,031	9,070,995	0.0447	0.0455	0.0437
FL	May	10	5,706,734	3,039,074	9,862,622	0.0481	0.0492	0.0475
FL	May	11	6,030,558	3,227,787	10,499,703	0.0509	0.0522	0.0505
FL	May	12	6,263,770	3,385,820	10,897,017	0.0528	0.0548	0.0524
FL	May	13	6,446,397	3,492,920	11,144,147	0.0544	0.0565	0.0536
FL	May	14	6,543,458	3,558,781	11,309,808	0.0552	0.0576	0.0544
FL	May	15	6,614,706	3,583,476	11,374,785	0.0558	0.0580	0.0547
FL	May	16	6,562,714	3,553,849	11,330,486	0.0553	0.0575	0.0545
FL	May	17	6,427,404	3,442,964	11,098,178	0.0542	0.0557	0.0534
FL	May	18	6,181,112	3,276,351	10,751,974	0.0521	0.0530	0.0517
FL	May	19	6,139,862	3,238,277	10,691,352	0.0518	0.0524	0.0514
FL	May	20	5,893,410	3,067,363	10,097,821	0.0497	0.0496	0.0486
FL	May	21	5,287,670	2,690,286	9,149,571	0.0446	0.0435	0.0440
FL	May	22	4,599,556	2,287,025	7,794,463	0.0388	0.0370	0.0375
FL	May	23	3,861,183	1,888,530	6,647,187	0.0326	0.0306	0.0320
FL	Jun	0	3,334,119	1,623,321	6,030,237	0.0287	0.0271	0.0297
FL	Jun	1	3,042,173	1,477,781	5,675,625	0.0262	0.0247	0.0280
FL	Jun	2	2,871,886	1,395,072	5,469,455	0.0247	0.0233	0.0270
FL	Jun	3	2,808,510	1,364,334	5,407,215	0.0242	0.0228	0.0267
FL	Jun	4	2,878,822	1,415,032	5,509,409	0.0248	0.0237	0.0272
FL	Jun	5	3,119,955	1,566,763	5,839,325	0.0269	0.0262	0.0288
FL	Jun	6	3,404,220	1,735,684	6,254,804	0.0293	0.0290	0.0309
FL	Jun	7	4,032,166	2,035,794	7,016,218	0.0347	0.0340	0.0346
FL	Jun	8	4,776,825	2,462,038	8,031,552	0.0412	0.0412	0.0396
FL	Jun	9	5,423,465	2,825,843	9,043,192	0.0467	0.0473	0.0446
FL	Jun	10	5,815,644	3,070,394	9,883,174	0.0501	0.0513	0.0488
FL	Jun	11	6,093,639	3,216,302	10,461,280	0.0525	0.0538	0.0516
FL	Jun	12	6,247,754	3,312,468	10,811,077	0.0538	0.0554	0.0533
FL	Jun	13	6,320,569	3,356,495	10,962,083	0.0545	0.0561	0.0541
FL	Jun	14	6,341,297	3,367,293	10,985,575	0.0546	0.0563	0.0542
FL	Jun	15	6,344,416	3,369,723	10,982,417	0.0547	0.0563	0.0542

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			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Jun	16	6,269,294	3,320,859	10,860,559	0.0540	0.0555	0.0536
FL	Jun	17	6,120,897	3,218,578	10,637,320	0.0527	0.0538	0.0525
FL	Jun	18	5,922,533	3,097,039	10,290,936	0.0510	0.0518	0.0508
FL	Jun	19	5,845,292	3,040,879	10,168,724	0.0504	0.0508	0.0502
FL	Jun	20	5,689,872	2,925,963	9,695,671	0.0490	0.0489	0.0478
FL	Jun	21	5,131,651	2,575,186	8,588,464	0.0442	0.0431	0.0424
FL	Jun	22	4,444,503	2,187,491	7,527,536	0.0383	0.0366	0.0371
FL	Jun	23	3,789,487	1,841,308	6,584,364	0.0326	0.0308	0.0325
FL	Jul	0	3,575,775	1,727,375	6,473,654	0.0289	0.0276	0.0305
FL	Jul	1	3,231,898	1,562,357	6,065,421	0.0261	0.0250	0.0285
FL	Jul	2	3,057,902	1,477,501	5,858,455	0.0247	0.0236	0.0276
FL	Jul	3	2,974,058	1,438,242	5,770,235	0.0240	0.0230	0.0272
FL	Jul	4	3,053,015	1,480,314	5,869,580	0.0246	0.0237	0.0276
FL	Jul	5	3,325,632	1,634,831	6,179,486	0.0268	0.0262	0.0291
FL	Jul	6	3,613,376	1,799,944	6,528,285	0.0292	0.0288	0.0307
FL	Jul	7	4,246,867	2,096,989	7,276,877	0.0343	0.0336	0.0342
FL	Jul	8	5,069,730	2,544,519	8,299,636	0.0409	0.0407	0.0391
FL	Jul	9	5,740,767	2,923,651	9,388,410	0.0463	0.0468	0.0442
FL	Jul	10	6,186,872	3,176,179	10,346,853	0.0499	0.0508	0.0487
FL	Jul	11	6,503,084	3,330,370	10,857,354	0.0525	0.0533	0.0511
FL	Jul	12	6,647,623	3,431,257	11,223,802	0.0537	0.0549	0.0528
FL	Jul	13	6,737,151	3,484,978	11,394,602	0.0544	0.0558	0.0536
FL	Jul	14	6,778,167	3,495,377	11,454,929	0.0547	0.0559	0.0539
FL	Jul	15	6,758,177	3,484,708	11,429,250	0.0546	0.0558	0.0538
FL	Jul	16	6,679,320	3,434,352	11,299,820	0.0539	0.0549	0.0532
FL	Jul	17	6,539,832	3,347,206	11,082,596	0.0528	0.0536	0.0522
FL	Jul	18	6,335,429	3,246,664	10,752,871	0.0511	0.0519	0.0506
FL	Jul	19	6,236,519	3,181,356	10,486,444	0.0503	0.0509	0.0494
FL	Jul	20	6,045,983	3,064,615	10,047,487	0.0488	0.0490	0.0473
FL	Jul	21	5,518,680	2,743,333	9,067,924	0.0446	0.0439	0.0427
FL	Jul	22	4,869,850	2,380,279	8,127,752	0.0393	0.0381	0.0383
FL	Jul	23	4,143,043	2,013,772	7,196,712	0.0334	0.0322	0.0339
FL	Aug	0	3,564,393	1,781,146	6,534,802	0.0284	0.0276	0.0304
FL	Aug	1	3,276,121	1,613,514	6,181,075	0.0261	0.0250	0.0288
FL	Aug	2	3,100,454	1,529,078	5,969,374	0.0247	0.0237	0.0278
FL	Aug	3	3,052,193	1,498,961	5,901,660	0.0243	0.0232	0.0275
FL	Aug	4	3,179,466	1,572,152	6,057,681	0.0254	0.0243	0.0282
FL	Aug	5	3,552,813	1,774,970	6,500,915	0.0283	0.0275	0.0303
FL	Aug	6	3,836,397	1,946,107	6,840,145	0.0306	0.0301	0.0319
FL	Aug	7	4,360,651	2,201,808	7,491,447	0.0348	0.0341	0.0349
FL	Aug	8	5,147,287	2,615,712	8,415,064	0.0411	0.0405	0.0392
FL	Aug	9	5,851,181	3,045,606	9,440,418	0.0467	0.0472	0.0440
FL	Aug	10	6,280,147	3,278,659	10,326,913	0.0501	0.0508	0.0481
FL	Aug	11	6,574,423	3,434,963	10,940,166	0.0524	0.0532	0.0510
FL	Aug	12	6,728,198	3,523,530	11,253,235	0.0537	0.0546	0.0524
FL	Aug	13	6,802,676	3,570,035	11,389,350	0.0543	0.0553	0.0531
FL	Aug	14	6,811,688	3,579,043	11,441,662	0.0543	0.0554	0.0533
FL	Aug	15	6,807,926	3,589,688	11,446,440	0.0543	0.0556	0.0533
FL	Aug	16	6,728,261	3,547,074	11,342,046	0.0537	0.0549	0.0528
FL	Aug	17	6,590,840	3,459,057	11,113,844	0.0526	0.0536	0.0518
FL	Aug	18	6,406,482	3,356,251	10,830,083	0.0511	0.0520	0.0505
FL	Aug	19	6,374,766	3,331,776	10,715,705	0.0508	0.0516	0.0499
FL	Aug	20	6,083,356	3,144,413	10,114,289	0.0485	0.0487	0.0471

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Aug	21	5,460,832	2,778,636	9,148,809	0.0436	0.0430	0.0426
FL	Aug	22	4,740,533	2,377,352	8,125,071	0.0378	0.0368	0.0379
FL	Aug	23	4,073,852	2,023,312	7,117,022	0.0325	0.0313	0.0332
FL	Sep	0	3,295,486	1,683,032	6,357,252	0.0291	0.0281	0.0308
FL	Sep	1	3,054,328	1,544,844	6,027,816	0.0270	0.0258	0.0292
FL	Sep	2	2,909,071	1,470,927	5,840,466	0.0257	0.0246	0.0283
FL	Sep	3	2,848,662	1,439,026	5,769,383	0.0252	0.0240	0.0279
FL	Sep	4	2,985,098	1,516,893	5,976,600	0.0264	0.0253	0.0289
FL	Sep	5	3,413,573	1,762,053	6,558,840	0.0302	0.0294	0.0317
FL	Sep	6	3,693,072	1,927,679	6,928,814	0.0327	0.0322	0.0335
FL	Sep	7	4,056,408	2,104,073	7,379,883	0.0359	0.0351	0.0357
FL	Sep	8	4,636,127	2,448,223	8,179,183	0.0410	0.0409	0.0396
FL	Sep	9	5,147,884	2,756,871	9,025,355	0.0455	0.0460	0.0437
FL	Sep	10	5,478,304	2,958,241	9,788,328	0.0484	0.0494	0.0474
FL	Sep	11	5,747,325	3,097,586	10,302,132	0.0508	0.0517	0.0498
FL	Sep	12	5,907,674	3,199,328	10,642,966	0.0522	0.0534	0.0515
FL	Sep	13	6,019,188	3,261,256	10,812,176	0.0532	0.0544	0.0523
FL	Sep	14	6,059,976	3,280,405	10,903,981	0.0536	0.0548	0.0527
FL	Sep	15	6,064,459	3,290,948	10,906,861	0.0536	0.0549	0.0528
FL	Sep	16	6,006,647	3,254,683	10,822,329	0.0531	0.0543	0.0524
FL	Sep	17	5,876,036	3,171,578	10,598,132	0.0520	0.0529	0.0513
FL	Sep	18	5,822,108	3,118,206	10,463,069	0.0515	0.0520	0.0506
FL	Sep	19	5,797,575	3,093,577	10,346,960	0.0513	0.0516	0.0501
FL	Sep	20	5,414,502	2,869,423	9,652,916	0.0479	0.0479	0.0467
FL	Sep	21	4,853,029	2,546,396	8,714,372	0.0429	0.0425	0.0422
FL	Sep	22	4,293,776	2,222,527	7,824,944	0.0380	0.0371	0.0379
FL	Sep	23	3,700,481	1,895,950	6,890,195	0.0327	0.0316	0.0333
FL	Oct	0	3,104,734	1,651,439	6,268,709	0.0282	0.0268	0.0303
FL	Oct	1	2,862,531	1,530,723	5,950,210	0.0260	0.0249	0.0288
FL	Oct	2	2,742,880	1,464,239	5,745,508	0.0249	0.0238	0.0278
FL	Oct	3	2,709,592	1,446,897	5,673,751	0.0246	0.0235	0.0274
FL	Oct	4	2,849,720	1,533,459	5,866,761	0.0259	0.0249	0.0284
FL	Oct	5	3,313,322	1,844,985	6,602,870	0.0301	0.0300	0.0319
FL	Oct	6	3,695,928	2,074,978	7,203,247	0.0336	0.0337	0.0348
FL	Oct	7	3,974,216	2,235,297	7,565,209	0.0361	0.0363	0.0366
FL	Oct	8	4,429,740	2,515,143	8,198,854	0.0403	0.0409	0.0396
FL	Oct	9	4,882,509	2,807,084	8,993,535	0.0444	0.0456	0.0435
FL	Oct	10	5,202,215	2,991,865	9,637,381	0.0473	0.0486	0.0466
FL	Oct	11	5,474,511	3,162,491	10,194,001	0.0498	0.0514	0.0493
FL	Oct	12	5,678,861	3,277,154	10,535,313	0.0516	0.0532	0.0509
FL	Oct	13	5,837,087	3,344,772	10,753,557	0.0531	0.0543	0.0520
FL	Oct	14	5,945,864	3,397,996	10,895,397	0.0541	0.0552	0.0527
FL	Oct	15	5,991,411	3,424,548	10,944,894	0.0545	0.0556	0.0529
FL	Oct	16	5,949,385	3,372,697	10,837,382	0.0541	0.0548	0.0524
FL	Oct	17	5,848,989	3,309,247	10,653,810	0.0532	0.0538	0.0515
FL	Oct	18	5,901,087	3,332,412	10,819,210	0.0537	0.0541	0.0523
FL	Oct	19	5,694,397	3,193,654	10,459,446	0.0518	0.0519	0.0505
FL	Oct	20	5,260,538	2,914,173	9,707,974	0.0478	0.0473	0.0469
FL	Oct	21	4,791,615	2,599,563	8,698,668	0.0436	0.0422	0.0420
FL	Oct	22	4,225,071	2,247,514	7,851,632	0.0384	0.0365	0.0379
FL	Oct	23	3,594,624	1,878,981	6,866,853	0.0327	0.0305	0.0332
FL	Nov	0	3,044,968	1,618,401	5,819,531	0.0299	0.0290	0.0311
FL	Nov	1	2,777,594	1,468,989	5,512,673	0.0273	0.0263	0.0295

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
FL	Nov	2	2,653,691	1,395,551	5,353,049	0.0261	0.0250	0.0286
FL	Nov	3	2,586,368	1,355,820	5,261,410	0.0254	0.0243	0.0281
FL	Nov	4	2,598,990	1,378,455	5,353,885	0.0255	0.0247	0.0286
FL	Nov	5	2,819,377	1,506,116	5,782,260	0.0277	0.0270	0.0309
FL	Nov	6	3,302,710	1,792,289	6,614,270	0.0324	0.0321	0.0354
FL	Nov	7	3,734,201	2,034,922	7,193,222	0.0367	0.0364	0.0385
FL	Nov	8	4,072,530	2,217,271	7,562,409	0.0400	0.0397	0.0404
FL	Nov	9	4,497,804	2,477,548	7,992,516	0.0442	0.0444	0.0427
FL	Nov	10	4,816,543	2,669,967	8,478,717	0.0473	0.0478	0.0453
FL	Nov	11	4,973,313	2,782,983	8,868,292	0.0489	0.0498	0.0474
FL	Nov	12	5,118,667	2,866,930	9,226,948	0.0503	0.0513	0.0493
FL	Nov	13	5,187,656	2,908,628	9,435,498	0.0510	0.0521	0.0505
FL	Nov	14	5,207,361	2,925,067	9,516,005	0.0512	0.0524	0.0509
FL	Nov	15	5,186,047	2,916,563	9,510,674	0.0510	0.0522	0.0509
FL	Nov	16	5,165,234	2,887,608	9,415,200	0.0507	0.0517	0.0504
FL	Nov	17	5,372,940	2,950,688	9,536,043	0.0528	0.0528	0.0510
FL	Nov	18	5,786,071	3,242,415	10,104,293	0.0568	0.0580	0.0540
FL	Nov	19	5,502,445	3,071,543	9,685,622	0.0541	0.0550	0.0518
FL	Nov	20	5,083,579	2,787,902	8,950,110	0.0499	0.0499	0.0479
FL	Nov	21	4,606,891	2,501,085	8,062,198	0.0453	0.0448	0.0431
FL	Nov	22	4,121,388	2,198,178	7,242,891	0.0405	0.0394	0.0387
FL	Nov	23	3,565,017	1,906,796	6,506,948	0.0350	0.0341	0.0348
FL	Dec	0	3,867,036	1,958,903	6,697,383	0.0335	0.0323	0.0339
FL	Dec	1	3,646,266	1,827,185	6,449,122	0.0315	0.0302	0.0326
FL	Dec	2	3,531,691	1,771,459	6,333,062	0.0306	0.0292	0.0321
FL	Dec	3	3,530,144	1,784,984	6,386,244	0.0305	0.0295	0.0323
FL	Dec	4	3,591,211	1,829,544	6,604,823	0.0311	0.0302	0.0334
FL	Dec	5	3,878,589	2,007,700	7,188,348	0.0336	0.0331	0.0364
FL	Dec	6	4,514,013	2,346,050	8,223,759	0.0391	0.0387	0.0416
FL	Dec	7	5,015,086	2,616,065	8,843,233	0.0434	0.0432	0.0448
FL	Dec	8	5,230,443	2,748,219	9,012,759	0.0453	0.0454	0.0456
FL	Dec	9	5,364,090	2,830,596	9,011,280	0.0464	0.0467	0.0456
FL	Dec	10	5,394,263	2,883,931	8,907,500	0.0467	0.0476	0.0451
FL	Dec	11	5,246,008	2,804,416	8,686,481	0.0454	0.0463	0.0440
FL	Dec	12	5,131,615	2,728,167	8,552,591	0.0444	0.0450	0.0433
FL	Dec	13	5,010,970	2,670,246	8,458,189	0.0434	0.0441	0.0428
FL	Dec	14	4,860,948	2,552,274	8,308,360	0.0421	0.0421	0.0420
FL	Dec	15	4,796,664	2,524,132	8,249,553	0.0415	0.0417	0.0418
FL	Dec	16	4,920,343	2,580,134	8,347,312	0.0426	0.0426	0.0422
FL	Dec	17	5,445,792	2,859,955	9,027,178	0.0471	0.0472	0.0457
FL	Dec	18	6,101,562	3,267,980	10,037,688	0.0528	0.0540	0.0508
FL	Dec	19	5,991,902	3,205,477	9,967,374	0.0518	0.0529	0.0504
FL	Dec	20	5,759,969	3,055,643	9,593,120	0.0498	0.0505	0.0486
FL	Dec	21	5,416,896	2,849,012	9,004,299	0.0469	0.0470	0.0456
FL	Dec	22	4,967,136	2,594,369	8,264,178	0.0430	0.0428	0.0418
FL	Dec	23	4,376,102	2,270,002	7,438,294	0.0379	0.0375	0.0376
GA	Jan	0	4,233,689	1,304,214	3,602,490	0.0380	0.0369	0.0355
GA	Jan	1	4,069,755	1,242,993	3,360,124	0.0365	0.0352	0.0331
GA	Jan	2	4,036,727	1,236,644	3,363,390	0.0362	0.0350	0.0331
GA	Jan	3	4,084,970	1,261,863	3,490,189	0.0367	0.0357	0.0344
GA	Jan	4	4,187,679	1,305,573	3,674,953	0.0376	0.0370	0.0362
GA	Jan	5	4,413,590	1,397,250	4,080,038	0.0396	0.0396	0.0402
GA	Jan	6	4,762,719	1,532,193	4,632,863	0.0428	0.0434	0.0456

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Jan	7	4,959,825	1,614,529	5,048,216	0.0445	0.0457	0.0497
GA	Jan	8	4,980,466	1,638,500	5,145,586	0.0447	0.0464	0.0507
GA	Jan	9	5,038,432	1,636,170	5,034,586	0.0452	0.0464	0.0496
GA	Jan	10	5,027,956	1,623,096	4,814,350	0.0451	0.0460	0.0474
GA	Jan	11	4,917,419	1,577,624	4,517,124	0.0441	0.0447	0.0445
GA	Jan	12	4,785,959	1,518,170	4,183,606	0.0430	0.0430	0.0412
GA	Jan	13	4,654,797	1,472,083	4,005,913	0.0418	0.0417	0.0394
GA	Jan	14	4,502,347	1,414,721	3,869,244	0.0404	0.0401	0.0381
GA	Jan	15	4,421,647	1,382,037	3,798,692	0.0397	0.0392	0.0374
GA	Jan	16	4,411,331	1,378,984	3,815,287	0.0396	0.0391	0.0376
GA	Jan	17	4,600,671	1,441,859	4,086,980	0.0413	0.0408	0.0402
GA	Jan	18	5,002,493	1,594,476	4,576,213	0.0449	0.0452	0.0451
GA	Jan	19	5,009,244	1,604,307	4,711,802	0.0450	0.0454	0.0464
GA	Jan	20	4,965,073	1,590,262	4,702,389	0.0446	0.0450	0.0463
GA	Jan	21	4,963,539	1,581,832	4,629,572	0.0446	0.0448	0.0456
GA	Jan	22	4,817,725	1,531,220	4,449,776	0.0433	0.0434	0.0438
GA	Jan	23	4,533,780	1,419,571	3,985,482	0.0407	0.0402	0.0392
GA	Feb	0	3,774,340	1,130,138	2,958,453	0.0382	0.0368	0.0341
GA	Feb	1	3,574,504	1,067,150	2,758,105	0.0361	0.0348	0.0318
GA	Feb	2	3,492,743	1,051,378	2,710,799	0.0353	0.0343	0.0313
GA	Feb	3	3,526,641	1,070,488	2,777,636	0.0357	0.0349	0.0320
GA	Feb	4	3,588,548	1,096,820	2,928,871	0.0363	0.0358	0.0338
GA	Feb	5	3,775,058	1,177,114	3,298,174	0.0382	0.0384	0.0380
GA	Feb	6	4,167,738	1,314,960	3,899,627	0.0421	0.0429	0.0450
GA	Feb	7	4,340,787	1,386,477	4,218,243	0.0439	0.0452	0.0486
GA	Feb	8	4,371,863	1,400,001	4,243,185	0.0442	0.0456	0.0489
GA	Feb	9	4,433,066	1,403,554	4,174,920	0.0448	0.0458	0.0481
GA	Feb	10	4,443,237	1,396,970	4,068,977	0.0449	0.0455	0.0469
GA	Feb	11	4,425,360	1,378,942	3,983,664	0.0447	0.0449	0.0459
GA	Feb	12	4,357,426	1,352,110	3,864,261	0.0441	0.0441	0.0446
GA	Feb	13	4,280,320	1,327,913	3,729,155	0.0433	0.0433	0.0430
GA	Feb	14	4,184,175	1,305,094	3,640,022	0.0423	0.0425	0.0420
GA	Feb	15	4,114,094	1,273,613	3,589,221	0.0416	0.0415	0.0414
GA	Feb	16	4,070,973	1,262,909	3,578,142	0.0412	0.0412	0.0413
GA	Feb	17	4,106,193	1,266,073	3,628,022	0.0415	0.0413	0.0418
GA	Feb	18	4,346,078	1,348,178	3,895,020	0.0439	0.0439	0.0449
GA	Feb	19	4,492,274	1,404,199	4,038,269	0.0454	0.0458	0.0466
GA	Feb	20	4,424,737	1,379,514	3,981,189	0.0447	0.0450	0.0459
GA	Feb	21	4,374,151	1,361,595	3,873,017	0.0442	0.0444	0.0447
GA	Feb	22	4,233,273	1,307,169	3,626,230	0.0428	0.0426	0.0418
GA	Feb	23	3,998,749	1,216,302	3,255,135	0.0404	0.0396	0.0375
GA	Mar	0	3,997,495	1,189,785	3,154,773	0.0375	0.0360	0.0342
GA	Mar	1	3,738,974	1,109,156	2,891,616	0.0351	0.0335	0.0313
GA	Mar	2	3,585,477	1,068,313	2,786,741	0.0337	0.0323	0.0302
GA	Mar	3	3,558,898	1,065,843	2,798,856	0.0334	0.0322	0.0303
GA	Mar	4	3,615,956	1,100,086	2,984,181	0.0340	0.0333	0.0324
GA	Mar	5	3,893,344	1,195,768	3,355,232	0.0366	0.0361	0.0364
GA	Mar	6	4,365,454	1,374,678	3,958,846	0.0410	0.0416	0.0429
GA	Mar	7	4,537,585	1,441,590	4,213,546	0.0426	0.0436	0.0457
GA	Mar	8	4,623,927	1,467,417	4,258,813	0.0434	0.0444	0.0462
GA	Mar	9	4,776,001	1,511,176	4,314,932	0.0449	0.0457	0.0468
GA	Mar	10	4,832,769	1,529,287	4,307,109	0.0454	0.0462	0.0467
GA	Mar	11	4,820,067	1,525,683	4,301,294	0.0453	0.0461	0.0466

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Mar	12	4,809,839	1,512,714	4,247,577	0.0452	0.0457	0.0460
GA	Mar	13	4,757,300	1,489,644	4,136,289	0.0447	0.0450	0.0448
GA	Mar	14	4,717,782	1,477,282	4,099,208	0.0443	0.0447	0.0444
GA	Mar	15	4,713,095	1,473,379	4,102,564	0.0443	0.0445	0.0445
GA	Mar	16	4,686,402	1,463,323	4,082,266	0.0440	0.0442	0.0443
GA	Mar	17	4,618,436	1,432,837	4,026,578	0.0434	0.0433	0.0437
GA	Mar	18	4,641,666	1,440,117	4,064,085	0.0436	0.0435	0.0441
GA	Mar	19	4,892,867	1,544,277	4,351,853	0.0459	0.0467	0.0472
GA	Mar	20	4,811,260	1,515,075	4,312,097	0.0452	0.0458	0.0467
GA	Mar	21	4,690,833	1,461,199	4,130,124	0.0441	0.0442	0.0448
GA	Mar	22	4,519,180	1,390,013	3,859,115	0.0424	0.0420	0.0418
GA	Mar	23	4,280,676	1,300,423	3,505,280	0.0402	0.0393	0.0380
GA	Apr	0	3,564,230	971,430	2,917,929	0.0346	0.0324	0.0282
GA	Apr	1	3,339,119	905,329	2,732,239	0.0324	0.0302	0.0264
GA	Apr	2	3,241,743	877,514	2,678,089	0.0315	0.0292	0.0259
GA	Apr	3	3,255,517	885,104	2,714,157	0.0316	0.0295	0.0263
GA	Apr	4	3,457,823	952,887	2,963,657	0.0336	0.0318	0.0287
GA	Apr	5	3,961,985	1,135,362	3,481,924	0.0385	0.0378	0.0337
GA	Apr	6	4,241,795	1,229,424	3,813,166	0.0412	0.0410	0.0369
GA	Apr	7	4,401,604	1,275,710	3,966,276	0.0427	0.0425	0.0384
GA	Apr	8	4,554,260	1,326,462	4,085,351	0.0442	0.0442	0.0395
GA	Apr	9	4,655,368	1,359,978	4,229,157	0.0452	0.0453	0.0409
GA	Apr	10	4,708,373	1,401,019	4,580,473	0.0457	0.0467	0.0443
GA	Apr	11	4,703,864	1,410,975	4,870,975	0.0457	0.0470	0.0471
GA	Apr	12	4,706,411	1,424,680	5,117,829	0.0457	0.0475	0.0495
GA	Apr	13	4,716,791	1,439,289	5,394,576	0.0458	0.0480	0.0522
GA	Apr	14	4,720,339	1,442,419	5,451,060	0.0458	0.0481	0.0528
GA	Apr	15	4,735,104	1,448,755	5,561,599	0.0460	0.0483	0.0538
GA	Apr	16	4,703,517	1,431,275	5,545,151	0.0457	0.0477	0.0537
GA	Apr	17	4,610,615	1,381,529	5,419,379	0.0448	0.0460	0.0525
GA	Apr	18	4,491,048	1,325,156	5,255,384	0.0436	0.0442	0.0509
GA	Apr	19	4,686,475	1,395,209	5,312,978	0.0455	0.0465	0.0514
GA	Apr	20	4,775,348	1,416,077	5,255,071	0.0464	0.0472	0.0509
GA	Apr	21	4,585,231	1,323,660	4,778,860	0.0445	0.0441	0.0463
GA	Apr	22	4,269,437	1,191,494	3,936,623	0.0415	0.0397	0.0381
GA	Apr	23	3,888,147	1,058,123	3,262,708	0.0378	0.0353	0.0316
GA	May	0	3,651,805	808,018	2,983,275	0.0347	0.0311	0.0279
GA	May	1	3,436,095	746,479	2,781,290	0.0326	0.0287	0.0260
GA	May	2	3,348,132	717,894	2,702,478	0.0318	0.0276	0.0253
GA	May	3	3,334,788	713,170	2,703,132	0.0317	0.0275	0.0253
GA	May	4	3,446,730	753,127	2,848,337	0.0327	0.0290	0.0266
GA	May	5	3,779,436	863,032	3,208,566	0.0359	0.0332	0.0300
GA	May	6	3,987,086	944,548	3,517,897	0.0379	0.0364	0.0329
GA	May	7	4,163,886	1,018,931	3,905,273	0.0395	0.0392	0.0365
GA	May	8	4,424,183	1,094,434	4,219,525	0.0420	0.0421	0.0395
GA	May	9	4,670,900	1,173,432	4,529,682	0.0444	0.0452	0.0424
GA	May	10	4,843,085	1,236,541	4,850,410	0.0460	0.0476	0.0454
GA	May	11	4,924,055	1,267,461	5,178,330	0.0468	0.0488	0.0484
GA	May	12	4,964,755	1,294,195	5,474,421	0.0472	0.0498	0.0512
GA	May	13	4,991,458	1,317,943	5,747,084	0.0474	0.0508	0.0537
GA	May	14	5,029,247	1,331,694	5,932,574	0.0478	0.0513	0.0555
GA	May	15	5,034,896	1,332,001	6,003,879	0.0478	0.0513	0.0561
GA	May	16	5,003,154	1,314,935	5,970,214	0.0475	0.0506	0.0558

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	May	17	4,914,107	1,273,901	5,778,889	0.0467	0.0491	0.0540
GA	May	18	4,762,392	1,216,180	5,526,261	0.0452	0.0468	0.0517
GA	May	19	4,735,841	1,205,339	5,405,658	0.0450	0.0464	0.0505
GA	May	20	4,900,591	1,254,824	5,403,299	0.0465	0.0483	0.0505
GA	May	21	4,668,636	1,164,526	4,883,439	0.0443	0.0448	0.0457
GA	May	22	4,315,373	1,023,301	4,023,238	0.0410	0.0394	0.0376
GA	May	23	3,963,186	903,119	3,375,443	0.0376	0.0348	0.0316
GA	Jun	0	3,539,056	783,143	2,898,646	0.0346	0.0317	0.0273
GA	Jun	1	3,342,924	724,888	2,707,026	0.0327	0.0293	0.0255
GA	Jun	2	3,238,457	691,664	2,613,966	0.0317	0.0280	0.0247
GA	Jun	3	3,198,469	679,105	2,581,471	0.0313	0.0275	0.0244
GA	Jun	4	3,277,062	705,914	2,687,844	0.0320	0.0285	0.0254
GA	Jun	5	3,467,538	758,652	2,875,700	0.0339	0.0307	0.0271
GA	Jun	6	3,611,886	809,678	3,072,767	0.0353	0.0327	0.0290
GA	Jun	7	3,857,779	897,104	3,406,586	0.0377	0.0363	0.0321
GA	Jun	8	4,163,525	988,231	3,773,158	0.0407	0.0399	0.0356
GA	Jun	9	4,513,208	1,097,174	4,254,964	0.0441	0.0443	0.0401
GA	Jun	10	4,782,141	1,192,779	4,820,628	0.0468	0.0482	0.0455
GA	Jun	11	4,920,265	1,247,510	5,332,737	0.0481	0.0504	0.0503
GA	Jun	12	4,957,509	1,278,881	5,769,697	0.0485	0.0517	0.0544
GA	Jun	13	4,981,459	1,297,463	6,002,578	0.0487	0.0524	0.0566
GA	Jun	14	4,986,980	1,294,551	6,099,520	0.0488	0.0523	0.0575
GA	Jun	15	4,989,560	1,292,507	6,153,735	0.0488	0.0522	0.0581
GA	Jun	16	4,952,392	1,274,892	6,091,568	0.0484	0.0515	0.0575
GA	Jun	17	4,836,568	1,235,405	5,954,563	0.0473	0.0499	0.0562
GA	Jun	18	4,705,878	1,189,573	5,785,139	0.0460	0.0481	0.0546
GA	Jun	19	4,618,851	1,158,250	5,588,600	0.0452	0.0468	0.0527
GA	Jun	20	4,756,115	1,183,186	5,416,940	0.0465	0.0478	0.0511
GA	Jun	21	4,552,378	1,108,365	4,893,067	0.0445	0.0448	0.0462
GA	Jun	22	4,199,228	988,296	3,994,790	0.0411	0.0399	0.0377
GA	Jun	23	3,822,417	861,775	3,230,562	0.0374	0.0348	0.0305
GA	Jul	0	3,916,819	877,213	3,541,583	0.0359	0.0325	0.0293
GA	Jul	1	3,650,716	805,041	3,167,031	0.0335	0.0299	0.0262
GA	Jul	2	3,514,882	765,635	3,014,404	0.0323	0.0284	0.0249
GA	Jul	3	3,452,895	747,095	2,961,853	0.0317	0.0277	0.0245
GA	Jul	4	3,511,223	767,987	3,045,310	0.0322	0.0285	0.0252
GA	Jul	5	3,704,041	826,229	3,250,414	0.0340	0.0307	0.0269
GA	Jul	6	3,829,278	867,426	3,468,228	0.0351	0.0322	0.0287
GA	Jul	7	4,091,703	953,981	3,809,941	0.0376	0.0354	0.0315
GA	Jul	8	4,457,430	1,077,515	4,336,979	0.0409	0.0400	0.0359
GA	Jul	9	4,806,955	1,207,677	4,964,175	0.0441	0.0448	0.0411
GA	Jul	10	5,036,079	1,300,925	5,666,292	0.0462	0.0483	0.0469
GA	Jul	11	5,155,520	1,349,260	6,155,695	0.0473	0.0501	0.0509
GA	Jul	12	5,177,825	1,371,464	6,492,532	0.0475	0.0509	0.0537
GA	Jul	13	5,175,246	1,379,488	6,643,936	0.0475	0.0512	0.0550
GA	Jul	14	5,194,096	1,376,909	6,701,037	0.0477	0.0511	0.0554
GA	Jul	15	5,193,852	1,371,416	6,710,450	0.0477	0.0509	0.0555
GA	Jul	16	5,171,250	1,361,059	6,684,938	0.0475	0.0505	0.0553
GA	Jul	17	5,116,520	1,335,488	6,577,580	0.0470	0.0495	0.0544
GA	Jul	18	5,034,524	1,301,262	6,433,627	0.0462	0.0483	0.0532
GA	Jul	19	4,973,180	1,280,116	6,269,343	0.0456	0.0475	0.0519
GA	Jul	20	5,062,736	1,303,367	6,155,679	0.0465	0.0484	0.0509
GA	Jul	21	4,866,836	1,225,906	5,752,022	0.0447	0.0455	0.0476

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Jul	22	4,604,811	1,113,275	4,995,747	0.0423	0.0413	0.0413
GA	Jul	23	4,258,902	986,882	4,079,119	0.0391	0.0366	0.0337
GA	Aug	0	3,899,937	855,590	3,426,179	0.0359	0.0321	0.0285
GA	Aug	1	3,645,352	794,616	3,103,869	0.0335	0.0298	0.0258
GA	Aug	2	3,506,094	756,285	2,972,926	0.0322	0.0284	0.0247
GA	Aug	3	3,440,903	742,445	2,933,373	0.0316	0.0279	0.0244
GA	Aug	4	3,532,488	773,278	3,076,898	0.0325	0.0290	0.0256
GA	Aug	5	3,841,756	865,886	3,377,050	0.0353	0.0325	0.0281
GA	Aug	6	3,988,737	913,918	3,599,891	0.0367	0.0343	0.0300
GA	Aug	7	4,115,834	961,077	3,859,834	0.0378	0.0361	0.0321
GA	Aug	8	4,410,849	1,055,034	4,285,284	0.0406	0.0396	0.0357
GA	Aug	9	4,741,335	1,174,399	4,876,520	0.0436	0.0441	0.0406
GA	Aug	10	4,972,801	1,268,303	5,513,837	0.0457	0.0476	0.0459
GA	Aug	11	5,072,919	1,309,543	6,015,051	0.0466	0.0492	0.0500
GA	Aug	12	5,114,743	1,343,072	6,406,516	0.0470	0.0504	0.0533
GA	Aug	13	5,141,330	1,358,804	6,585,912	0.0473	0.0510	0.0548
GA	Aug	14	5,194,964	1,370,203	6,668,961	0.0478	0.0514	0.0555
GA	Aug	15	5,222,165	1,375,254	6,718,781	0.0480	0.0516	0.0559
GA	Aug	16	5,185,128	1,355,869	6,691,244	0.0477	0.0509	0.0557
GA	Aug	17	5,103,254	1,324,349	6,589,148	0.0469	0.0497	0.0548
GA	Aug	18	5,003,743	1,282,766	6,434,687	0.0460	0.0482	0.0535
GA	Aug	19	5,063,989	1,295,580	6,373,416	0.0466	0.0486	0.0530
GA	Aug	20	5,089,131	1,292,450	6,247,038	0.0468	0.0485	0.0520
GA	Aug	21	4,795,709	1,169,200	5,654,475	0.0441	0.0439	0.0470
GA	Aug	22	4,486,241	1,051,342	4,812,187	0.0413	0.0395	0.0400
GA	Aug	23	4,182,935	950,486	3,967,411	0.0385	0.0357	0.0330
GA	Sep	0	3,374,537	727,276	2,859,911	0.0345	0.0310	0.0275
GA	Sep	1	3,210,218	685,875	2,683,783	0.0328	0.0292	0.0258
GA	Sep	2	3,153,568	669,187	2,627,830	0.0322	0.0285	0.0252
GA	Sep	3	3,131,174	663,527	2,613,517	0.0320	0.0283	0.0251
GA	Sep	4	3,244,687	699,243	2,761,757	0.0331	0.0298	0.0265
GA	Sep	5	3,548,272	789,280	3,064,049	0.0362	0.0336	0.0294
GA	Sep	6	3,745,576	852,643	3,280,593	0.0383	0.0363	0.0315
GA	Sep	7	3,794,073	881,809	3,444,831	0.0387	0.0375	0.0331
GA	Sep	8	4,002,588	949,104	3,767,079	0.0409	0.0404	0.0362
GA	Sep	9	4,256,241	1,033,429	4,083,764	0.0435	0.0440	0.0392
GA	Sep	10	4,451,006	1,107,189	4,569,307	0.0455	0.0471	0.0439
GA	Sep	11	4,564,647	1,152,980	5,152,056	0.0466	0.0491	0.0495
GA	Sep	12	4,608,962	1,177,435	5,560,161	0.0471	0.0501	0.0534
GA	Sep	13	4,627,153	1,190,764	5,783,572	0.0473	0.0507	0.0556
GA	Sep	14	4,681,501	1,200,116	5,879,271	0.0478	0.0511	0.0565
GA	Sep	15	4,695,492	1,198,842	5,967,405	0.0480	0.0510	0.0573
GA	Sep	16	4,669,153	1,187,923	5,976,244	0.0477	0.0506	0.0574
GA	Sep	17	4,567,468	1,149,742	5,805,500	0.0466	0.0490	0.0558
GA	Sep	18	4,539,377	1,132,314	5,675,597	0.0464	0.0482	0.0545
GA	Sep	19	4,694,527	1,184,088	5,733,354	0.0479	0.0504	0.0551
GA	Sep	20	4,599,510	1,143,616	5,342,792	0.0470	0.0487	0.0513
GA	Sep	21	4,262,360	1,017,576	4,559,609	0.0435	0.0433	0.0438
GA	Sep	22	3,883,605	889,294	3,697,881	0.0397	0.0379	0.0355
GA	Sep	23	3,613,029	804,234	3,182,885	0.0369	0.0342	0.0306
GA	Oct	0	3,424,077	966,476	2,726,697	0.0337	0.0318	0.0283
GA	Oct	1	3,252,068	915,461	2,577,881	0.0320	0.0301	0.0267
GA	Oct	2	3,176,936	892,948	2,520,048	0.0313	0.0294	0.0261

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Oct	3	3,175,461	897,825	2,557,847	0.0313	0.0296	0.0265
GA	Oct	4	3,348,361	956,620	2,744,659	0.0330	0.0315	0.0285
GA	Oct	5	3,820,292	1,114,324	3,199,393	0.0376	0.0367	0.0332
GA	Oct	6	4,202,916	1,250,409	3,611,767	0.0414	0.0412	0.0374
GA	Oct	7	4,204,944	1,270,721	3,743,463	0.0414	0.0418	0.0388
GA	Oct	8	4,409,792	1,330,379	3,923,733	0.0434	0.0438	0.0407
GA	Oct	9	4,595,307	1,397,727	4,201,872	0.0453	0.0460	0.0436
GA	Oct	10	4,711,321	1,433,500	4,428,597	0.0464	0.0472	0.0459
GA	Oct	11	4,738,024	1,443,424	4,583,088	0.0467	0.0475	0.0475
GA	Oct	12	4,760,172	1,455,292	4,826,392	0.0469	0.0479	0.0500
GA	Oct	13	4,758,664	1,464,295	5,010,417	0.0469	0.0482	0.0519
GA	Oct	14	4,763,471	1,465,501	5,158,158	0.0469	0.0483	0.0535
GA	Oct	15	4,717,659	1,449,246	5,136,118	0.0465	0.0477	0.0533
GA	Oct	16	4,611,236	1,407,859	5,035,569	0.0454	0.0464	0.0522
GA	Oct	17	4,512,979	1,370,102	4,912,889	0.0444	0.0451	0.0509
GA	Oct	18	4,768,229	1,449,458	5,048,325	0.0470	0.0477	0.0523
GA	Oct	19	4,762,668	1,452,551	5,052,950	0.0469	0.0478	0.0524
GA	Oct	20	4,639,316	1,405,279	4,762,206	0.0457	0.0463	0.0494
GA	Oct	21	4,410,969	1,314,796	4,141,260	0.0434	0.0433	0.0429
GA	Oct	22	4,061,281	1,194,468	3,501,240	0.0400	0.0393	0.0363
GA	Oct	23	3,710,386	1,070,787	3,048,189	0.0365	0.0353	0.0316
GA	Nov	0	3,339,248	974,946	2,619,608	0.0356	0.0345	0.0334
GA	Nov	1	3,104,177	907,681	2,423,547	0.0331	0.0322	0.0309
GA	Nov	2	3,020,999	886,724	2,355,047	0.0322	0.0314	0.0300
GA	Nov	3	3,013,150	886,579	2,353,815	0.0321	0.0314	0.0300
GA	Nov	4	3,066,621	906,274	2,421,072	0.0327	0.0321	0.0309
GA	Nov	5	3,294,479	981,968	2,662,847	0.0351	0.0348	0.0339
GA	Nov	6	3,768,468	1,133,368	3,123,551	0.0402	0.0402	0.0398
GA	Nov	7	4,045,097	1,235,041	3,506,006	0.0431	0.0438	0.0447
GA	Nov	8	4,161,953	1,273,471	3,644,833	0.0444	0.0451	0.0465
GA	Nov	9	4,287,329	1,310,591	3,701,404	0.0457	0.0464	0.0472
GA	Nov	10	4,331,493	1,317,657	3,655,153	0.0462	0.0467	0.0466
GA	Nov	11	4,297,831	1,314,550	3,618,832	0.0458	0.0466	0.0461
GA	Nov	12	4,228,371	1,283,989	3,561,181	0.0451	0.0455	0.0454
GA	Nov	13	4,165,705	1,260,147	3,531,828	0.0444	0.0446	0.0450
GA	Nov	14	4,131,484	1,247,108	3,519,628	0.0441	0.0442	0.0449
GA	Nov	15	4,062,566	1,219,187	3,486,301	0.0433	0.0432	0.0444
GA	Nov	16	4,031,658	1,215,620	3,499,167	0.0430	0.0431	0.0446
GA	Nov	17	4,213,972	1,274,386	3,628,985	0.0449	0.0452	0.0463
GA	Nov	18	4,521,904	1,386,003	3,960,477	0.0482	0.0491	0.0505
GA	Nov	19	4,382,118	1,337,215	3,843,649	0.0467	0.0474	0.0490
GA	Nov	20	4,320,515	1,309,486	3,677,802	0.0461	0.0464	0.0469
GA	Nov	21	4,240,784	1,275,965	3,501,895	0.0452	0.0452	0.0446
GA	Nov	22	4,064,271	1,209,613	3,259,259	0.0433	0.0429	0.0416
GA	Nov	23	3,665,672	1,075,833	2,883,966	0.0391	0.0381	0.0368
GA	Dec	0	3,837,633	1,131,780	3,093,718	0.0380	0.0370	0.0351
GA	Dec	1	3,672,392	1,082,553	2,924,854	0.0364	0.0354	0.0332
GA	Dec	2	3,621,449	1,073,040	2,894,487	0.0359	0.0351	0.0328
GA	Dec	3	3,640,778	1,080,398	2,937,894	0.0360	0.0353	0.0333
GA	Dec	4	3,721,883	1,112,084	3,085,335	0.0368	0.0364	0.0350
GA	Dec	5	3,910,893	1,178,593	3,433,534	0.0387	0.0386	0.0389
GA	Dec	6	4,226,394	1,282,594	3,879,233	0.0418	0.0420	0.0440
GA	Dec	7	4,482,590	1,370,859	4,255,348	0.0444	0.0448	0.0482

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
GA	Dec	8	4,558,899	1,409,269	4,358,639	0.0451	0.0461	0.0494
GA	Dec	9	4,612,392	1,424,630	4,293,378	0.0457	0.0466	0.0487
GA	Dec	10	4,573,677	1,403,007	4,160,159	0.0453	0.0459	0.0472
GA	Dec	11	4,458,898	1,355,399	3,887,129	0.0441	0.0443	0.0441
GA	Dec	12	4,308,783	1,297,717	3,629,673	0.0427	0.0424	0.0411
GA	Dec	13	4,156,484	1,255,626	3,506,045	0.0412	0.0411	0.0397
GA	Dec	14	4,015,529	1,210,667	3,411,210	0.0398	0.0396	0.0387
GA	Dec	15	3,959,067	1,196,777	3,433,052	0.0392	0.0391	0.0389
GA	Dec	16	4,005,596	1,213,230	3,525,463	0.0397	0.0397	0.0400
GA	Dec	17	4,309,394	1,323,255	3,849,614	0.0427	0.0433	0.0436
GA	Dec	18	4,666,711	1,437,174	4,246,551	0.0462	0.0470	0.0481
GA	Dec	19	4,572,719	1,403,027	4,144,171	0.0453	0.0459	0.0470
GA	Dec	20	4,548,095	1,387,602	4,091,091	0.0450	0.0454	0.0464
GA	Dec	21	4,571,509	1,388,237	4,027,651	0.0453	0.0454	0.0457
GA	Dec	22	4,453,767	1,333,361	3,780,662	0.0441	0.0436	0.0429
GA	Dec	23	4,121,076	1,219,656	3,374,982	0.0408	0.0399	0.0383
KY	Jan	0	4,500,866	2,001,047	3,975,257	0.0393	0.0393	0.0385
KY	Jan	1	4,436,772	1,977,257	3,908,176	0.0388	0.0388	0.0379
KY	Jan	2	4,412,167	1,966,631	3,883,196	0.0386	0.0386	0.0376
KY	Jan	3	4,405,383	1,974,544	3,894,925	0.0385	0.0387	0.0378
KY	Jan	4	4,435,119	1,990,452	3,944,448	0.0388	0.0391	0.0382
KY	Jan	5	4,513,939	2,035,915	4,082,797	0.0394	0.0399	0.0396
KY	Jan	6	4,735,881	2,124,301	4,313,142	0.0414	0.0417	0.0418
KY	Jan	7	4,881,373	2,179,241	4,507,545	0.0427	0.0428	0.0437
KY	Jan	8	4,899,244	2,207,273	4,565,778	0.0428	0.0433	0.0443
KY	Jan	9	4,959,430	2,220,561	4,581,241	0.0433	0.0436	0.0444
KY	Jan	10	4,966,733	2,218,116	4,560,570	0.0434	0.0435	0.0442
KY	Jan	11	4,926,481	2,185,309	4,469,160	0.0430	0.0429	0.0433
KY	Jan	12	4,897,325	2,166,493	4,396,183	0.0428	0.0425	0.0426
KY	Jan	13	4,858,282	2,145,888	4,334,245	0.0424	0.0421	0.0420
KY	Jan	14	4,803,975	2,121,569	4,259,493	0.0420	0.0416	0.0413
KY	Jan	15	4,787,506	2,116,853	4,251,772	0.0418	0.0415	0.0412
KY	Jan	16	4,805,200	2,132,483	4,277,592	0.0420	0.0418	0.0415
KY	Jan	17	4,902,475	2,173,992	4,377,939	0.0428	0.0427	0.0424
KY	Jan	18	5,019,134	2,227,712	4,540,738	0.0439	0.0437	0.0440
KY	Jan	19	5,000,308	2,222,379	4,582,619	0.0437	0.0436	0.0444
KY	Jan	20	4,971,779	2,210,874	4,538,035	0.0434	0.0434	0.0440
KY	Jan	21	4,910,317	2,179,426	4,432,861	0.0429	0.0428	0.0430
KY	Jan	22	4,784,827	2,126,094	4,305,074	0.0418	0.0417	0.0417
KY	Jan	23	4,636,595	2,057,219	4,173,941	0.0405	0.0404	0.0405
KY	Feb	0	3,904,092	1,761,180	3,580,773	0.0392	0.0389	0.0386
KY	Feb	1	3,816,587	1,728,628	3,495,285	0.0383	0.0382	0.0377
KY	Feb	2	3,792,744	1,718,868	3,462,109	0.0381	0.0380	0.0374
KY	Feb	3	3,810,281	1,726,383	3,467,620	0.0383	0.0381	0.0374
KY	Feb	4	3,842,768	1,745,450	3,507,867	0.0386	0.0386	0.0378
KY	Feb	5	3,947,749	1,806,439	3,628,623	0.0396	0.0399	0.0391
KY	Feb	6	4,176,764	1,912,472	3,944,300	0.0419	0.0423	0.0426
KY	Feb	7	4,281,095	1,958,390	4,125,044	0.0430	0.0433	0.0445
KY	Feb	8	4,317,449	1,973,880	4,156,268	0.0434	0.0436	0.0448
KY	Feb	9	4,356,226	1,969,929	4,130,960	0.0437	0.0435	0.0446
KY	Feb	10	4,359,609	1,964,589	4,086,993	0.0438	0.0434	0.0441
KY	Feb	11	4,311,166	1,943,159	4,039,097	0.0433	0.0429	0.0436
KY	Feb	12	4,272,545	1,927,415	3,983,427	0.0429	0.0426	0.0430

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Feb	13	4,236,215	1,916,654	3,932,234	0.0425	0.0423	0.0424
KY	Feb	14	4,167,600	1,882,801	3,848,899	0.0419	0.0416	0.0415
KY	Feb	15	4,134,586	1,872,977	3,821,080	0.0415	0.0414	0.0412
KY	Feb	16	4,147,038	1,884,240	3,828,076	0.0416	0.0416	0.0413
KY	Feb	17	4,197,152	1,920,450	3,887,857	0.0421	0.0424	0.0419
KY	Feb	18	4,301,661	1,971,850	4,016,102	0.0432	0.0436	0.0433
KY	Feb	19	4,364,422	2,001,534	4,106,892	0.0438	0.0442	0.0443
KY	Feb	20	4,344,268	1,987,726	4,061,985	0.0436	0.0439	0.0438
KY	Feb	21	4,296,576	1,966,727	4,013,780	0.0431	0.0435	0.0433
KY	Feb	22	4,179,160	1,894,824	3,854,612	0.0420	0.0419	0.0416
KY	Feb	23	4,024,438	1,823,859	3,712,043	0.0404	0.0403	0.0400
KY	Mar	0	4,086,927	1,934,000	3,943,944	0.0384	0.0390	0.0385
KY	Mar	1	4,004,215	1,894,561	3,852,671	0.0376	0.0382	0.0376
KY	Mar	2	3,977,961	1,875,819	3,810,690	0.0374	0.0378	0.0372
KY	Mar	3	3,977,743	1,874,604	3,814,943	0.0374	0.0378	0.0372
KY	Mar	4	4,040,951	1,904,597	3,857,613	0.0380	0.0384	0.0376
KY	Mar	5	4,163,395	1,975,952	4,001,836	0.0391	0.0399	0.0390
KY	Mar	6	4,382,627	2,082,066	4,297,761	0.0412	0.0420	0.0419
KY	Mar	7	4,504,820	2,126,263	4,486,558	0.0423	0.0429	0.0438
KY	Mar	8	4,562,347	2,144,795	4,534,086	0.0429	0.0433	0.0442
KY	Mar	9	4,627,690	2,159,579	4,567,228	0.0435	0.0436	0.0445
KY	Mar	10	4,653,192	2,151,241	4,511,098	0.0437	0.0434	0.0440
KY	Mar	11	4,641,558	2,133,268	4,448,941	0.0436	0.0430	0.0434
KY	Mar	12	4,622,702	2,121,208	4,411,987	0.0434	0.0428	0.0430
KY	Mar	13	4,619,393	2,125,075	4,393,357	0.0434	0.0429	0.0429
KY	Mar	14	4,552,286	2,088,576	4,330,586	0.0428	0.0421	0.0422
KY	Mar	15	4,531,458	2,076,448	4,292,113	0.0426	0.0419	0.0419
KY	Mar	16	4,559,495	2,082,061	4,299,148	0.0428	0.0420	0.0419
KY	Mar	17	4,566,306	2,095,974	4,333,645	0.0429	0.0423	0.0423
KY	Mar	18	4,614,477	2,131,694	4,403,611	0.0434	0.0430	0.0430
KY	Mar	19	4,692,033	2,181,572	4,520,447	0.0441	0.0440	0.0441
KY	Mar	20	4,691,985	2,182,351	4,554,215	0.0441	0.0440	0.0444
KY	Mar	21	4,607,786	2,156,225	4,469,784	0.0433	0.0435	0.0436
KY	Mar	22	4,453,423	2,076,668	4,283,360	0.0419	0.0419	0.0418
KY	Mar	23	4,277,227	1,999,878	4,106,925	0.0402	0.0403	0.0401
KY	Apr	0	3,751,872	1,682,748	3,623,721	0.0371	0.0373	0.0360
KY	Apr	1	3,662,781	1,651,886	3,538,402	0.0362	0.0366	0.0352
KY	Apr	2	3,620,832	1,638,447	3,506,688	0.0358	0.0363	0.0348
KY	Apr	3	3,665,762	1,658,243	3,540,689	0.0363	0.0368	0.0352
KY	Apr	4	3,808,138	1,716,346	3,665,877	0.0377	0.0381	0.0364
KY	Apr	5	4,024,823	1,815,205	3,894,961	0.0398	0.0402	0.0387
KY	Apr	6	4,208,966	1,884,379	4,124,667	0.0416	0.0418	0.0410
KY	Apr	7	4,271,575	1,920,454	4,261,166	0.0422	0.0426	0.0423
KY	Apr	8	4,393,556	1,942,695	4,351,959	0.0434	0.0431	0.0432
KY	Apr	9	4,461,370	1,966,842	4,440,429	0.0441	0.0436	0.0441
KY	Apr	10	4,462,912	1,971,490	4,461,202	0.0441	0.0437	0.0443
KY	Apr	11	4,451,212	1,972,903	4,476,859	0.0440	0.0437	0.0445
KY	Apr	12	4,470,687	1,978,658	4,533,135	0.0442	0.0439	0.0450
KY	Apr	13	4,480,194	2,007,588	4,572,059	0.0443	0.0445	0.0454
KY	Apr	14	4,443,252	1,988,851	4,545,641	0.0439	0.0441	0.0452
KY	Apr	15	4,459,430	1,990,362	4,545,012	0.0441	0.0441	0.0452
KY	Apr	16	4,426,122	1,974,950	4,512,511	0.0438	0.0438	0.0448
KY	Apr	17	4,375,559	1,955,702	4,480,287	0.0433	0.0434	0.0445

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Apr	18	4,346,922	1,937,715	4,442,685	0.0430	0.0430	0.0441
KY	Apr	19	4,451,615	1,983,979	4,497,189	0.0440	0.0440	0.0447
KY	Apr	20	4,487,128	1,998,714	4,533,191	0.0444	0.0443	0.0450
KY	Apr	21	4,346,269	1,920,820	4,312,822	0.0430	0.0426	0.0428
KY	Apr	22	4,122,750	1,812,181	4,019,469	0.0408	0.0402	0.0399
KY	Apr	23	3,924,575	1,734,979	3,773,132	0.0388	0.0385	0.0375
KY	May	0	3,773,655	1,352,468	3,542,077	0.0363	0.0360	0.0356
KY	May	1	3,626,105	1,306,849	3,428,995	0.0349	0.0348	0.0344
KY	May	2	3,557,597	1,280,494	3,362,397	0.0342	0.0341	0.0338
KY	May	3	3,555,469	1,284,693	3,358,152	0.0342	0.0342	0.0337
KY	May	4	3,659,305	1,327,703	3,447,123	0.0352	0.0353	0.0346
KY	May	5	3,905,440	1,411,666	3,625,333	0.0375	0.0376	0.0364
KY	May	6	4,142,333	1,491,145	3,781,949	0.0398	0.0397	0.0380
KY	May	7	4,318,983	1,568,459	3,929,856	0.0415	0.0417	0.0395
KY	May	8	4,478,646	1,598,725	4,088,864	0.0431	0.0425	0.0411
KY	May	9	4,581,002	1,652,673	4,264,629	0.0440	0.0440	0.0428
KY	May	10	4,631,086	1,688,064	4,419,795	0.0445	0.0449	0.0444
KY	May	11	4,669,476	1,710,802	4,522,994	0.0449	0.0455	0.0454
KY	May	12	4,705,224	1,719,757	4,625,655	0.0452	0.0458	0.0465
KY	May	13	4,706,169	1,724,945	4,685,196	0.0452	0.0459	0.0471
KY	May	14	4,712,999	1,725,831	4,707,889	0.0453	0.0459	0.0473
KY	May	15	4,719,302	1,735,212	4,763,219	0.0454	0.0462	0.0478
KY	May	16	4,729,889	1,718,237	4,725,277	0.0455	0.0457	0.0475
KY	May	17	4,719,789	1,706,360	4,680,119	0.0454	0.0454	0.0470
KY	May	18	4,650,145	1,672,135	4,567,479	0.0447	0.0445	0.0459
KY	May	19	4,675,073	1,667,803	4,484,805	0.0449	0.0444	0.0451
KY	May	20	4,733,280	1,690,796	4,518,596	0.0455	0.0450	0.0454
KY	May	21	4,535,352	1,614,490	4,301,519	0.0436	0.0430	0.0432
KY	May	22	4,249,836	1,512,277	3,992,532	0.0409	0.0402	0.0401
KY	May	23	3,985,492	1,418,470	3,721,915	0.0383	0.0377	0.0374
KY	Jun	0	3,863,171	1,220,143	3,431,721	0.0365	0.0358	0.0351
KY	Jun	1	3,700,537	1,165,437	3,302,332	0.0350	0.0341	0.0338
KY	Jun	2	3,588,577	1,129,534	3,210,334	0.0339	0.0331	0.0328
KY	Jun	3	3,586,996	1,129,886	3,190,439	0.0339	0.0331	0.0326
KY	Jun	4	3,632,093	1,154,070	3,239,053	0.0343	0.0338	0.0331
KY	Jun	5	3,772,311	1,205,869	3,353,578	0.0356	0.0353	0.0343
KY	Jun	6	3,863,128	1,248,430	3,502,938	0.0365	0.0366	0.0358
KY	Jun	7	4,206,029	1,359,881	3,735,013	0.0397	0.0398	0.0382
KY	Jun	8	4,471,390	1,441,168	3,957,538	0.0422	0.0422	0.0405
KY	Jun	9	4,645,909	1,506,312	4,129,541	0.0439	0.0441	0.0422
KY	Jun	10	4,775,656	1,553,406	4,301,488	0.0451	0.0455	0.0440
KY	Jun	11	4,835,680	1,581,661	4,493,449	0.0457	0.0463	0.0459
KY	Jun	12	4,776,857	1,585,404	4,599,158	0.0451	0.0465	0.0470
KY	Jun	13	4,910,861	1,611,741	4,741,756	0.0464	0.0472	0.0485
KY	Jun	14	4,928,605	1,621,672	4,832,356	0.0466	0.0475	0.0494
KY	Jun	15	4,942,474	1,619,521	4,850,437	0.0467	0.0475	0.0496
KY	Jun	16	4,933,104	1,611,032	4,831,962	0.0466	0.0472	0.0494
KY	Jun	17	4,916,801	1,592,114	4,755,486	0.0464	0.0466	0.0486
KY	Jun	18	4,856,359	1,562,556	4,620,856	0.0459	0.0458	0.0472
KY	Jun	19	4,816,576	1,539,277	4,493,010	0.0455	0.0451	0.0459
KY	Jun	20	4,753,614	1,529,185	4,423,245	0.0449	0.0448	0.0452
KY	Jun	21	4,655,054	1,482,923	4,278,389	0.0440	0.0435	0.0437
KY	Jun	22	4,385,723	1,391,689	3,941,221	0.0414	0.0408	0.0403

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Jun	23	4,054,527	1,286,083	3,612,850	0.0383	0.0377	0.0369
KY	Jul	0	4,049,096	1,282,804	3,688,261	0.0372	0.0366	0.0344
KY	Jul	1	3,859,804	1,223,049	3,520,391	0.0354	0.0349	0.0328
KY	Jul	2	3,714,990	1,176,808	3,405,973	0.0341	0.0336	0.0318
KY	Jul	3	3,662,887	1,161,823	3,358,049	0.0336	0.0331	0.0313
KY	Jul	4	3,704,383	1,178,366	3,395,477	0.0340	0.0336	0.0317
KY	Jul	5	3,828,676	1,218,826	3,482,956	0.0352	0.0348	0.0325
KY	Jul	6	3,986,423	1,267,527	3,619,712	0.0366	0.0362	0.0338
KY	Jul	7	4,247,926	1,349,889	3,855,419	0.0390	0.0385	0.0360
KY	Jul	8	4,535,396	1,444,423	4,155,868	0.0417	0.0412	0.0388
KY	Jul	9	4,752,020	1,526,015	4,469,496	0.0436	0.0435	0.0417
KY	Jul	10	4,884,645	1,578,497	4,770,162	0.0449	0.0450	0.0445
KY	Jul	11	4,950,005	1,607,852	5,012,157	0.0455	0.0459	0.0468
KY	Jul	12	5,016,008	1,626,016	5,146,206	0.0461	0.0464	0.0480
KY	Jul	13	5,045,517	1,642,891	5,271,836	0.0463	0.0469	0.0492
KY	Jul	14	5,061,500	1,650,629	5,322,911	0.0465	0.0471	0.0497
KY	Jul	15	5,075,205	1,660,057	5,371,341	0.0466	0.0474	0.0501
KY	Jul	16	5,056,500	1,657,780	5,382,711	0.0464	0.0473	0.0502
KY	Jul	17	5,022,118	1,639,832	5,337,848	0.0461	0.0468	0.0498
KY	Jul	18	4,951,315	1,607,513	5,209,080	0.0455	0.0459	0.0486
KY	Jul	19	4,911,340	1,587,576	5,072,958	0.0451	0.0453	0.0473
KY	Jul	20	4,909,883	1,586,904	5,030,514	0.0451	0.0453	0.0469
KY	Jul	21	4,785,599	1,545,511	4,835,539	0.0440	0.0441	0.0451
KY	Jul	22	4,570,546	1,464,509	4,450,048	0.0420	0.0418	0.0415
KY	Jul	23	4,299,974	1,371,090	4,027,131	0.0395	0.0391	0.0376
KY	Aug	0	3,868,606	1,253,876	3,668,033	0.0369	0.0364	0.0348
KY	Aug	1	3,698,970	1,200,877	3,519,453	0.0353	0.0348	0.0334
KY	Aug	2	3,585,674	1,166,312	3,418,823	0.0342	0.0338	0.0324
KY	Aug	3	3,543,793	1,157,396	3,386,520	0.0338	0.0336	0.0321
KY	Aug	4	3,621,646	1,183,818	3,458,499	0.0346	0.0343	0.0328
KY	Aug	5	3,806,315	1,239,542	3,588,177	0.0363	0.0359	0.0340
KY	Aug	6	3,936,819	1,277,616	3,689,986	0.0376	0.0370	0.0350
KY	Aug	7	4,114,177	1,348,119	3,846,883	0.0393	0.0391	0.0365
KY	Aug	8	4,361,613	1,424,818	4,072,241	0.0416	0.0413	0.0386
KY	Aug	9	4,556,504	1,503,981	4,366,498	0.0435	0.0436	0.0414
KY	Aug	10	4,676,703	1,547,003	4,636,588	0.0446	0.0449	0.0440
KY	Aug	11	4,737,663	1,576,020	4,888,307	0.0452	0.0457	0.0463
KY	Aug	12	4,814,736	1,602,156	5,042,982	0.0459	0.0465	0.0478
KY	Aug	13	4,837,597	1,614,023	5,150,918	0.0462	0.0468	0.0488
KY	Aug	14	4,856,220	1,626,339	5,243,914	0.0463	0.0472	0.0497
KY	Aug	15	4,872,044	1,631,474	5,286,851	0.0465	0.0473	0.0501
KY	Aug	16	4,852,491	1,626,072	5,274,429	0.0463	0.0472	0.0500
KY	Aug	17	4,825,909	1,605,755	5,227,445	0.0460	0.0466	0.0496
KY	Aug	18	4,776,144	1,575,964	5,098,419	0.0456	0.0457	0.0483
KY	Aug	19	4,773,544	1,572,600	5,002,780	0.0455	0.0456	0.0474
KY	Aug	20	4,745,844	1,558,889	4,908,751	0.0453	0.0452	0.0465
KY	Aug	21	4,554,333	1,479,458	4,582,344	0.0435	0.0429	0.0434
KY	Aug	22	4,322,024	1,398,382	4,233,380	0.0412	0.0405	0.0401
KY	Aug	23	4,059,551	1,315,846	3,876,845	0.0387	0.0382	0.0368
KY	Sep	0	3,595,868	1,141,883	3,329,502	0.0359	0.0357	0.0347
KY	Sep	1	3,486,734	1,105,426	3,238,293	0.0348	0.0346	0.0337
KY	Sep	2	3,410,086	1,089,099	3,177,867	0.0340	0.0341	0.0331
KY	Sep	3	3,417,881	1,091,186	3,181,031	0.0341	0.0341	0.0331

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Sep	4	3,528,297	1,135,485	3,276,690	0.0352	0.0355	0.0341
KY	Sep	5	3,739,213	1,213,349	3,456,769	0.0373	0.0380	0.0360
KY	Sep	6	3,909,221	1,258,762	3,616,506	0.0390	0.0394	0.0377
KY	Sep	7	4,008,091	1,292,595	3,689,943	0.0400	0.0405	0.0384
KY	Sep	8	4,198,238	1,338,655	3,834,792	0.0419	0.0419	0.0399
KY	Sep	9	4,341,058	1,380,097	3,985,620	0.0433	0.0432	0.0415
KY	Sep	10	4,453,788	1,421,503	4,176,388	0.0445	0.0445	0.0435
KY	Sep	11	4,536,502	1,453,187	4,334,552	0.0453	0.0455	0.0451
KY	Sep	12	4,593,953	1,462,800	4,460,414	0.0459	0.0458	0.0465
KY	Sep	13	4,628,123	1,482,574	4,597,150	0.0462	0.0464	0.0479
KY	Sep	14	4,638,119	1,494,562	4,698,708	0.0463	0.0468	0.0489
KY	Sep	15	4,652,224	1,500,168	4,721,765	0.0464	0.0469	0.0492
KY	Sep	16	4,628,168	1,488,561	4,737,804	0.0462	0.0466	0.0493
KY	Sep	17	4,609,485	1,465,982	4,696,333	0.0460	0.0459	0.0489
KY	Sep	18	4,598,710	1,452,171	4,598,248	0.0459	0.0454	0.0479
KY	Sep	19	4,652,661	1,463,449	4,572,473	0.0464	0.0458	0.0476
KY	Sep	20	4,547,881	1,434,233	4,387,924	0.0454	0.0449	0.0457
KY	Sep	21	4,279,254	1,347,403	4,039,635	0.0427	0.0422	0.0421
KY	Sep	22	3,968,649	1,254,129	3,728,872	0.0396	0.0392	0.0388
KY	Sep	23	3,745,030	1,186,129	3,474,766	0.0374	0.0371	0.0362
KY	Oct	0	3,743,224	1,601,952	3,532,574	0.0362	0.0367	0.0362
KY	Oct	1	3,676,531	1,576,043	3,476,375	0.0356	0.0361	0.0356
KY	Oct	2	3,641,292	1,565,349	3,437,966	0.0352	0.0359	0.0352
KY	Oct	3	3,681,681	1,581,523	3,468,699	0.0356	0.0363	0.0355
KY	Oct	4	3,847,834	1,642,075	3,597,738	0.0372	0.0376	0.0368
KY	Oct	5	4,098,543	1,738,160	3,794,676	0.0396	0.0399	0.0389
KY	Oct	6	4,364,063	1,824,083	4,028,308	0.0422	0.0418	0.0412
KY	Oct	7	4,439,117	1,859,253	4,154,973	0.0429	0.0426	0.0425
KY	Oct	8	4,518,793	1,884,741	4,203,259	0.0437	0.0432	0.0430
KY	Oct	9	4,572,090	1,908,542	4,241,582	0.0442	0.0438	0.0434
KY	Oct	10	4,588,821	1,901,085	4,279,813	0.0444	0.0436	0.0438
KY	Oct	11	4,591,634	1,910,189	4,355,897	0.0444	0.0438	0.0446
KY	Oct	12	4,587,310	1,912,504	4,395,571	0.0444	0.0438	0.0450
KY	Oct	13	4,564,707	1,913,776	4,412,969	0.0442	0.0439	0.0452
KY	Oct	14	4,547,844	1,921,307	4,410,947	0.0440	0.0441	0.0452
KY	Oct	15	4,536,425	1,922,594	4,399,521	0.0439	0.0441	0.0450
KY	Oct	16	4,530,762	1,923,359	4,378,106	0.0438	0.0441	0.0448
KY	Oct	17	4,559,994	1,931,107	4,380,389	0.0441	0.0443	0.0449
KY	Oct	18	4,659,377	1,971,527	4,443,252	0.0451	0.0452	0.0455
KY	Oct	19	4,679,388	1,963,456	4,437,459	0.0453	0.0450	0.0454
KY	Oct	20	4,584,836	1,917,232	4,296,721	0.0443	0.0440	0.0440
KY	Oct	21	4,379,886	1,835,392	4,061,547	0.0424	0.0421	0.0416
KY	Oct	22	4,096,250	1,740,025	3,819,906	0.0396	0.0399	0.0391
KY	Oct	23	3,893,430	1,670,287	3,652,729	0.0377	0.0383	0.0374
KY	Nov	0	3,885,540	1,750,644	3,602,585	0.0385	0.0392	0.0382
KY	Nov	1	3,806,089	1,712,194	3,515,552	0.0377	0.0384	0.0373
KY	Nov	2	3,782,755	1,699,053	3,464,064	0.0374	0.0381	0.0367
KY	Nov	3	3,761,073	1,689,317	3,436,481	0.0372	0.0379	0.0364
KY	Nov	4	3,804,639	1,704,848	3,481,357	0.0377	0.0382	0.0369
KY	Nov	5	3,910,926	1,750,748	3,597,416	0.0387	0.0392	0.0381
KY	Nov	6	4,148,114	1,834,043	3,843,327	0.0411	0.0411	0.0407
KY	Nov	7	4,287,622	1,889,795	3,994,287	0.0424	0.0424	0.0423
KY	Nov	8	4,341,922	1,909,899	4,037,655	0.0430	0.0428	0.0428

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
KY	Nov	9	4,410,751	1,957,861	4,189,187	0.0437	0.0439	0.0444
KY	Nov	10	4,418,332	1,949,448	4,205,116	0.0437	0.0437	0.0446
KY	Nov	11	4,382,413	1,922,612	4,155,770	0.0434	0.0431	0.0440
KY	Nov	12	4,350,220	1,906,738	4,103,225	0.0431	0.0427	0.0435
KY	Nov	13	4,320,793	1,886,606	4,070,285	0.0428	0.0423	0.0431
KY	Nov	14	4,275,911	1,873,512	4,040,693	0.0423	0.0420	0.0428
KY	Nov	15	4,260,221	1,863,874	4,013,074	0.0422	0.0418	0.0425
KY	Nov	16	4,313,487	1,885,821	4,020,640	0.0427	0.0423	0.0426
KY	Nov	17	4,448,983	1,941,737	4,137,653	0.0440	0.0435	0.0439
KY	Nov	18	4,530,551	1,984,254	4,283,590	0.0448	0.0445	0.0454
KY	Nov	19	4,467,945	1,958,744	4,222,870	0.0442	0.0439	0.0448
KY	Nov	20	4,431,262	1,946,314	4,171,257	0.0439	0.0436	0.0442
KY	Nov	21	4,391,773	1,922,060	4,096,687	0.0435	0.0431	0.0434
KY	Nov	22	4,254,473	1,872,895	3,932,831	0.0421	0.0420	0.0417
KY	Nov	23	4,042,484	1,800,724	3,728,212	0.0400	0.0404	0.0395
KY	Dec	0	4,096,348	1,833,401	3,841,112	0.0386	0.0389	0.0385
KY	Dec	1	4,015,003	1,797,081	3,752,951	0.0379	0.0381	0.0376
KY	Dec	2	3,977,439	1,781,198	3,716,696	0.0375	0.0378	0.0372
KY	Dec	3	3,988,022	1,784,905	3,708,916	0.0376	0.0379	0.0371
KY	Dec	4	4,032,701	1,809,153	3,754,042	0.0380	0.0384	0.0376
KY	Dec	5	4,136,744	1,856,495	3,860,181	0.0390	0.0394	0.0387
KY	Dec	6	4,384,290	1,943,801	4,105,937	0.0413	0.0412	0.0411
KY	Dec	7	4,542,866	2,007,485	4,278,565	0.0428	0.0426	0.0428
KY	Dec	8	4,614,637	2,053,177	4,352,720	0.0435	0.0436	0.0436
KY	Dec	9	4,664,192	2,081,825	4,380,686	0.0440	0.0442	0.0439
KY	Dec	10	4,673,389	2,062,430	4,369,361	0.0441	0.0438	0.0438
KY	Dec	11	4,605,441	2,028,991	4,287,122	0.0434	0.0431	0.0429
KY	Dec	12	4,553,175	2,004,430	4,233,054	0.0429	0.0425	0.0424
KY	Dec	13	4,498,006	1,977,010	4,182,376	0.0424	0.0420	0.0419
KY	Dec	14	4,415,048	1,947,384	4,126,576	0.0416	0.0413	0.0413
KY	Dec	15	4,400,399	1,940,391	4,123,632	0.0415	0.0412	0.0413
KY	Dec	16	4,465,730	1,977,764	4,216,038	0.0421	0.0420	0.0422
KY	Dec	17	4,620,341	2,049,791	4,386,809	0.0436	0.0435	0.0439
KY	Dec	18	4,698,027	2,102,642	4,549,990	0.0443	0.0446	0.0456
KY	Dec	19	4,647,661	2,084,675	4,517,525	0.0438	0.0442	0.0452
KY	Dec	20	4,654,175	2,083,508	4,489,359	0.0439	0.0442	0.0450
KY	Dec	21	4,614,689	2,037,441	4,378,947	0.0435	0.0432	0.0438
KY	Dec	22	4,490,234	1,977,015	4,228,895	0.0423	0.0420	0.0423
KY	Dec	23	4,288,008	1,904,969	4,023,779	0.0404	0.0404	0.0403
MS	Jan	0	976,875	498,392	1,739,588	0.0376	0.0333	0.0347
MS	Jan	1	967,600	492,280	1,737,384	0.0372	0.0329	0.0347
MS	Jan	2	966,502	493,295	1,747,320	0.0372	0.0330	0.0349
MS	Jan	3	962,249	508,849	1,778,073	0.0370	0.0340	0.0355
MS	Jan	4	981,931	549,003	1,904,800	0.0378	0.0367	0.0380
MS	Jan	5	1,039,940	615,695	2,137,993	0.0400	0.0412	0.0427
MS	Jan	6	1,119,075	681,717	2,401,350	0.0430	0.0456	0.0479
MS	Jan	7	1,151,104	699,041	2,427,699	0.0443	0.0467	0.0485
MS	Jan	8	1,166,258	695,736	2,384,436	0.0449	0.0465	0.0476
MS	Jan	9	1,167,831	708,759	2,397,599	0.0449	0.0474	0.0479
MS	Jan	10	1,146,639	687,503	2,299,806	0.0441	0.0460	0.0459
MS	Jan	11	1,122,590	649,347	2,153,434	0.0432	0.0434	0.0430
MS	Jan	12	1,096,730	609,196	2,022,231	0.0422	0.0407	0.0404
MS	Jan	13	1,056,734	578,828	1,944,175	0.0406	0.0387	0.0388

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Jan	14	1,044,419	557,767	1,862,213	0.0402	0.0373	0.0372
MS	Jan	15	1,032,758	552,681	1,873,015	0.0397	0.0369	0.0374
MS	Jan	16	1,046,335	583,599	2,004,610	0.0402	0.0390	0.0400
MS	Jan	17	1,135,430	648,329	2,225,482	0.0437	0.0433	0.0444
MS	Jan	18	1,192,392	768,843	2,357,158	0.0459	0.0514	0.0471
MS	Jan	19	1,189,077	762,937	2,339,568	0.0457	0.0510	0.0467
MS	Jan	20	1,179,745	746,721	2,295,175	0.0454	0.0499	0.0458
MS	Jan	21	1,145,469	689,003	2,183,575	0.0441	0.0461	0.0436
MS	Jan	22	1,091,264	637,313	2,013,011	0.0420	0.0426	0.0402
MS	Jan	23	1,023,481	544,166	1,852,825	0.0394	0.0364	0.0370
MS	Feb	0	782,528	405,907	1,334,862	0.0369	0.0342	0.0330
MS	Feb	1	761,745	401,506	1,337,948	0.0359	0.0338	0.0331
MS	Feb	2	755,850	403,215	1,350,362	0.0356	0.0339	0.0334
MS	Feb	3	763,382	411,139	1,398,640	0.0360	0.0346	0.0346
MS	Feb	4	793,389	437,762	1,491,685	0.0374	0.0368	0.0369
MS	Feb	5	857,681	544,057	1,775,888	0.0404	0.0458	0.0439
MS	Feb	6	920,643	596,173	2,014,117	0.0434	0.0502	0.0498
MS	Feb	7	947,559	608,252	2,067,668	0.0447	0.0512	0.0511
MS	Feb	8	950,365	589,715	2,020,860	0.0448	0.0496	0.0499
MS	Feb	9	950,211	565,430	1,979,216	0.0448	0.0476	0.0489
MS	Feb	10	942,757	540,653	1,914,755	0.0445	0.0455	0.0473
MS	Feb	11	914,688	511,901	1,752,373	0.0431	0.0431	0.0433
MS	Feb	12	893,919	471,062	1,655,216	0.0422	0.0397	0.0409
MS	Feb	13	879,496	456,988	1,617,049	0.0415	0.0385	0.0400
MS	Feb	14	855,118	432,880	1,584,270	0.0403	0.0364	0.0391
MS	Feb	15	848,094	421,215	1,607,720	0.0400	0.0355	0.0397
MS	Feb	16	860,437	436,690	1,640,618	0.0406	0.0368	0.0405
MS	Feb	17	908,058	483,560	1,725,576	0.0428	0.0407	0.0426
MS	Feb	18	985,014	568,812	1,821,913	0.0464	0.0479	0.0450
MS	Feb	19	989,298	579,566	1,825,118	0.0467	0.0488	0.0451
MS	Feb	20	979,458	568,497	1,821,790	0.0462	0.0479	0.0450
MS	Feb	21	940,195	527,405	1,766,089	0.0443	0.0444	0.0436
MS	Feb	22	898,298	487,622	1,568,812	0.0424	0.0410	0.0388
MS	Feb	23	828,050	430,352	1,398,637	0.0390	0.0362	0.0346
MS	Mar	0	954,881	432,830	1,574,089	0.0374	0.0329	0.0334
MS	Mar	1	935,148	415,563	1,553,449	0.0366	0.0316	0.0330
MS	Mar	2	917,828	406,837	1,559,763	0.0360	0.0309	0.0331
MS	Mar	3	917,621	412,039	1,568,383	0.0359	0.0313	0.0333
MS	Mar	4	963,382	428,249	1,639,701	0.0377	0.0325	0.0348
MS	Mar	5	1,034,739	534,402	1,864,996	0.0405	0.0406	0.0396
MS	Mar	6	1,096,759	584,575	2,091,039	0.0430	0.0444	0.0444
MS	Mar	7	1,153,326	626,345	2,154,794	0.0452	0.0476	0.0457
MS	Mar	8	1,143,476	626,895	2,190,586	0.0448	0.0476	0.0465
MS	Mar	9	1,165,825	623,847	2,199,674	0.0457	0.0474	0.0467
MS	Mar	10	1,151,525	608,980	2,144,582	0.0451	0.0463	0.0455
MS	Mar	11	1,125,374	589,039	2,091,865	0.0441	0.0448	0.0444
MS	Mar	12	1,076,202	557,410	2,057,352	0.0422	0.0424	0.0437
MS	Mar	13	1,068,691	550,131	2,043,582	0.0419	0.0418	0.0434
MS	Mar	14	1,055,441	541,076	2,034,504	0.0413	0.0411	0.0432
MS	Mar	15	1,049,146	534,740	1,992,792	0.0411	0.0406	0.0423
MS	Mar	16	1,057,606	534,775	2,017,401	0.0414	0.0406	0.0428
MS	Mar	17	1,092,432	560,060	2,056,732	0.0428	0.0426	0.0436
MS	Mar	18	1,152,332	651,794	2,207,503	0.0451	0.0495	0.0468

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Mar	19	1,169,586	679,546	2,243,045	0.0458	0.0516	0.0476
MS	Mar	20	1,139,946	655,626	2,209,640	0.0447	0.0498	0.0469
MS	Mar	21	1,082,949	587,151	2,089,080	0.0424	0.0446	0.0443
MS	Mar	22	1,048,288	550,462	1,873,115	0.0411	0.0418	0.0397
MS	Mar	23	975,839	465,913	1,671,856	0.0382	0.0354	0.0355
MS	Apr	0	772,566	395,311	1,407,007	0.0363	0.0324	0.0305
MS	Apr	1	727,365	371,519	1,369,160	0.0342	0.0304	0.0296
MS	Apr	2	695,726	356,402	1,368,820	0.0327	0.0292	0.0296
MS	Apr	3	695,255	374,894	1,432,477	0.0327	0.0307	0.0310
MS	Apr	4	762,780	412,138	1,592,961	0.0359	0.0337	0.0345
MS	Apr	5	828,092	480,397	1,805,007	0.0389	0.0393	0.0391
MS	Apr	6	869,604	505,058	1,968,219	0.0409	0.0414	0.0426
MS	Apr	7	908,044	527,567	1,986,696	0.0427	0.0432	0.0430
MS	Apr	8	926,930	537,431	2,031,932	0.0436	0.0440	0.0440
MS	Apr	9	929,940	536,164	2,064,047	0.0437	0.0439	0.0447
MS	Apr	10	937,093	548,544	2,110,221	0.0440	0.0449	0.0457
MS	Apr	11	948,619	555,186	2,162,389	0.0446	0.0455	0.0468
MS	Apr	12	950,648	565,077	2,185,293	0.0447	0.0463	0.0473
MS	Apr	13	953,427	577,198	2,222,039	0.0448	0.0473	0.0481
MS	Apr	14	954,511	585,989	2,255,173	0.0449	0.0480	0.0488
MS	Apr	15	956,697	583,302	2,263,206	0.0450	0.0478	0.0490
MS	Apr	16	959,172	577,035	2,253,560	0.0451	0.0472	0.0488
MS	Apr	17	960,271	559,977	2,205,491	0.0451	0.0458	0.0477
MS	Apr	18	952,015	551,979	2,198,435	0.0448	0.0452	0.0476
MS	Apr	19	963,862	586,654	2,202,683	0.0453	0.0480	0.0477
MS	Apr	20	955,924	575,209	2,102,011	0.0449	0.0471	0.0455
MS	Apr	21	947,733	552,387	1,924,351	0.0445	0.0452	0.0417
MS	Apr	22	890,373	478,750	1,639,137	0.0419	0.0392	0.0355
MS	Apr	23	827,109	420,042	1,445,397	0.0389	0.0344	0.0313
MS	May	0	715,201	330,126	1,298,404	0.0323	0.0280	0.0257
MS	May	1	677,673	307,288	1,253,942	0.0306	0.0261	0.0249
MS	May	2	656,721	300,770	1,219,929	0.0297	0.0255	0.0242
MS	May	3	663,276	316,185	1,265,573	0.0300	0.0268	0.0251
MS	May	4	709,047	340,140	1,392,627	0.0320	0.0288	0.0276
MS	May	5	768,858	376,436	1,560,987	0.0348	0.0319	0.0309
MS	May	6	829,693	418,639	1,720,209	0.0375	0.0355	0.0341
MS	May	7	898,423	470,946	1,912,519	0.0406	0.0399	0.0379
MS	May	8	955,768	514,322	2,110,543	0.0432	0.0436	0.0418
MS	May	9	1,008,756	557,351	2,328,014	0.0456	0.0473	0.0462
MS	May	10	1,032,535	567,895	2,486,836	0.0467	0.0482	0.0493
MS	May	11	1,059,756	589,319	2,620,857	0.0479	0.0500	0.0520
MS	May	12	1,079,462	616,742	2,717,455	0.0488	0.0523	0.0539
MS	May	13	1,070,333	619,949	2,782,148	0.0484	0.0526	0.0552
MS	May	14	1,078,912	624,270	2,802,049	0.0488	0.0529	0.0556
MS	May	15	1,081,271	630,482	2,781,499	0.0489	0.0535	0.0551
MS	May	16	1,070,065	615,326	2,736,638	0.0484	0.0522	0.0543
MS	May	17	1,055,335	595,135	2,694,842	0.0477	0.0505	0.0534
MS	May	18	1,034,974	570,012	2,603,665	0.0468	0.0483	0.0516
MS	May	19	1,033,392	566,827	2,599,581	0.0467	0.0481	0.0515
MS	May	20	1,013,439	548,786	2,399,707	0.0458	0.0465	0.0476
MS	May	21	972,911	508,458	2,080,242	0.0440	0.0431	0.0412
MS	May	22	875,080	435,618	1,683,078	0.0396	0.0369	0.0334
MS	May	23	784,191	371,369	1,385,644	0.0354	0.0315	0.0275

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Jun	0	693,057	344,560	1,298,517	0.0338	0.0286	0.0266
MS	Jun	1	641,024	315,711	1,228,335	0.0313	0.0262	0.0251
MS	Jun	2	608,473	299,470	1,213,302	0.0297	0.0249	0.0248
MS	Jun	3	604,057	305,099	1,248,131	0.0295	0.0253	0.0256
MS	Jun	4	627,870	327,870	1,315,012	0.0306	0.0272	0.0269
MS	Jun	5	658,954	348,172	1,440,853	0.0322	0.0289	0.0295
MS	Jun	6	717,612	390,034	1,572,467	0.0350	0.0324	0.0322
MS	Jun	7	809,271	455,342	1,749,532	0.0395	0.0378	0.0358
MS	Jun	8	884,976	519,093	2,006,403	0.0432	0.0431	0.0411
MS	Jun	9	936,419	567,045	2,253,920	0.0457	0.0471	0.0461
MS	Jun	10	959,564	596,672	2,437,858	0.0468	0.0495	0.0499
MS	Jun	11	987,549	628,365	2,566,208	0.0482	0.0522	0.0525
MS	Jun	12	1,000,996	657,721	2,723,350	0.0488	0.0546	0.0558
MS	Jun	13	1,007,469	664,717	2,791,149	0.0492	0.0552	0.0571
MS	Jun	14	1,009,341	669,603	2,790,780	0.0493	0.0556	0.0571
MS	Jun	15	1,005,767	665,511	2,774,655	0.0491	0.0552	0.0568
MS	Jun	16	997,092	646,415	2,717,234	0.0487	0.0537	0.0556
MS	Jun	17	979,915	610,289	2,583,011	0.0478	0.0507	0.0529
MS	Jun	18	956,736	578,327	2,477,314	0.0467	0.0480	0.0507
MS	Jun	19	953,737	565,651	2,428,028	0.0465	0.0470	0.0497
MS	Jun	20	942,193	548,786	2,277,559	0.0460	0.0456	0.0466
MS	Jun	21	908,344	507,922	1,932,253	0.0443	0.0422	0.0396
MS	Jun	22	839,080	446,927	1,612,668	0.0409	0.0371	0.0330
MS	Jun	23	761,741	387,710	1,402,334	0.0372	0.0322	0.0287
MS	Jul	0	760,598	397,306	1,499,963	0.0351	0.0294	0.0258
MS	Jul	1	711,370	364,853	1,452,523	0.0328	0.0270	0.0250
MS	Jul	2	666,740	338,276	1,405,479	0.0308	0.0250	0.0242
MS	Jul	3	643,773	337,333	1,404,755	0.0297	0.0249	0.0242
MS	Jul	4	655,130	354,902	1,467,009	0.0303	0.0262	0.0253
MS	Jul	5	676,286	374,686	1,758,070	0.0312	0.0277	0.0303
MS	Jul	6	722,819	408,570	1,885,563	0.0334	0.0302	0.0325
MS	Jul	7	817,648	475,561	2,076,359	0.0378	0.0352	0.0358
MS	Jul	8	919,631	557,605	2,368,658	0.0425	0.0412	0.0408
MS	Jul	9	993,779	630,222	2,728,777	0.0459	0.0466	0.0470
MS	Jul	10	1,025,758	678,736	2,990,540	0.0474	0.0502	0.0515
MS	Jul	11	1,042,649	714,015	3,169,150	0.0481	0.0528	0.0546
MS	Jul	12	1,051,103	742,497	3,253,348	0.0485	0.0549	0.0560
MS	Jul	13	1,052,791	756,236	3,285,360	0.0486	0.0559	0.0566
MS	Jul	14	1,058,132	755,227	3,333,601	0.0489	0.0559	0.0574
MS	Jul	15	1,055,069	750,217	3,315,158	0.0487	0.0555	0.0571
MS	Jul	16	1,044,146	732,793	3,257,144	0.0482	0.0542	0.0561
MS	Jul	17	1,037,635	704,258	3,185,647	0.0479	0.0521	0.0549
MS	Jul	18	1,015,745	665,967	3,057,679	0.0469	0.0493	0.0527
MS	Jul	19	1,017,161	648,713	2,913,409	0.0470	0.0480	0.0502
MS	Jul	20	997,024	618,629	2,724,596	0.0460	0.0458	0.0469
MS	Jul	21	964,773	566,178	2,103,852	0.0445	0.0419	0.0362
MS	Jul	22	895,908	503,736	1,810,122	0.0414	0.0373	0.0312
MS	Jul	23	830,653	444,290	1,625,263	0.0384	0.0329	0.0280
MS	Aug	0	832,407	423,411	1,632,693	0.0360	0.0306	0.0287
MS	Aug	1	774,523	385,152	1,564,862	0.0335	0.0278	0.0275
MS	Aug	2	718,968	352,132	1,488,142	0.0311	0.0255	0.0262
MS	Aug	3	696,007	354,736	1,466,857	0.0301	0.0256	0.0258
MS	Aug	4	736,513	384,127	1,554,116	0.0319	0.0278	0.0274

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Aug	5	782,676	413,448	1,703,308	0.0339	0.0299	0.0300
MS	Aug	6	821,293	440,409	1,786,431	0.0356	0.0318	0.0314
MS	Aug	7	919,917	497,708	1,973,582	0.0398	0.0360	0.0347
MS	Aug	8	1,010,016	569,031	2,215,648	0.0437	0.0411	0.0390
MS	Aug	9	1,048,842	631,049	2,544,890	0.0454	0.0456	0.0448
MS	Aug	10	1,075,499	671,487	2,787,078	0.0466	0.0485	0.0491
MS	Aug	11	1,104,426	710,489	2,982,489	0.0478	0.0514	0.0525
MS	Aug	12	1,111,768	746,322	3,109,940	0.0481	0.0539	0.0547
MS	Aug	13	1,108,156	762,173	3,179,210	0.0480	0.0551	0.0560
MS	Aug	14	1,106,101	757,714	3,195,332	0.0479	0.0548	0.0562
MS	Aug	15	1,105,323	761,168	3,220,917	0.0479	0.0550	0.0567
MS	Aug	16	1,090,817	746,486	3,199,653	0.0472	0.0540	0.0563
MS	Aug	17	1,078,272	724,441	3,130,402	0.0467	0.0524	0.0551
MS	Aug	18	1,066,795	683,503	2,981,841	0.0462	0.0494	0.0525
MS	Aug	19	1,071,924	677,271	2,849,156	0.0464	0.0490	0.0501
MS	Aug	20	1,039,562	627,485	2,559,854	0.0450	0.0454	0.0451
MS	Aug	21	983,898	554,806	2,121,898	0.0426	0.0401	0.0373
MS	Aug	22	933,076	502,633	1,873,343	0.0404	0.0363	0.0330
MS	Aug	23	881,598	457,180	1,692,686	0.0382	0.0330	0.0298
MS	Sep	0	677,459	331,288	1,326,078	0.0330	0.0274	0.0284
MS	Sep	1	644,451	311,621	1,291,764	0.0314	0.0258	0.0277
MS	Sep	2	620,103	295,726	1,270,350	0.0302	0.0245	0.0272
MS	Sep	3	620,863	313,025	1,270,149	0.0303	0.0259	0.0272
MS	Sep	4	675,330	350,263	1,365,677	0.0329	0.0290	0.0292
MS	Sep	5	729,603	399,641	1,522,765	0.0356	0.0331	0.0326
MS	Sep	6	765,053	424,637	1,573,078	0.0373	0.0352	0.0337
MS	Sep	7	814,461	469,966	1,677,289	0.0397	0.0389	0.0359
MS	Sep	8	868,577	498,987	1,832,422	0.0423	0.0413	0.0392
MS	Sep	9	915,772	534,876	1,956,811	0.0446	0.0443	0.0419
MS	Sep	10	941,466	581,876	2,136,604	0.0459	0.0482	0.0457
MS	Sep	11	965,028	620,768	2,343,200	0.0470	0.0514	0.0502
MS	Sep	12	994,287	647,175	2,462,775	0.0484	0.0536	0.0527
MS	Sep	13	1,001,554	652,358	2,541,349	0.0488	0.0540	0.0544
MS	Sep	14	1,002,505	665,235	2,587,460	0.0488	0.0551	0.0554
MS	Sep	15	1,006,460	670,557	2,601,917	0.0490	0.0555	0.0557
MS	Sep	16	1,002,423	649,414	2,570,001	0.0488	0.0538	0.0550
MS	Sep	17	982,787	617,191	2,497,219	0.0479	0.0511	0.0535
MS	Sep	18	975,939	612,714	2,462,554	0.0476	0.0507	0.0527
MS	Sep	19	972,567	600,126	2,368,900	0.0474	0.0497	0.0507
MS	Sep	20	931,131	542,176	2,112,019	0.0454	0.0449	0.0452
MS	Sep	21	879,869	491,403	1,870,755	0.0429	0.0407	0.0401
MS	Sep	22	807,921	428,259	1,618,622	0.0394	0.0355	0.0347
MS	Sep	23	727,684	367,911	1,447,438	0.0355	0.0305	0.0310
MS	Oct	0	871,339	400,670	1,438,404	0.0359	0.0294	0.0328
MS	Oct	1	846,178	382,127	1,391,055	0.0349	0.0281	0.0317
MS	Oct	2	828,495	374,997	1,378,269	0.0341	0.0275	0.0314
MS	Oct	3	836,621	388,796	1,396,860	0.0345	0.0286	0.0318
MS	Oct	4	908,179	483,350	1,466,201	0.0374	0.0355	0.0334
MS	Oct	5	977,255	555,759	1,593,104	0.0403	0.0408	0.0363
MS	Oct	6	1,015,219	594,592	1,675,235	0.0418	0.0437	0.0382
MS	Oct	7	1,035,786	604,809	1,698,851	0.0427	0.0444	0.0387
MS	Oct	8	1,050,150	614,722	1,759,169	0.0433	0.0452	0.0401
MS	Oct	9	1,058,415	642,497	1,863,096	0.0436	0.0472	0.0424

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Oct	10	1,057,888	624,425	1,974,628	0.0436	0.0459	0.0450
MS	Oct	11	1,058,906	625,425	2,027,461	0.0436	0.0459	0.0462
MS	Oct	12	1,060,871	658,573	2,099,963	0.0437	0.0484	0.0478
MS	Oct	13	1,067,447	672,788	2,137,711	0.0440	0.0494	0.0487
MS	Oct	14	1,069,322	657,719	2,185,782	0.0441	0.0483	0.0498
MS	Oct	15	1,077,341	657,106	2,169,737	0.0444	0.0483	0.0494
MS	Oct	16	1,083,412	653,251	2,157,074	0.0446	0.0480	0.0491
MS	Oct	17	1,105,122	658,900	2,175,847	0.0455	0.0484	0.0496
MS	Oct	18	1,119,474	665,373	2,189,952	0.0461	0.0489	0.0499
MS	Oct	19	1,097,619	629,441	2,103,011	0.0452	0.0462	0.0479
MS	Oct	20	1,075,426	588,481	2,007,873	0.0443	0.0432	0.0457
MS	Oct	21	1,056,396	553,395	1,863,573	0.0435	0.0406	0.0424
MS	Oct	22	994,149	490,323	1,636,301	0.0410	0.0360	0.0373
MS	Oct	23	924,165	437,325	1,518,220	0.0381	0.0321	0.0346
MS	Nov	0	873,994	419,723	1,319,979	0.0361	0.0291	0.0319
MS	Nov	1	852,947	401,495	1,283,359	0.0352	0.0279	0.0310
MS	Nov	2	830,951	389,995	1,261,174	0.0343	0.0271	0.0305
MS	Nov	3	826,026	391,038	1,262,690	0.0341	0.0272	0.0305
MS	Nov	4	857,253	417,220	1,308,806	0.0354	0.0290	0.0316
MS	Nov	5	958,948	508,090	1,458,443	0.0396	0.0353	0.0353
MS	Nov	6	1,022,014	630,716	1,659,706	0.0422	0.0438	0.0401
MS	Nov	7	1,060,943	640,532	1,755,027	0.0438	0.0445	0.0424
MS	Nov	8	1,091,560	651,059	1,801,817	0.0451	0.0452	0.0436
MS	Nov	9	1,103,148	683,533	1,857,927	0.0455	0.0475	0.0449
MS	Nov	10	1,078,324	694,360	1,880,080	0.0445	0.0482	0.0455
MS	Nov	11	1,065,364	668,754	1,889,916	0.0440	0.0464	0.0457
MS	Nov	12	1,032,203	637,744	1,903,624	0.0426	0.0443	0.0460
MS	Nov	13	1,017,096	632,959	1,918,195	0.0420	0.0440	0.0464
MS	Nov	14	991,302	621,379	1,936,214	0.0409	0.0432	0.0468
MS	Nov	15	991,334	615,452	1,910,301	0.0409	0.0427	0.0462
MS	Nov	16	1,038,741	662,734	1,952,063	0.0429	0.0460	0.0472
MS	Nov	17	1,118,397	752,304	2,049,173	0.0462	0.0522	0.0495
MS	Nov	18	1,139,616	804,866	2,097,309	0.0470	0.0559	0.0507
MS	Nov	19	1,122,336	781,325	2,065,487	0.0463	0.0543	0.0499
MS	Nov	20	1,099,154	709,431	1,965,038	0.0454	0.0493	0.0475
MS	Nov	21	1,068,182	620,932	1,794,635	0.0441	0.0431	0.0434
MS	Nov	22	1,033,176	572,600	1,595,278	0.0427	0.0398	0.0386
MS	Nov	23	949,071	490,972	1,433,679	0.0392	0.0341	0.0347
MS	Dec	0	985,774	547,406	1,523,183	0.0382	0.0351	0.0338
MS	Dec	1	958,678	534,960	1,512,551	0.0372	0.0343	0.0335
MS	Dec	2	934,029	521,102	1,524,804	0.0362	0.0334	0.0338
MS	Dec	3	934,104	526,929	1,560,808	0.0362	0.0338	0.0346
MS	Dec	4	974,296	548,706	1,660,840	0.0378	0.0352	0.0368
MS	Dec	5	1,039,798	612,444	1,841,503	0.0403	0.0393	0.0408
MS	Dec	6	1,113,547	721,122	2,036,031	0.0432	0.0462	0.0452
MS	Dec	7	1,159,345	753,347	2,071,427	0.0450	0.0483	0.0459
MS	Dec	8	1,173,841	760,317	2,095,025	0.0455	0.0488	0.0465
MS	Dec	9	1,176,528	727,906	2,045,553	0.0456	0.0467	0.0454
MS	Dec	10	1,154,951	702,026	1,964,054	0.0448	0.0450	0.0436
MS	Dec	11	1,121,403	667,756	1,869,824	0.0435	0.0428	0.0415
MS	Dec	12	1,083,924	639,652	1,821,740	0.0420	0.0410	0.0404
MS	Dec	13	1,047,128	607,261	1,783,500	0.0406	0.0389	0.0396
MS	Dec	14	1,004,758	568,687	1,763,453	0.0390	0.0365	0.0391

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
MS	Dec	15	990,339	548,686	1,785,581	0.0384	0.0352	0.0396
MS	Dec	16	1,034,926	600,093	1,877,670	0.0401	0.0385	0.0416
MS	Dec	17	1,132,545	725,446	2,120,044	0.0439	0.0465	0.0470
MS	Dec	18	1,182,372	785,125	2,220,651	0.0458	0.0503	0.0493
MS	Dec	19	1,175,656	770,915	2,225,372	0.0456	0.0494	0.0494
MS	Dec	20	1,169,944	758,124	2,203,589	0.0454	0.0486	0.0489
MS	Dec	21	1,128,007	715,886	2,103,635	0.0437	0.0459	0.0467
MS	Dec	22	1,085,539	659,297	1,851,805	0.0421	0.0423	0.0411
MS	Dec	23	1,026,441	590,507	1,625,055	0.0398	0.0379	0.0360
NC	Jan	0	3,625,870	1,340,390	3,136,181	0.0373	0.0362	0.0340
NC	Jan	1	3,547,305	1,308,649	3,066,666	0.0364	0.0353	0.0332
NC	Jan	2	3,547,177	1,317,699	3,090,405	0.0364	0.0356	0.0335
NC	Jan	3	3,588,787	1,347,741	3,203,085	0.0369	0.0364	0.0347
NC	Jan	4	3,699,352	1,403,864	3,417,648	0.0380	0.0379	0.0370
NC	Jan	5	3,908,915	1,499,733	3,756,822	0.0402	0.0405	0.0407
NC	Jan	6	4,256,587	1,655,285	4,258,104	0.0437	0.0447	0.0462
NC	Jan	7	4,483,631	1,774,004	4,707,090	0.0461	0.0479	0.0510
NC	Jan	8	4,515,366	1,766,638	4,645,775	0.0464	0.0477	0.0504
NC	Jan	9	4,491,734	1,754,783	4,636,411	0.0461	0.0474	0.0503
NC	Jan	10	4,393,796	1,702,344	4,374,553	0.0451	0.0459	0.0474
NC	Jan	11	4,250,196	1,636,046	4,145,824	0.0437	0.0442	0.0449
NC	Jan	12	4,086,233	1,544,270	3,809,889	0.0420	0.0417	0.0413
NC	Jan	13	3,955,293	1,476,462	3,617,829	0.0406	0.0398	0.0392
NC	Jan	14	3,816,633	1,418,449	3,450,107	0.0392	0.0383	0.0374
NC	Jan	15	3,743,931	1,389,505	3,382,436	0.0385	0.0375	0.0367
NC	Jan	16	3,815,007	1,417,757	3,483,763	0.0392	0.0383	0.0378
NC	Jan	17	4,092,382	1,537,546	3,810,633	0.0420	0.0415	0.0413
NC	Jan	18	4,420,054	1,716,940	4,361,423	0.0454	0.0463	0.0473
NC	Jan	19	4,435,210	1,708,171	4,331,349	0.0456	0.0461	0.0469
NC	Jan	20	4,392,805	1,679,293	4,212,749	0.0451	0.0453	0.0457
NC	Jan	21	4,302,264	1,645,099	4,096,848	0.0442	0.0444	0.0444
NC	Jan	22	4,123,178	1,572,475	3,824,535	0.0424	0.0424	0.0415
NC	Jan	23	3,840,179	1,440,491	3,434,780	0.0395	0.0389	0.0372
NC	Feb	0	3,184,603	1,111,659	2,584,219	0.0365	0.0355	0.0335
NC	Feb	1	3,104,814	1,084,322	2,526,549	0.0356	0.0346	0.0327
NC	Feb	2	3,102,384	1,084,226	2,523,155	0.0356	0.0346	0.0327
NC	Feb	3	3,150,560	1,102,189	2,565,178	0.0362	0.0352	0.0332
NC	Feb	4	3,265,151	1,154,184	2,727,067	0.0375	0.0369	0.0353
NC	Feb	5	3,477,336	1,241,276	2,998,673	0.0399	0.0396	0.0388
NC	Feb	6	3,822,164	1,386,221	3,442,195	0.0439	0.0443	0.0446
NC	Feb	7	4,018,486	1,469,047	3,700,102	0.0461	0.0469	0.0479
NC	Feb	8	4,046,941	1,482,539	3,747,404	0.0464	0.0474	0.0485
NC	Feb	9	4,018,646	1,459,740	3,678,388	0.0461	0.0466	0.0476
NC	Feb	10	3,950,541	1,421,953	3,537,090	0.0453	0.0454	0.0458
NC	Feb	11	3,820,149	1,364,963	3,395,422	0.0438	0.0436	0.0440
NC	Feb	12	3,695,389	1,319,860	3,286,832	0.0424	0.0422	0.0426
NC	Feb	13	3,589,834	1,286,954	3,238,548	0.0412	0.0411	0.0419
NC	Feb	14	3,480,630	1,245,758	3,140,457	0.0399	0.0398	0.0407
NC	Feb	15	3,413,401	1,225,689	3,112,350	0.0392	0.0392	0.0403
NC	Feb	16	3,436,366	1,238,232	3,156,097	0.0394	0.0396	0.0409
NC	Feb	17	3,578,845	1,301,549	3,309,765	0.0411	0.0416	0.0429
NC	Feb	18	3,916,367	1,444,037	3,687,236	0.0449	0.0461	0.0477
NC	Feb	19	4,026,027	1,479,808	3,763,280	0.0462	0.0473	0.0487

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Feb	20	4,006,346	1,462,311	3,636,622	0.0460	0.0467	0.0471
NC	Feb	21	3,910,149	1,416,593	3,470,296	0.0449	0.0452	0.0449
NC	Feb	22	3,715,354	1,327,212	3,175,393	0.0426	0.0424	0.0411
NC	Feb	23	3,406,957	1,195,674	2,817,750	0.0391	0.0382	0.0365
NC	Mar	0	3,495,471	1,156,479	2,781,502	0.0357	0.0344	0.0338
NC	Mar	1	3,364,317	1,111,545	2,674,119	0.0344	0.0331	0.0325
NC	Mar	2	3,321,515	1,101,682	2,646,229	0.0340	0.0328	0.0321
NC	Mar	3	3,325,853	1,110,846	2,677,665	0.0340	0.0330	0.0325
NC	Mar	4	3,432,883	1,154,085	2,799,670	0.0351	0.0343	0.0340
NC	Mar	5	3,679,438	1,253,842	3,101,527	0.0376	0.0373	0.0377
NC	Mar	6	4,083,241	1,423,687	3,556,842	0.0417	0.0423	0.0432
NC	Mar	7	4,325,741	1,523,695	3,835,215	0.0442	0.0453	0.0466
NC	Mar	8	4,408,061	1,554,926	3,978,168	0.0451	0.0462	0.0483
NC	Mar	9	4,446,596	1,560,347	3,954,716	0.0455	0.0464	0.0480
NC	Mar	10	4,422,051	1,540,513	3,787,457	0.0452	0.0458	0.0460
NC	Mar	11	4,368,120	1,515,980	3,696,220	0.0446	0.0451	0.0449
NC	Mar	12	4,320,676	1,487,685	3,591,910	0.0442	0.0442	0.0436
NC	Mar	13	4,260,564	1,462,294	3,552,480	0.0435	0.0435	0.0432
NC	Mar	14	4,181,428	1,428,179	3,424,153	0.0427	0.0425	0.0416
NC	Mar	15	4,125,296	1,400,339	3,358,859	0.0422	0.0417	0.0408
NC	Mar	16	4,137,088	1,409,567	3,382,900	0.0423	0.0419	0.0411
NC	Mar	17	4,186,812	1,437,864	3,490,868	0.0428	0.0428	0.0424
NC	Mar	18	4,384,996	1,518,976	3,714,131	0.0448	0.0452	0.0451
NC	Mar	19	4,597,710	1,613,055	3,968,091	0.0470	0.0480	0.0482
NC	Mar	20	4,561,487	1,604,590	3,972,640	0.0466	0.0477	0.0483
NC	Mar	21	4,431,834	1,545,633	3,790,920	0.0453	0.0460	0.0460
NC	Mar	22	4,186,059	1,433,121	3,483,528	0.0428	0.0426	0.0423
NC	Mar	23	3,785,976	1,271,907	3,103,453	0.0387	0.0378	0.0377
NC	Apr	0	3,039,447	989,438	2,429,415	0.0328	0.0314	0.0296
NC	Apr	1	2,910,931	945,386	2,307,952	0.0314	0.0300	0.0281
NC	Apr	2	2,850,958	927,453	2,269,071	0.0308	0.0294	0.0276
NC	Apr	3	2,896,556	942,765	2,335,243	0.0313	0.0299	0.0284
NC	Apr	4	3,135,361	1,025,528	2,555,352	0.0339	0.0325	0.0311
NC	Apr	5	3,584,481	1,188,997	2,979,186	0.0387	0.0377	0.0363
NC	Apr	6	3,881,843	1,294,539	3,271,639	0.0419	0.0411	0.0398
NC	Apr	7	4,047,382	1,346,556	3,417,421	0.0437	0.0427	0.0416
NC	Apr	8	4,171,051	1,385,765	3,451,552	0.0451	0.0440	0.0420
NC	Apr	9	4,231,500	1,414,685	3,525,438	0.0457	0.0449	0.0429
NC	Apr	10	4,270,268	1,444,254	3,674,803	0.0461	0.0458	0.0448
NC	Apr	11	4,286,067	1,471,462	3,829,895	0.0463	0.0467	0.0466
NC	Apr	12	4,290,947	1,505,275	4,032,680	0.0463	0.0478	0.0491
NC	Apr	13	4,262,841	1,500,242	4,108,312	0.0460	0.0476	0.0500
NC	Apr	14	4,252,222	1,503,067	4,136,316	0.0459	0.0477	0.0504
NC	Apr	15	4,260,951	1,532,047	4,188,783	0.0460	0.0486	0.0510
NC	Apr	16	4,235,832	1,522,595	4,190,814	0.0458	0.0483	0.0510
NC	Apr	17	4,180,904	1,484,742	4,120,053	0.0452	0.0471	0.0502
NC	Apr	18	4,151,241	1,442,982	3,980,953	0.0448	0.0458	0.0485
NC	Apr	19	4,327,964	1,496,496	4,079,513	0.0467	0.0475	0.0497
NC	Apr	20	4,309,003	1,478,214	3,952,971	0.0465	0.0469	0.0481
NC	Apr	21	4,083,738	1,377,185	3,538,885	0.0441	0.0437	0.0431
NC	Apr	22	3,659,870	1,215,010	3,052,504	0.0395	0.0386	0.0372
NC	Apr	23	3,262,225	1,075,490	2,685,449	0.0352	0.0341	0.0327
NC	May	0	2,988,299	951,099	2,688,735	0.0321	0.0307	0.0290

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	May	1	2,792,481	891,529	2,497,088	0.0300	0.0288	0.0269
NC	May	2	2,674,871	855,789	2,392,481	0.0288	0.0276	0.0258
NC	May	3	2,669,331	854,116	2,383,638	0.0287	0.0276	0.0257
NC	May	4	2,890,248	927,239	2,554,672	0.0311	0.0299	0.0276
NC	May	5	3,297,681	1,061,987	2,886,430	0.0355	0.0343	0.0311
NC	May	6	3,634,181	1,170,557	3,184,623	0.0391	0.0378	0.0344
NC	May	7	3,846,900	1,245,848	3,416,574	0.0414	0.0402	0.0369
NC	May	8	4,034,773	1,310,353	3,667,525	0.0434	0.0423	0.0396
NC	May	9	4,184,672	1,371,573	3,893,093	0.0450	0.0443	0.0420
NC	May	10	4,305,947	1,424,820	4,141,648	0.0463	0.0460	0.0447
NC	May	11	4,404,097	1,483,068	4,458,155	0.0474	0.0479	0.0481
NC	May	12	4,475,259	1,539,283	4,697,419	0.0481	0.0497	0.0507
NC	May	13	4,491,964	1,569,034	4,875,921	0.0483	0.0506	0.0526
NC	May	14	4,498,554	1,561,658	4,951,990	0.0484	0.0504	0.0534
NC	May	15	4,523,801	1,571,285	5,012,379	0.0486	0.0507	0.0541
NC	May	16	4,523,778	1,568,349	5,003,593	0.0486	0.0506	0.0540
NC	May	17	4,482,997	1,542,267	4,944,140	0.0482	0.0498	0.0533
NC	May	18	4,391,547	1,496,982	4,799,984	0.0472	0.0483	0.0518
NC	May	19	4,391,525	1,490,306	4,803,533	0.0472	0.0481	0.0518
NC	May	20	4,395,887	1,482,807	4,719,101	0.0473	0.0478	0.0509
NC	May	21	4,138,037	1,371,218	4,192,432	0.0445	0.0442	0.0452
NC	May	22	3,688,336	1,200,680	3,546,431	0.0397	0.0387	0.0383
NC	May	23	3,285,445	1,051,167	2,990,351	0.0353	0.0339	0.0323
NC	Jun	0	2,965,187	875,221	2,530,360	0.0330	0.0313	0.0292
NC	Jun	1	2,750,053	815,628	2,369,418	0.0306	0.0291	0.0273
NC	Jun	2	2,598,072	773,177	2,259,001	0.0289	0.0276	0.0261
NC	Jun	3	2,545,090	759,204	2,218,521	0.0283	0.0271	0.0256
NC	Jun	4	2,651,641	791,787	2,303,803	0.0295	0.0283	0.0266
NC	Jun	5	2,843,468	850,485	2,461,441	0.0317	0.0304	0.0284
NC	Jun	6	3,072,903	914,963	2,644,430	0.0342	0.0327	0.0305
NC	Jun	7	3,386,526	1,011,128	2,920,142	0.0377	0.0361	0.0337
NC	Jun	8	3,709,883	1,115,505	3,237,030	0.0413	0.0399	0.0374
NC	Jun	9	4,019,872	1,225,834	3,603,667	0.0448	0.0438	0.0416
NC	Jun	10	4,235,939	1,310,821	3,971,825	0.0472	0.0468	0.0458
NC	Jun	11	4,372,819	1,396,154	4,238,914	0.0487	0.0499	0.0489
NC	Jun	12	4,454,747	1,447,004	4,513,322	0.0496	0.0517	0.0521
NC	Jun	13	4,496,004	1,465,037	4,671,766	0.0501	0.0524	0.0539
NC	Jun	14	4,506,747	1,470,722	4,793,038	0.0502	0.0526	0.0553
NC	Jun	15	4,519,474	1,471,545	4,844,987	0.0503	0.0526	0.0559
NC	Jun	16	4,508,458	1,466,571	4,842,407	0.0502	0.0524	0.0559
NC	Jun	17	4,456,620	1,439,530	4,757,817	0.0496	0.0514	0.0549
NC	Jun	18	4,327,832	1,388,804	4,596,146	0.0482	0.0496	0.0530
NC	Jun	19	4,226,778	1,343,402	4,472,457	0.0471	0.0480	0.0516
NC	Jun	20	4,229,304	1,336,758	4,374,033	0.0471	0.0478	0.0505
NC	Jun	21	3,991,005	1,238,023	3,917,165	0.0445	0.0442	0.0452
NC	Jun	22	3,644,049	1,106,567	3,327,381	0.0406	0.0395	0.0384
NC	Jun	23	3,271,149	967,979	2,787,309	0.0364	0.0346	0.0322
NC	Jul	0	3,203,381	924,262	2,845,009	0.0332	0.0312	0.0297
NC	Jul	1	2,965,161	855,451	2,596,343	0.0308	0.0288	0.0271
NC	Jul	2	2,800,743	813,580	2,476,811	0.0291	0.0274	0.0259
NC	Jul	3	2,736,180	793,048	2,404,572	0.0284	0.0267	0.0251
NC	Jul	4	2,830,295	824,684	2,476,064	0.0294	0.0278	0.0259
NC	Jul	5	3,047,522	889,319	2,647,583	0.0316	0.0300	0.0277

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Jul	6	3,271,366	946,124	2,816,944	0.0339	0.0319	0.0294
NC	Jul	7	3,616,680	1,052,025	3,223,059	0.0375	0.0355	0.0337
NC	Jul	8	3,953,695	1,168,302	3,623,778	0.0410	0.0394	0.0379
NC	Jul	9	4,291,848	1,283,942	3,984,938	0.0445	0.0433	0.0417
NC	Jul	10	4,524,538	1,375,387	4,335,515	0.0469	0.0464	0.0453
NC	Jul	11	4,668,460	1,454,562	4,648,805	0.0484	0.0490	0.0486
NC	Jul	12	4,750,356	1,527,006	4,933,908	0.0493	0.0515	0.0516
NC	Jul	13	4,798,813	1,559,248	5,125,858	0.0498	0.0526	0.0536
NC	Jul	14	4,812,096	1,564,905	5,188,364	0.0499	0.0528	0.0542
NC	Jul	15	4,821,883	1,575,434	5,266,185	0.0500	0.0531	0.0550
NC	Jul	16	4,819,234	1,570,114	5,297,395	0.0500	0.0529	0.0554
NC	Jul	17	4,778,497	1,549,473	5,257,998	0.0496	0.0522	0.0550
NC	Jul	18	4,673,354	1,496,447	5,116,396	0.0485	0.0505	0.0535
NC	Jul	19	4,583,203	1,443,042	4,962,470	0.0476	0.0487	0.0519
NC	Jul	20	4,554,945	1,438,105	4,863,301	0.0473	0.0485	0.0508
NC	Jul	21	4,324,076	1,333,900	4,447,802	0.0449	0.0450	0.0465
NC	Jul	22	3,973,197	1,184,353	3,900,877	0.0412	0.0399	0.0408
NC	Jul	23	3,573,947	1,033,602	3,224,929	0.0371	0.0349	0.0337
NC	Aug	0	3,304,852	963,941	2,898,716	0.0337	0.0315	0.0295
NC	Aug	1	3,081,864	895,575	2,683,361	0.0314	0.0292	0.0274
NC	Aug	2	2,924,085	855,384	2,554,207	0.0298	0.0279	0.0260
NC	Aug	3	2,863,192	840,718	2,510,575	0.0292	0.0274	0.0256
NC	Aug	4	3,005,461	884,898	2,620,875	0.0306	0.0289	0.0267
NC	Aug	5	3,356,686	990,812	2,913,206	0.0342	0.0323	0.0297
NC	Aug	6	3,565,695	1,050,611	3,109,145	0.0363	0.0343	0.0317
NC	Aug	7	3,823,159	1,133,457	3,368,494	0.0390	0.0370	0.0343
NC	Aug	8	4,119,121	1,247,193	3,792,038	0.0420	0.0407	0.0387
NC	Aug	9	4,379,709	1,338,095	4,201,047	0.0446	0.0437	0.0428
NC	Aug	10	4,560,689	1,437,327	4,545,567	0.0465	0.0469	0.0463
NC	Aug	11	4,679,909	1,487,234	4,789,916	0.0477	0.0486	0.0488
NC	Aug	12	4,756,748	1,559,170	5,073,057	0.0485	0.0509	0.0517
NC	Aug	13	4,774,631	1,580,678	5,225,795	0.0487	0.0516	0.0533
NC	Aug	14	4,777,253	1,580,098	5,280,027	0.0487	0.0516	0.0538
NC	Aug	15	4,794,051	1,587,918	5,331,244	0.0489	0.0518	0.0543
NC	Aug	16	4,797,668	1,583,009	5,319,490	0.0489	0.0517	0.0542
NC	Aug	17	4,755,560	1,559,949	5,259,749	0.0485	0.0509	0.0536
NC	Aug	18	4,661,588	1,506,549	5,116,358	0.0475	0.0492	0.0522
NC	Aug	19	4,629,150	1,490,605	5,077,271	0.0472	0.0487	0.0518
NC	Aug	20	4,574,623	1,454,956	4,901,477	0.0466	0.0475	0.0500
NC	Aug	21	4,333,660	1,342,227	4,457,401	0.0442	0.0438	0.0454
NC	Aug	22	3,985,537	1,198,084	3,847,163	0.0406	0.0391	0.0392
NC	Aug	23	3,604,838	1,059,628	3,227,349	0.0367	0.0346	0.0329
NC	Sep	0	2,831,718	843,999	2,569,763	0.0314	0.0310	0.0304
NC	Sep	1	2,671,813	806,005	2,439,499	0.0296	0.0296	0.0289
NC	Sep	2	2,572,274	783,030	2,353,479	0.0285	0.0288	0.0279
NC	Sep	3	2,562,140	782,625	2,362,933	0.0284	0.0287	0.0280
NC	Sep	4	2,741,434	832,267	2,487,419	0.0304	0.0306	0.0295
NC	Sep	5	3,169,190	949,868	2,725,482	0.0351	0.0349	0.0323
NC	Sep	6	3,446,956	1,025,547	2,945,275	0.0382	0.0377	0.0349
NC	Sep	7	3,602,068	1,070,749	3,070,781	0.0399	0.0393	0.0364
NC	Sep	8	3,819,430	1,131,711	3,298,495	0.0423	0.0416	0.0391
NC	Sep	9	4,029,055	1,202,680	3,585,863	0.0446	0.0442	0.0425
NC	Sep	10	4,217,518	1,265,309	3,849,918	0.0467	0.0465	0.0456

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Sep	11	4,330,923	1,307,158	4,050,205	0.0480	0.0480	0.0480
NC	Sep	12	4,419,852	1,350,136	4,214,846	0.0489	0.0496	0.0499
NC	Sep	13	4,447,094	1,372,538	4,362,014	0.0492	0.0504	0.0516
NC	Sep	14	4,464,546	1,372,945	4,435,916	0.0494	0.0504	0.0525
NC	Sep	15	4,479,217	1,375,057	4,470,927	0.0496	0.0505	0.0529
NC	Sep	16	4,465,511	1,365,792	4,432,498	0.0494	0.0502	0.0525
NC	Sep	17	4,416,809	1,340,361	4,368,640	0.0489	0.0492	0.0517
NC	Sep	18	4,382,304	1,322,191	4,323,960	0.0485	0.0486	0.0512
NC	Sep	19	4,425,808	1,337,459	4,385,946	0.0490	0.0491	0.0519
NC	Sep	20	4,265,207	1,269,439	4,077,678	0.0472	0.0466	0.0483
NC	Sep	21	3,933,113	1,163,534	3,660,789	0.0436	0.0427	0.0433
NC	Sep	22	3,508,261	1,035,938	3,191,631	0.0388	0.0381	0.0378
NC	Sep	23	3,107,606	919,230	2,792,129	0.0344	0.0338	0.0331
NC	Oct	0	2,885,070	928,449	2,442,398	0.0310	0.0298	0.0293
NC	Oct	1	2,763,997	887,557	2,351,682	0.0297	0.0285	0.0282
NC	Oct	2	2,720,289	873,564	2,300,310	0.0292	0.0281	0.0276
NC	Oct	3	2,783,044	896,560	2,344,762	0.0299	0.0288	0.0281
NC	Oct	4	3,082,324	1,006,245	2,601,114	0.0331	0.0323	0.0312
NC	Oct	5	3,619,699	1,193,245	3,037,925	0.0389	0.0383	0.0364
NC	Oct	6	4,009,044	1,336,083	3,415,044	0.0431	0.0429	0.0410
NC	Oct	7	4,124,324	1,361,719	3,513,460	0.0443	0.0437	0.0422
NC	Oct	8	4,246,949	1,415,941	3,666,854	0.0456	0.0455	0.0440
NC	Oct	9	4,314,835	1,440,726	3,784,701	0.0464	0.0463	0.0454
NC	Oct	10	4,339,629	1,450,914	3,816,711	0.0466	0.0466	0.0458
NC	Oct	11	4,349,419	1,461,892	3,841,587	0.0467	0.0469	0.0461
NC	Oct	12	4,357,347	1,476,232	3,953,621	0.0468	0.0474	0.0474
NC	Oct	13	4,338,826	1,487,464	4,094,481	0.0466	0.0478	0.0491
NC	Oct	14	4,314,366	1,488,527	4,131,106	0.0464	0.0478	0.0496
NC	Oct	15	4,316,652	1,485,833	4,106,754	0.0464	0.0477	0.0493
NC	Oct	16	4,309,747	1,474,424	4,093,656	0.0463	0.0473	0.0491
NC	Oct	17	4,339,072	1,478,737	4,084,329	0.0466	0.0475	0.0490
NC	Oct	18	4,493,664	1,540,332	4,212,273	0.0483	0.0495	0.0505
NC	Oct	19	4,450,160	1,514,183	4,126,568	0.0478	0.0486	0.0495
NC	Oct	20	4,284,031	1,443,363	3,900,011	0.0460	0.0464	0.0468
NC	Oct	21	3,975,347	1,323,443	3,594,778	0.0427	0.0425	0.0431
NC	Oct	22	3,512,993	1,149,489	3,134,673	0.0377	0.0369	0.0376
NC	Oct	23	3,146,439	1,025,300	2,806,812	0.0338	0.0329	0.0337
NC	Nov	0	3,150,839	1,015,387	2,449,180	0.0350	0.0339	0.0336
NC	Nov	1	3,028,579	971,948	2,360,809	0.0337	0.0324	0.0324
NC	Nov	2	2,980,393	959,450	2,315,231	0.0331	0.0320	0.0317
NC	Nov	3	2,996,471	969,449	2,326,773	0.0333	0.0323	0.0319
NC	Nov	4	3,110,091	1,013,456	2,432,433	0.0346	0.0338	0.0333
NC	Nov	5	3,397,863	1,122,707	2,719,216	0.0378	0.0375	0.0373
NC	Nov	6	3,816,334	1,281,051	3,145,075	0.0424	0.0427	0.0431
NC	Nov	7	4,044,328	1,358,786	3,355,851	0.0450	0.0453	0.0460
NC	Nov	8	4,121,076	1,380,735	3,392,485	0.0458	0.0461	0.0465
NC	Nov	9	4,141,648	1,394,679	3,387,725	0.0460	0.0465	0.0464
NC	Nov	10	4,108,343	1,378,482	3,320,442	0.0457	0.0460	0.0455
NC	Nov	11	4,021,305	1,349,512	3,269,332	0.0447	0.0450	0.0448
NC	Nov	12	3,904,488	1,315,604	3,216,716	0.0434	0.0439	0.0441
NC	Nov	13	3,825,065	1,289,627	3,183,346	0.0425	0.0430	0.0436
NC	Nov	14	3,746,599	1,261,138	3,114,744	0.0416	0.0421	0.0427
NC	Nov	15	3,701,103	1,252,501	3,108,862	0.0411	0.0418	0.0426

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
NC	Nov	16	3,777,052	1,273,672	3,164,960	0.0420	0.0425	0.0434
NC	Nov	17	4,062,557	1,381,041	3,395,008	0.0452	0.0461	0.0465
NC	Nov	18	4,291,870	1,463,476	3,557,570	0.0477	0.0488	0.0488
NC	Nov	19	4,247,162	1,429,480	3,479,287	0.0472	0.0477	0.0477
NC	Nov	20	4,186,388	1,395,882	3,370,869	0.0465	0.0466	0.0462
NC	Nov	21	4,049,659	1,347,541	3,230,259	0.0450	0.0450	0.0443
NC	Nov	22	3,799,944	1,252,490	2,970,701	0.0422	0.0418	0.0407
NC	Nov	23	3,445,867	1,119,348	2,674,017	0.0383	0.0373	0.0367
NC	Dec	0	3,746,730	1,304,213	3,329,238	0.0381	0.0364	0.0343
NC	Dec	1	3,640,826	1,249,301	3,111,292	0.0371	0.0349	0.0320
NC	Dec	2	3,604,310	1,236,941	3,029,282	0.0367	0.0346	0.0312
NC	Dec	3	3,629,794	1,243,360	3,030,814	0.0369	0.0347	0.0312
NC	Dec	4	3,728,167	1,296,002	3,236,096	0.0379	0.0362	0.0333
NC	Dec	5	3,902,435	1,395,928	3,643,907	0.0397	0.0390	0.0375
NC	Dec	6	4,205,452	1,551,236	4,365,683	0.0428	0.0433	0.0449
NC	Dec	7	4,435,132	1,683,579	4,874,322	0.0451	0.0470	0.0502
NC	Dec	8	4,518,449	1,723,609	4,993,567	0.0460	0.0482	0.0514
NC	Dec	9	4,494,805	1,704,798	4,884,158	0.0457	0.0476	0.0503
NC	Dec	10	4,377,997	1,646,309	4,645,870	0.0446	0.0460	0.0478
NC	Dec	11	4,201,701	1,574,751	4,439,375	0.0428	0.0440	0.0457
NC	Dec	12	4,035,944	1,488,621	4,115,556	0.0411	0.0416	0.0423
NC	Dec	13	3,895,872	1,379,646	3,606,995	0.0396	0.0385	0.0371
NC	Dec	14	3,780,919	1,338,989	3,454,137	0.0385	0.0374	0.0355
NC	Dec	15	3,725,324	1,326,372	3,466,080	0.0379	0.0371	0.0357
NC	Dec	16	3,856,207	1,379,749	3,737,941	0.0392	0.0385	0.0385
NC	Dec	17	4,270,038	1,574,946	4,407,860	0.0435	0.0440	0.0454
NC	Dec	18	4,520,968	1,690,557	4,747,898	0.0460	0.0472	0.0489
NC	Dec	19	4,528,494	1,690,133	4,819,407	0.0461	0.0472	0.0496
NC	Dec	20	4,505,067	1,682,184	4,769,232	0.0458	0.0470	0.0491
NC	Dec	21	4,432,600	1,659,975	4,657,151	0.0451	0.0464	0.0479
NC	Dec	22	4,259,928	1,562,495	4,182,135	0.0434	0.0437	0.0430
NC	Dec	23	3,968,211	1,409,786	3,637,388	0.0404	0.0394	0.0374
SC	Jan	0	1,728,093	721,116	1,850,156	0.0395	0.0391	0.0373
SC	Jan	1	1,700,006	706,997	1,809,948	0.0389	0.0384	0.0365
SC	Jan	2	1,698,665	704,675	1,809,371	0.0389	0.0382	0.0365
SC	Jan	3	1,707,947	709,505	1,821,754	0.0391	0.0385	0.0367
SC	Jan	4	1,729,700	717,457	1,871,774	0.0396	0.0389	0.0378
SC	Jan	5	1,776,301	752,197	2,094,917	0.0406	0.0408	0.0423
SC	Jan	6	1,860,983	787,384	2,287,912	0.0426	0.0427	0.0461
SC	Jan	7	1,923,567	829,128	2,465,540	0.0440	0.0450	0.0497
SC	Jan	8	1,933,655	810,887	2,466,285	0.0442	0.0440	0.0497
SC	Jan	9	1,936,894	813,441	2,411,559	0.0443	0.0441	0.0486
SC	Jan	10	1,918,638	794,597	2,235,280	0.0439	0.0431	0.0451
SC	Jan	11	1,876,381	778,460	2,130,643	0.0429	0.0422	0.0430
SC	Jan	12	1,830,742	761,547	2,036,485	0.0419	0.0413	0.0411
SC	Jan	13	1,789,149	745,241	1,995,539	0.0409	0.0404	0.0402
SC	Jan	14	1,759,395	727,972	1,952,888	0.0402	0.0395	0.0394
SC	Jan	15	1,744,819	723,566	1,906,404	0.0399	0.0393	0.0385
SC	Jan	16	1,757,000	739,319	1,922,537	0.0402	0.0401	0.0388
SC	Jan	17	1,823,893	777,143	2,023,581	0.0417	0.0422	0.0408
SC	Jan	18	1,912,362	829,821	2,168,269	0.0437	0.0450	0.0437
SC	Jan	19	1,913,185	836,772	2,171,758	0.0438	0.0454	0.0438
SC	Jan	20	1,898,515	825,406	2,135,170	0.0434	0.0448	0.0431

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Jan	21	1,883,924	803,841	2,093,017	0.0431	0.0436	0.0422
SC	Jan	22	1,838,539	781,559	2,006,926	0.0421	0.0424	0.0405
SC	Jan	23	1,779,635	754,512	1,912,777	0.0407	0.0409	0.0386
SC	Feb	0	1,491,213	613,334	1,607,464	0.0387	0.0381	0.0372
SC	Feb	1	1,463,158	597,825	1,576,644	0.0380	0.0372	0.0365
SC	Feb	2	1,460,769	595,351	1,569,584	0.0379	0.0370	0.0363
SC	Feb	3	1,473,152	604,627	1,575,911	0.0382	0.0376	0.0365
SC	Feb	4	1,496,362	618,267	1,614,304	0.0388	0.0384	0.0373
SC	Feb	5	1,557,038	644,924	1,726,173	0.0404	0.0401	0.0399
SC	Feb	6	1,653,909	683,041	1,882,275	0.0429	0.0425	0.0435
SC	Feb	7	1,728,362	721,019	2,067,084	0.0448	0.0448	0.0478
SC	Feb	8	1,736,534	759,406	2,064,784	0.0451	0.0472	0.0478
SC	Feb	9	1,735,409	775,830	1,994,870	0.0450	0.0482	0.0461
SC	Feb	10	1,721,097	711,635	1,913,585	0.0447	0.0442	0.0443
SC	Feb	11	1,673,555	696,036	1,846,604	0.0434	0.0433	0.0427
SC	Feb	12	1,619,888	682,489	1,794,420	0.0420	0.0424	0.0415
SC	Feb	13	1,578,544	650,899	1,749,844	0.0410	0.0405	0.0405
SC	Feb	14	1,547,477	644,188	1,721,217	0.0402	0.0401	0.0398
SC	Feb	15	1,532,282	624,880	1,698,203	0.0398	0.0388	0.0393
SC	Feb	16	1,539,109	631,259	1,713,567	0.0399	0.0392	0.0396
SC	Feb	17	1,579,567	657,001	1,791,698	0.0410	0.0408	0.0414
SC	Feb	18	1,663,058	701,384	1,921,503	0.0432	0.0436	0.0445
SC	Feb	19	1,697,528	723,836	1,976,870	0.0440	0.0450	0.0457
SC	Feb	20	1,697,268	705,811	1,953,211	0.0440	0.0439	0.0452
SC	Feb	21	1,687,160	699,588	1,924,838	0.0438	0.0435	0.0445
SC	Feb	22	1,645,415	681,704	1,829,540	0.0427	0.0424	0.0423
SC	Feb	23	1,563,182	660,164	1,713,133	0.0406	0.0410	0.0396
SC	Mar	0	1,570,028	617,676	1,729,461	0.0376	0.0366	0.0358
SC	Mar	1	1,531,400	602,756	1,688,537	0.0366	0.0357	0.0350
SC	Mar	2	1,521,077	591,850	1,683,137	0.0364	0.0351	0.0349
SC	Mar	3	1,523,949	595,935	1,703,237	0.0365	0.0353	0.0353
SC	Mar	4	1,548,871	605,469	1,742,061	0.0371	0.0359	0.0361
SC	Mar	5	1,620,422	643,732	1,902,989	0.0388	0.0382	0.0394
SC	Mar	6	1,745,903	702,598	2,107,986	0.0418	0.0417	0.0437
SC	Mar	7	1,830,523	747,531	2,335,048	0.0438	0.0443	0.0484
SC	Mar	8	1,844,727	759,818	2,341,894	0.0441	0.0451	0.0485
SC	Mar	9	1,855,820	756,820	2,275,264	0.0444	0.0449	0.0471
SC	Mar	10	1,838,923	749,713	2,162,459	0.0440	0.0445	0.0448
SC	Mar	11	1,818,689	737,663	2,094,414	0.0435	0.0437	0.0434
SC	Mar	12	1,799,958	730,198	2,050,291	0.0431	0.0433	0.0425
SC	Mar	13	1,778,256	720,279	2,024,946	0.0425	0.0427	0.0419
SC	Mar	14	1,762,992	716,285	2,004,596	0.0422	0.0425	0.0415
SC	Mar	15	1,754,896	712,561	1,989,139	0.0420	0.0423	0.0412
SC	Mar	16	1,763,911	714,222	1,989,251	0.0422	0.0424	0.0412
SC	Mar	17	1,787,826	729,933	2,036,373	0.0428	0.0433	0.0422
SC	Mar	18	1,825,407	741,845	2,106,974	0.0437	0.0440	0.0436
SC	Mar	19	1,883,948	769,078	2,165,672	0.0451	0.0456	0.0449
SC	Mar	20	1,885,767	774,288	2,171,867	0.0451	0.0459	0.0450
SC	Mar	21	1,865,243	759,550	2,122,958	0.0446	0.0450	0.0440
SC	Mar	22	1,796,203	724,800	2,006,710	0.0430	0.0430	0.0416
SC	Mar	23	1,644,196	659,138	1,835,734	0.0393	0.0391	0.0380
SC	Apr	0	1,449,915	578,366	1,541,052	0.0369	0.0355	0.0331
SC	Apr	1	1,413,251	559,096	1,508,815	0.0360	0.0343	0.0324

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Apr	2	1,399,197	553,497	1,497,568	0.0356	0.0340	0.0322
SC	Apr	3	1,395,975	554,522	1,498,333	0.0355	0.0340	0.0322
SC	Apr	4	1,444,258	579,023	1,584,251	0.0367	0.0355	0.0340
SC	Apr	5	1,541,273	627,007	1,735,422	0.0392	0.0385	0.0373
SC	Apr	6	1,626,261	664,207	1,877,552	0.0414	0.0407	0.0403
SC	Apr	7	1,651,226	691,226	1,961,326	0.0420	0.0424	0.0421
SC	Apr	8	1,692,028	700,213	1,940,268	0.0430	0.0430	0.0417
SC	Apr	9	1,719,835	714,123	1,947,967	0.0437	0.0438	0.0418
SC	Apr	10	1,729,069	721,714	2,021,772	0.0440	0.0443	0.0434
SC	Apr	11	1,737,657	729,330	2,128,857	0.0442	0.0447	0.0457
SC	Apr	12	1,741,301	732,848	2,180,195	0.0443	0.0450	0.0468
SC	Apr	13	1,736,903	735,831	2,235,280	0.0442	0.0451	0.0480
SC	Apr	14	1,736,370	735,125	2,259,505	0.0442	0.0451	0.0485
SC	Apr	15	1,740,580	739,391	2,251,512	0.0443	0.0454	0.0484
SC	Apr	16	1,747,930	740,665	2,226,652	0.0445	0.0454	0.0478
SC	Apr	17	1,741,543	742,101	2,206,888	0.0443	0.0455	0.0474
SC	Apr	18	1,728,436	728,244	2,173,481	0.0440	0.0447	0.0467
SC	Apr	19	1,755,766	735,011	2,190,506	0.0447	0.0451	0.0471
SC	Apr	20	1,761,299	738,799	2,158,688	0.0448	0.0453	0.0464
SC	Apr	21	1,705,932	721,195	2,017,954	0.0434	0.0442	0.0433
SC	Apr	22	1,608,642	670,600	1,797,648	0.0409	0.0411	0.0386
SC	Apr	23	1,506,893	610,338	1,608,882	0.0383	0.0374	0.0346
SC	May	0	1,498,612	637,097	1,833,832	0.0362	0.0347	0.0316
SC	May	1	1,450,392	615,904	1,771,923	0.0351	0.0336	0.0306
SC	May	2	1,417,869	602,820	1,744,069	0.0343	0.0329	0.0301
SC	May	3	1,400,882	600,357	1,733,497	0.0339	0.0327	0.0299
SC	May	4	1,428,284	614,115	1,759,756	0.0345	0.0335	0.0304
SC	May	5	1,519,500	652,482	1,859,793	0.0367	0.0356	0.0321
SC	May	6	1,611,498	693,767	1,967,396	0.0390	0.0378	0.0339
SC	May	7	1,648,860	723,968	2,049,759	0.0399	0.0395	0.0354
SC	May	8	1,720,799	755,914	2,185,667	0.0416	0.0412	0.0377
SC	May	9	1,779,287	792,359	2,389,819	0.0430	0.0432	0.0412
SC	May	10	1,833,007	822,368	2,607,752	0.0443	0.0448	0.0450
SC	May	11	1,873,194	849,691	2,835,887	0.0453	0.0463	0.0489
SC	May	12	1,894,648	868,950	2,950,397	0.0458	0.0474	0.0509
SC	May	13	1,910,942	888,796	2,995,481	0.0462	0.0485	0.0517
SC	May	14	1,907,923	885,213	3,037,408	0.0461	0.0483	0.0524
SC	May	15	1,918,453	876,112	3,069,418	0.0464	0.0478	0.0530
SC	May	16	1,921,958	876,388	3,063,115	0.0465	0.0478	0.0529
SC	May	17	1,904,834	867,684	3,023,165	0.0461	0.0473	0.0522
SC	May	18	1,876,441	841,868	2,911,756	0.0454	0.0459	0.0502
SC	May	19	1,868,291	830,060	2,862,350	0.0452	0.0453	0.0494
SC	May	20	1,868,894	830,803	2,786,645	0.0452	0.0453	0.0481
SC	May	21	1,817,535	803,046	2,460,990	0.0440	0.0438	0.0425
SC	May	22	1,699,689	738,375	2,120,530	0.0411	0.0403	0.0366
SC	May	23	1,576,820	673,205	1,933,990	0.0381	0.0367	0.0334
SC	Jun	0	1,493,640	582,310	1,794,445	0.0364	0.0353	0.0323
SC	Jun	1	1,432,120	558,309	1,727,493	0.0349	0.0339	0.0311
SC	Jun	2	1,391,295	543,551	1,690,485	0.0339	0.0330	0.0304
SC	Jun	3	1,374,261	540,031	1,666,058	0.0335	0.0328	0.0300
SC	Jun	4	1,385,262	541,945	1,672,944	0.0338	0.0329	0.0301
SC	Jun	5	1,428,870	557,257	1,718,034	0.0349	0.0338	0.0309
SC	Jun	6	1,496,140	582,334	1,784,352	0.0365	0.0353	0.0321

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Jun	7	1,569,789	624,786	1,885,299	0.0383	0.0379	0.0339
SC	Jun	8	1,687,007	681,249	2,089,132	0.0411	0.0413	0.0376
SC	Jun	9	1,773,648	718,864	2,303,706	0.0433	0.0436	0.0414
SC	Jun	10	1,849,785	758,252	2,555,332	0.0451	0.0460	0.0460
SC	Jun	11	1,898,722	778,157	2,738,523	0.0463	0.0472	0.0492
SC	Jun	12	1,919,728	793,701	2,834,378	0.0468	0.0481	0.0510
SC	Jun	13	1,932,270	798,164	2,886,166	0.0471	0.0484	0.0519
SC	Jun	14	1,936,457	797,934	2,921,888	0.0472	0.0484	0.0525
SC	Jun	15	1,936,616	792,769	2,936,701	0.0472	0.0481	0.0528
SC	Jun	16	1,928,347	785,587	2,920,656	0.0470	0.0477	0.0525
SC	Jun	17	1,911,440	779,492	2,886,164	0.0466	0.0473	0.0519
SC	Jun	18	1,882,383	761,132	2,799,440	0.0459	0.0462	0.0503
SC	Jun	19	1,855,166	746,872	2,702,881	0.0453	0.0453	0.0486
SC	Jun	20	1,851,233	746,366	2,676,326	0.0452	0.0453	0.0481
SC	Jun	21	1,801,170	725,445	2,437,466	0.0439	0.0440	0.0438
SC	Jun	22	1,692,344	673,917	2,079,593	0.0413	0.0409	0.0374
SC	Jun	23	1,570,218	616,659	1,900,884	0.0383	0.0374	0.0342
SC	Jul	0	1,620,900	617,147	1,915,031	0.0369	0.0358	0.0326
SC	Jul	1	1,551,483	588,500	1,850,564	0.0354	0.0341	0.0315
SC	Jul	2	1,500,227	571,371	1,806,669	0.0342	0.0331	0.0308
SC	Jul	3	1,472,648	563,618	1,788,381	0.0336	0.0327	0.0304
SC	Jul	4	1,479,367	567,725	1,795,608	0.0337	0.0329	0.0306
SC	Jul	5	1,524,479	585,021	1,839,929	0.0348	0.0339	0.0313
SC	Jul	6	1,587,303	606,797	1,891,656	0.0362	0.0352	0.0322
SC	Jul	7	1,670,210	646,514	2,008,168	0.0381	0.0375	0.0342
SC	Jul	8	1,793,230	704,890	2,254,461	0.0409	0.0409	0.0384
SC	Jul	9	1,900,677	759,809	2,535,975	0.0433	0.0441	0.0432
SC	Jul	10	1,974,755	791,754	2,719,318	0.0450	0.0459	0.0463
SC	Jul	11	2,012,079	807,840	2,877,177	0.0459	0.0469	0.0490
SC	Jul	12	2,040,709	822,946	2,967,171	0.0465	0.0477	0.0505
SC	Jul	13	2,049,158	825,391	3,004,287	0.0467	0.0479	0.0511
SC	Jul	14	2,052,040	833,307	3,047,656	0.0468	0.0483	0.0519
SC	Jul	15	2,060,489	832,450	3,057,284	0.0470	0.0483	0.0520
SC	Jul	16	2,055,686	825,135	3,025,976	0.0469	0.0479	0.0515
SC	Jul	17	2,043,298	816,427	2,987,729	0.0466	0.0474	0.0509
SC	Jul	18	2,018,525	798,095	2,919,358	0.0460	0.0463	0.0497
SC	Jul	19	1,991,587	781,061	2,863,829	0.0454	0.0453	0.0488
SC	Jul	20	1,992,241	778,797	2,817,732	0.0454	0.0452	0.0480
SC	Jul	21	1,932,045	752,881	2,540,668	0.0440	0.0437	0.0433
SC	Jul	22	1,830,533	705,997	2,211,035	0.0417	0.0409	0.0376
SC	Jul	23	1,713,740	657,337	2,016,164	0.0391	0.0381	0.0343
SC	Aug	0	1,669,000	626,459	1,923,024	0.0374	0.0366	0.0328
SC	Aug	1	1,599,912	597,112	1,868,252	0.0358	0.0349	0.0319
SC	Aug	2	1,549,850	579,237	1,827,890	0.0347	0.0339	0.0312
SC	Aug	3	1,525,004	570,235	1,806,279	0.0342	0.0333	0.0308
SC	Aug	4	1,545,884	575,793	1,820,358	0.0346	0.0337	0.0310
SC	Aug	5	1,624,700	601,188	1,883,030	0.0364	0.0351	0.0321
SC	Aug	6	1,690,450	623,077	1,925,134	0.0379	0.0364	0.0328
SC	Aug	7	1,723,400	650,536	2,013,158	0.0386	0.0380	0.0343
SC	Aug	8	1,814,519	684,468	2,197,919	0.0406	0.0400	0.0375
SC	Aug	9	1,906,415	742,701	2,474,234	0.0427	0.0434	0.0422
SC	Aug	10	1,980,397	776,292	2,713,602	0.0444	0.0454	0.0463
SC	Aug	11	2,032,443	786,958	2,847,333	0.0455	0.0460	0.0486

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Aug	12	2,052,610	802,943	2,924,493	0.0460	0.0469	0.0499
SC	Aug	13	2,056,243	814,991	2,990,621	0.0461	0.0476	0.0510
SC	Aug	14	2,063,580	821,035	3,064,772	0.0462	0.0480	0.0523
SC	Aug	15	2,069,925	820,542	3,065,071	0.0464	0.0480	0.0523
SC	Aug	16	2,063,212	816,753	3,024,907	0.0462	0.0477	0.0516
SC	Aug	17	2,052,183	799,002	2,966,453	0.0460	0.0467	0.0506
SC	Aug	18	2,029,780	779,424	2,877,464	0.0455	0.0456	0.0491
SC	Aug	19	2,026,175	773,835	2,859,409	0.0454	0.0452	0.0488
SC	Aug	20	2,020,544	769,733	2,798,475	0.0453	0.0450	0.0477
SC	Aug	21	1,956,666	743,184	2,558,532	0.0438	0.0434	0.0436
SC	Aug	22	1,863,302	700,535	2,201,837	0.0417	0.0409	0.0375
SC	Aug	23	1,735,189	654,070	2,012,343	0.0389	0.0382	0.0343
SC	Sep	0	1,433,481	529,517	1,641,405	0.0355	0.0342	0.0322
SC	Sep	1	1,389,388	511,584	1,593,230	0.0345	0.0330	0.0313
SC	Sep	2	1,359,473	502,039	1,572,801	0.0337	0.0324	0.0309
SC	Sep	3	1,348,909	500,153	1,562,637	0.0335	0.0323	0.0307
SC	Sep	4	1,380,888	510,443	1,593,344	0.0342	0.0330	0.0313
SC	Sep	5	1,492,551	550,177	1,702,039	0.0370	0.0355	0.0334
SC	Sep	6	1,579,565	590,679	1,812,898	0.0392	0.0382	0.0356
SC	Sep	7	1,593,015	604,185	1,865,786	0.0395	0.0390	0.0366
SC	Sep	8	1,677,248	638,007	1,960,842	0.0416	0.0412	0.0385
SC	Sep	9	1,746,822	679,229	2,095,183	0.0433	0.0439	0.0411
SC	Sep	10	1,806,770	703,403	2,249,399	0.0448	0.0454	0.0441
SC	Sep	11	1,847,957	722,659	2,412,048	0.0458	0.0467	0.0473
SC	Sep	12	1,866,568	732,681	2,543,527	0.0463	0.0473	0.0499
SC	Sep	13	1,871,396	737,879	2,614,316	0.0464	0.0477	0.0513
SC	Sep	14	1,875,795	743,721	2,648,594	0.0465	0.0480	0.0520
SC	Sep	15	1,881,431	748,017	2,675,173	0.0467	0.0483	0.0525
SC	Sep	16	1,885,700	750,387	2,653,661	0.0468	0.0485	0.0521
SC	Sep	17	1,870,019	736,902	2,605,312	0.0464	0.0476	0.0511
SC	Sep	18	1,861,590	728,943	2,528,650	0.0462	0.0471	0.0496
SC	Sep	19	1,868,290	725,154	2,512,852	0.0463	0.0468	0.0493
SC	Sep	20	1,835,112	702,531	2,382,740	0.0455	0.0454	0.0467
SC	Sep	21	1,740,640	664,927	2,132,217	0.0432	0.0430	0.0418
SC	Sep	22	1,614,198	610,261	1,897,061	0.0400	0.0394	0.0372
SC	Sep	23	1,496,236	557,588	1,722,445	0.0371	0.0360	0.0338
SC	Oct	0	1,584,045	572,629	1,614,079	0.0372	0.0356	0.0336
SC	Oct	1	1,563,179	560,778	1,593,106	0.0367	0.0348	0.0331
SC	Oct	2	1,552,024	555,435	1,585,690	0.0365	0.0345	0.0330
SC	Oct	3	1,563,378	558,152	1,592,294	0.0367	0.0347	0.0331
SC	Oct	4	1,622,994	580,487	1,649,210	0.0381	0.0361	0.0343
SC	Oct	5	1,736,202	627,877	1,768,874	0.0408	0.0390	0.0368
SC	Oct	6	1,825,628	676,786	1,886,492	0.0429	0.0420	0.0392
SC	Oct	7	1,821,919	686,702	1,951,542	0.0428	0.0426	0.0406
SC	Oct	8	1,847,515	700,465	2,011,122	0.0434	0.0435	0.0418
SC	Oct	9	1,859,064	707,811	2,060,220	0.0437	0.0440	0.0428
SC	Oct	10	1,856,435	713,978	2,110,551	0.0436	0.0443	0.0439
SC	Oct	11	1,856,542	718,014	2,185,946	0.0436	0.0446	0.0455
SC	Oct	12	1,860,690	724,268	2,260,835	0.0437	0.0450	0.0470
SC	Oct	13	1,852,592	726,262	2,313,236	0.0435	0.0451	0.0481
SC	Oct	14	1,850,542	731,678	2,351,017	0.0435	0.0454	0.0489
SC	Oct	15	1,849,413	726,668	2,355,006	0.0435	0.0451	0.0490
SC	Oct	16	1,852,257	727,366	2,351,463	0.0435	0.0452	0.0489

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Oct	17	1,856,069	722,520	2,320,623	0.0436	0.0449	0.0483
SC	Oct	18	1,877,238	724,131	2,326,335	0.0441	0.0450	0.0484
SC	Oct	19	1,866,808	719,859	2,264,805	0.0439	0.0447	0.0471
SC	Oct	20	1,846,455	709,888	2,120,661	0.0434	0.0441	0.0441
SC	Oct	21	1,808,760	687,389	1,949,504	0.0425	0.0427	0.0405
SC	Oct	22	1,719,502	642,997	1,780,385	0.0404	0.0399	0.0370
SC	Oct	23	1,631,545	599,680	1,684,084	0.0383	0.0372	0.0350
SC	Nov	0	1,634,166	594,383	1,624,338	0.0388	0.0380	0.0363
SC	Nov	1	1,610,839	582,397	1,581,038	0.0382	0.0372	0.0353
SC	Nov	2	1,596,014	575,703	1,568,622	0.0379	0.0368	0.0350
SC	Nov	3	1,593,761	576,837	1,571,912	0.0378	0.0369	0.0351
SC	Nov	4	1,617,385	588,331	1,616,640	0.0384	0.0376	0.0361
SC	Nov	5	1,680,281	616,701	1,740,703	0.0399	0.0394	0.0389
SC	Nov	6	1,776,053	662,254	1,965,145	0.0422	0.0423	0.0439
SC	Nov	7	1,827,927	691,215	2,079,637	0.0434	0.0442	0.0465
SC	Nov	8	1,827,180	687,112	2,072,905	0.0434	0.0439	0.0463
SC	Nov	9	1,844,213	692,367	1,998,167	0.0438	0.0442	0.0446
SC	Nov	10	1,835,738	684,115	1,937,503	0.0436	0.0437	0.0433
SC	Nov	11	1,821,015	673,682	1,913,900	0.0432	0.0430	0.0428
SC	Nov	12	1,798,370	667,312	1,914,041	0.0427	0.0426	0.0428
SC	Nov	13	1,777,001	660,714	1,895,154	0.0422	0.0422	0.0423
SC	Nov	14	1,759,967	658,086	1,914,232	0.0418	0.0421	0.0428
SC	Nov	15	1,747,486	655,088	1,914,966	0.0415	0.0419	0.0428
SC	Nov	16	1,755,083	656,719	1,932,851	0.0417	0.0420	0.0432
SC	Nov	17	1,810,800	678,076	1,991,746	0.0430	0.0433	0.0445
SC	Nov	18	1,863,271	701,664	2,081,308	0.0442	0.0448	0.0465
SC	Nov	19	1,852,579	697,417	2,055,872	0.0440	0.0446	0.0459
SC	Nov	20	1,830,891	688,044	1,988,740	0.0435	0.0440	0.0444
SC	Nov	21	1,807,895	678,467	1,926,918	0.0429	0.0434	0.0430
SC	Nov	22	1,772,932	660,130	1,801,442	0.0421	0.0422	0.0402
SC	Nov	23	1,689,054	622,763	1,674,656	0.0401	0.0398	0.0374
SC	Dec	0	1,790,705	674,127	1,908,284	0.0401	0.0395	0.0375
SC	Dec	1	1,760,847	659,279	1,877,399	0.0395	0.0386	0.0369
SC	Dec	2	1,766,498	660,719	1,890,957	0.0396	0.0387	0.0372
SC	Dec	3	1,766,455	664,407	1,922,535	0.0396	0.0389	0.0378
SC	Dec	4	1,788,023	677,882	2,005,041	0.0401	0.0397	0.0394
SC	Dec	5	1,839,136	708,796	2,193,779	0.0412	0.0415	0.0431
SC	Dec	6	1,903,431	736,781	2,379,535	0.0427	0.0432	0.0468
SC	Dec	7	1,957,422	760,608	2,504,498	0.0439	0.0446	0.0492
SC	Dec	8	1,958,923	768,669	2,515,860	0.0439	0.0450	0.0494
SC	Dec	9	1,974,624	767,392	2,419,052	0.0443	0.0450	0.0475
SC	Dec	10	1,944,825	751,207	2,264,252	0.0436	0.0440	0.0445
SC	Dec	11	1,888,552	723,857	2,140,166	0.0423	0.0424	0.0421
SC	Dec	12	1,833,408	694,261	2,022,036	0.0411	0.0407	0.0397
SC	Dec	13	1,781,162	673,316	1,936,841	0.0399	0.0395	0.0381
SC	Dec	14	1,755,403	663,791	1,911,001	0.0393	0.0389	0.0376
SC	Dec	15	1,743,443	660,042	1,897,088	0.0391	0.0387	0.0373
SC	Dec	16	1,775,717	669,264	1,937,000	0.0398	0.0392	0.0381
SC	Dec	17	1,877,548	713,920	2,099,275	0.0421	0.0418	0.0413
SC	Dec	18	1,948,165	753,627	2,255,923	0.0437	0.0442	0.0443
SC	Dec	19	1,940,185	753,123	2,258,417	0.0435	0.0441	0.0444
SC	Dec	20	1,941,859	750,942	2,221,568	0.0435	0.0440	0.0437
SC	Dec	21	1,930,605	743,880	2,182,689	0.0433	0.0436	0.0429

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
SC	Dec	22	1,909,077	732,480	2,140,416	0.0428	0.0429	0.0421
SC	Dec	23	1,841,457	702,464	2,003,560	0.0413	0.0412	0.0394
TN	Jan	0	2,920,730	1,316,670	2,817,787	0.0408	0.0406	0.0399
TN	Jan	1	2,905,383	1,309,968	2,787,169	0.0406	0.0404	0.0395
TN	Jan	2	2,896,852	1,315,743	2,779,735	0.0405	0.0405	0.0394
TN	Jan	3	2,903,214	1,311,102	2,795,456	0.0405	0.0404	0.0396
TN	Jan	4	2,942,126	1,324,196	2,817,908	0.0411	0.0408	0.0399
TN	Jan	5	2,996,259	1,367,394	2,947,753	0.0418	0.0421	0.0418
TN	Jan	6	3,012,850	1,387,044	3,096,095	0.0421	0.0427	0.0439
TN	Jan	7	2,990,321	1,386,216	3,127,023	0.0418	0.0427	0.0443
TN	Jan	8	3,017,898	1,385,708	3,089,071	0.0421	0.0427	0.0438
TN	Jan	9	3,024,338	1,380,461	3,016,715	0.0422	0.0425	0.0428
TN	Jan	10	3,015,220	1,377,561	2,955,646	0.0421	0.0424	0.0419
TN	Jan	11	2,997,070	1,360,861	2,908,329	0.0419	0.0419	0.0412
TN	Jan	12	2,980,028	1,337,986	2,842,003	0.0416	0.0412	0.0403
TN	Jan	13	2,963,100	1,326,028	2,807,869	0.0414	0.0408	0.0398
TN	Jan	14	2,941,105	1,324,684	2,798,369	0.0411	0.0408	0.0397
TN	Jan	15	2,954,133	1,330,977	2,803,884	0.0413	0.0410	0.0397
TN	Jan	16	2,995,673	1,341,978	2,875,433	0.0418	0.0413	0.0408
TN	Jan	17	3,039,411	1,375,915	3,031,799	0.0424	0.0424	0.0430
TN	Jan	18	3,053,103	1,390,734	3,145,028	0.0426	0.0428	0.0446
TN	Jan	19	3,047,225	1,383,178	3,101,091	0.0426	0.0426	0.0440
TN	Jan	20	3,042,230	1,375,234	3,059,203	0.0425	0.0424	0.0434
TN	Jan	21	3,028,915	1,367,629	3,027,200	0.0423	0.0421	0.0429
TN	Jan	22	2,988,540	1,351,866	2,980,122	0.0417	0.0416	0.0422
TN	Jan	23	2,952,443	1,334,516	2,933,297	0.0412	0.0411	0.0416
TN	Feb	0	2,574,224	1,151,313	2,217,245	0.0406	0.0404	0.0384
TN	Feb	1	2,557,366	1,145,383	2,206,566	0.0403	0.0402	0.0382
TN	Feb	2	2,551,600	1,144,234	2,207,289	0.0402	0.0401	0.0382
TN	Feb	3	2,559,011	1,148,687	2,216,546	0.0403	0.0403	0.0383
TN	Feb	4	2,591,672	1,162,344	2,248,486	0.0408	0.0408	0.0389
TN	Feb	5	2,651,923	1,189,079	2,344,707	0.0418	0.0417	0.0406
TN	Feb	6	2,680,511	1,223,915	2,551,773	0.0422	0.0429	0.0441
TN	Feb	7	2,650,988	1,211,667	2,578,810	0.0418	0.0425	0.0446
TN	Feb	8	2,679,949	1,217,896	2,576,993	0.0422	0.0427	0.0446
TN	Feb	9	2,683,101	1,211,581	2,564,322	0.0423	0.0425	0.0444
TN	Feb	10	2,673,675	1,206,579	2,544,375	0.0421	0.0423	0.0440
TN	Feb	11	2,664,060	1,202,952	2,520,062	0.0420	0.0422	0.0436
TN	Feb	12	2,653,417	1,190,479	2,460,839	0.0418	0.0417	0.0426
TN	Feb	13	2,639,218	1,180,516	2,413,891	0.0416	0.0414	0.0418
TN	Feb	14	2,628,210	1,177,559	2,384,980	0.0414	0.0413	0.0413
TN	Feb	15	2,628,281	1,178,523	2,372,935	0.0414	0.0413	0.0410
TN	Feb	16	2,651,670	1,186,017	2,397,712	0.0418	0.0416	0.0415
TN	Feb	17	2,685,519	1,202,328	2,475,913	0.0423	0.0422	0.0428
TN	Feb	18	2,698,565	1,217,822	2,570,199	0.0425	0.0427	0.0445
TN	Feb	19	2,701,659	1,216,684	2,552,752	0.0426	0.0427	0.0442
TN	Feb	20	2,704,139	1,212,103	2,497,266	0.0426	0.0425	0.0432
TN	Feb	21	2,690,620	1,196,275	2,377,774	0.0424	0.0419	0.0411
TN	Feb	22	2,646,491	1,178,261	2,285,972	0.0417	0.0413	0.0395
TN	Feb	23	2,601,231	1,164,774	2,240,497	0.0410	0.0408	0.0388
TN	Mar	0	2,863,192	1,262,633	2,526,716	0.0407	0.0410	0.0401
TN	Mar	1	2,837,249	1,251,145	2,507,599	0.0404	0.0406	0.0398
TN	Mar	2	2,823,322	1,249,157	2,496,297	0.0402	0.0406	0.0396

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Mar	3	2,828,541	1,248,522	2,501,230	0.0402	0.0406	0.0397
TN	Mar	4	2,869,746	1,260,202	2,544,223	0.0408	0.0409	0.0404
TN	Mar	5	2,928,552	1,284,292	2,623,597	0.0417	0.0417	0.0417
TN	Mar	6	2,953,220	1,306,974	2,753,518	0.0420	0.0424	0.0437
TN	Mar	7	2,923,573	1,299,658	2,758,224	0.0416	0.0422	0.0438
TN	Mar	8	2,957,454	1,304,343	2,741,578	0.0421	0.0424	0.0435
TN	Mar	9	2,963,917	1,299,364	2,741,377	0.0422	0.0422	0.0435
TN	Mar	10	2,968,817	1,300,732	2,714,868	0.0422	0.0422	0.0431
TN	Mar	11	2,964,270	1,296,993	2,676,089	0.0422	0.0421	0.0425
TN	Mar	12	2,950,743	1,287,801	2,649,580	0.0420	0.0418	0.0421
TN	Mar	13	2,941,859	1,279,364	2,612,823	0.0419	0.0416	0.0415
TN	Mar	14	2,930,183	1,277,018	2,593,250	0.0417	0.0415	0.0412
TN	Mar	15	2,932,723	1,281,825	2,599,888	0.0417	0.0416	0.0413
TN	Mar	16	2,943,762	1,284,331	2,636,583	0.0419	0.0417	0.0419
TN	Mar	17	2,957,894	1,290,928	2,647,950	0.0421	0.0419	0.0420
TN	Mar	18	2,993,900	1,301,854	2,674,917	0.0426	0.0423	0.0425
TN	Mar	19	2,994,829	1,298,907	2,650,295	0.0426	0.0422	0.0421
TN	Mar	20	2,989,464	1,292,354	2,613,530	0.0425	0.0420	0.0415
TN	Mar	21	2,969,883	1,292,277	2,616,515	0.0423	0.0420	0.0415
TN	Mar	22	2,916,682	1,274,315	2,562,055	0.0415	0.0414	0.0407
TN	Mar	23	2,881,256	1,264,335	2,535,423	0.0410	0.0411	0.0403
TN	Apr	0	2,625,217	1,172,033	2,299,120	0.0391	0.0397	0.0369
TN	Apr	1	2,578,697	1,159,617	2,271,067	0.0384	0.0393	0.0365
TN	Apr	2	2,574,083	1,158,195	2,265,690	0.0384	0.0392	0.0364
TN	Apr	3	2,624,825	1,173,118	2,297,404	0.0391	0.0397	0.0369
TN	Apr	4	2,720,941	1,202,595	2,359,428	0.0405	0.0407	0.0379
TN	Apr	5	2,788,626	1,226,813	2,427,784	0.0415	0.0415	0.0390
TN	Apr	6	2,788,759	1,227,899	2,474,661	0.0416	0.0416	0.0397
TN	Apr	7	2,818,389	1,238,747	2,527,803	0.0420	0.0419	0.0406
TN	Apr	8	2,849,956	1,246,791	2,586,541	0.0425	0.0422	0.0415
TN	Apr	9	2,867,309	1,254,034	2,663,316	0.0427	0.0424	0.0428
TN	Apr	10	2,867,472	1,253,711	2,698,362	0.0427	0.0424	0.0433
TN	Apr	11	2,863,549	1,249,645	2,741,716	0.0427	0.0423	0.0440
TN	Apr	12	2,867,333	1,252,766	2,759,701	0.0427	0.0424	0.0443
TN	Apr	13	2,858,513	1,254,263	2,807,480	0.0426	0.0425	0.0451
TN	Apr	14	2,856,845	1,260,763	2,853,766	0.0426	0.0427	0.0458
TN	Apr	15	2,864,303	1,261,551	2,879,269	0.0427	0.0427	0.0462
TN	Apr	16	2,868,405	1,267,334	2,886,568	0.0427	0.0429	0.0464
TN	Apr	17	2,861,870	1,261,902	2,846,282	0.0426	0.0427	0.0457
TN	Apr	18	2,880,421	1,265,115	2,844,539	0.0429	0.0428	0.0457
TN	Apr	19	2,900,870	1,265,814	2,820,568	0.0432	0.0428	0.0453
TN	Apr	20	2,880,610	1,256,356	2,697,267	0.0429	0.0425	0.0433
TN	Apr	21	2,835,442	1,237,363	2,502,602	0.0422	0.0419	0.0402
TN	Apr	22	2,769,167	1,209,273	2,405,900	0.0413	0.0409	0.0386
TN	Apr	23	2,703,503	1,188,450	2,347,113	0.0403	0.0402	0.0377
TN	May	0	2,631,555	1,160,164	2,615,593	0.0389	0.0384	0.0354
TN	May	1	2,574,254	1,143,565	2,581,271	0.0381	0.0378	0.0349
TN	May	2	2,548,784	1,137,709	2,564,942	0.0377	0.0376	0.0347
TN	May	3	2,577,452	1,147,024	2,583,630	0.0381	0.0379	0.0349
TN	May	4	2,663,387	1,172,451	2,638,991	0.0394	0.0388	0.0357
TN	May	5	2,728,230	1,195,582	2,693,617	0.0404	0.0395	0.0364
TN	May	6	2,740,909	1,207,176	2,733,403	0.0405	0.0399	0.0370
TN	May	7	2,813,279	1,224,967	2,802,616	0.0416	0.0405	0.0379

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	May	8	2,866,414	1,259,872	2,956,049	0.0424	0.0417	0.0400
TN	May	9	2,897,754	1,290,113	3,148,346	0.0429	0.0427	0.0426
TN	May	10	2,904,984	1,300,993	3,325,062	0.0430	0.0430	0.0450
TN	May	11	2,909,001	1,312,403	3,428,253	0.0430	0.0434	0.0464
TN	May	12	2,919,046	1,348,697	3,527,999	0.0432	0.0446	0.0477
TN	May	13	2,937,062	1,358,846	3,575,834	0.0434	0.0449	0.0484
TN	May	14	2,941,896	1,351,649	3,567,107	0.0435	0.0447	0.0483
TN	May	15	2,942,890	1,349,174	3,547,924	0.0435	0.0446	0.0480
TN	May	16	2,937,367	1,352,944	3,547,779	0.0434	0.0447	0.0480
TN	May	17	2,930,449	1,327,585	3,484,890	0.0433	0.0439	0.0471
TN	May	18	2,925,523	1,313,653	3,400,207	0.0433	0.0434	0.0460
TN	May	19	2,944,354	1,341,489	3,438,419	0.0436	0.0444	0.0465
TN	May	20	2,922,881	1,309,977	3,282,625	0.0432	0.0433	0.0444
TN	May	21	2,856,276	1,253,934	3,031,131	0.0422	0.0415	0.0410
TN	May	22	2,784,018	1,203,191	2,779,087	0.0412	0.0398	0.0376
TN	May	23	2,707,081	1,176,836	2,669,865	0.0400	0.0389	0.0361
TN	Jun	0	2,531,287	1,069,631	2,469,862	0.0389	0.0388	0.0353
TN	Jun	1	2,443,469	1,043,386	2,397,826	0.0376	0.0378	0.0343
TN	Jun	2	2,397,437	1,027,933	2,357,153	0.0369	0.0373	0.0337
TN	Jun	3	2,396,925	1,025,848	2,357,414	0.0369	0.0372	0.0337
TN	Jun	4	2,445,340	1,040,336	2,396,349	0.0376	0.0377	0.0342
TN	Jun	5	2,482,825	1,053,426	2,436,201	0.0382	0.0382	0.0348
TN	Jun	6	2,521,704	1,060,823	2,495,153	0.0388	0.0385	0.0357
TN	Jun	7	2,635,894	1,101,150	2,593,679	0.0406	0.0399	0.0371
TN	Jun	8	2,732,826	1,140,529	2,779,909	0.0420	0.0414	0.0397
TN	Jun	9	2,800,274	1,162,971	2,984,580	0.0431	0.0422	0.0426
TN	Jun	10	2,836,621	1,177,750	3,089,931	0.0436	0.0427	0.0442
TN	Jun	11	2,849,870	1,210,074	3,219,989	0.0438	0.0439	0.0460
TN	Jun	12	2,855,389	1,228,430	3,356,100	0.0439	0.0446	0.0480
TN	Jun	13	2,866,373	1,247,300	3,439,845	0.0441	0.0452	0.0492
TN	Jun	14	2,878,041	1,264,423	3,509,291	0.0443	0.0459	0.0501
TN	Jun	15	2,881,635	1,267,266	3,520,666	0.0443	0.0460	0.0503
TN	Jun	16	2,882,816	1,264,887	3,500,832	0.0444	0.0459	0.0500
TN	Jun	17	2,869,204	1,246,990	3,480,150	0.0441	0.0452	0.0497
TN	Jun	18	2,854,483	1,211,944	3,339,200	0.0439	0.0440	0.0477
TN	Jun	19	2,864,838	1,207,185	3,253,969	0.0441	0.0438	0.0465
TN	Jun	20	2,849,824	1,180,223	3,078,778	0.0438	0.0428	0.0440
TN	Jun	21	2,789,397	1,137,460	2,774,259	0.0429	0.0413	0.0396
TN	Jun	22	2,703,450	1,112,048	2,618,597	0.0416	0.0403	0.0374
TN	Jun	23	2,625,264	1,088,507	2,533,520	0.0404	0.0395	0.0362
TN	Jul	0	2,723,708	1,110,322	2,630,084	0.0394	0.0390	0.0348
TN	Jul	1	2,624,427	1,086,640	2,553,484	0.0380	0.0382	0.0338
TN	Jul	2	2,565,432	1,071,490	2,508,515	0.0371	0.0376	0.0332
TN	Jul	3	2,558,337	1,065,857	2,500,314	0.0370	0.0374	0.0331
TN	Jul	4	2,590,626	1,074,783	2,530,485	0.0375	0.0377	0.0335
TN	Jul	5	2,613,348	1,095,830	2,605,724	0.0378	0.0385	0.0345
TN	Jul	6	2,663,132	1,112,119	2,717,291	0.0385	0.0391	0.0359
TN	Jul	7	2,792,800	1,160,549	2,861,812	0.0404	0.0408	0.0378
TN	Jul	8	2,901,848	1,192,854	2,992,444	0.0420	0.0419	0.0396
TN	Jul	9	2,986,710	1,215,248	3,154,026	0.0432	0.0427	0.0417
TN	Jul	10	3,019,673	1,238,587	3,388,925	0.0437	0.0435	0.0448
TN	Jul	11	3,030,857	1,258,066	3,546,524	0.0439	0.0442	0.0469
TN	Jul	12	3,033,672	1,269,558	3,660,236	0.0439	0.0446	0.0484

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Jul	13	3,035,795	1,283,130	3,724,626	0.0439	0.0451	0.0492
TN	Jul	14	3,049,375	1,271,091	3,739,835	0.0441	0.0446	0.0495
TN	Jul	15	3,054,282	1,283,295	3,762,381	0.0442	0.0451	0.0497
TN	Jul	16	3,051,969	1,267,330	3,729,801	0.0442	0.0445	0.0493
TN	Jul	17	3,047,008	1,253,508	3,688,802	0.0441	0.0440	0.0488
TN	Jul	18	3,032,675	1,244,605	3,616,111	0.0439	0.0437	0.0478
TN	Jul	19	3,038,425	1,223,429	3,570,939	0.0440	0.0430	0.0472
TN	Jul	20	3,019,713	1,214,702	3,458,750	0.0437	0.0427	0.0457
TN	Jul	21	2,966,264	1,187,856	3,145,381	0.0429	0.0417	0.0416
TN	Jul	22	2,887,611	1,156,287	2,829,045	0.0418	0.0406	0.0374
TN	Jul	23	2,827,578	1,135,334	2,712,072	0.0409	0.0399	0.0359
TN	Aug	0	2,704,871	1,102,508	2,637,888	0.0397	0.0395	0.0349
TN	Aug	1	2,610,282	1,079,338	2,571,826	0.0383	0.0386	0.0341
TN	Aug	2	2,545,750	1,061,310	2,520,123	0.0373	0.0380	0.0334
TN	Aug	3	2,546,295	1,059,227	2,516,465	0.0373	0.0379	0.0333
TN	Aug	4	2,611,452	1,075,701	2,573,329	0.0383	0.0385	0.0341
TN	Aug	5	2,657,809	1,100,407	2,684,810	0.0390	0.0394	0.0356
TN	Aug	6	2,663,412	1,101,584	2,720,984	0.0391	0.0394	0.0360
TN	Aug	7	2,762,946	1,132,309	2,801,321	0.0405	0.0405	0.0371
TN	Aug	8	2,842,089	1,151,929	2,910,709	0.0417	0.0412	0.0386
TN	Aug	9	2,914,392	1,178,167	3,104,027	0.0427	0.0422	0.0411
TN	Aug	10	2,951,929	1,198,192	3,378,553	0.0433	0.0429	0.0448
TN	Aug	11	2,969,254	1,213,378	3,546,918	0.0435	0.0434	0.0470
TN	Aug	12	2,993,434	1,227,359	3,643,276	0.0439	0.0439	0.0483
TN	Aug	13	3,001,505	1,250,890	3,720,523	0.0440	0.0448	0.0493
TN	Aug	14	3,007,352	1,268,602	3,812,830	0.0441	0.0454	0.0505
TN	Aug	15	3,013,955	1,261,537	3,812,731	0.0442	0.0452	0.0505
TN	Aug	16	3,003,960	1,233,673	3,706,531	0.0440	0.0442	0.0491
TN	Aug	17	2,989,885	1,216,095	3,618,215	0.0438	0.0435	0.0479
TN	Aug	18	2,985,473	1,210,229	3,621,920	0.0438	0.0433	0.0480
TN	Aug	19	2,996,742	1,206,770	3,563,558	0.0439	0.0432	0.0472
TN	Aug	20	2,948,212	1,188,294	3,391,834	0.0432	0.0425	0.0449
TN	Aug	21	2,884,880	1,164,179	3,110,539	0.0423	0.0417	0.0412
TN	Aug	22	2,823,438	1,137,206	2,829,114	0.0414	0.0407	0.0375
TN	Aug	23	2,774,451	1,119,134	2,684,939	0.0407	0.0401	0.0356
TN	Sep	0	2,488,084	1,035,716	2,445,041	0.0389	0.0395	0.0367
TN	Sep	1	2,423,357	1,016,450	2,397,907	0.0378	0.0388	0.0360
TN	Sep	2	2,384,567	1,003,630	2,368,491	0.0372	0.0383	0.0355
TN	Sep	3	2,403,840	1,005,862	2,378,308	0.0375	0.0384	0.0357
TN	Sep	4	2,488,355	1,035,930	2,444,261	0.0389	0.0395	0.0367
TN	Sep	5	2,577,024	1,062,376	2,505,657	0.0402	0.0405	0.0376
TN	Sep	6	2,557,078	1,057,122	2,504,384	0.0399	0.0403	0.0376
TN	Sep	7	2,614,651	1,073,584	2,575,635	0.0408	0.0409	0.0386
TN	Sep	8	2,685,130	1,087,661	2,645,223	0.0419	0.0415	0.0397
TN	Sep	9	2,732,166	1,103,190	2,737,383	0.0427	0.0421	0.0411
TN	Sep	10	2,762,113	1,117,353	2,842,572	0.0431	0.0426	0.0426
TN	Sep	11	2,782,370	1,127,506	2,980,048	0.0435	0.0430	0.0447
TN	Sep	12	2,800,262	1,134,332	3,067,131	0.0437	0.0433	0.0460
TN	Sep	13	2,814,052	1,148,125	3,174,079	0.0440	0.0438	0.0476
TN	Sep	14	2,821,888	1,145,774	3,240,123	0.0441	0.0437	0.0486
TN	Sep	15	2,821,754	1,158,303	3,275,168	0.0441	0.0442	0.0491
TN	Sep	16	2,813,655	1,150,036	3,261,138	0.0439	0.0439	0.0489
TN	Sep	17	2,802,747	1,142,894	3,184,333	0.0438	0.0436	0.0478

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Sep	18	2,834,387	1,156,020	3,163,428	0.0443	0.0441	0.0475
TN	Sep	19	2,822,964	1,138,348	3,033,651	0.0441	0.0434	0.0455
TN	Sep	20	2,763,242	1,114,604	2,792,921	0.0432	0.0425	0.0419
TN	Sep	21	2,677,231	1,087,394	2,604,748	0.0418	0.0415	0.0391
TN	Sep	22	2,606,449	1,068,943	2,541,266	0.0407	0.0408	0.0381
TN	Sep	23	2,550,642	1,052,066	2,494,745	0.0398	0.0401	0.0374
TN	Oct	0	2,648,670	1,199,661	2,430,822	0.0394	0.0396	0.0382
TN	Oct	1	2,606,559	1,184,587	2,386,665	0.0388	0.0391	0.0375
TN	Oct	2	2,587,766	1,179,838	2,376,278	0.0385	0.0389	0.0374
TN	Oct	3	2,629,687	1,190,681	2,401,778	0.0391	0.0393	0.0378
TN	Oct	4	2,733,080	1,226,766	2,494,082	0.0407	0.0405	0.0392
TN	Oct	5	2,816,578	1,262,228	2,583,919	0.0419	0.0417	0.0406
TN	Oct	6	2,776,422	1,257,264	2,582,838	0.0413	0.0415	0.0406
TN	Oct	7	2,808,840	1,268,614	2,596,248	0.0418	0.0419	0.0408
TN	Oct	8	2,849,356	1,276,976	2,636,870	0.0424	0.0421	0.0415
TN	Oct	9	2,864,222	1,282,922	2,695,881	0.0426	0.0423	0.0424
TN	Oct	10	2,870,140	1,285,628	2,715,317	0.0427	0.0424	0.0427
TN	Oct	11	2,863,848	1,285,491	2,766,329	0.0426	0.0424	0.0435
TN	Oct	12	2,863,927	1,289,405	2,798,583	0.0426	0.0426	0.0440
TN	Oct	13	2,860,159	1,288,937	2,845,583	0.0426	0.0425	0.0447
TN	Oct	14	2,865,749	1,292,539	2,859,716	0.0426	0.0427	0.0450
TN	Oct	15	2,872,462	1,293,765	2,868,969	0.0427	0.0427	0.0451
TN	Oct	16	2,874,892	1,299,907	2,845,788	0.0428	0.0429	0.0447
TN	Oct	17	2,903,047	1,304,194	2,829,086	0.0432	0.0430	0.0445
TN	Oct	18	2,910,031	1,305,793	2,869,447	0.0433	0.0431	0.0451
TN	Oct	19	2,881,997	1,298,066	2,793,512	0.0429	0.0428	0.0439
TN	Oct	20	2,855,000	1,287,168	2,657,664	0.0425	0.0425	0.0418
TN	Oct	21	2,808,338	1,270,931	2,575,916	0.0418	0.0419	0.0405
TN	Oct	22	2,749,485	1,243,810	2,508,375	0.0409	0.0410	0.0394
TN	Oct	23	2,707,486	1,226,915	2,480,437	0.0403	0.0405	0.0390
TN	Nov	0	2,604,100	1,223,715	2,414,220	0.0405	0.0408	0.0396
TN	Nov	1	2,578,310	1,211,595	2,389,128	0.0401	0.0404	0.0392
TN	Nov	2	2,557,600	1,200,125	2,361,621	0.0397	0.0400	0.0388
TN	Nov	3	2,568,661	1,204,600	2,366,562	0.0399	0.0401	0.0388
TN	Nov	4	2,623,612	1,217,848	2,407,952	0.0408	0.0406	0.0395
TN	Nov	5	2,687,151	1,248,059	2,523,039	0.0418	0.0416	0.0414
TN	Nov	6	2,704,525	1,266,926	2,645,725	0.0420	0.0422	0.0434
TN	Nov	7	2,670,826	1,255,243	2,629,014	0.0415	0.0418	0.0431
TN	Nov	8	2,713,597	1,266,947	2,610,660	0.0422	0.0422	0.0428
TN	Nov	9	2,720,609	1,262,270	2,566,911	0.0423	0.0420	0.0421
TN	Nov	10	2,715,670	1,256,873	2,548,418	0.0422	0.0419	0.0418
TN	Nov	11	2,712,072	1,260,680	2,561,064	0.0421	0.0420	0.0420
TN	Nov	12	2,702,597	1,253,317	2,537,363	0.0420	0.0417	0.0416
TN	Nov	13	2,695,535	1,252,529	2,535,453	0.0419	0.0417	0.0416
TN	Nov	14	2,680,817	1,247,847	2,507,614	0.0417	0.0416	0.0412
TN	Nov	15	2,687,063	1,252,224	2,534,862	0.0418	0.0417	0.0416
TN	Nov	16	2,734,418	1,270,390	2,592,730	0.0425	0.0423	0.0426
TN	Nov	17	2,779,092	1,292,706	2,717,599	0.0432	0.0431	0.0446
TN	Nov	18	2,754,809	1,286,552	2,720,184	0.0428	0.0428	0.0446
TN	Nov	19	2,737,104	1,278,157	2,665,501	0.0425	0.0426	0.0437
TN	Nov	20	2,731,155	1,272,948	2,621,086	0.0424	0.0424	0.0430
TN	Nov	21	2,709,698	1,262,720	2,554,839	0.0421	0.0421	0.0419
TN	Nov	22	2,657,072	1,245,841	2,479,549	0.0413	0.0415	0.0407

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
TN	Nov	23	2,625,041	1,235,042	2,439,622	0.0408	0.0411	0.0400
TN	Dec	0	2,663,981	1,289,065	2,507,568	0.0408	0.0408	0.0394
TN	Dec	1	2,645,626	1,280,508	2,484,469	0.0405	0.0405	0.0390
TN	Dec	2	2,634,110	1,286,252	2,484,816	0.0403	0.0407	0.0390
TN	Dec	3	2,645,923	1,281,573	2,494,571	0.0405	0.0405	0.0392
TN	Dec	4	2,672,147	1,295,077	2,508,733	0.0409	0.0410	0.0394
TN	Dec	5	2,714,654	1,312,960	2,590,503	0.0416	0.0415	0.0407
TN	Dec	6	2,739,343	1,333,082	2,753,101	0.0419	0.0422	0.0432
TN	Dec	7	2,728,200	1,329,177	2,792,244	0.0418	0.0420	0.0438
TN	Dec	8	2,762,203	1,339,330	2,740,797	0.0423	0.0424	0.0430
TN	Dec	9	2,765,252	1,332,508	2,673,899	0.0423	0.0422	0.0420
TN	Dec	10	2,747,708	1,326,693	2,660,846	0.0421	0.0420	0.0418
TN	Dec	11	2,722,929	1,315,400	2,630,674	0.0417	0.0416	0.0413
TN	Dec	12	2,706,948	1,303,174	2,606,085	0.0415	0.0412	0.0409
TN	Dec	13	2,691,091	1,296,111	2,605,810	0.0412	0.0410	0.0409
TN	Dec	14	2,676,333	1,296,782	2,611,653	0.0410	0.0410	0.0410
TN	Dec	15	2,692,667	1,297,404	2,630,815	0.0412	0.0410	0.0413
TN	Dec	16	2,753,111	1,328,902	2,705,495	0.0422	0.0420	0.0425
TN	Dec	17	2,799,414	1,356,867	2,861,533	0.0429	0.0429	0.0449
TN	Dec	18	2,797,651	1,360,399	2,894,345	0.0428	0.0430	0.0454
TN	Dec	19	2,789,920	1,357,761	2,857,256	0.0427	0.0429	0.0449
TN	Dec	20	2,781,081	1,346,472	2,804,239	0.0426	0.0426	0.0440
TN	Dec	21	2,761,333	1,329,175	2,664,052	0.0423	0.0420	0.0418
TN	Dec	22	2,724,350	1,315,984	2,583,267	0.0417	0.0416	0.0406
TN	Dec	23	2,688,453	1,302,560	2,544,592	0.0412	0.0412	0.0400
VA	Jan	0	1,870,379	709,902	2,270,410	0.0383	0.0367	0.0371
VA	Jan	1	1,831,974	691,688	2,231,241	0.0375	0.0357	0.0365
VA	Jan	2	1,827,302	691,721	2,231,915	0.0374	0.0357	0.0365
VA	Jan	3	1,837,996	703,311	2,256,183	0.0376	0.0363	0.0369
VA	Jan	4	1,866,693	724,798	2,302,253	0.0382	0.0374	0.0376
VA	Jan	5	1,945,705	775,203	2,466,811	0.0399	0.0401	0.0403
VA	Jan	6	2,062,853	836,803	2,725,271	0.0423	0.0432	0.0445
VA	Jan	7	2,140,346	880,948	2,856,575	0.0438	0.0455	0.0467
VA	Jan	8	2,159,894	888,955	2,855,767	0.0442	0.0459	0.0467
VA	Jan	9	2,163,920	881,331	2,813,527	0.0443	0.0455	0.0460
VA	Jan	10	2,153,422	866,893	2,735,486	0.0441	0.0448	0.0447
VA	Jan	11	2,119,462	838,567	2,617,860	0.0434	0.0433	0.0428
VA	Jan	12	2,078,796	813,172	2,521,855	0.0426	0.0420	0.0412
VA	Jan	13	2,047,908	799,858	2,482,400	0.0419	0.0413	0.0406
VA	Jan	14	1,997,935	786,336	2,448,434	0.0409	0.0406	0.0400
VA	Jan	15	1,977,299	774,786	2,418,877	0.0405	0.0400	0.0395
VA	Jan	16	2,013,541	798,569	2,495,827	0.0412	0.0413	0.0408
VA	Jan	17	2,124,878	851,772	2,677,806	0.0435	0.0440	0.0438
VA	Jan	18	2,164,716	880,522	2,774,355	0.0443	0.0455	0.0453
VA	Jan	19	2,163,230	878,862	2,749,837	0.0443	0.0454	0.0449
VA	Jan	20	2,146,022	867,355	2,731,130	0.0440	0.0448	0.0446
VA	Jan	21	2,115,187	847,165	2,651,884	0.0433	0.0438	0.0433
VA	Jan	22	2,042,874	803,242	2,491,078	0.0418	0.0415	0.0407
VA	Jan	23	1,967,584	762,909	2,394,744	0.0403	0.0394	0.0391
VA	Feb	0	1,599,388	582,578	1,818,400	0.0377	0.0361	0.0363
VA	Feb	1	1,561,874	568,444	1,799,278	0.0368	0.0353	0.0359
VA	Feb	2	1,541,608	563,050	1,790,993	0.0363	0.0349	0.0358
VA	Feb	3	1,557,819	571,057	1,818,631	0.0367	0.0354	0.0363

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Feb	4	1,592,189	595,065	1,867,807	0.0375	0.0369	0.0373
VA	Feb	5	1,683,408	645,839	1,998,704	0.0396	0.0401	0.0399
VA	Feb	6	1,821,048	705,616	2,234,999	0.0429	0.0438	0.0446
VA	Feb	7	1,905,874	747,449	2,377,369	0.0449	0.0464	0.0475
VA	Feb	8	1,917,379	753,740	2,394,464	0.0452	0.0468	0.0478
VA	Feb	9	1,910,638	746,578	2,316,944	0.0450	0.0463	0.0463
VA	Feb	10	1,899,147	732,901	2,244,827	0.0447	0.0455	0.0448
VA	Feb	11	1,872,042	718,408	2,198,206	0.0441	0.0446	0.0439
VA	Feb	12	1,834,364	698,984	2,134,129	0.0432	0.0434	0.0426
VA	Feb	13	1,793,426	677,313	2,084,720	0.0422	0.0420	0.0416
VA	Feb	14	1,738,207	654,142	2,013,181	0.0409	0.0406	0.0402
VA	Feb	15	1,711,206	641,374	1,995,756	0.0403	0.0398	0.0399
VA	Feb	16	1,725,413	647,856	2,006,861	0.0406	0.0402	0.0401
VA	Feb	17	1,791,324	677,478	2,110,886	0.0422	0.0420	0.0422
VA	Feb	18	1,882,725	726,377	2,265,468	0.0443	0.0451	0.0453
VA	Feb	19	1,895,405	735,420	2,280,882	0.0446	0.0456	0.0456
VA	Feb	20	1,886,456	725,703	2,235,068	0.0444	0.0450	0.0446
VA	Feb	21	1,864,672	711,588	2,160,640	0.0439	0.0441	0.0432
VA	Feb	22	1,790,496	672,276	2,023,752	0.0422	0.0417	0.0404
VA	Feb	23	1,683,098	621,449	1,887,921	0.0396	0.0385	0.0377
VA	Mar	0	1,758,366	650,813	1,958,208	0.0379	0.0370	0.0373
VA	Mar	1	1,699,884	625,566	1,912,678	0.0366	0.0355	0.0365
VA	Mar	2	1,668,736	612,417	1,871,624	0.0359	0.0348	0.0357
VA	Mar	3	1,666,394	615,889	1,869,659	0.0359	0.0350	0.0356
VA	Mar	4	1,695,337	631,901	1,911,423	0.0365	0.0359	0.0364
VA	Mar	5	1,806,545	688,144	2,080,880	0.0389	0.0391	0.0397
VA	Mar	6	1,955,755	748,155	2,284,033	0.0421	0.0425	0.0435
VA	Mar	7	2,030,859	782,349	2,391,046	0.0437	0.0444	0.0456
VA	Mar	8	2,055,789	790,511	2,395,390	0.0443	0.0449	0.0457
VA	Mar	9	2,060,765	790,080	2,362,747	0.0444	0.0449	0.0450
VA	Mar	10	2,043,878	782,768	2,314,866	0.0440	0.0445	0.0441
VA	Mar	11	2,049,188	786,663	2,318,184	0.0441	0.0447	0.0442
VA	Mar	12	2,024,587	774,772	2,279,104	0.0436	0.0440	0.0434
VA	Mar	13	1,986,131	754,057	2,214,779	0.0428	0.0428	0.0422
VA	Mar	14	1,940,082	733,412	2,140,863	0.0418	0.0416	0.0408
VA	Mar	15	1,925,488	723,075	2,112,312	0.0415	0.0411	0.0403
VA	Mar	16	1,938,153	726,924	2,136,893	0.0417	0.0413	0.0407
VA	Mar	17	1,976,195	745,490	2,206,656	0.0425	0.0423	0.0421
VA	Mar	18	2,056,356	783,585	2,355,568	0.0443	0.0445	0.0449
VA	Mar	19	2,120,327	817,470	2,443,217	0.0457	0.0464	0.0466
VA	Mar	20	2,097,262	808,478	2,384,264	0.0452	0.0459	0.0455
VA	Mar	21	2,051,980	788,969	2,291,897	0.0442	0.0448	0.0437
VA	Mar	22	1,972,283	750,617	2,161,156	0.0425	0.0426	0.0412
VA	Mar	23	1,865,522	697,871	2,059,027	0.0402	0.0396	0.0393
VA	Apr	0	1,638,889	577,304	1,834,424	0.0361	0.0340	0.0330
VA	Apr	1	1,594,698	559,341	1,802,263	0.0351	0.0329	0.0324
VA	Apr	2	1,562,427	555,289	1,788,274	0.0344	0.0327	0.0321
VA	Apr	3	1,576,066	563,216	1,802,304	0.0347	0.0332	0.0324
VA	Apr	4	1,657,137	600,545	1,934,289	0.0365	0.0354	0.0348
VA	Apr	5	1,826,177	677,142	2,168,369	0.0402	0.0399	0.0390
VA	Apr	6	1,933,743	726,479	2,356,745	0.0426	0.0428	0.0424
VA	Apr	7	1,993,353	748,843	2,477,510	0.0439	0.0441	0.0445
VA	Apr	8	2,025,742	763,741	2,517,734	0.0446	0.0450	0.0453

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Apr	9	2,041,423	775,974	2,526,864	0.0449	0.0457	0.0454
VA	Apr	10	2,038,005	775,956	2,495,178	0.0449	0.0457	0.0448
VA	Apr	11	2,035,891	776,647	2,531,868	0.0448	0.0457	0.0455
VA	Apr	12	2,028,858	776,330	2,563,478	0.0447	0.0457	0.0461
VA	Apr	13	2,014,909	769,460	2,586,347	0.0443	0.0453	0.0465
VA	Apr	14	1,990,455	758,601	2,572,695	0.0438	0.0447	0.0462
VA	Apr	15	1,979,220	753,188	2,550,001	0.0436	0.0444	0.0458
VA	Apr	16	1,973,384	753,216	2,559,697	0.0434	0.0444	0.0460
VA	Apr	17	1,969,120	749,495	2,530,581	0.0433	0.0441	0.0455
VA	Apr	18	1,965,055	747,742	2,526,264	0.0433	0.0440	0.0454
VA	Apr	19	2,038,650	782,884	2,629,371	0.0449	0.0461	0.0473
VA	Apr	20	2,031,218	775,341	2,571,418	0.0447	0.0457	0.0462
VA	Apr	21	1,961,332	736,084	2,327,375	0.0432	0.0434	0.0418
VA	Apr	22	1,834,270	663,387	2,075,886	0.0404	0.0391	0.0373
VA	Apr	23	1,724,616	612,053	1,910,047	0.0380	0.0360	0.0343
VA	May	0	1,545,919	654,334	2,088,904	0.0347	0.0323	0.0297
VA	May	1	1,461,493	607,067	1,978,313	0.0328	0.0299	0.0282
VA	May	2	1,405,092	585,011	1,925,685	0.0316	0.0289	0.0274
VA	May	3	1,408,183	590,009	1,939,362	0.0316	0.0291	0.0276
VA	May	4	1,502,013	633,614	2,066,155	0.0337	0.0312	0.0294
VA	May	5	1,681,946	723,721	2,309,172	0.0378	0.0357	0.0329
VA	May	6	1,818,634	788,660	2,548,153	0.0409	0.0389	0.0363
VA	May	7	1,898,757	830,139	2,738,723	0.0427	0.0409	0.0390
VA	May	8	1,965,350	861,379	2,942,454	0.0442	0.0425	0.0419
VA	May	9	2,017,153	891,212	3,177,740	0.0453	0.0440	0.0452
VA	May	10	2,027,359	899,446	3,310,099	0.0455	0.0444	0.0471
VA	May	11	2,047,161	908,927	3,397,209	0.0460	0.0448	0.0483
VA	May	12	2,056,265	918,265	3,452,711	0.0462	0.0453	0.0491
VA	May	13	2,051,908	930,715	3,519,202	0.0461	0.0459	0.0501
VA	May	14	2,045,504	980,043	3,570,203	0.0460	0.0483	0.0508
VA	May	15	2,055,001	1,017,045	3,652,560	0.0462	0.0502	0.0520
VA	May	16	2,052,028	1,032,844	3,671,994	0.0461	0.0509	0.0523
VA	May	17	2,035,819	1,028,615	3,633,407	0.0457	0.0507	0.0517
VA	May	18	2,003,778	989,684	3,506,801	0.0450	0.0488	0.0499
VA	May	19	2,024,818	983,499	3,488,501	0.0455	0.0485	0.0496
VA	May	20	2,012,754	977,582	3,362,578	0.0452	0.0482	0.0478
VA	May	21	1,919,739	921,385	3,039,895	0.0431	0.0454	0.0433
VA	May	22	1,803,204	807,713	2,640,306	0.0405	0.0398	0.0376
VA	May	23	1,670,172	716,308	2,313,371	0.0375	0.0353	0.0329
VA	Jun	0	1,535,718	564,493	1,955,809	0.0346	0.0303	0.0300
VA	Jun	1	1,451,250	528,202	1,833,151	0.0327	0.0283	0.0281
VA	Jun	2	1,405,228	508,902	1,781,072	0.0317	0.0273	0.0273
VA	Jun	3	1,389,390	499,680	1,755,892	0.0313	0.0268	0.0270
VA	Jun	4	1,425,828	516,426	1,809,811	0.0322	0.0277	0.0278
VA	Jun	5	1,533,300	561,962	1,921,105	0.0346	0.0301	0.0295
VA	Jun	6	1,652,876	625,775	2,097,904	0.0373	0.0336	0.0322
VA	Jun	7	1,768,922	682,630	2,326,594	0.0399	0.0366	0.0357
VA	Jun	8	1,893,400	732,207	2,550,700	0.0427	0.0393	0.0391
VA	Jun	9	1,991,270	774,871	2,816,433	0.0449	0.0416	0.0432
VA	Jun	10	2,041,222	806,659	3,032,658	0.0460	0.0433	0.0465
VA	Jun	11	2,072,743	838,435	3,180,998	0.0467	0.0450	0.0488
VA	Jun	12	2,085,477	877,111	3,323,443	0.0470	0.0470	0.0510
VA	Jun	13	2,098,860	899,423	3,411,762	0.0473	0.0482	0.0524

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Jun	14	2,102,088	917,146	3,436,868	0.0474	0.0492	0.0528
VA	Jun	15	2,119,470	1,003,475	3,530,180	0.0478	0.0538	0.0542
VA	Jun	16	2,108,789	1,032,366	3,559,636	0.0476	0.0554	0.0546
VA	Jun	17	2,089,661	1,011,585	3,493,026	0.0471	0.0543	0.0536
VA	Jun	18	2,047,308	995,992	3,388,159	0.0462	0.0534	0.0520
VA	Jun	19	2,029,003	984,707	3,283,292	0.0458	0.0528	0.0504
VA	Jun	20	2,028,236	972,622	3,212,192	0.0457	0.0522	0.0493
VA	Jun	21	1,951,798	896,752	2,825,095	0.0440	0.0481	0.0434
VA	Jun	22	1,835,164	764,662	2,434,870	0.0414	0.0410	0.0374
VA	Jun	23	1,679,820	647,799	2,192,048	0.0379	0.0347	0.0336
VA	Jul	0	1,704,862	636,854	2,231,134	0.0362	0.0341	0.0311
VA	Jul	1	1,604,772	591,512	2,103,040	0.0341	0.0317	0.0293
VA	Jul	2	1,522,774	559,116	2,019,643	0.0323	0.0299	0.0281
VA	Jul	3	1,498,593	549,833	1,994,835	0.0318	0.0294	0.0278
VA	Jul	4	1,537,955	563,336	2,036,226	0.0326	0.0301	0.0283
VA	Jul	5	1,646,697	609,949	2,147,751	0.0349	0.0326	0.0299
VA	Jul	6	1,734,217	655,628	2,289,967	0.0368	0.0351	0.0319
VA	Jul	7	1,861,090	726,201	2,516,843	0.0395	0.0389	0.0350
VA	Jul	8	1,980,867	791,032	2,786,784	0.0420	0.0423	0.0388
VA	Jul	9	2,087,828	840,961	3,145,276	0.0443	0.0450	0.0438
VA	Jul	10	2,142,626	863,668	3,388,605	0.0455	0.0462	0.0472
VA	Jul	11	2,181,701	876,762	3,551,120	0.0463	0.0469	0.0494
VA	Jul	12	2,204,128	896,024	3,675,653	0.0468	0.0480	0.0512
VA	Jul	13	2,212,650	912,529	3,758,506	0.0470	0.0488	0.0523
VA	Jul	14	2,209,449	918,906	3,788,632	0.0469	0.0492	0.0527
VA	Jul	15	2,214,598	928,365	3,808,015	0.0470	0.0497	0.0530
VA	Jul	16	2,210,019	935,751	3,828,290	0.0469	0.0501	0.0533
VA	Jul	17	2,202,293	926,825	3,788,591	0.0467	0.0496	0.0527
VA	Jul	18	2,169,071	898,383	3,651,230	0.0460	0.0481	0.0508
VA	Jul	19	2,151,777	872,785	3,552,127	0.0457	0.0467	0.0494
VA	Jul	20	2,139,263	857,022	3,435,399	0.0454	0.0459	0.0478
VA	Jul	21	2,078,706	817,698	3,105,858	0.0441	0.0438	0.0432
VA	Jul	22	1,973,834	764,842	2,785,915	0.0419	0.0409	0.0388
VA	Jul	23	1,846,230	692,049	2,463,293	0.0392	0.0370	0.0343
VA	Aug	0	1,711,775	647,585	2,290,030	0.0364	0.0330	0.0305
VA	Aug	1	1,605,465	606,484	2,133,784	0.0341	0.0309	0.0285
VA	Aug	2	1,535,053	580,947	2,039,166	0.0326	0.0296	0.0272
VA	Aug	3	1,517,699	571,203	2,008,252	0.0322	0.0291	0.0268
VA	Aug	4	1,569,706	587,754	2,078,976	0.0333	0.0300	0.0277
VA	Aug	5	1,694,608	644,673	2,243,588	0.0360	0.0329	0.0299
VA	Aug	6	1,777,196	683,969	2,379,500	0.0378	0.0349	0.0317
VA	Aug	7	1,865,924	747,614	2,601,536	0.0396	0.0381	0.0347
VA	Aug	8	1,967,164	814,989	2,853,217	0.0418	0.0416	0.0381
VA	Aug	9	2,072,030	885,577	3,285,050	0.0440	0.0451	0.0438
VA	Aug	10	2,130,434	903,557	3,584,803	0.0453	0.0461	0.0478
VA	Aug	11	2,173,665	925,152	3,754,210	0.0462	0.0472	0.0501
VA	Aug	12	2,195,527	942,316	3,844,172	0.0466	0.0480	0.0513
VA	Aug	13	2,211,728	945,287	3,926,084	0.0470	0.0482	0.0524
VA	Aug	14	2,208,769	945,097	3,976,443	0.0469	0.0482	0.0530
VA	Aug	15	2,212,499	994,435	4,061,200	0.0470	0.0507	0.0542
VA	Aug	16	2,205,808	991,010	4,039,150	0.0469	0.0505	0.0539
VA	Aug	17	2,187,955	983,714	3,994,992	0.0465	0.0502	0.0533
VA	Aug	18	2,150,114	972,668	3,849,458	0.0457	0.0496	0.0513

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Aug	19	2,145,209	955,439	3,813,380	0.0456	0.0487	0.0509
VA	Aug	20	2,122,441	918,658	3,591,925	0.0451	0.0468	0.0479
VA	Aug	21	2,041,917	869,407	3,263,683	0.0434	0.0443	0.0435
VA	Aug	22	1,945,967	798,195	2,879,613	0.0413	0.0407	0.0384
VA	Aug	23	1,823,013	698,474	2,490,415	0.0387	0.0356	0.0332
VA	Sep	0	1,461,731	556,344	1,955,407	0.0352	0.0335	0.0322
VA	Sep	1	1,382,592	530,143	1,885,856	0.0333	0.0319	0.0311
VA	Sep	2	1,339,279	515,282	1,842,656	0.0323	0.0311	0.0304
VA	Sep	3	1,338,556	513,039	1,837,859	0.0323	0.0309	0.0303
VA	Sep	4	1,415,967	539,645	1,911,194	0.0341	0.0325	0.0315
VA	Sep	5	1,561,436	600,269	2,079,636	0.0376	0.0362	0.0343
VA	Sep	6	1,632,176	637,192	2,183,543	0.0393	0.0384	0.0360
VA	Sep	7	1,692,573	665,444	2,294,394	0.0408	0.0401	0.0378
VA	Sep	8	1,774,399	707,846	2,444,289	0.0428	0.0427	0.0403
VA	Sep	9	1,846,712	739,380	2,617,034	0.0445	0.0446	0.0431
VA	Sep	10	1,883,020	762,275	2,784,859	0.0454	0.0459	0.0459
VA	Sep	11	1,910,570	772,433	2,901,819	0.0461	0.0465	0.0478
VA	Sep	12	1,919,899	782,398	2,973,831	0.0463	0.0471	0.0490
VA	Sep	13	1,925,538	795,341	3,030,486	0.0464	0.0479	0.0499
VA	Sep	14	1,926,222	810,628	3,088,146	0.0464	0.0488	0.0509
VA	Sep	15	1,944,694	804,607	3,113,187	0.0469	0.0485	0.0513
VA	Sep	16	1,935,466	800,161	3,110,833	0.0467	0.0482	0.0513
VA	Sep	17	1,913,087	786,619	3,046,683	0.0461	0.0474	0.0502
VA	Sep	18	1,906,905	778,185	2,993,230	0.0460	0.0469	0.0493
VA	Sep	19	1,914,964	783,836	2,968,559	0.0462	0.0472	0.0489
VA	Sep	20	1,854,886	752,391	2,770,907	0.0447	0.0453	0.0457
VA	Sep	21	1,767,540	703,860	2,493,164	0.0426	0.0424	0.0411
VA	Sep	22	1,681,509	665,591	2,285,052	0.0405	0.0401	0.0377
VA	Sep	23	1,558,897	592,209	2,078,114	0.0376	0.0357	0.0342
VA	Oct	0	1,459,155	527,767	1,557,534	0.0349	0.0326	0.0316
VA	Oct	1	1,407,432	507,021	1,503,662	0.0336	0.0313	0.0305
VA	Oct	2	1,375,083	494,354	1,474,394	0.0329	0.0305	0.0299
VA	Oct	3	1,400,961	503,970	1,502,729	0.0335	0.0311	0.0305
VA	Oct	4	1,518,711	561,887	1,643,656	0.0363	0.0347	0.0333
VA	Oct	5	1,702,274	656,045	1,885,549	0.0407	0.0405	0.0383
VA	Oct	6	1,796,400	707,685	2,041,507	0.0429	0.0437	0.0414
VA	Oct	7	1,835,639	720,119	2,139,628	0.0439	0.0445	0.0434
VA	Oct	8	1,853,898	733,272	2,198,294	0.0443	0.0453	0.0446
VA	Oct	9	1,871,841	740,040	2,225,061	0.0447	0.0457	0.0451
VA	Oct	10	1,859,894	730,019	2,237,954	0.0445	0.0451	0.0454
VA	Oct	11	1,862,059	734,874	2,313,179	0.0445	0.0454	0.0469
VA	Oct	12	1,861,698	735,906	2,341,942	0.0445	0.0454	0.0475
VA	Oct	13	1,854,347	735,241	2,340,131	0.0443	0.0454	0.0475
VA	Oct	14	1,832,371	729,339	2,329,439	0.0438	0.0450	0.0473
VA	Oct	15	1,843,434	734,231	2,371,719	0.0441	0.0453	0.0481
VA	Oct	16	1,850,521	734,549	2,378,945	0.0442	0.0454	0.0483
VA	Oct	17	1,890,123	747,080	2,393,980	0.0452	0.0461	0.0486
VA	Oct	18	1,932,878	772,163	2,452,793	0.0462	0.0477	0.0498
VA	Oct	19	1,919,161	759,032	2,363,976	0.0459	0.0469	0.0480
VA	Oct	20	1,881,186	736,427	2,180,428	0.0450	0.0455	0.0442
VA	Oct	21	1,795,193	690,402	1,976,024	0.0429	0.0426	0.0401
VA	Oct	22	1,671,660	624,826	1,779,365	0.0400	0.0386	0.0361
VA	Oct	23	1,559,109	579,253	1,655,089	0.0373	0.0358	0.0336

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
VA	Nov	0	1,637,417	592,858	1,838,004	0.0379	0.0360	0.0351
VA	Nov	1	1,552,704	555,410	1,728,485	0.0359	0.0337	0.0330
VA	Nov	2	1,518,901	543,104	1,692,818	0.0352	0.0330	0.0323
VA	Nov	3	1,514,254	545,644	1,713,103	0.0351	0.0331	0.0327
VA	Nov	4	1,550,494	570,307	1,791,663	0.0359	0.0346	0.0342
VA	Nov	5	1,672,278	629,969	1,981,937	0.0387	0.0382	0.0378
VA	Nov	6	1,798,921	696,879	2,215,326	0.0416	0.0423	0.0423
VA	Nov	7	1,872,624	732,474	2,366,203	0.0434	0.0445	0.0451
VA	Nov	8	1,887,423	741,235	2,383,026	0.0437	0.0450	0.0455
VA	Nov	9	1,908,394	747,384	2,404,329	0.0442	0.0454	0.0459
VA	Nov	10	1,897,770	734,029	2,335,473	0.0439	0.0445	0.0446
VA	Nov	11	1,885,066	731,676	2,315,386	0.0436	0.0444	0.0442
VA	Nov	12	1,861,046	723,081	2,272,625	0.0431	0.0439	0.0434
VA	Nov	13	1,838,977	716,864	2,271,855	0.0426	0.0435	0.0433
VA	Nov	14	1,805,476	703,084	2,252,952	0.0418	0.0427	0.0430
VA	Nov	15	1,805,630	705,871	2,250,979	0.0418	0.0428	0.0429
VA	Nov	16	1,853,985	717,772	2,309,856	0.0429	0.0436	0.0441
VA	Nov	17	1,961,704	761,798	2,485,751	0.0454	0.0462	0.0474
VA	Nov	18	1,975,554	772,106	2,535,740	0.0457	0.0469	0.0484
VA	Nov	19	1,967,820	762,064	2,489,163	0.0456	0.0462	0.0475
VA	Nov	20	1,937,653	740,890	2,392,853	0.0449	0.0450	0.0456
VA	Nov	21	1,901,085	721,691	2,294,533	0.0440	0.0438	0.0438
VA	Nov	22	1,831,409	684,860	2,118,594	0.0424	0.0416	0.0404
VA	Nov	23	1,757,588	647,451	1,982,226	0.0407	0.0393	0.0378
VA	Dec	0	1,871,009	707,198	2,191,515	0.0393	0.0378	0.0366
VA	Dec	1	1,797,581	678,009	2,131,867	0.0377	0.0363	0.0356
VA	Dec	2	1,764,860	662,189	2,078,089	0.0370	0.0354	0.0347
VA	Dec	3	1,765,502	664,438	2,105,390	0.0370	0.0356	0.0352
VA	Dec	4	1,798,697	688,912	2,196,313	0.0377	0.0369	0.0367
VA	Dec	5	1,892,914	739,064	2,373,134	0.0397	0.0396	0.0396
VA	Dec	6	2,001,053	791,819	2,602,807	0.0420	0.0424	0.0435
VA	Dec	7	2,078,075	828,793	2,774,223	0.0436	0.0444	0.0463
VA	Dec	8	2,109,883	842,461	2,789,344	0.0443	0.0451	0.0466
VA	Dec	9	2,109,922	839,269	2,739,040	0.0443	0.0449	0.0457
VA	Dec	10	2,085,586	822,797	2,630,637	0.0438	0.0440	0.0439
VA	Dec	11	2,037,597	801,933	2,542,300	0.0427	0.0429	0.0425
VA	Dec	12	1,980,822	774,133	2,446,193	0.0416	0.0414	0.0409
VA	Dec	13	1,936,750	754,310	2,393,210	0.0406	0.0404	0.0400
VA	Dec	14	1,897,795	743,729	2,346,263	0.0398	0.0398	0.0392
VA	Dec	15	1,890,263	738,259	2,356,067	0.0397	0.0395	0.0393
VA	Dec	16	1,969,412	774,824	2,492,375	0.0413	0.0415	0.0416
VA	Dec	17	2,125,408	856,294	2,793,917	0.0446	0.0458	0.0467
VA	Dec	18	2,157,214	874,751	2,871,318	0.0453	0.0468	0.0480
VA	Dec	19	2,151,564	863,628	2,799,458	0.0451	0.0462	0.0468
VA	Dec	20	2,130,113	849,899	2,748,439	0.0447	0.0455	0.0459
VA	Dec	21	2,108,469	836,597	2,675,403	0.0442	0.0448	0.0447
VA	Dec	22	2,044,722	799,528	2,497,562	0.0429	0.0428	0.0417
VA	Dec	23	1,963,746	752,627	2,302,076	0.0412	0.0403	0.0384
WV	Jan	0	4,249,442	1,894,435	3,529,625	0.0380	0.0364	0.0381
WV	Jan	1	4,155,781	1,843,877	3,454,729	0.0371	0.0354	0.0372
WV	Jan	2	4,104,091	1,817,862	3,419,085	0.0367	0.0349	0.0369
WV	Jan	3	4,088,203	1,810,242	3,403,126	0.0365	0.0348	0.0367
WV	Jan	4	4,127,942	1,835,248	3,437,783	0.0369	0.0353	0.0371

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Jan	5	4,280,014	1,917,371	3,558,210	0.0383	0.0368	0.0384
WV	Jan	6	4,573,064	2,088,359	3,776,220	0.0409	0.0401	0.0407
WV	Jan	7	4,813,806	2,259,285	3,960,273	0.0430	0.0434	0.0427
WV	Jan	8	4,879,139	2,300,620	4,017,639	0.0436	0.0442	0.0433
WV	Jan	9	4,933,020	2,330,795	4,048,192	0.0441	0.0448	0.0436
WV	Jan	10	4,943,863	2,336,407	4,064,235	0.0442	0.0449	0.0438
WV	Jan	11	4,893,676	2,322,078	4,052,805	0.0437	0.0446	0.0437
WV	Jan	12	4,848,694	2,295,186	4,014,446	0.0433	0.0441	0.0433
WV	Jan	13	4,801,586	2,265,567	3,971,121	0.0429	0.0435	0.0428
WV	Jan	14	4,754,843	2,232,995	3,942,716	0.0425	0.0429	0.0425
WV	Jan	15	4,723,854	2,212,249	3,918,167	0.0422	0.0425	0.0422
WV	Jan	16	4,760,189	2,238,053	3,969,454	0.0425	0.0430	0.0428
WV	Jan	17	4,899,062	2,329,166	4,105,390	0.0438	0.0448	0.0443
WV	Jan	18	5,004,069	2,413,424	4,193,319	0.0447	0.0464	0.0452
WV	Jan	19	5,001,107	2,398,920	4,186,256	0.0447	0.0461	0.0451
WV	Jan	20	4,967,170	2,366,811	4,115,894	0.0444	0.0455	0.0444
WV	Jan	21	4,880,408	2,310,906	4,031,032	0.0436	0.0444	0.0435
WV	Jan	22	4,714,799	2,190,675	3,892,699	0.0421	0.0421	0.0420
WV	Jan	23	4,478,076	2,032,321	3,695,311	0.0400	0.0391	0.0398
WV	Feb	0	3,869,369	1,753,162	3,236,329	0.0382	0.0369	0.0382
WV	Feb	1	3,770,577	1,700,262	3,170,530	0.0372	0.0358	0.0374
WV	Feb	2	3,733,964	1,680,205	3,142,389	0.0368	0.0353	0.0371
WV	Feb	3	3,713,913	1,673,979	3,130,291	0.0366	0.0352	0.0369
WV	Feb	4	3,764,787	1,703,968	3,176,549	0.0371	0.0358	0.0375
WV	Feb	5	3,926,718	1,790,203	3,310,414	0.0387	0.0377	0.0391
WV	Feb	6	4,194,362	1,950,867	3,502,900	0.0414	0.0410	0.0413
WV	Feb	7	4,387,531	2,086,412	3,672,590	0.0433	0.0439	0.0433
WV	Feb	8	4,445,016	2,125,658	3,720,802	0.0439	0.0447	0.0439
WV	Feb	9	4,472,381	2,141,326	3,729,108	0.0441	0.0451	0.0440
WV	Feb	10	4,479,402	2,143,699	3,737,825	0.0442	0.0451	0.0441
WV	Feb	11	4,462,117	2,124,564	3,707,530	0.0440	0.0447	0.0438
WV	Feb	12	4,408,304	2,093,781	3,653,998	0.0435	0.0440	0.0431
WV	Feb	13	4,371,736	2,070,454	3,638,093	0.0431	0.0436	0.0429
WV	Feb	14	4,295,638	2,021,150	3,577,435	0.0424	0.0425	0.0422
WV	Feb	15	4,240,145	1,990,890	3,545,135	0.0418	0.0419	0.0418
WV	Feb	16	4,251,408	2,003,139	3,553,782	0.0419	0.0421	0.0419
WV	Feb	17	4,323,999	2,043,226	3,624,587	0.0427	0.0430	0.0428
WV	Feb	18	4,465,413	2,143,792	3,753,621	0.0441	0.0451	0.0443
WV	Feb	19	4,515,452	2,173,197	3,769,244	0.0446	0.0457	0.0445
WV	Feb	20	4,491,732	2,151,329	3,750,907	0.0443	0.0453	0.0443
WV	Feb	21	4,426,423	2,104,985	3,682,807	0.0437	0.0443	0.0435
WV	Feb	22	4,276,431	1,998,377	3,554,922	0.0422	0.0420	0.0420
WV	Feb	23	4,058,278	1,863,379	3,383,904	0.0400	0.0392	0.0399
WV	Mar	0	4,118,452	1,798,426	3,471,235	0.0374	0.0359	0.0376
WV	Mar	1	4,003,114	1,739,733	3,384,796	0.0364	0.0347	0.0367
WV	Mar	2	3,943,335	1,717,039	3,348,712	0.0358	0.0343	0.0363
WV	Mar	3	3,948,106	1,717,969	3,351,715	0.0359	0.0343	0.0363
WV	Mar	4	4,013,975	1,753,160	3,409,329	0.0365	0.0350	0.0369
WV	Mar	5	4,239,145	1,868,300	3,576,856	0.0385	0.0373	0.0387
WV	Mar	6	4,548,297	2,063,518	3,837,582	0.0413	0.0412	0.0416
WV	Mar	7	4,743,869	2,185,264	4,009,854	0.0431	0.0436	0.0434
WV	Mar	8	4,832,323	2,242,822	4,082,783	0.0439	0.0448	0.0442
WV	Mar	9	4,884,415	2,270,433	4,095,487	0.0444	0.0453	0.0444

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Mar	10	4,906,289	2,283,364	4,094,196	0.0446	0.0456	0.0443
WV	Mar	11	4,893,727	2,272,244	4,069,624	0.0445	0.0454	0.0441
WV	Mar	12	4,843,689	2,245,144	4,038,034	0.0440	0.0448	0.0437
WV	Mar	13	4,803,944	2,216,099	4,015,612	0.0437	0.0442	0.0435
WV	Mar	14	4,737,384	2,173,090	3,969,588	0.0431	0.0434	0.0430
WV	Mar	15	4,659,118	2,130,057	3,916,365	0.0423	0.0425	0.0424
WV	Mar	16	4,655,959	2,126,639	3,907,090	0.0423	0.0425	0.0423
WV	Mar	17	4,708,997	2,160,066	3,939,650	0.0428	0.0431	0.0427
WV	Mar	18	4,817,024	2,223,988	4,025,737	0.0438	0.0444	0.0436
WV	Mar	19	4,951,627	2,316,098	4,123,755	0.0450	0.0462	0.0447
WV	Mar	20	4,926,890	2,300,298	4,107,029	0.0448	0.0459	0.0445
WV	Mar	21	4,844,452	2,247,796	4,039,020	0.0440	0.0449	0.0437
WV	Mar	22	4,640,082	2,105,813	3,877,380	0.0422	0.0420	0.0420
WV	Mar	23	4,357,781	1,924,858	3,646,142	0.0396	0.0384	0.0395
WV	Apr	0	3,731,648	1,646,822	3,211,698	0.0358	0.0344	0.0359
WV	Apr	1	3,646,046	1,608,033	3,152,817	0.0350	0.0336	0.0352
WV	Apr	2	3,629,253	1,601,105	3,144,249	0.0348	0.0334	0.0351
WV	Apr	3	3,654,980	1,611,201	3,159,810	0.0350	0.0336	0.0353
WV	Apr	4	3,793,856	1,673,928	3,255,696	0.0364	0.0349	0.0364
WV	Apr	5	4,113,071	1,836,218	3,507,644	0.0394	0.0383	0.0392
WV	Apr	6	4,372,897	2,000,714	3,729,969	0.0419	0.0418	0.0417
WV	Apr	7	4,521,742	2,097,030	3,854,921	0.0434	0.0438	0.0431
WV	Apr	8	4,604,510	2,152,911	3,950,373	0.0441	0.0449	0.0442
WV	Apr	9	4,672,995	2,194,434	4,008,133	0.0448	0.0458	0.0448
WV	Apr	10	4,684,136	2,206,171	4,027,220	0.0449	0.0461	0.0450
WV	Apr	11	4,663,471	2,191,299	3,994,709	0.0447	0.0457	0.0447
WV	Apr	12	4,654,850	2,187,479	3,994,312	0.0446	0.0457	0.0447
WV	Apr	13	4,639,780	2,178,588	3,992,917	0.0445	0.0455	0.0446
WV	Apr	14	4,596,659	2,147,389	3,947,058	0.0441	0.0448	0.0441
WV	Apr	15	4,597,268	2,150,804	3,961,040	0.0441	0.0449	0.0443
WV	Apr	16	4,581,958	2,139,654	3,954,941	0.0439	0.0447	0.0442
WV	Apr	17	4,563,950	2,122,381	3,923,906	0.0438	0.0443	0.0439
WV	Apr	18	4,560,416	2,115,866	3,922,354	0.0437	0.0442	0.0438
WV	Apr	19	4,663,756	2,177,061	4,007,298	0.0447	0.0454	0.0448
WV	Apr	20	4,691,196	2,193,010	4,023,341	0.0450	0.0458	0.0450
WV	Apr	21	4,527,465	2,067,526	3,828,168	0.0434	0.0432	0.0428
WV	Apr	22	4,208,315	1,875,409	3,554,492	0.0403	0.0392	0.0397
WV	Apr	23	3,923,150	1,727,144	3,346,359	0.0376	0.0361	0.0374
WV	May	0	3,703,271	1,459,683	3,366,264	0.0355	0.0351	0.0364
WV	May	1	3,608,320	1,418,524	3,298,432	0.0346	0.0341	0.0356
WV	May	2	3,543,860	1,399,333	3,256,146	0.0340	0.0336	0.0352
WV	May	3	3,577,232	1,411,771	3,284,512	0.0343	0.0339	0.0355
WV	May	4	3,749,129	1,477,311	3,403,791	0.0359	0.0355	0.0368
WV	May	5	4,030,588	1,589,148	3,617,389	0.0386	0.0382	0.0391
WV	May	6	4,267,917	1,687,539	3,788,669	0.0409	0.0405	0.0409
WV	May	7	4,464,301	1,782,705	3,935,179	0.0428	0.0428	0.0425
WV	May	8	4,586,199	1,836,948	4,007,875	0.0439	0.0441	0.0433
WV	May	9	4,675,983	1,879,607	4,119,060	0.0448	0.0452	0.0445
WV	May	10	4,719,217	1,907,253	4,134,937	0.0452	0.0458	0.0447
WV	May	11	4,724,379	1,908,904	4,143,719	0.0453	0.0459	0.0448
WV	May	12	4,727,655	1,915,606	4,168,739	0.0453	0.0460	0.0450
WV	May	13	4,720,532	1,908,164	4,151,268	0.0452	0.0458	0.0449
WV	May	14	4,702,889	1,902,024	4,148,550	0.0451	0.0457	0.0448

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	May	15	4,706,341	1,900,025	4,150,358	0.0451	0.0456	0.0448
WV	May	16	4,680,703	1,879,212	4,131,555	0.0449	0.0451	0.0446
WV	May	17	4,652,827	1,864,064	4,097,898	0.0446	0.0448	0.0443
WV	May	18	4,617,372	1,841,005	4,044,140	0.0442	0.0442	0.0437
WV	May	19	4,643,719	1,850,934	4,059,618	0.0445	0.0445	0.0439
WV	May	20	4,690,038	1,876,110	4,092,223	0.0449	0.0451	0.0442
WV	May	21	4,500,464	1,777,130	3,948,367	0.0431	0.0427	0.0427
WV	May	22	4,176,506	1,631,243	3,701,583	0.0400	0.0392	0.0400
WV	May	23	3,890,418	1,520,452	3,489,207	0.0373	0.0365	0.0377
WV	Jun	0	3,526,345	1,276,527	3,194,799	0.0353	0.0346	0.0361
WV	Jun	1	3,433,368	1,243,935	3,122,356	0.0344	0.0337	0.0353
WV	Jun	2	3,356,399	1,219,119	3,069,736	0.0336	0.0331	0.0347
WV	Jun	3	3,345,493	1,209,212	3,049,646	0.0335	0.0328	0.0345
WV	Jun	4	3,435,049	1,241,041	3,115,593	0.0344	0.0337	0.0352
WV	Jun	5	3,591,579	1,297,902	3,226,070	0.0360	0.0352	0.0365
WV	Jun	6	3,815,818	1,381,086	3,397,933	0.0382	0.0375	0.0384
WV	Jun	7	4,074,791	1,482,268	3,603,647	0.0408	0.0402	0.0407
WV	Jun	8	4,276,798	1,566,502	3,751,856	0.0429	0.0425	0.0424
WV	Jun	9	4,446,350	1,646,703	3,884,483	0.0446	0.0447	0.0439
WV	Jun	10	4,553,449	1,701,459	3,987,246	0.0456	0.0462	0.0451
WV	Jun	11	4,607,093	1,726,340	4,045,598	0.0462	0.0468	0.0457
WV	Jun	12	4,631,195	1,748,354	4,097,366	0.0464	0.0474	0.0463
WV	Jun	13	4,631,242	1,751,277	4,103,910	0.0464	0.0475	0.0464
WV	Jun	14	4,616,662	1,749,726	4,091,018	0.0463	0.0475	0.0462
WV	Jun	15	4,622,580	1,754,529	4,112,343	0.0463	0.0476	0.0465
WV	Jun	16	4,617,336	1,749,965	4,088,543	0.0463	0.0475	0.0462
WV	Jun	17	4,580,967	1,727,426	4,052,582	0.0459	0.0469	0.0458
WV	Jun	18	4,532,265	1,692,096	3,989,552	0.0454	0.0459	0.0451
WV	Jun	19	4,483,250	1,656,820	3,908,289	0.0449	0.0450	0.0442
WV	Jun	20	4,505,031	1,659,174	3,912,114	0.0452	0.0450	0.0442
WV	Jun	21	4,343,384	1,585,978	3,784,443	0.0435	0.0430	0.0428
WV	Jun	22	4,024,747	1,452,580	3,547,404	0.0403	0.0394	0.0401
WV	Jun	23	3,711,406	1,337,610	3,324,257	0.0372	0.0363	0.0376
WV	Jul	0	3,743,508	1,383,466	3,456,762	0.0361	0.0354	0.0365
WV	Jul	1	3,610,331	1,339,518	3,365,124	0.0348	0.0343	0.0355
WV	Jul	2	3,524,932	1,309,072	3,298,397	0.0340	0.0335	0.0348
WV	Jul	3	3,494,866	1,294,885	3,273,892	0.0337	0.0332	0.0346
WV	Jul	4	3,569,280	1,321,295	3,328,862	0.0344	0.0338	0.0351
WV	Jul	5	3,700,928	1,366,872	3,424,223	0.0357	0.0350	0.0362
WV	Jul	6	3,893,625	1,439,413	3,557,209	0.0376	0.0369	0.0376
WV	Jul	7	4,154,289	1,538,617	3,753,377	0.0401	0.0394	0.0396
WV	Jul	8	4,385,314	1,630,970	3,944,418	0.0423	0.0418	0.0416
WV	Jul	9	4,567,384	1,713,825	4,111,614	0.0441	0.0439	0.0434
WV	Jul	10	4,682,749	1,783,318	4,235,872	0.0452	0.0457	0.0447
WV	Jul	11	4,746,345	1,816,426	4,303,714	0.0458	0.0465	0.0454
WV	Jul	12	4,775,065	1,833,806	4,349,875	0.0461	0.0470	0.0459
WV	Jul	13	4,810,956	1,852,239	4,414,617	0.0464	0.0474	0.0466
WV	Jul	14	4,816,485	1,858,710	4,433,846	0.0465	0.0476	0.0468
WV	Jul	15	4,816,436	1,855,133	4,425,900	0.0465	0.0475	0.0467
WV	Jul	16	4,815,910	1,853,918	4,422,182	0.0465	0.0475	0.0467
WV	Jul	17	4,791,958	1,832,647	4,378,522	0.0462	0.0469	0.0462
WV	Jul	18	4,730,850	1,798,833	4,300,188	0.0456	0.0461	0.0454
WV	Jul	19	4,665,159	1,760,578	4,236,120	0.0450	0.0451	0.0447

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			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Jul	20	4,669,014	1,756,389	4,200,597	0.0450	0.0450	0.0443
WV	Jul	21	4,504,520	1,684,422	4,057,296	0.0435	0.0431	0.0428
WV	Jul	22	4,235,289	1,567,823	3,829,574	0.0409	0.0402	0.0404
WV	Jul	23	3,946,975	1,456,164	3,616,258	0.0381	0.0373	0.0382
WV	Aug	0	3,815,866	1,318,988	3,480,132	0.0363	0.0349	0.0360
WV	Aug	1	3,704,477	1,280,416	3,400,927	0.0352	0.0339	0.0351
WV	Aug	2	3,616,820	1,251,130	3,343,470	0.0344	0.0331	0.0346
WV	Aug	3	3,586,321	1,239,763	3,321,327	0.0341	0.0328	0.0343
WV	Aug	4	3,666,197	1,268,885	3,381,692	0.0348	0.0336	0.0349
WV	Aug	5	3,853,805	1,337,138	3,537,563	0.0366	0.0354	0.0366
WV	Aug	6	4,004,264	1,413,501	3,653,440	0.0380	0.0374	0.0378
WV	Aug	7	4,215,225	1,492,878	3,822,830	0.0401	0.0395	0.0395
WV	Aug	8	4,429,912	1,577,776	4,020,808	0.0421	0.0418	0.0416
WV	Aug	9	4,595,394	1,648,263	4,200,879	0.0437	0.0437	0.0434
WV	Aug	10	4,702,032	1,710,509	4,329,477	0.0447	0.0453	0.0447
WV	Aug	11	4,777,262	1,755,067	4,401,562	0.0454	0.0465	0.0455
WV	Aug	12	4,815,118	1,778,830	4,455,038	0.0458	0.0471	0.0460
WV	Aug	13	4,830,298	1,786,874	4,485,768	0.0459	0.0473	0.0464
WV	Aug	14	4,836,202	1,790,038	4,508,929	0.0460	0.0474	0.0466
WV	Aug	15	4,863,624	1,795,929	4,509,896	0.0462	0.0476	0.0466
WV	Aug	16	4,867,949	1,798,227	4,501,725	0.0463	0.0476	0.0465
WV	Aug	17	4,841,578	1,778,250	4,474,502	0.0460	0.0471	0.0462
WV	Aug	18	4,782,787	1,748,185	4,427,765	0.0454	0.0463	0.0458
WV	Aug	19	4,782,890	1,734,883	4,400,760	0.0454	0.0460	0.0455
WV	Aug	20	4,783,861	1,731,149	4,381,216	0.0455	0.0459	0.0453
WV	Aug	21	4,571,284	1,631,975	4,161,064	0.0434	0.0432	0.0430
WV	Aug	22	4,297,752	1,502,746	3,925,645	0.0408	0.0398	0.0406
WV	Aug	23	4,000,028	1,379,902	3,642,811	0.0380	0.0366	0.0376
WV	Sep	0	3,523,763	1,222,164	3,270,388	0.0350	0.0337	0.0359
WV	Sep	1	3,438,300	1,194,098	3,216,142	0.0342	0.0330	0.0353
WV	Sep	2	3,387,944	1,173,545	3,182,110	0.0337	0.0324	0.0350
WV	Sep	3	3,383,266	1,177,349	3,186,215	0.0336	0.0325	0.0350
WV	Sep	4	3,520,278	1,224,693	3,285,269	0.0350	0.0338	0.0361
WV	Sep	5	3,808,971	1,336,444	3,494,425	0.0379	0.0369	0.0384
WV	Sep	6	4,025,182	1,438,461	3,658,869	0.0400	0.0397	0.0402
WV	Sep	7	4,174,065	1,508,426	3,767,733	0.0415	0.0416	0.0414
WV	Sep	8	4,331,561	1,564,838	3,866,430	0.0431	0.0432	0.0425
WV	Sep	9	4,445,198	1,614,392	3,946,971	0.0442	0.0446	0.0434
WV	Sep	10	4,523,534	1,647,257	4,011,206	0.0450	0.0455	0.0441
WV	Sep	11	4,574,930	1,672,820	4,057,023	0.0455	0.0462	0.0446
WV	Sep	12	4,594,450	1,692,603	4,100,649	0.0457	0.0467	0.0451
WV	Sep	13	4,595,168	1,701,257	4,131,734	0.0457	0.0470	0.0454
WV	Sep	14	4,605,800	1,701,610	4,154,687	0.0458	0.0470	0.0457
WV	Sep	15	4,599,618	1,703,620	4,171,726	0.0457	0.0470	0.0458
WV	Sep	16	4,596,596	1,707,130	4,178,073	0.0457	0.0471	0.0459
WV	Sep	17	4,569,107	1,681,107	4,130,915	0.0454	0.0464	0.0454
WV	Sep	18	4,586,528	1,677,310	4,123,245	0.0456	0.0463	0.0453
WV	Sep	19	4,642,216	1,704,072	4,140,909	0.0462	0.0470	0.0455
WV	Sep	20	4,580,511	1,664,178	4,061,607	0.0456	0.0459	0.0446
WV	Sep	21	4,337,546	1,540,779	3,854,213	0.0431	0.0425	0.0424
WV	Sep	22	4,003,844	1,393,256	3,611,866	0.0398	0.0385	0.0397
WV	Sep	23	3,699,525	1,288,883	3,400,905	0.0368	0.0356	0.0374
WV	Oct	0	3,618,974	1,621,144	3,272,296	0.0348	0.0338	0.0360

Average 2000-2004 State Level Monthly-Diurnal Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Oct	1	3,559,758	1,595,812	3,226,071	0.0342	0.0333	0.0355
WV	Oct	2	3,534,706	1,586,482	3,207,668	0.0339	0.0331	0.0353
WV	Oct	3	3,565,625	1,597,969	3,227,938	0.0342	0.0333	0.0355
WV	Oct	4	3,741,408	1,671,527	3,352,988	0.0359	0.0349	0.0369
WV	Oct	5	4,095,204	1,838,716	3,610,407	0.0393	0.0384	0.0397
WV	Oct	6	4,418,184	2,029,335	3,865,236	0.0424	0.0423	0.0425
WV	Oct	7	4,562,323	2,104,804	3,976,631	0.0438	0.0439	0.0437
WV	Oct	8	4,652,025	2,152,739	4,019,973	0.0447	0.0449	0.0442
WV	Oct	9	4,705,295	2,183,397	4,028,147	0.0452	0.0456	0.0443
WV	Oct	10	4,710,830	2,185,421	4,032,132	0.0452	0.0456	0.0443
WV	Oct	11	4,704,875	2,186,333	4,036,216	0.0452	0.0456	0.0444
WV	Oct	12	4,688,124	2,181,432	4,033,725	0.0450	0.0455	0.0443
WV	Oct	13	4,651,476	2,169,748	4,018,589	0.0447	0.0453	0.0442
WV	Oct	14	4,610,580	2,140,643	3,987,181	0.0443	0.0447	0.0438
WV	Oct	15	4,599,434	2,139,660	3,991,966	0.0442	0.0446	0.0439
WV	Oct	16	4,592,520	2,139,428	3,995,499	0.0441	0.0446	0.0439
WV	Oct	17	4,625,574	2,153,201	4,012,460	0.0444	0.0449	0.0441
WV	Oct	18	4,756,187	2,234,812	4,120,427	0.0457	0.0466	0.0453
WV	Oct	19	4,747,451	2,230,628	4,110,519	0.0456	0.0465	0.0452
WV	Oct	20	4,665,754	2,174,455	4,022,393	0.0448	0.0454	0.0442
WV	Oct	21	4,435,772	2,041,910	3,838,779	0.0426	0.0426	0.0422
WV	Oct	22	4,101,607	1,860,468	3,602,312	0.0394	0.0388	0.0396
WV	Oct	23	3,790,504	1,708,542	3,388,919	0.0364	0.0356	0.0372
WV	Nov	0	3,780,067	1,750,447	3,309,421	0.0371	0.0364	0.0378
WV	Nov	1	3,661,608	1,691,403	3,224,450	0.0360	0.0352	0.0369
WV	Nov	2	3,613,349	1,660,122	3,180,830	0.0355	0.0345	0.0364
WV	Nov	3	3,602,998	1,654,742	3,176,508	0.0354	0.0344	0.0363
WV	Nov	4	3,643,413	1,674,743	3,202,564	0.0358	0.0348	0.0366
WV	Nov	5	3,822,824	1,761,094	3,327,694	0.0376	0.0366	0.0380
WV	Nov	6	4,157,762	1,942,323	3,562,470	0.0408	0.0404	0.0407
WV	Nov	7	4,378,537	2,068,776	3,736,076	0.0430	0.0430	0.0427
WV	Nov	8	4,471,261	2,126,790	3,816,344	0.0439	0.0442	0.0436
WV	Nov	9	4,506,389	2,150,115	3,848,135	0.0443	0.0447	0.0440
WV	Nov	10	4,533,363	2,165,649	3,864,271	0.0445	0.0450	0.0442
WV	Nov	11	4,500,842	2,147,500	3,833,688	0.0442	0.0447	0.0438
WV	Nov	12	4,467,510	2,128,701	3,799,494	0.0439	0.0443	0.0434
WV	Nov	13	4,428,889	2,106,013	3,767,883	0.0435	0.0438	0.0431
WV	Nov	14	4,378,096	2,079,127	3,749,338	0.0430	0.0432	0.0428
WV	Nov	15	4,346,037	2,069,195	3,730,916	0.0427	0.0430	0.0426
WV	Nov	16	4,385,192	2,092,295	3,764,646	0.0431	0.0435	0.0430
WV	Nov	17	4,533,795	2,174,044	3,881,309	0.0445	0.0452	0.0444
WV	Nov	18	4,603,067	2,211,814	3,956,061	0.0452	0.0460	0.0452
WV	Nov	19	4,581,686	2,195,725	3,921,569	0.0450	0.0457	0.0448
WV	Nov	20	4,563,731	2,185,415	3,875,566	0.0448	0.0454	0.0443
WV	Nov	21	4,496,010	2,149,681	3,810,368	0.0442	0.0447	0.0435
WV	Nov	22	4,288,692	2,023,264	3,666,694	0.0421	0.0421	0.0419
WV	Nov	23	4,044,102	1,882,045	3,495,387	0.0397	0.0391	0.0399
WV	Dec	0	3,940,230	1,799,753	3,420,736	0.0376	0.0365	0.0379
WV	Dec	1	3,800,336	1,723,432	3,319,181	0.0363	0.0350	0.0368
WV	Dec	2	3,751,357	1,705,779	3,289,072	0.0358	0.0346	0.0364
WV	Dec	3	3,745,571	1,701,450	3,281,035	0.0358	0.0345	0.0364
WV	Dec	4	3,794,848	1,727,318	3,316,106	0.0362	0.0350	0.0367
WV	Dec	5	3,949,201	1,809,509	3,437,236	0.0377	0.0367	0.0381

Average 2000-2004 State Level Monthly-Diurnal Profiles
CEM-Based Distribution

			Average Values [2000-2004]					
			SO2 Mass	NOx Mass	Heat Input	Calculated Ratios		
State	Month	Hour	[lbs]	[lbs]	[MMBtu]	SO2 Ratio	NOx Ratio	Heat Input
WV	Dec	6	4,233,989	1,981,725	3,662,959	0.0404	0.0402	0.0406
WV	Dec	7	4,474,020	2,117,521	3,862,515	0.0427	0.0429	0.0428
WV	Dec	8	4,593,061	2,191,965	3,945,255	0.0438	0.0445	0.0437
WV	Dec	9	4,651,094	2,225,221	3,991,071	0.0444	0.0451	0.0442
WV	Dec	10	4,661,681	2,228,131	3,986,219	0.0445	0.0452	0.0442
WV	Dec	11	4,606,381	2,195,141	3,936,405	0.0440	0.0445	0.0436
WV	Dec	12	4,553,573	2,153,039	3,879,133	0.0435	0.0437	0.0430
WV	Dec	13	4,495,870	2,121,901	3,840,522	0.0429	0.0430	0.0426
WV	Dec	14	4,401,121	2,071,610	3,784,798	0.0420	0.0420	0.0419
WV	Dec	15	4,354,333	2,044,563	3,760,254	0.0416	0.0415	0.0417
WV	Dec	16	4,436,939	2,089,638	3,836,218	0.0424	0.0424	0.0425
WV	Dec	17	4,663,174	2,228,940	4,013,471	0.0445	0.0452	0.0445
WV	Dec	18	4,772,139	2,307,759	4,122,732	0.0456	0.0468	0.0457
WV	Dec	19	4,769,498	2,299,340	4,097,800	0.0455	0.0466	0.0454
WV	Dec	20	4,736,443	2,275,618	4,034,921	0.0452	0.0462	0.0447
WV	Dec	21	4,680,463	2,238,335	3,976,665	0.0447	0.0454	0.0441
WV	Dec	22	4,495,343	2,120,487	3,824,887	0.0429	0.0430	0.0424
WV	Dec	23	4,203,589	1,947,792	3,616,058	0.0401	0.0395	0.0401

Appendix H.3
White Paper on Mobile Source SMOKE Modeling

Processing Mobile Emissions in SMOKE: Is it worth simulating everyday onroad mobile emissions to support 8-hr ozone modeling?

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ABSTRACT

The most computationally limiting step in emissions modeling is typically the generation of onroad mobile sources. Motor vehicle emissions are influenced by meteorological variability and the processing requirements for daily motor vehicle emissions have been determined to be rate limiting under most modeling schedules. Rather than utilizing averaged meteorological data or pre-calculated motor vehicle emissions, the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) / Association for Southeastern Integrated Planning (ASIP) modeling team developed an emissions processing approach that models a representative week for each month of the year in order to make the SMOKE processing time more manageable and consistent with VISTAS/ASIP modeling schedules. This representative week was selected from mid-month, to try to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would require atypical processing.

The purpose of this paper is to describe processing options for onroad mobile source emissions using the MOBILE module of the SMOKE emissions processor and to determine, based on air quality predictions and time and resource expenditure, benefits of simulating everyday for onroad mobile emissions to support 8-hr ozone modeling. We will present 12km evaluations of everyday vs. representative week emissions and associated air quality for a number of domains and discuss the benefits and limitations of the various methods relative to ozone, PM and regional haze prediction.

INTRODUCTION

On December 17, 2004, EPA made fine particle ($PM_{2.5}$) nonattainment determinations for at least one area in seven of the states participating in the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regional haze project. They are Alabama, Georgia, North Carolina, Kentucky, Tennessee, Virginia, and West Virginia. In addition, South Carolina has one three-county area that was designated as unclassifiable in the same action. EPA's Clean Air Interstate Rule (CAIR) modeling indicated that certain nonattainment areas may still be in nonattainment after full implementation of CAIR. These areas include Jefferson County, Alabama and Clayton and Fulton Counties in Georgia.

The $PM_{2.5}$ compliance date is April 2010 unless a state demonstrates that more time is necessary in which case up to five additional years may be granted. The nonattainment designations triggered the requirement for development of state implementation plans (SIPs) that will be due in April 2008. The draft guidance from EPA indicates that a significant requirement of $PM_{2.5}$ SIPs will be attainment demonstrations using, at least in part, modeling analyses to define effective emissions control strategies and confirm that attainment can be achieved after implementation of the strategies. 2009 is the modeling year for the $PM_{2.5}$ attainment demonstration and also is an interim analysis year for the VISTAS regional haze demonstration.

In April of 2004, EPA determined areas that were not meeting the 8-hour ozone standard. States having one or more 8-hour ozone nonattainment areas in the Southeast are Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. EPA will require attainment of the 8-hour ozone standard in basic nonattainment areas by June 15, 2009 and in moderate nonattainment areas by June 15, 2010. This will require states with basic 8-hour ozone nonattainment areas to model 2008 as the SIP modeling demonstration year while moderate nonattainment areas will require 2009 as the modeling year. Given that North Carolina and Virginia have two year SIP approval processes, there is an immediate need to complete an analysis of ozone attainment using air quality modeling.

The states participating in the VISTAS project (the SESARM EPA Region 4 states plus Virginia and West Virginia from Region 3) have concluded that a collaborative process will be the most efficient approach for the collective states to develop information upon which to base the $PM_{2.5}$ and 8-hour ozone attainment demonstrations. The local air regulatory agencies for Jefferson County, AL, Jefferson County, KY, Mecklenburg County, NC, Forsyth County, NC, Knox County, TN, and Shelby County, TN have also become signatory parties to this collaborative effort. SESARM will coordinate among participating agencies and oversee the performance of the inventory and modeling tasks in parallel with the VISTAS regional haze project tasks.

The name of this collaborative effort is the Association for Southeastern Integrated Planning (ASIP). SESARM was awarded a grant from EPA on February 8, 2005 to conduct what was originally called the fine particle SIP development support project but is now known as ASIP.

These states need to submit their 8-hour ozone State Implementation Plans (SIPs) to EPA by June 2007; the $PM_{2.5}$ SIPs are due by April 2008. Some of the states involved in the ASIP ozone/PM modeling have two-year legislative review processes. Thus, the definition of the SIP control plans is needed in early 2006. Consequently, the ASIP regional ozone and PM modeling has an aggressive schedule.

Figure 1. $PM_{2.5}$ nonattainment counties designed by EPA in December 2004.

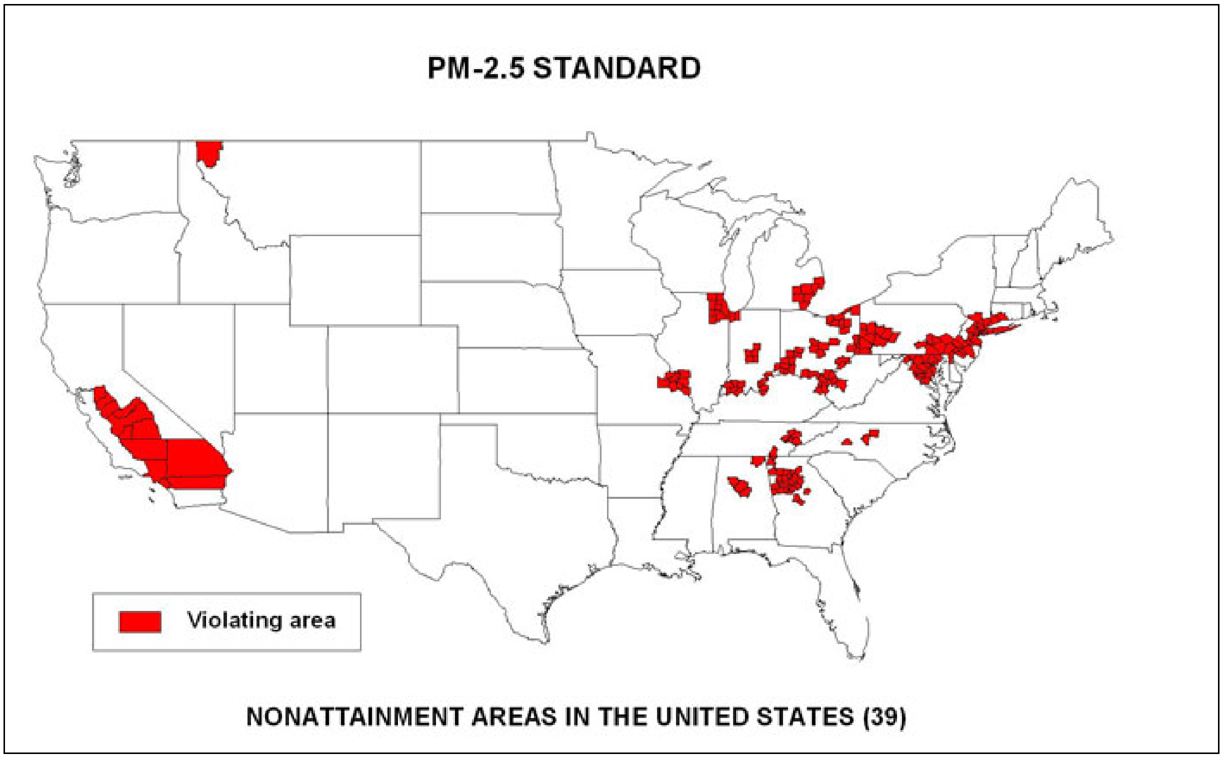
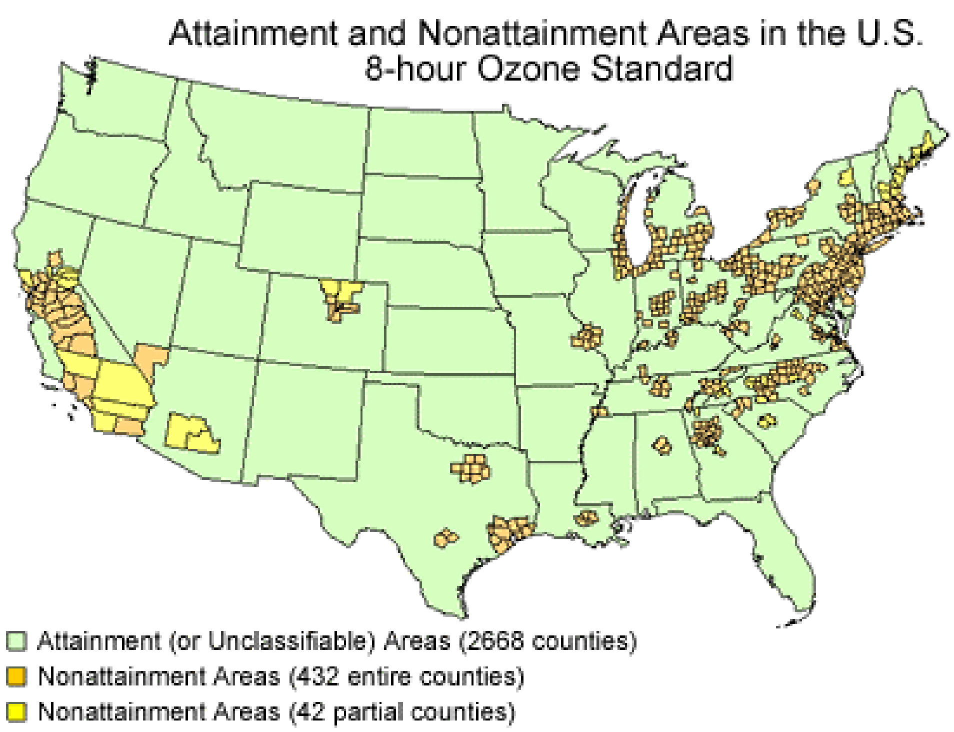


Figure 2. 8-hour ozone nonattainment counties in the US designated by EPA in April 2004.



By far the most computationally limiting step in emissions modeling is typically the generation of onroad mobile sources. Motor vehicle emissions are influenced by meteorological variability and the processing requirements for daily motor vehicle emissions have been determined to be rate limiting under most modeling schedules. Rather than utilizing averaged meteorological data or pre-calculated motor vehicle emissions, the VISTAS and ASIP modeling team developed an emissions processing approach that models a representative week for each month of the year in order to make the SMOKE processing time more manageable and consistent with modeling schedule[1]. This representative week was selected from mid-month, to try to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would require atypical processing.

Based on the findings in the VISTAS Phase I and II modeling activities, ASIP selected the following models for use in modeling 8-hour ozone and particulate matter (PM) of size of 2.5 microns or less ($PM_{2.5}$):

- **MM5[2,3]:** The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5) is a nonhydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate and regional haze regulatory modeling studies.

- **SMOKE[4]**: The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad, area, point, fire and biogenic emission sources for photochemical grid models.

- **CMAQ[5,6]:** EPA's Models-3/Community Multiscale Air Quality (CMAQ) modeling system is a 'One-Atmosphere' photochemical grid model capable of addressing ozone, particulate matter (PM), visibility and acid deposition at regional scale for periods up to one year.

The purpose of this paper is to describe processing options for onroad mobile source emissions using the MOBILE module of the SMOKE emissions processor and to determine, based on air quality predictions and time and resource expenditure, benefits of simulating everyday for onroad mobile emissions to support 8-hr ozone modeling. We will present 12km evaluations of everyday vs. representative week emissions and associated air quality for a number of domains and discuss the benefits and limitations of the various methods relative to ozone and regional haze prediction.

MOBILE6 / SMOKE PREPARATION

For the VISTAS/ASIP 2009 annual emissions inventory modeling, SMOKE was configured to generate point, area, nonroad, highway, and biogenic source emissions. In addition, certain subcategories, such as fires and EGUs were maintained in separate source category files in order to allow maximum flexibility in producing alternate strategies. With the exception of biogenic and highway mobile source emissions that are generated using the BEIS and MOBILE6 modules in SMOKE, pre-computed annual emissions will be processed using the month, day, and hour specific temporal profiles of the SMOKE model. Area, nonroad, and point sources were modeled as a block of Thursday, Friday, Saturday, Sunday, Monday one per month (total of 60 days modeled). Biogenics were modeled for each day of the episode.

For this investigation, the onroad mobile source emissions were produced using two approaches:

1) Modeling every day of the annual episode, using the MM5 meteorology files for each model day. When full annual runs were executed, holidays were modeled as Sundays.

2) Modeling selected weeks (seven days) of each month and using these days as representative of the entire month. This selection criterion allows for the representation of day-of-the-week variability in the onroad motor vehicles, and models a representation of the meteorological variability in each month. The modeled weeks were selected from mid-month, avoiding inclusion of major holidays.

The parameters for the SMOKE runs are as follows:

Episodes:

2002 Initial Base Year, and
2009 Future year, using 2009 inventory and modeled using the same meteorology and episode days as 2002.

Episode represented by the following weeks per month:

January 15-21
February 12-18
March 12-18
April16-22
May 14-20
June 11-17
July 16-22
August 13-19
September 17-23
October 15-21
November 12-18
December 17-23

Days modeled as holidays for annual run:

New Year's Day - January 1
Good Friday – March 29
Memorial Day – May 27
July 4th
Labor Day – September 2
Thanksgiving Day – November 28, 29
Christmas Eve – December 24
Christmas Day – December 25

Output time zone:

Greenwich Mean Time (zone 0)

Projection:

Lambert Conformal with Alpha=33, Beta=45, Gamma=-97, and center at (-97, 40).

Domain:

36 Kilometer Grid: Origin at (-2736, -2088) kilometers with 148 rows by 112 columns and 36-km square grid cells.
12 Kilometer Grid: Origin at (108, -1620) kilometers with 168 rows by 177 columns and 12-km square grid cells.

Layer structure:

The CMAQ layer structure will be 19 layers, with specific layer positions defined in the meteorology files to be provided by VISTAS meteorological contractor.

CMAQ model species:

The CMAQ configuration will be for CB-IV with PM. The model species will be: CO, NO, NO2, ALD2, ETH, FORM, ISOP, NR, OLE, PAR, TERPB, TOL, XYL, NH3, SO2, SULF, PEC, PMFINE, PNO3, POA, PSO4, and PMC.

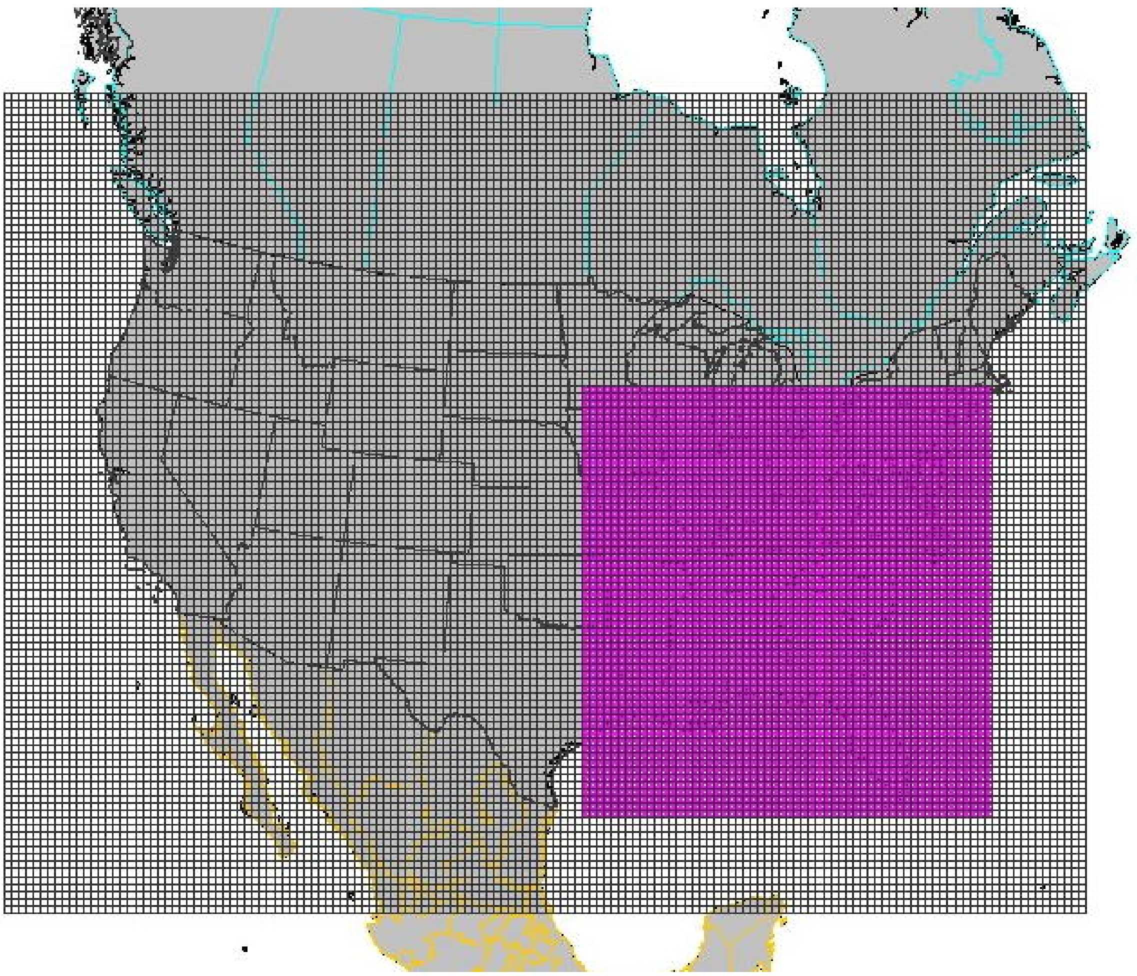
Meteorology data:

Daily (25-hour). SMOKE requires the following five types of MCIP outputs: (1) Grid cross 2-d, (2) Grid cross 3-d, (3) Met cross 2-d, (4) Met cross 3-d, and (5), Met dot 3-d.

Elevated sources:

All sources will be treated by SMOKE as potentially elevated. No plume-in-grid sources will be modeled. Wildfire emissions will be handled as point sources.

Figure 3. 36-km national unified RPO domain and VISTAS 12-km domain.



DEVELOPMENT OF ONROAD MOTOR VEHICLE SOURCE EMISSIONS

The MOBILE6 module of SMOKE was used to develop the onroad mobile source emissions estimates for CO, NOX, PM, and VOC emissions. The MOBILE6 parameters, vehicle fleet descriptions, and VMT estimates are combined with gridded, episode-specific temperature data to calculate the gridded, temporalized emission estimates. The MOBILE6 emissions factors are based on episode-specific temperatures predicted by the meteorological model. Further, the MOBILE6 emissions factors model accounts for the following:

- Hourly and daily minimum/maximum temperatures;
- Facility speeds;
- Locale-specific inspection/maintenance (I/M) control programs, if any;
- Adjustments for running losses;
- Splitting of evaporative and exhaust emissions into separate source categories;
- VMT, fleet turnover, and changes in fuel composition and Reid vapor pressure (RVP).

The primary input to MOBILE6 is the MOBILE shell file. The MOBILE shell contains the various options (e.g. type of inspection and maintenance program in effect, type of oxygenated fuel program in effect, alternative vehicle mix profiles, RVP of in-use fuel, operating mode) that direct the calculation of the MOBILE6 emissions factors. The shells used in these runs were based on VISTAS/ASIP BaseF modeling inputs[7]. The options for all MOBILE6 parameters were held constant between the annual and representative week runs.

Daily results of these model runs for a winter (January 17) and summer (July 18) day are represented in Figures 4 through 6 below. These data provide a comparison of the magnitude difference between ozone and particulate matter precursor species for each of these seasonally different episodes. As can be seen in these figures, the variable inputs (temperature, VMT, seasonal fuels) associated with each month's run have an impact on the overall emissions generated for the onroad mobile source category. It is through modeling these differences with CMAQ for both ozone and PM that we have based our conclusions.

Each of the onroad mobile source emissions runs conducted with the MOBILE6 module of SMOKE were performed on a dual Athlon MP 2600+ with 1.5 G RAM. With this configuration, the modeling team experienced run times of approximately sixty-three (63) minutes per run day on the 12km domain. Using this estimate, the representative week processing would require a total of 5,292 minutes (12 months x 7 days x 63 minutes per run day) or about 88.2 hours (3.5 days) of CPU runtime to generate the files necessary to simulate the annual episode. In comparison, actually running each day's onroad mobile source emissions using the same configuration would require 22,995 minutes (365 days x 63 minutes per run day) or about 383.25 hours (16 days) of CPU run time.

Figure 4. Daily VOC emissions as generated with the MOBILE6 module of SMOKE for a winter (January 17) and summer (July 18) episode day.

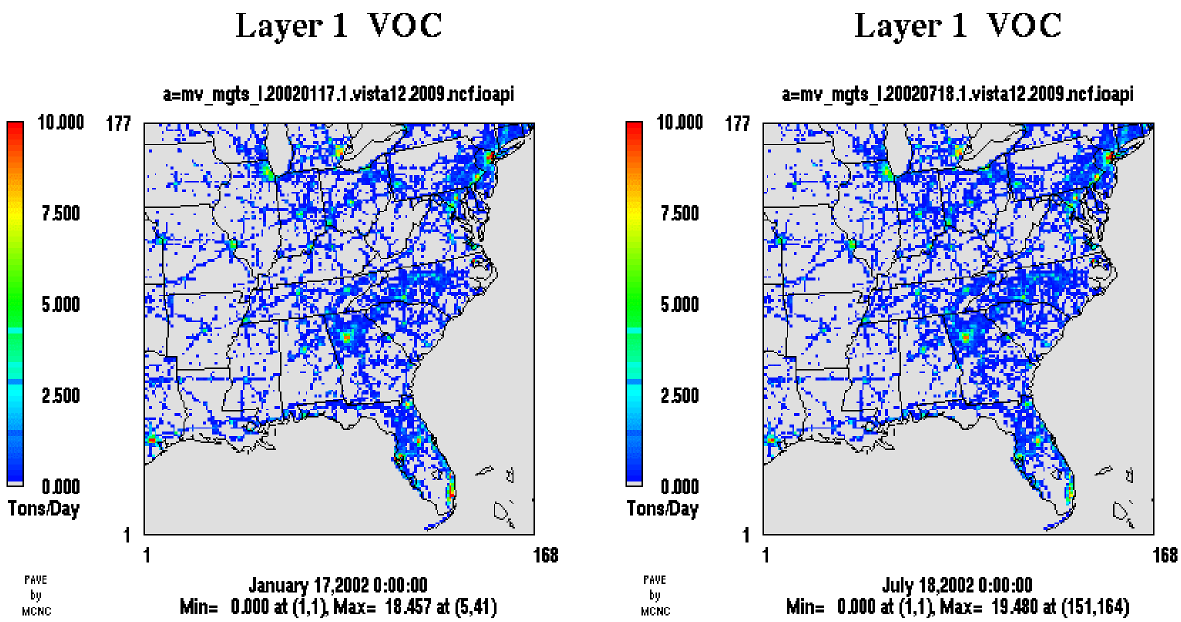


Figure 5. Daily NOx emissions as generated with the MOBILE6 module of SMOKE for a winter (January 17) and summer (July 18) episode day.

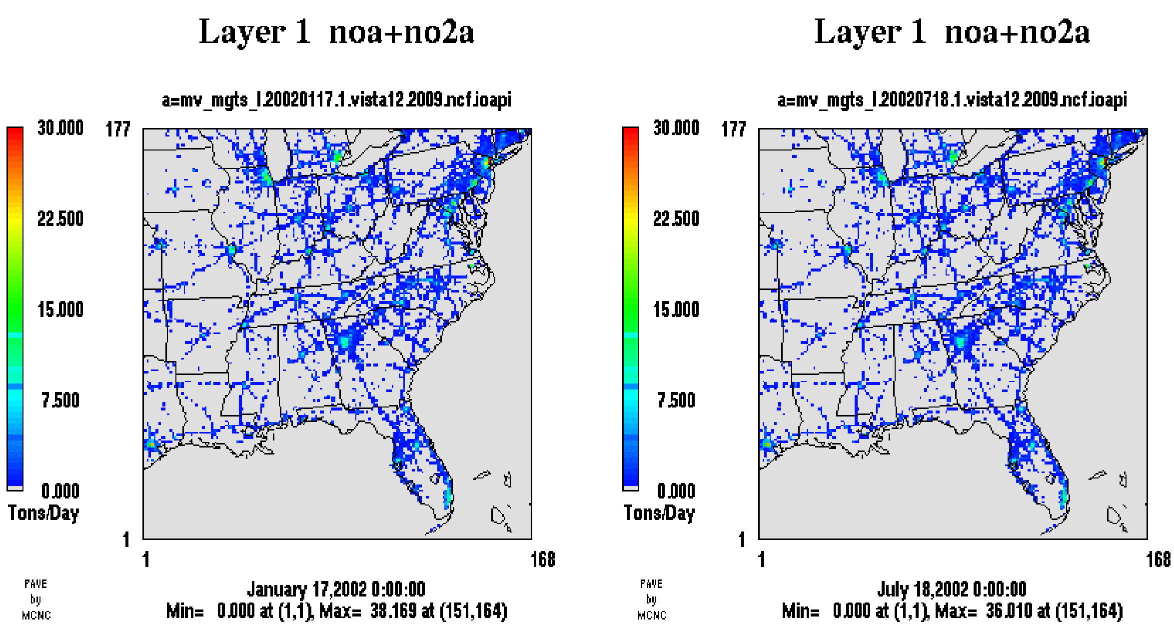
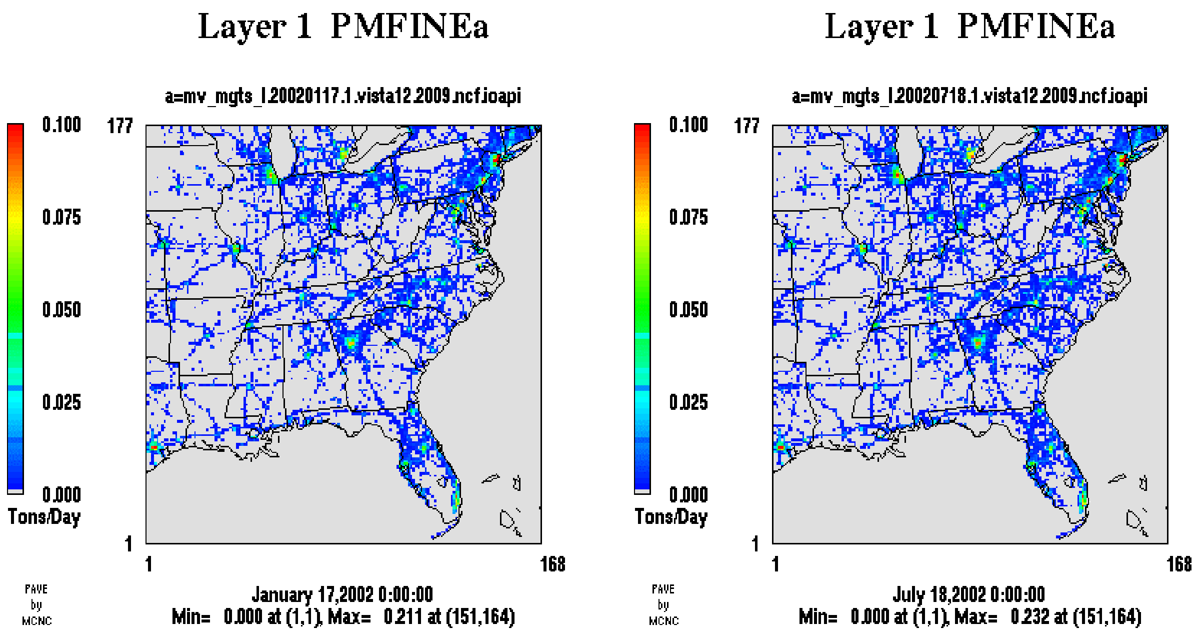


Figure 6. Daily PM-fine emissions as generated with the MOBILE6 module of SMOKE for a winter (January 17) and summer (July 18) episode day.



EMISSIONS SUMMARY

The reconstructed emissions based on the representative week run were calculated by mapping each day of week (Mon, Tue, Wed, etc.) from the modeled month to the same day of week generated in the representative week run. In the case of holidays, these days were mapped to representative week Sundays. An example of this mapping for the January episode is presented in Table 1. Note that although the emissions were generated for calendar year 2009, the meteorology is based on 2002. Table 2 presents a comparison of January emissions as generated using the everyday MOBILE6 module run for each VISTAS/ASIP State and these emissions as reconstructed from the representative week MOBILE6 module runs. In comparison, Table 3 presents these emissions for the month of July.

Table 1. Representative day mapping for January episode (Highlighted representative week).

Modeled Date	Representative Day	Modeled Date	Representative Day	Modeled Date	Representative Day
1/1/2002*	1/20/2002	1/11/2002	1/18/2002	1/22/2002	1/15/2002
1/2/2002	1/16/2002	1/12/2002	1/19/2002	1/23/2002	1/16/2002
1/3/2002	1/17/2002	1/13/2002	1/20/2002	1/24/2002	1/17/2002
1/4/2002	1/18/2002	1/14/2002	1/21/2002	1/25/2002	1/18/2002
1/5/2002	1/19/2002	1/15/2002	1/15/2002	1/26/2002	1/19/2002
1/6/2002	1/20/2002	1/16/2002	1/16/2002	1/27/2002	1/20/2002
1/7/2002	1/21/2002	1/17/2002	1/17/2002	1/28/2002	1/21/2002
1/8/2002	1/15/2002	1/18/2002	1/18/2002	1/29/2002	1/15/2002
1/9/2002	1/16/2002	1/19/2002	1/19/2002	1/30/2002	1/16/2002
1/10/2002	1/17/2002	1/20/2002	1/20/2002	1/31/2002	1/17/2002
		1/21/2002	1/21/2002		

* Modeled holiday

Table 2. January 2009 onroad mobile emissions comparison.

	January 2009 Emissions (Everyday Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	6,567	8,774	105,011	51	266	174	500
Florida	28,354	26,686	336,541	171	834	529	1,736
Georgia	15,558	17,935	224,920	100	509	328	999
Kentucky	5,321	8,618	102,603	47	250	165	453
Mississippi	3,928	5,999	61,323	31	191	130	312
North Carolina	13,590	18,406	231,897	104	489	311	988
South Carolina	5,372	7,934	92,169	44	240	159	429
Tennessee	8,729	12,954	142,906	67	356	238	609
Virginia	7,377	11,708	156,617	72	311	190	716
West Virginia	2,025	3,177	41,742	18	91	59	168
	96,821	**122,190**	**1,495,728**	**705**	**3,536**	**2,283**	**6,910**

	January 2009 Emissions (Representative Day Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	6,394	8,765	102,800	51	266	174	500
Florida	28,852	26,476	333,248	171	833	529	1,736
Georgia	15,337	17,867	218,990	100	509	328	999
Kentucky	5,023	8,679	104,247	47	250	165	453
Mississippi	3,710	6,012	60,454	31	191	130	312
North Carolina	12,605	18,383	225,563	104	489	311	988
South Carolina	5,226	7,911	89,001	44	240	159	430
Tennessee	8,011	13,000	141,962	67	356	238	609
Virginia	7,005	11,735	155,321	72	311	190	715
West Virginia	1,941	3,194	42,096	18	91	59	168
	94,104	**122,021**	**1,473,682**	**705**	**3,536**	**2,283**	**6,909**

	January 2009 Emissions (Difference as Percent)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	-2.6%	-0.1%	-2.1%	0.0%	0.0%	0.0%	0.0%
Florida	1.8%	-0.8%	-1.0%	0.0%	0.0%	0.0%	0.0%
Georgia	-1.4%	-0.4%	-2.6%	0.0%	0.0%	0.0%	0.0%
Kentucky	-5.6%	0.7%	1.6%	0.0%	0.0%	0.0%	0.0%
Mississippi	-5.5%	0.2%	-1.4%	0.0%	0.0%	0.0%	0.0%
North Carolina	-7.2%	-0.1%	-2.7%	0.0%	0.0%	0.0%	0.0%
South Carolina	-2.7%	-0.3%	-3.4%	0.0%	0.0%	0.0%	0.0%
Tennessee	-8.2%	0.4%	-0.7%	0.0%	0.0%	0.0%	0.0%
Virginia	-5.0%	0.2%	-0.8%	0.0%	0.0%	0.0%	0.0%
West Virginia	-4.1%	0.6%	0.8%	0.0%	0.0%	0.0%	0.0%
	-2.8%	**-0.1%**	**-1.5%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

Table 3. July 2009 onroad mobile emissions comparison.

	July 2009 Emissions (Everyday Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	5,968	8,654	61,362	58	278	175	584
Florida	21,715	27,067	208,947	190	864	531	1,971
Georgia	15,833	17,965	133,828	114	533	332	1,162
Kentucky	5,289	8,196	56,333	53	262	166	537
Mississippi	3,934	6,013	38,674	36	200	130	376
North Carolina	12,975	17,340	130,042	120	512	311	1,171
South Carolina	5,316	7,859	57,163	51	251	160	512
Tennessee	8,797	12,446	81,289	75	368	237	712
Virginia	7,064	11,221	87,946	82	331	195	832
West Virginia	2,038	3,006	23,429	21	96	61	205
	88,930	**119,768**	**879,013**	**800**	**3,695**	**2,299**	**8,063**

	July 2009 Emissions (Representative Day Calculation)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	6,017	8,682	61,581	58	278	175	585
Florida	22,006	27,217	210,901	190	864	531	1,971
Georgia	16,252	18,091	135,119	114	533	332	1,163
Kentucky	5,274	8,196	56,184	53	262	167	537
Mississippi	3,960	6,023	38,911	36	200	130	376
North Carolina	13,160	17,394	130,728	120	512	311	1,171
South Carolina	5,449	7,903	57,867	51	251	160	512
Tennessee	8,798	12,454	81,930	75	368	237	712
Virginia	7,104	11,248	87,523	82	331	195	832
West Virginia	2,047	3,010	23,419	21	96	61	205
	90,068	**120,218**	**884,162**	**800**	**3,695**	**2,299**	**8,063**

	July 2009 Emissions (Difference as Percent)						
State	**VOC**	**NOx**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
Alabama	0.8%	0.3%	0.4%	0.0%	0.0%	0.0%	0.0%
Florida	1.3%	0.6%	0.9%	0.0%	0.0%	0.0%	0.0%
Georgia	2.6%	0.7%	1.0%	0.0%	0.0%	0.0%	0.0%
Kentucky	-0.3%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%
Mississippi	0.7%	0.2%	0.6%	0.0%	0.0%	0.0%	0.0%
North Carolina	1.4%	0.3%	0.5%	0.0%	0.0%	0.0%	0.0%
South Carolina	2.5%	0.6%	1.2%	0.0%	0.0%	0.0%	0.0%
Tennessee	0.0%	0.1%	0.8%	0.0%	0.0%	0.0%	0.0%
Virginia	0.6%	0.2%	-0.5%	0.0%	0.0%	0.0%	0.0%
West Virginia	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	1.3%	**0.4%**	**0.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

These aggregate emission summaries would lead one to believe that on an extended episode scale (like those required for PM or regional haze modeling), the use of representative week onroad mobile source emissions would be appropriate. However, in modeling either 1-hr or 8-hr ozone, there is enough of a temperature variability and therefore apparent ozone precursor emissions delta on an hour-to-hour basis that this same assumption could not be made without accompanying air quality simulations.

AIR QUALITY MODELING

The VISTAS/ASIP modeling team has applied the CMAQ Version 4.5 O_3/$PM_{2.5}$ photochemical grid modeling system. The VISTAS/ASIP modeling team implemented a comprehensive evaluation of the meteorological[8], emissions and air quality models. The CMAQ model performance evaluation indicated an underestimation of 8-hour ozone maximums during the summer. The model demonstrated reasonably good performance for sulfate, winter overestimation bias and summer underestimation bias for nitrate and reasonably good performance for elemental carbon (EC), albeit with lots of scatter and low correlation. However, organic carbon (OC) was underestimated with the summer OC underestimation bias being quite severe. After an intense focused analysis of the OC underestimation issue, the VISTAS/ASIP modeling team identified processes important to the formation of secondary organic aerosols (SOA) that were not included in the CMAQ SOA module that may be important to OC in the Southeastern U.S.[9] Consequently, VISTAS/ASIP enhanced the CMAQ SOA module by adding several new processes. This enhancement, called "SOAmods", was implemented in CMAQ Version 4.5 and exhibited much improved OC model performance over the standard CMAQ SOA treatment[10]. A complete description of the modeling methods, configurations and performance are described elsewhere[1,7].

CMAQ was applied using both of the mobile emissions modeling methods described above. Recall, all emissions and air quality model inputs and configurations were held constant, with the exception of the mobile source emissions. This will allow us to isolate the air quality impacts of using the representative week mobile emissions versus the "actual" daily modeled mobile emissions. While the VISTAS/ASIP modeling is conducted on both 36-km National RPO and 12-km "VISTAS/ASIP" modeling domains as shown in Figure 3, this study focuses on evaluations of the 12-km air quality modeling results only.

Using each of the mobile emissions databases (daily and the representative week) generated for the January and July study periods, we performed future-year air quality simulations for 2009 using CMAQ. We then post-processed the air quality model results to qualitatively evaluate the magnitude, location, and spatial extent of the differences in predicted ozone and $PM_{2.5}$ concentrations due to the different mobile emissions modeling methodologies. Spatial plots were generated for each day simulated, including:

1) daily maximum 8-hour ozone difference plots;
2) maximum 1-hour ozone maximum difference plots; and,
3) daily $PM_{2.5}$ difference plots.

RESULTS

Our examination of the two air quality simulations began with the daily differences in $PM_{2.5}$ concentrations. Figures 7 and 8 represent the percent difference in the daily $PM_{2.5}$ concentrations between the air quality simulations with representative week mobile emissions and the daily mobile emissions for one winter day (January 22^{nd}) and one summer day (July 9^{th}). No change is seen in either plot indicating daily $PM_{2.5}$ concentrations changed less than one percent. Absolute differences in daily $PM_{2.5}$ concentrations are shown in Figures 9 and 10 for the same two days (January 22^{nd} and July 9^{th}). Again, no change is seen in either plot indicating daily $PM_{2.5}$ concentrations changed less than 0.2 $\mu g/m^3$. In fact, all of the fourteen days modeled (seven winter days and seven summer days) show no differences as high as 0.2 $\mu g/m^3$.

We next examined the results of the two air quality simulations with the daily differences in maximum 8-hour ozone concentrations. Figures 11 and 12 present the percent difference in the daily maximum 8-hour ozone concentrations for one winter day (January 28^{th}) and one summer day (July 15^{th}). In most areas for the winter day, daily maximum 8-hour ozone concentrations changed less than one percent. In a few urban corridors, namely, near Chicago, IL, Atlanta, GA and Baltimore, MD, changes of one percent are noted. Near Philadelphia, PA, changes of up to two percent are noted. However, this was the only day of the seven wintertime days simulated that showed a daily maximum 8-hour ozone difference as high as one percent anywhere in the modeling domain. It should also be noted that predicting wintertime ozone concentrations is not usually an interest because most, if not all high ozone events in the middle latitudes of the northern hemisphere occur during the summertime. Therefore the remainder of the ozone analysis will focus on summertime differences. On the summer day, July 15^{th}, presented in Figure 12, no changes are seen indicating daily maximum 8-hour ozone concentrations changed less than one percent. In fact, all seven of the summer days modeled showed no changes as high as one percent.

Absolute differences in daily maximum 8-hour ozone concentrations are shown in Figure 13 for July 15^{th}. Again, no change as high as 0.5 ppb (0.0005 ppm) was noted on this day or any of the seven summer days modeled. In addition to the 8-hour ozone metrics discussed above, differences in 1-hour ozone maximums were examined. As shown in Figure14 and 15, only two days during the seven day summertime period simulated showed differences in 1-hour ozone maximums as high as 0.5 ppb (0.0005 ppm).

Figure 7. Percent difference in 24-hour $PM_{2.5}$ concentrations for January 22nd (Representative week mobile emissions versus daily mobile emissions).

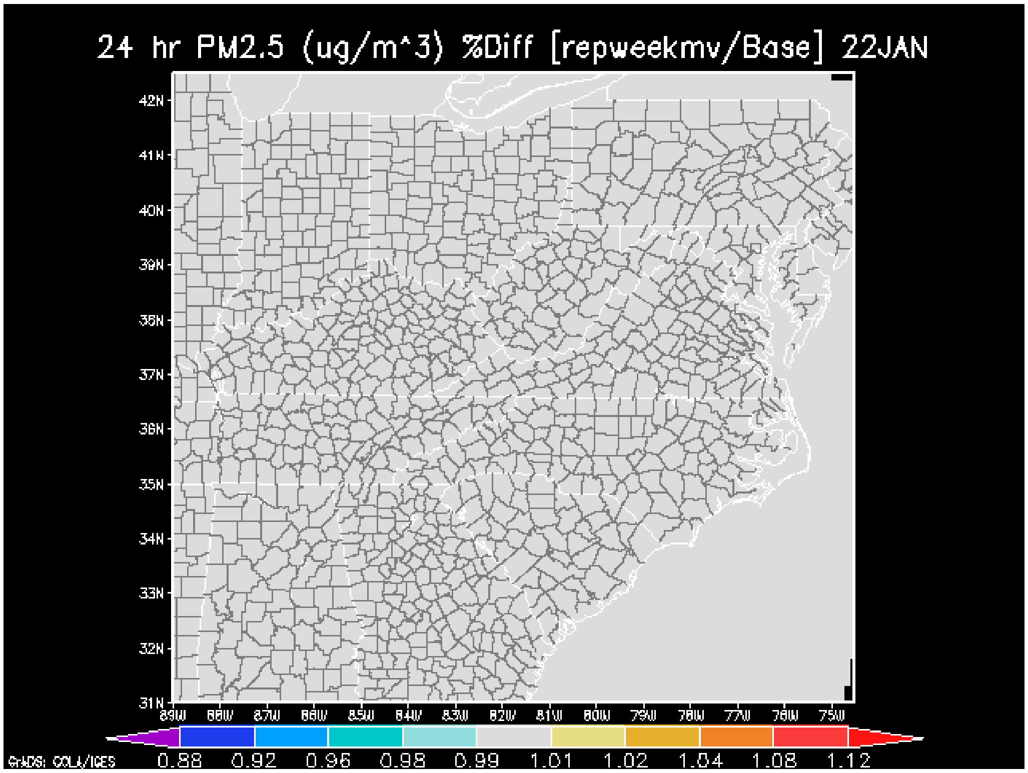


Figure 8. Percent difference in 24-hour $PM_{2.5}$ concentrations for July 9^{th} (Representative week mobile emissions versus daily mobile emissions).

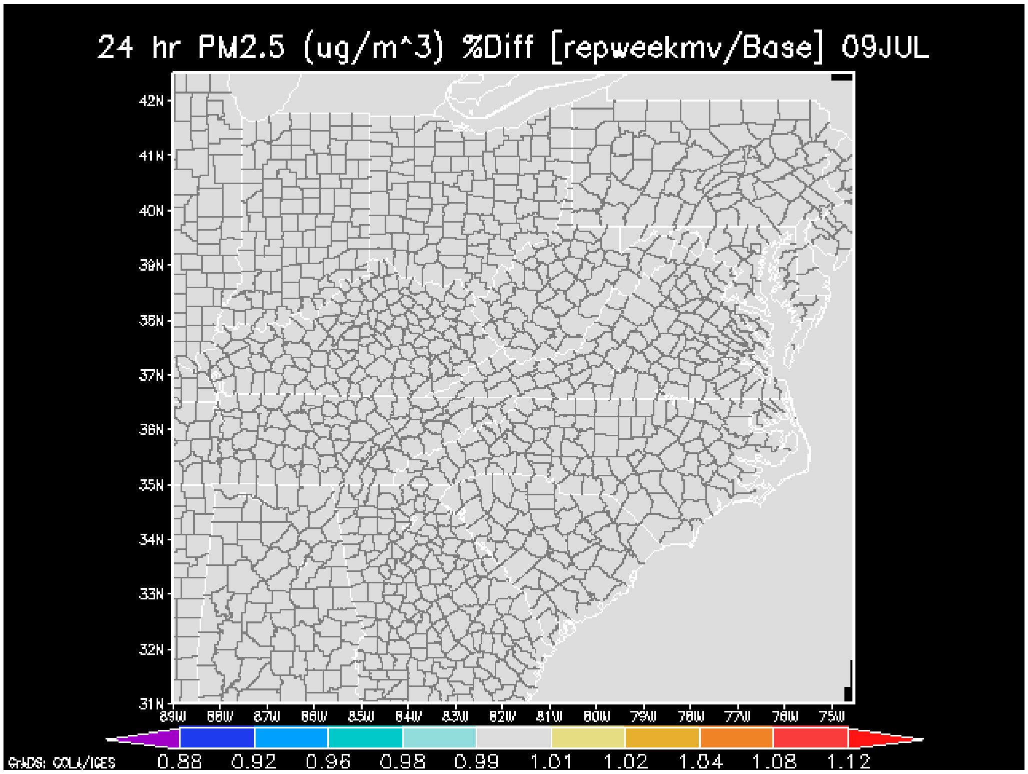


Figure 9. Absolute differences in 24-hour $PM_{2.5}$ concentrations for January (Representative week mobile emissions versus daily mobile emissions).

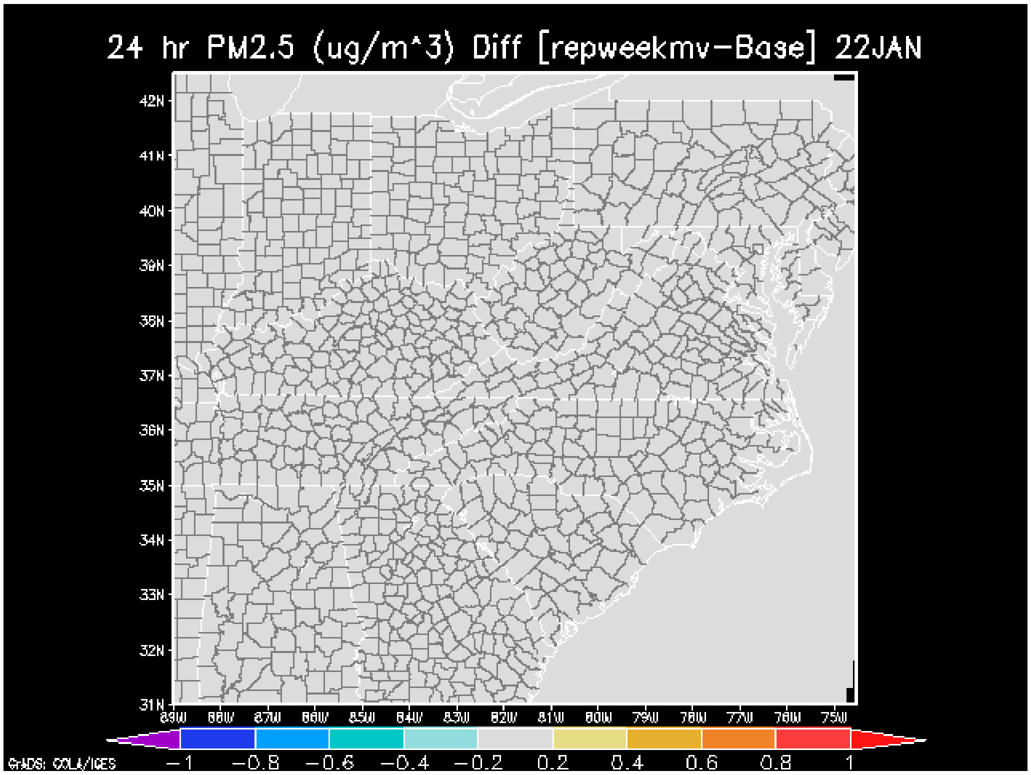


Figure 10. Absolute differences in 24-hour $PM_{2.5}$ concentrations for July 9^{th} (Representative week mobile emissions versus daily mobile emissions).

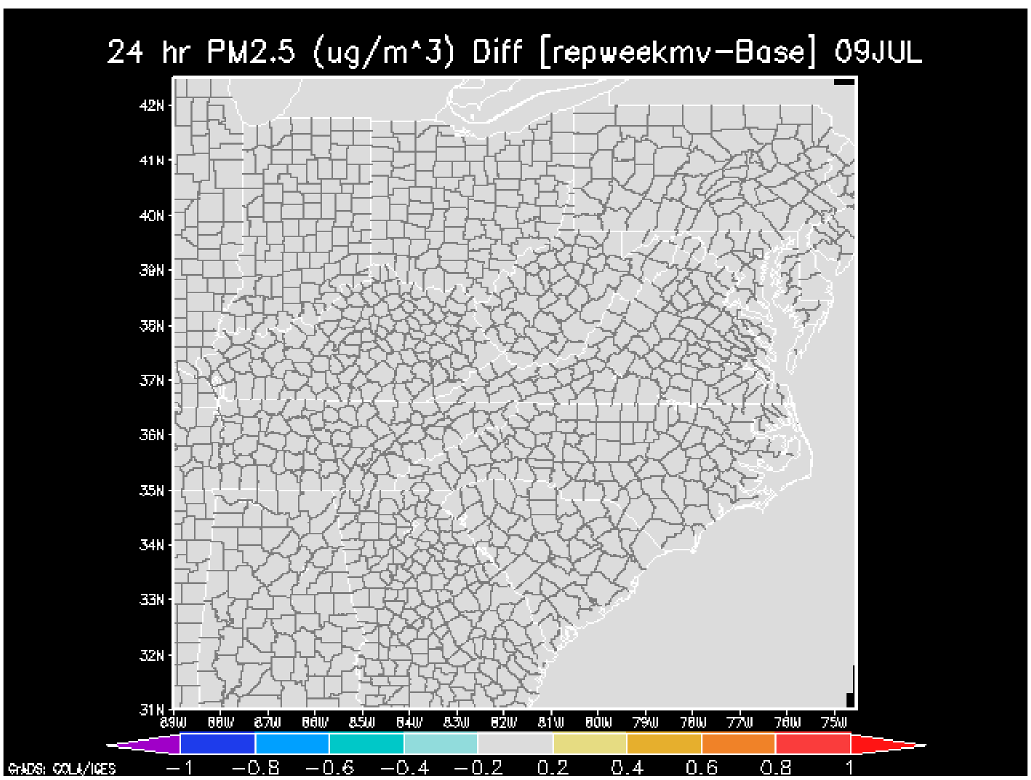


Figure 11. Percent differences in daily 8-hour maximum ozone concentrations for January 28th (Representative week mobile emissions versus daily mobile emissions).

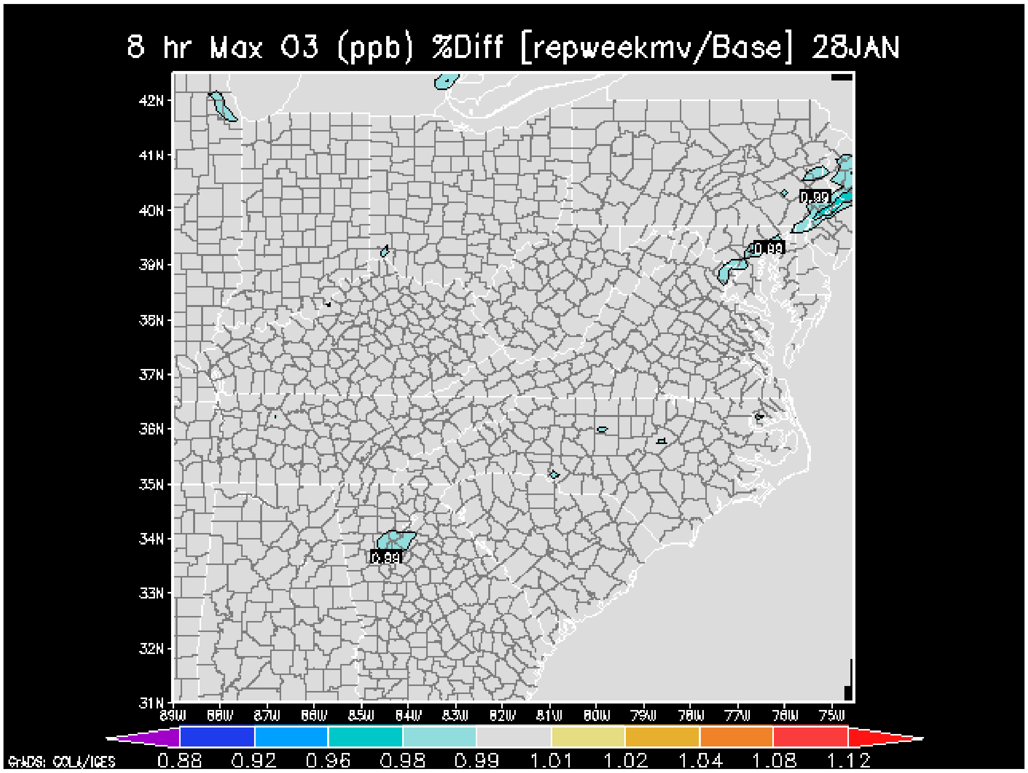


Figure 12. Percent differences in daily 8-hour maximum ozone concentrations for July 15th (Representative week mobile emissions versus daily mobile emissions).

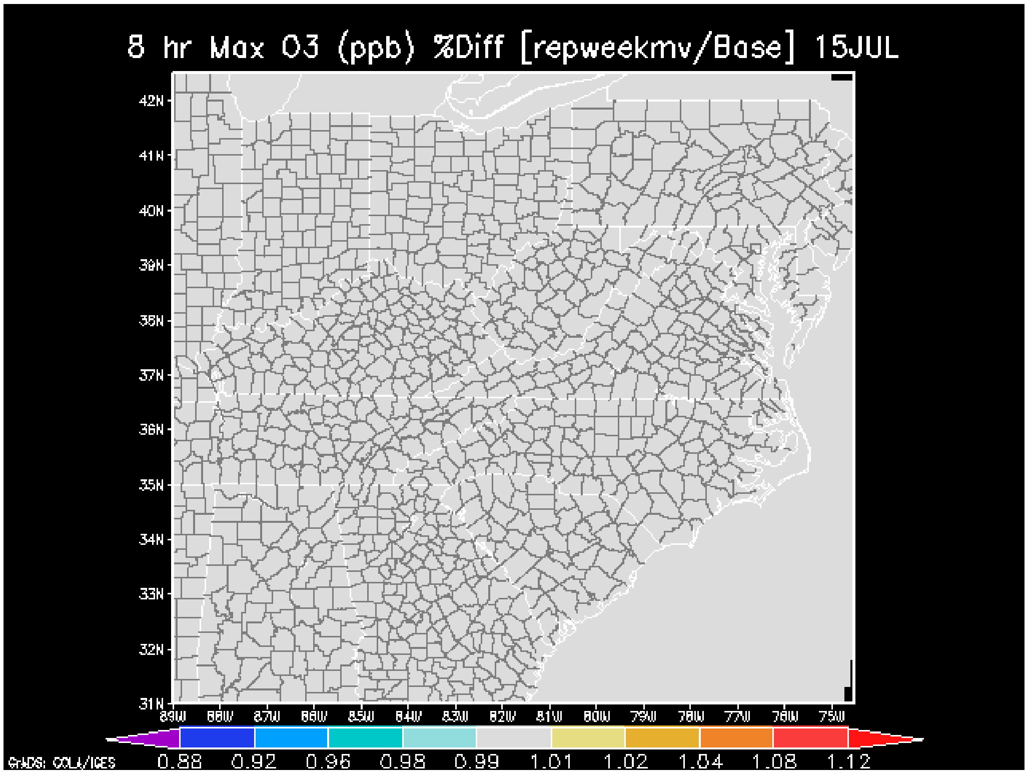


Figure 13. Absolute differences in daily 8-hour maximum ozone concentrations for July 15th (Representative week mobile emissions versus daily mobile emissions).

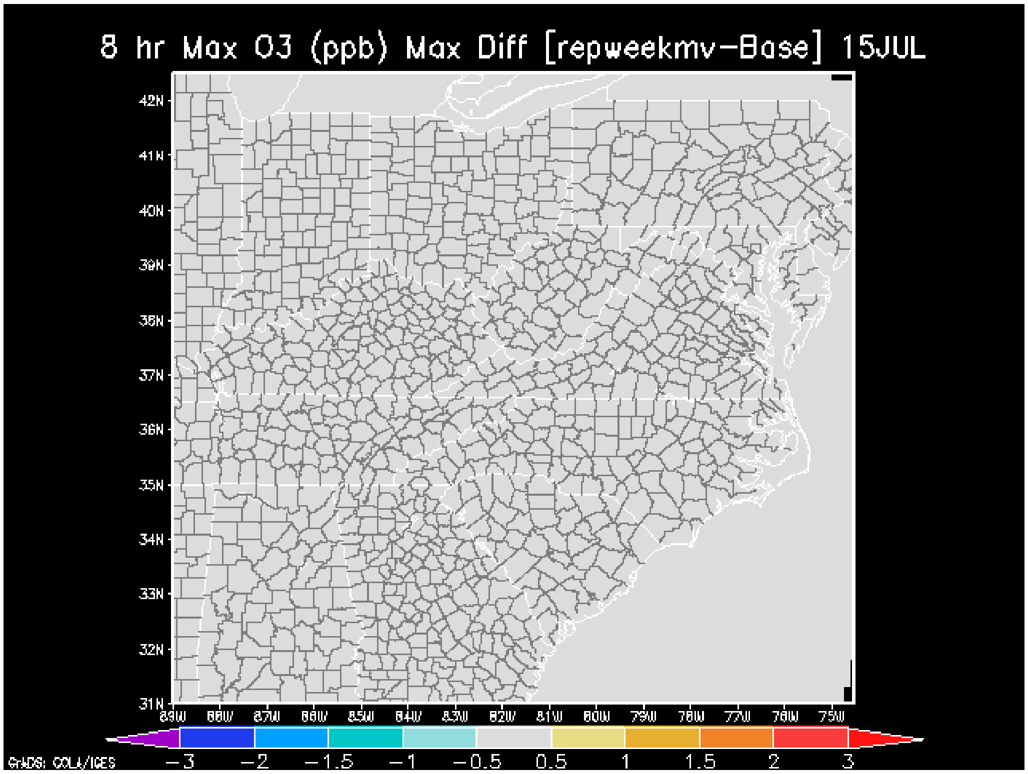


Figure 14. Absolute differences in 1-hour maximum ozone concentrations for July 12th.

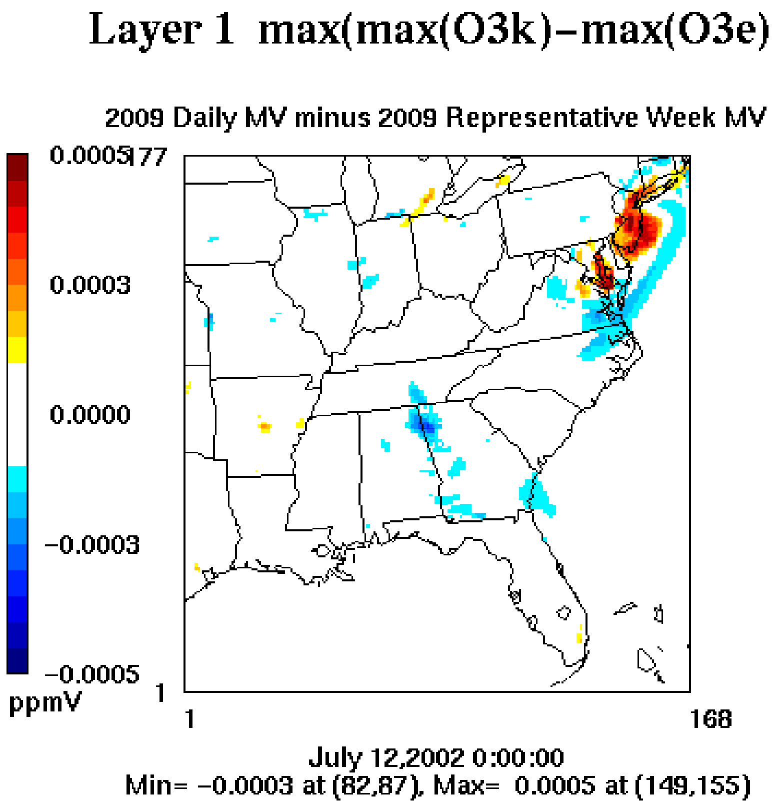
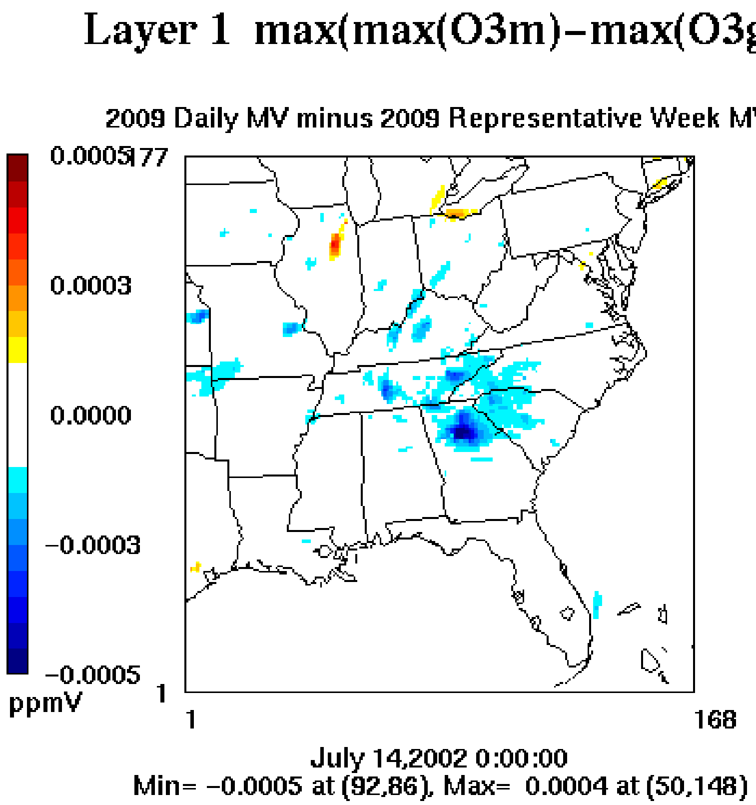


Figure 15. Absolute differences in 1-hour maximum ozone concentrations for July 14th.



CONCLUSIONS

U.S. EPA attainment demonstration modeling guidance[11,12] notes that in some cases it may be useful to evaluate how the response of an air quality model to emissions changes varies as a function of alternative model inputs or model algorithms. These types of tests can be used to assess the robustness of a base case or control strategy modeling evaluation. As an example, EPA remarks that States/Tribes could consider the effects of assumed boundary conditions on predicted effectiveness of a control strategy. If the model response does not differ greatly over a variety of alternative plausible configurations, this increases confidence in the model results.

The parameters for these sensitivity tests can include, but are not limited to: different chemical mechanisms, finer or coarser grid resolution, meteorological inputs from alternative, credible meteorological model(s), different initial/boundary conditions, and *multiple sets of reasonable emission projections*. Sensitivity tests can and should be applied throughout the modeling process, not just when model performance is being evaluated.

The modeling team's research in using *reasonable alternate sets of onroad emission projections* has determined that the use of representative week onroad mobile emissions for each month of our episodes within our 12km modeling domain predicts ozone and particulate matter concentration differences from annual, everyday onroad mobile modeling which could be considered insignificant from an air quality modeling standpoint. The small differences in the air quality results in combination with the length of time necessary to conduct daily onroad mobile runs using the MOBILE6 module of SMOKE has resulted in the project team's recommendation that representative week onroad mobile emissions methodology be carried forward in the VISTAS regional haze modeling and the ASIP $PM_{2.5}$ and 8-hour ozone modeling.

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KEYWORDS

ASIP
MOBILE
Modeling
Onroad Mobile
Ozone
Particulate Matter
Regional Haze
Regional Planning Organization
SMOKE
VISTAS

Appendix H.4
Emissions Modeling
Deviation From Defaults

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1. Introduction

The emissions modeling for the Hickory and Greensboro-Winston Salem-High Point, NC PM2.5 nonattainment areas were performed in conjunction with the regional haze modeling being done by the Southeast Regional Planning Organization, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the fine particulate matter (PM2.5) and ozone modeling being done by the Association of Southeastern Integrated Planning (ASIP). VISTAS and ASIP are run by the ten Southeast states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. The emissions preprocessing model used to ready the emissions for input into the air quality model was the Spare Matrix Operator Kernel Emissions (SMOKE) modeling system.

2. Deviation From Everyday Modeling

The VISTAS/ASIP modeling was an annual simulation. It would be too resource intensive to process all sources sectors for everyday of the year. Therefore, to produce an emissions inventory to support the annual modeling, representative time periods were selected and modeled.

The area and nonroad mobile sources were modeled as a block of Thursday, Friday, Saturday, Sunday, Monday, one per month (total of 60 days modeled for the annual simulation). Similarly, the on-road mobile sources were represented by an entire single week for each month. This select criteria allows for the representation of day-of-the-week variability in the on-road motor vehicles, and models a representation of the meteorological variability in each month.

The stationary point sources, which include the electric generating units (EGUs) and Non-EGUs, were modeled everyday of the annual simulation. This was due to the plume rise calculations used to parse the emissions into the various layers of the model is different everyday depending on the meteorological inputs. Additionally, VISTAS/ASIP modeled large wild land fires as day specific sources with plume rise incorporated into the emissions modeling. Similar to the stationary point sources, the biogenic emissions were modeled everyday of the annual simulation since the amount of volatile organic compounds emitted is significantly impacted by temperature and solar radiation.

For the area, nonroad mobile and on-road mobile sources, the holidays were modeled as a Sunday. Table 1 describes the representative time period for all source categories.

Table 1. Representative Time Period for Emissions Modeling

Source Category	Emission Modeling frequency of run
Area Sources	5 days per month
Biogenic	Everyday
Canada_area	5 days per month
Canada_point	5 days per month
Dust	5 days per month
EGU	Everyday
Fire_cenrap	Everyday
Hi_file_typ	Everyday
Lo_file_typ	5 days per month
Mexico_area	5 days per month
Mexico_point	5 days per month
mms_area	5 days per month
mms_point	Everyday
Non-EGU	Everyday
Nonroad Mobile	5 days per month
On-road Mobile	7 days per month

3. Point Source Deviation

The VISTAS/ASIP emissions modeling used results from the Integrated Planning Model (IPM) to generate future year emissions for the EGU source sector. Duke Energy and Progress Energy updated their plans for complying with North Carolina's Clean Smokestacks Act and the emission projections for the plans varied substantially from the IPM results (Table 2). Therefore, the North Carolina Division of Air Quality (NCDAQ) replaced the IPM emission projections for 2009 with projections from the 2006 Duke Energy and Progress Energy compliance plans. The Clean Smokestacks Act can be found in Appendix M.

Another point source deviation was the temporal profiles used for the typical emissions for the EGU source sector. Instead of using the 2002 continuous emissions monitoring (CEM) profiles for the EGUs, a typical temporal profile was created using data from 2000 through 2004. How the typical temporal profiles were generated is discussed in detail in Appendix F.1.

Table 2. Comparison of 2009 emissions for Duke and Progress compliance plans vs. IPM.

Facility	Compliance Plan 2009 NOx (tpy)	IPM 2009 NOx (tpy)
Duke Energy Facilities		
Allen	5,774	3,018
Belews Creek	4,296	5,230
Buck	1,713	1,788
Cliffside	2,740	2,619
Dan River	1,539	1,134
Marshall	12,903	12,262
Riverbend	1,944	1,989
Total Duke Energy	30,909	28,040
Progress Energy Facilities		
Asheville	3,057	1,049
Cape Fear	1,350	1,249
Lee	3,110	3,901
Mayo	1,741	1,748
Roxboro	6,350	4,069
Sutton	5,840	4,361
Weatherspoon	2,822	2,239
Total Progress Energy	24,270	18,616

Appendix I

Meteorological Model Performance

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TABLE OF CONTENTS

LIST OF FIGURES

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1 INTRODUCTION

The attainment demonstration for the PM2.5 SIP nonattainment areas used the meteorological modeling from the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regional haze modeling. VISTAS is run by the ten Southeast states: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. The meteorological model used for this project was the Pennsylvania State University/National Center for Atmospheric Research Mesoscale Meteorological Model (MM5).

The sections that follow summarize the meteorological model performance for North Carolina on the 12 kilometer (km) grid domain. The overall VISTAS meteorological model development and model performance was documented by the VISTAS contractor Baron Advanced Meteorological Systems, LLC and is attached to this Appendix.

2 12 KM MM5 PERFORMANCE IN NORTH CAROLINA

In general, the MM5 performance for North Carolina was very similar to the performance for the entire VISTAS modeling domain. The temperature bias was negative in the cooler months, reaching a minimum of -.8 K in January and December. The bias approached zero in the summer. Error ranged from 2-2.5 K in the winter to 1.5 K in the summer. The absolute temperature error hovered around 1.5 K from May-September. Figure 2-1 displays the overall temperature, temperature bias and absolute error for North Carolina and the VISTAS modeling domain.

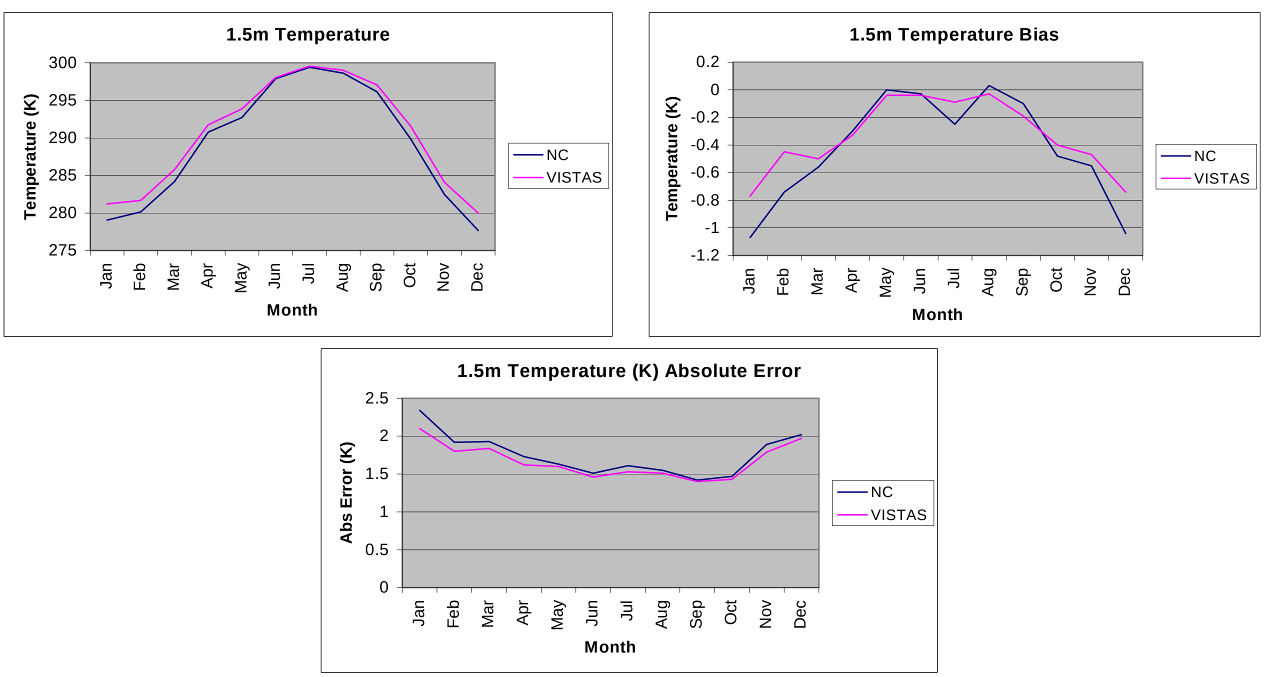


Figure 2-1 Monthly plots of modeled 1.5 meter temperature, bias and absolute error.

The mixing ratio bias in North Carolina was closer to neutral as compared to the entire VISTAS domain, hovering between 0.2 and –0.2 g/kg most of the year.   The worst performance was in September and October, when the negative bias in the MM5 dipped to around 0.6 g/kg. The model was slow to capture the effects of drought-busting rains that fell during those months. The absolute error was only slightly higher in North Carolina than the entire VISTAS domain, peaking at 1.8 g/kg in July, and falling to around 0.7 g/kg during the winter. Figure 2-2 displays the overall mixing ratio, mixing ratio bias and absolute error for North Carolina and the VISTAS modeling domain.

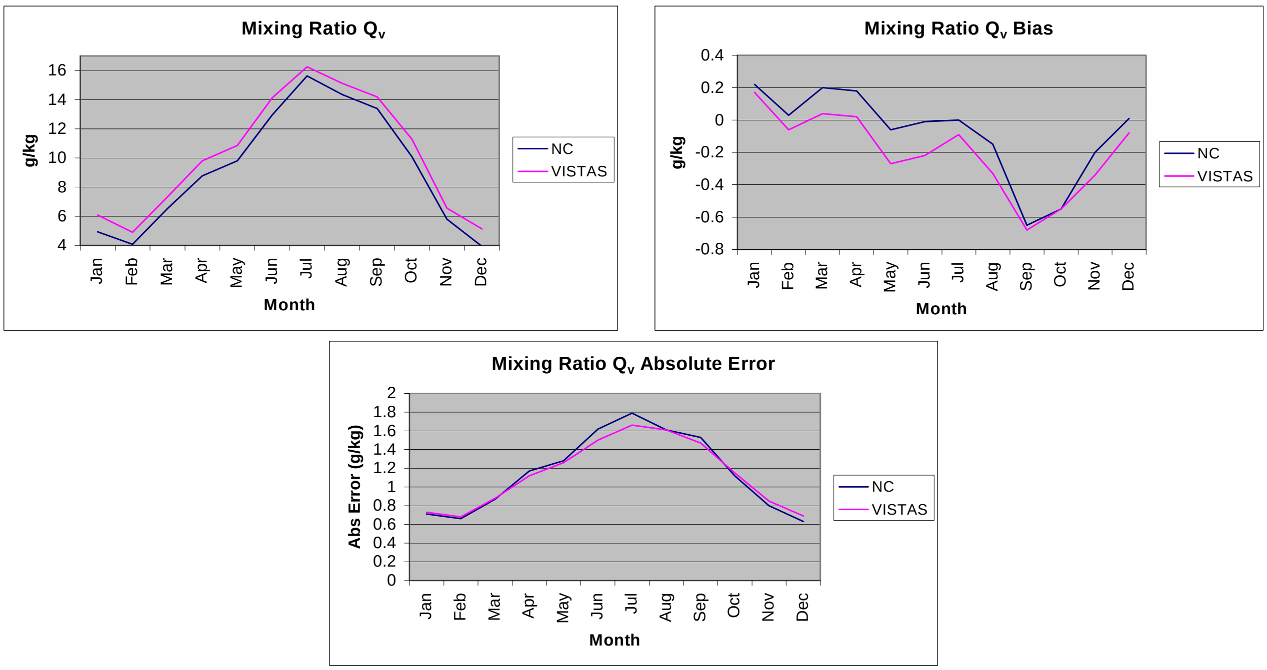


Figure 2-2 Monthly plots of modeled 1.5 meter mixing ratio, bias and absolute error.

The relative humidity bias in North Carolina was about 0.5% higher when compared to the entire VISTAS domain. The relative humidity bias in North Carolina generally hovered around ± 3%. The bias turned negative in September-November due to the models lag in capturing the affects of the drought-busting rains. The absolute error was slightly higher in North Carolina than the entire VISTAS domain, holding steady around 10% during the summer and rising to near 12 % during the winter. Figure 2-3 displays the overall relative humidity, relative humidity bias and absolute error for North Carolina and the VISTAS modeling domain.

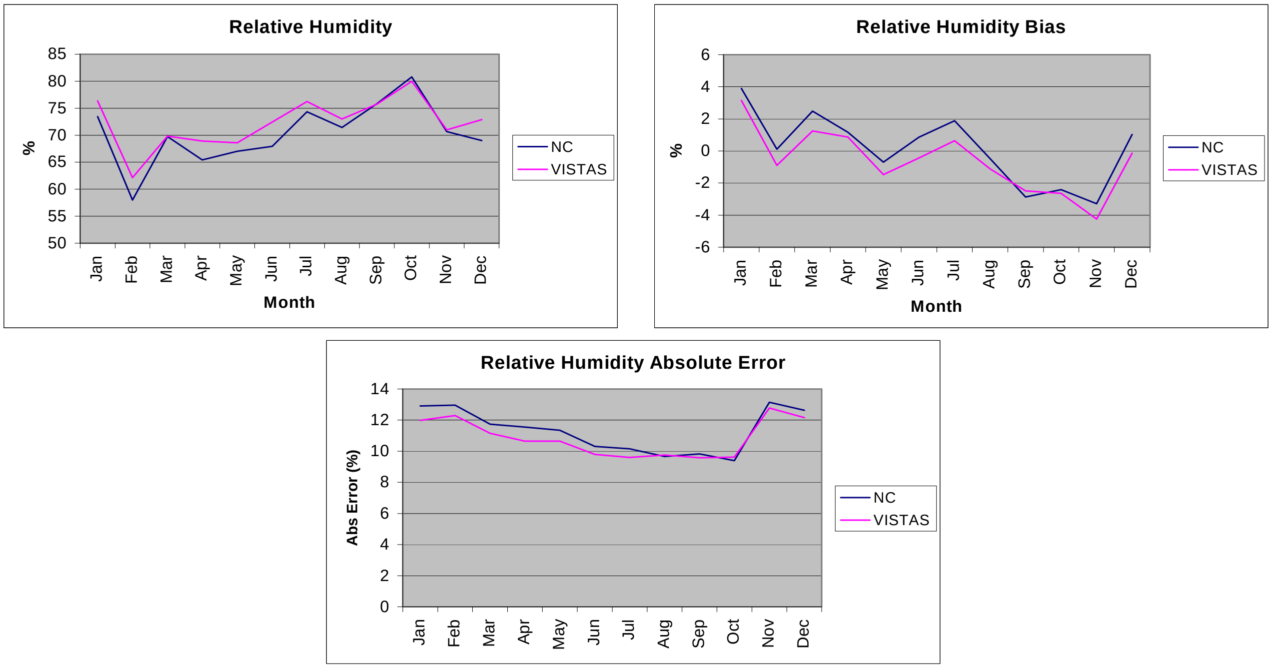


Figure 2-3 Monthly plots of modeled 1.5 meter relative humidity, bias and absolute error

The cloud coverage bias in North Carolina was 2 – 3% higher compared to the entire VISTAS domain. The cloud coverage bias peaked near 10% in July, with all other months with a bias less than 5%. The absolute error was generally 1 – 2% lower than the entire VISTAS domain, peaking at 31% in September and falling to 18-20% in the cooler months. Figure 2-4 displays the overall cloud coverage, cloud coverage bias and absolute error for North Carolina and the VISTAS modeling domain.

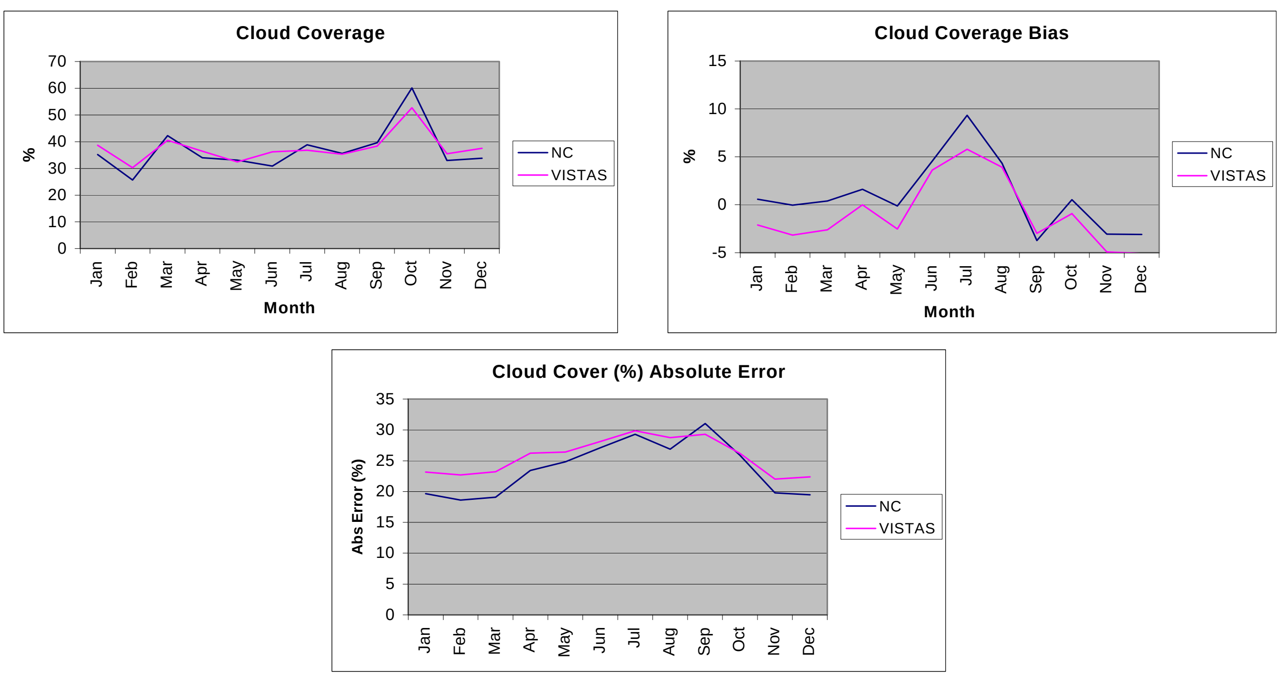


Figure 2-4 Monthly plots of modeled cloud coverage, bias and absolute error.

Wind direction was the most erratic of the measurements. The direction bias in North Carolina was more pronounced, being more negative April through July, and more positive in August and September. The bias during the rest of the year was negligible. The absolute error was close to the entire VISTAS domain, peaking at 35 degrees in July when the lightest winds are experienced. Figure 2-5 displays the overall wind direction, wind direction bias and absolute error for North Carolina and the VISTAS modeling domain.

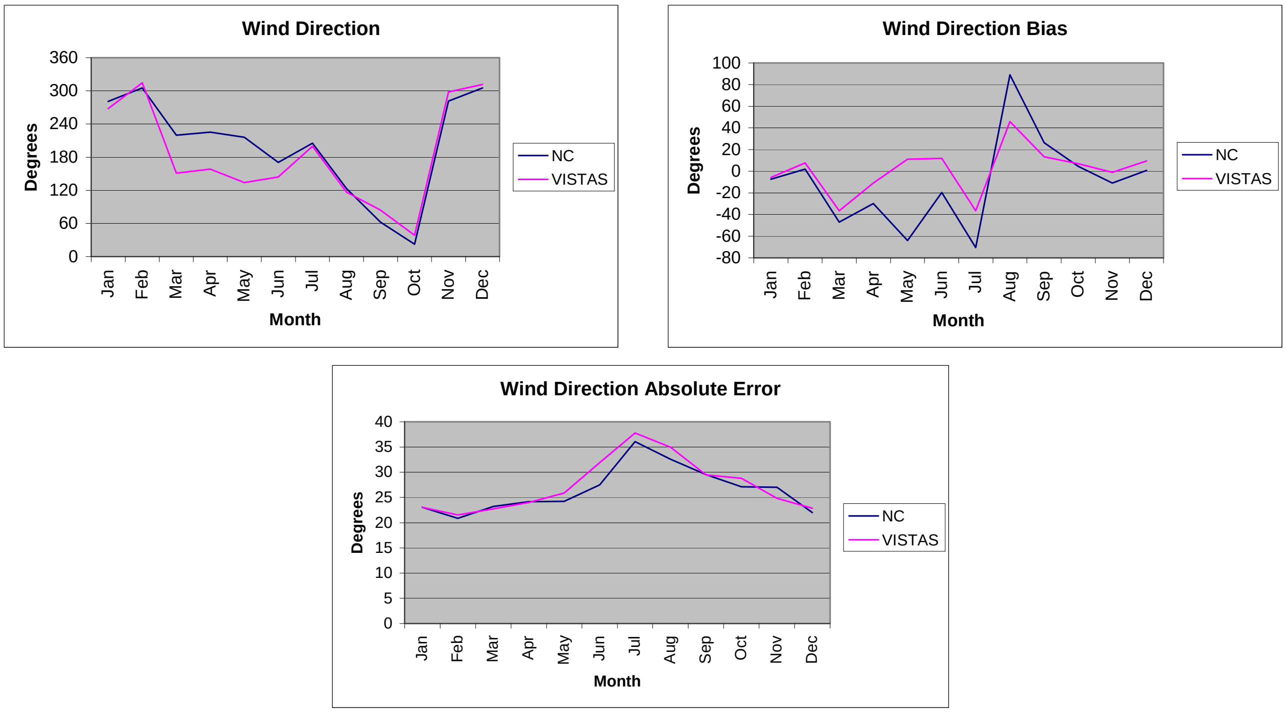


Figure 2-5 Monthly plots of modeled wind direction, bias and absolute error.

The wind speed bias in North Carolina was 0.3 to 0.4 meter/second (m/s) higher than wind speeds across the entire VISTAS domain. When considering all wind measurements, the wind speed was .8 to 1.0 m/s too strong. The absolute error is near 1.2 m/s, just above the entire VISTAS domain. When omitting calm observations, the bias falls to 0.2 to 0.5 m/s. The absolute error is near 1.2 m/s, very close to the entire VISTAS domain. When omitting modeled wind speeds below the threshold of the anemometer (<1.5 m/s), the bias is 0.5 to 0.8 m/s. The absolute error is near 1.3 m/s, just above the entire VISTAS domain. Figure 2-6 displays the overall wind speed, wind speed bias and absolute error for North Carolina and the VISTAS modeling domain. Figure 2-7 displays the wind speed when the calm observations are omitted as well as the bias and absolute error. Figure 2-8 displays the wind speed with modeled wind speeds below 1.5 m/s are omitted.

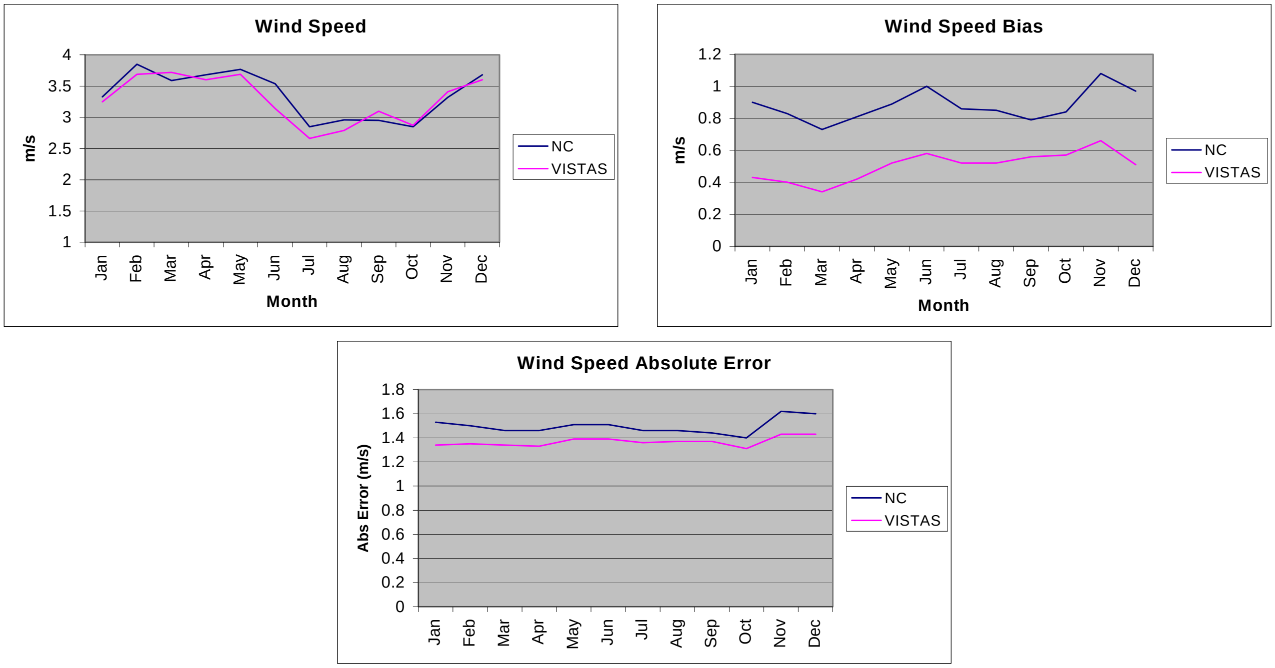


Figure 2-6 Monthly plots of modeled wind speed, bias and absolute error.

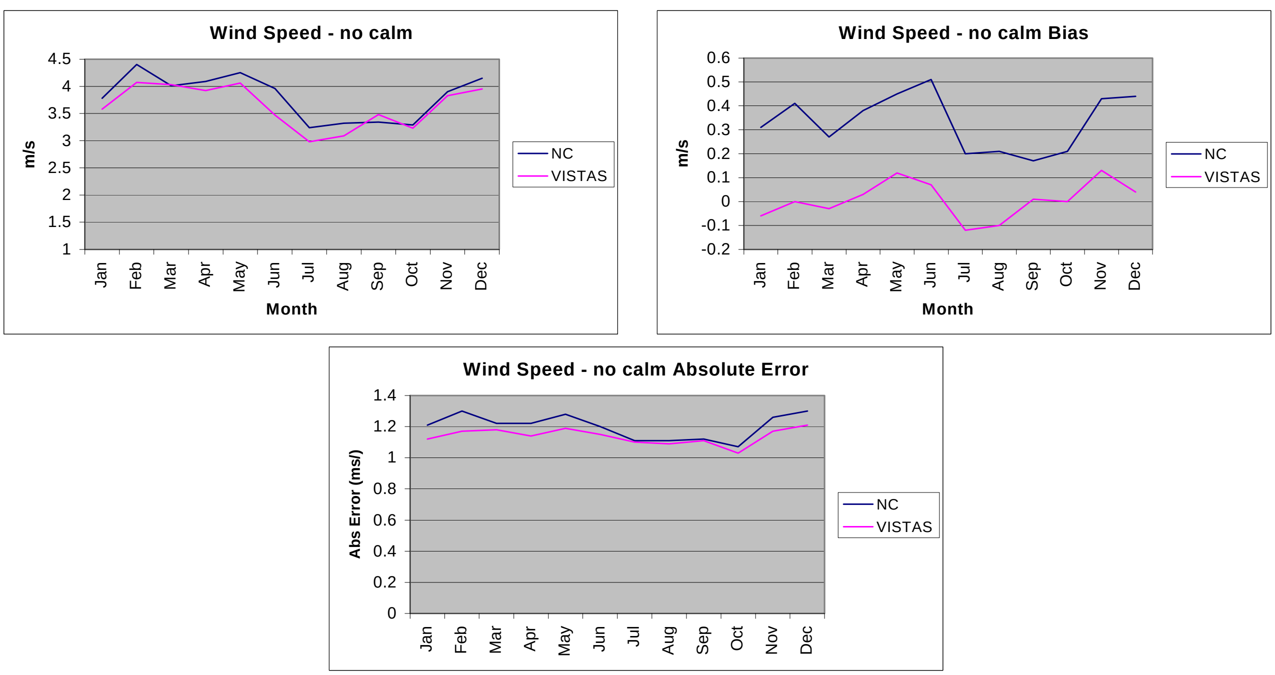


Figure 2-7 Monthly plots of modeled wind speed with calm observations omitted, bias and absolute error.

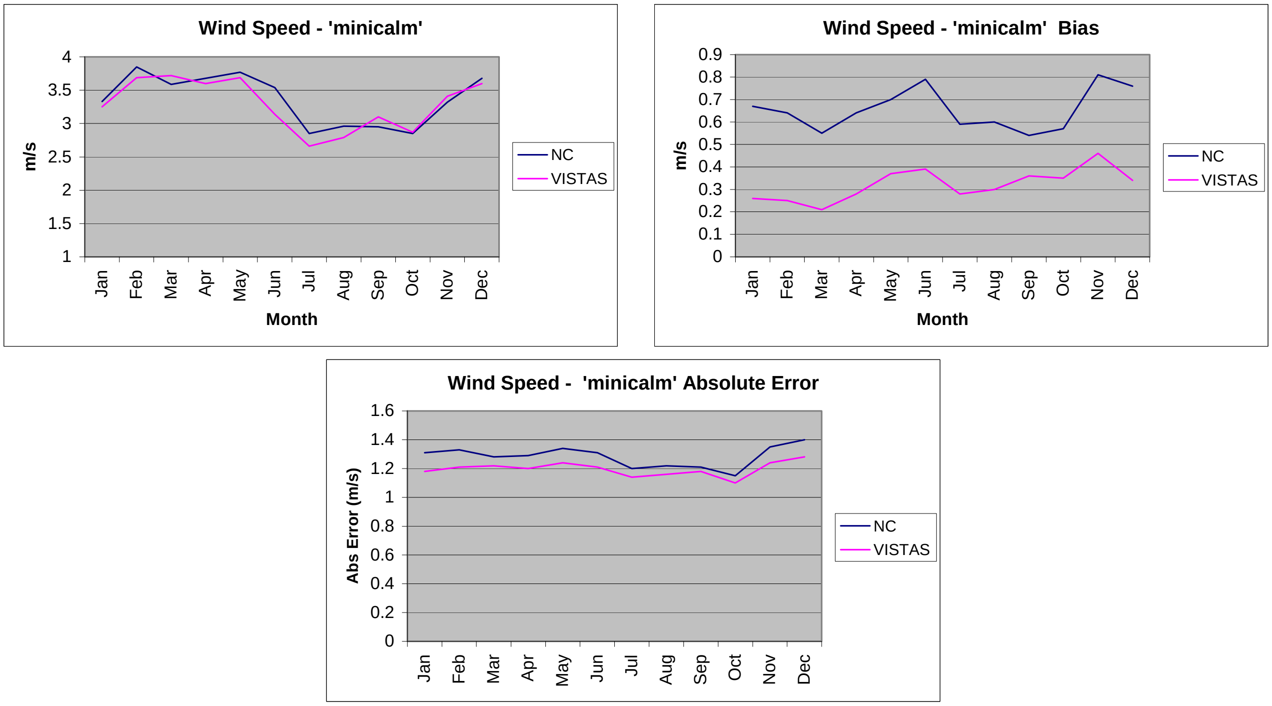


Figure 2-8 Monthly plots of modeled wind speed with modeled wind speed below 1.5 m/s omitted, bias and absolute error.

Overall excess wind speeds, increased relative humidity and cloud cover likely lead to under prediction of the daily maximum peak ozone concentration, which will be discussed in the air quality model performance (Appendix J).

3 MM5 MODEL PERFORMANCE AT GREENSBORO, NC

An additional way to evaluate model performance is to compare the various parameters to surface observations for a site-specific evaluation. Figures 3-1 and 3-2 show a time series of model and observed metrological data for the Greensboro, North Carolina Automated Surface Observing System (ASOS) site (KGSO). The time series include modeled surface values for temperature, mixing ratio, wind speed, wind direction, relative humidity, cloud cover, and precipitation (blue dashed lines). These model predicted values are compared to actual observations from the Greensboro site (solid black lines). Figure 3-1 depicts two different winter weeks (January 15-21 and November 12-18, 2002), while Figure 3-2 depicts two summer weeks (July 20-26 and August 19-25, 2002). It is important to look at both summer and winter events, as the forcing mechanisms for synoptic features can differ from season to season.

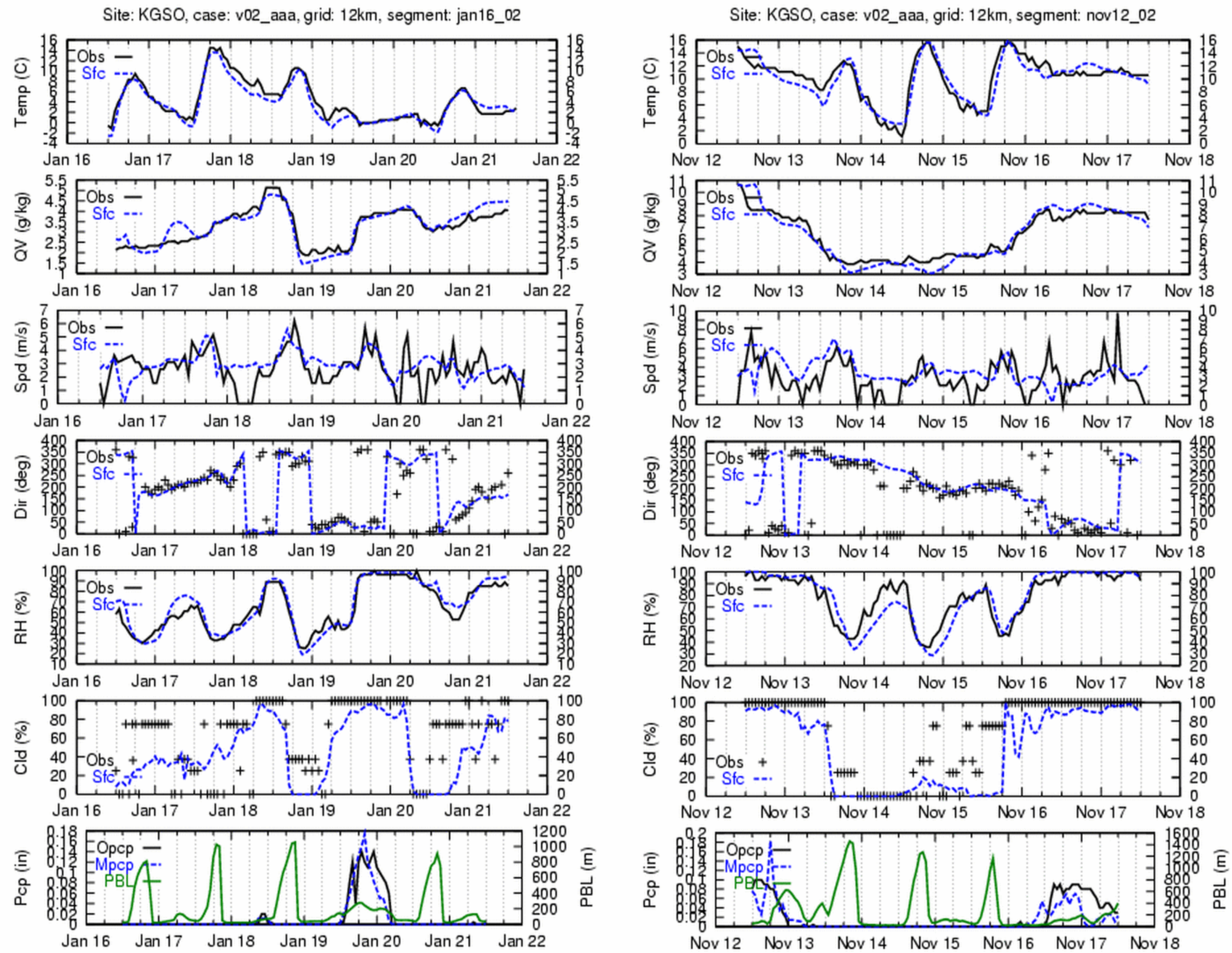


Figure 3-1 Modeled data compared to surface observations at the Greensboro, NC ASOS site (KGSO) for two weeks typical of winter conditions.

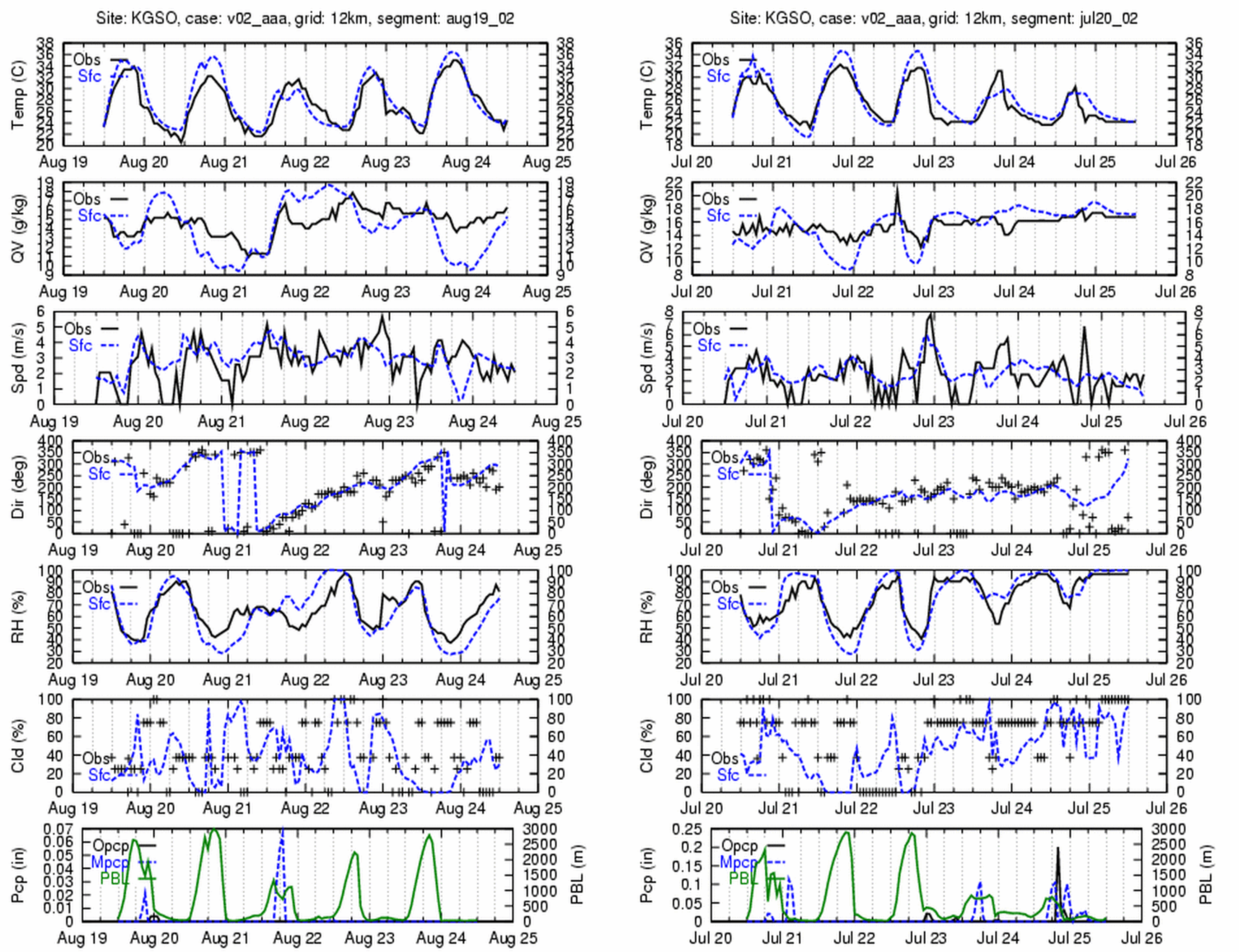


Figure 3-2 Modeled data compared to surface observations at the Greensboro, NC ASOS site (KGSO) for two weeks typical of summer conditions.

Generally the time series reflect what was seen on the monthly plots. Overall the plots reflect good model performance for 2002, when compared to modeling standards. Wind direction was close to observed values, and switched at the appropriate time, when frontal boundaries passed through the area. Wind speeds were captured well by the model during the daylight hours, but were often too strong at night.

Model performance was better at capturing the wintertime diurnal temperature trends than the summertime trends. For the summer temperatures the model was generally too cool with the afternoon high temperatures. Mixing ratio was close to observations in the winter, but, again, the model was more variable in the summertime. The diurnal trends in relative humidity were reasonably well captured, though the diurnal ranges were less in the model than with observations.

4 UPPER AIR MODEL PERFORMANCE

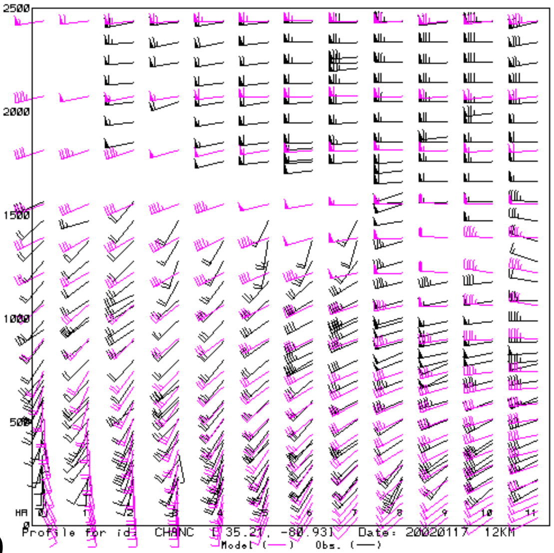
To go further to quantify model performance, upper air data from the model was compared to data from the Charlotte, North Carolina profiler. Figure 4-1 shows a series of profiler plots from the Charlotte, North Carolina profiler. Profilers yield results at a much finer vertical and temporal resolution than do standard rawinsondes (balloons with attached meteorological equipment used to take upper air readings). The profiler data are **not** used to nudge, or correct MM5 modeling results, and in fact cannot effectively be used in that capacity without additional quality control to remove or correct erroneous data. Since the model results will not be artificially biased toward the profiler data because of nudging and the profiler has a high data resolution, it makes an excellent source of data to judge model performance.

Figure 4-1 and 4-2 compare model predicted winds (purple wind barbs) with profiler-derived winds (black wind barbs) over the lowest 2500 meters of the atmosphere. Each plot contains 12 hours of data, with the hour of the observation labeled near the plot bottom, with the hours increasing from left to right. The wind barbs follow the meteorological standard, with a full barb representing a 10-knot (kt) wind, a half barb representing a 5-kt wind, and a full flag representing a 50-kt wind.

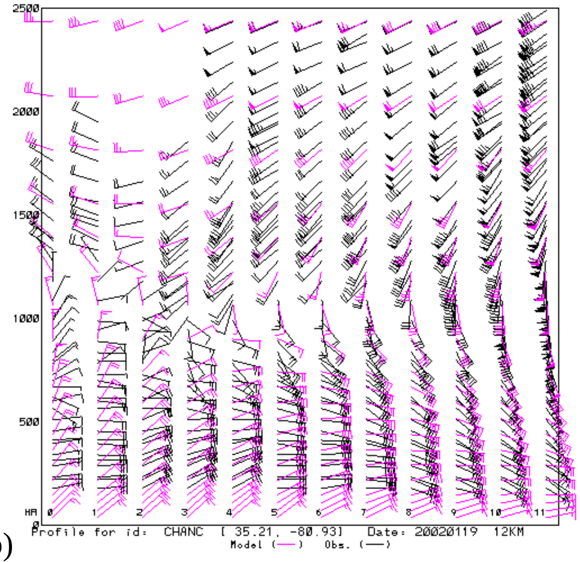
Figure 4-1(a) is from the period of 12 to 23 Coordinated Universal Time (UTC) on January 17, 2002, and depicts the typical wind flow pattern prior to frontal passage. Figure 4-1 (b) is 00-11 UTC on January 19, 2002, shows the disruption to the winds field as a cold front passes through the area, with Figure 4-1(c) (00-11 UTC on January 20, 2002) illustrating the northerly flow typically seen after front passage in the region. The model captures the wind direction fairly well through out the atmosphere. The model winds do become disjointed from the observations in the mid levels during the early hours of the frontal passage on the 19^{th} (Figure 4-1(b)).

Figure 4-2(a) represents the time period from 00 UTC to 11 UTC on November 10, 2002, and show the modeling capturing uniform flow through out the atmosphere. Figure 4-2(b) is from seven days later (12-23 UTC on November 17, 2002) and demonstrates the model capturing the disturbance of the uniform flow in the upper levels.

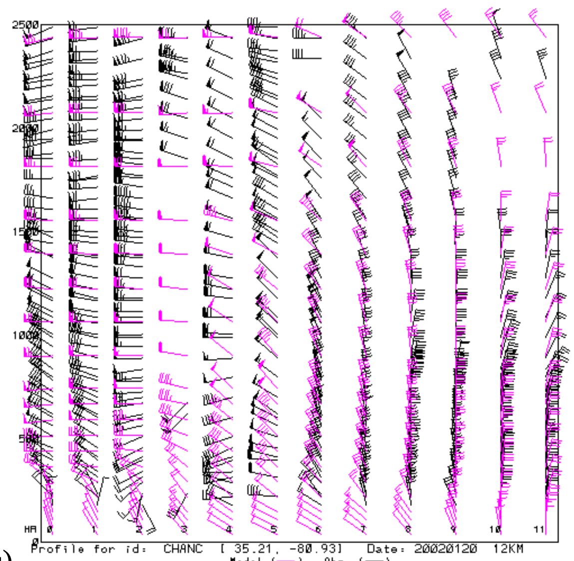
Overall, these Charlotte, North Carolina profiler plots show typical performance in that the model generally matches the profiler winds, but not perfectly. Upper levels winds are captured very well, as are the wind shifts associated with frontal passages. In the subset of days presented here, the model winds are approximately within 20 degrees of the profiler observed winds, and typically are much closer. Unfortunately, it is difficult to know if this slight wind direction bias indicates a model flaw or an issue with the profiler data being representative. It is likely that there are physical mechanisms in the real world of which the model is unaware, which in this case are not being compensated for via nudging.



(a)

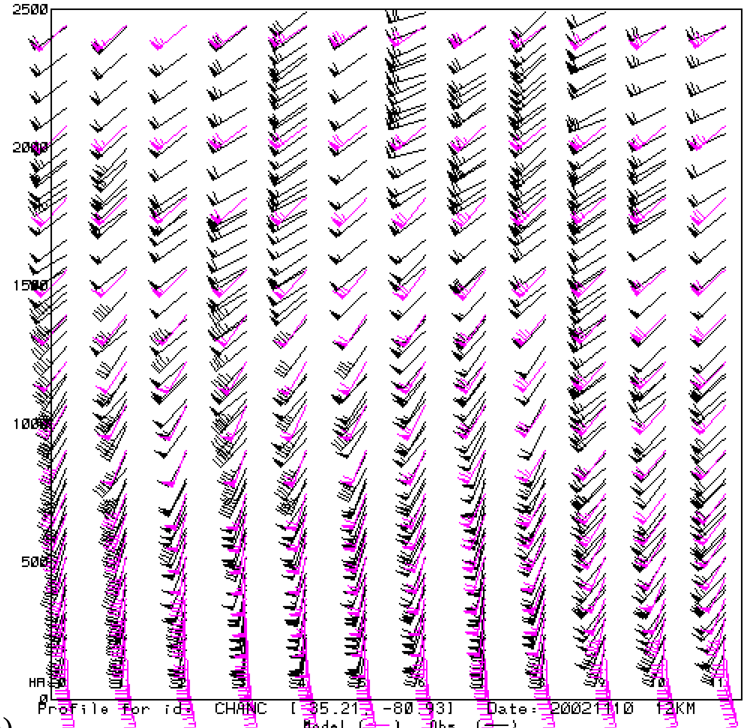


(b)

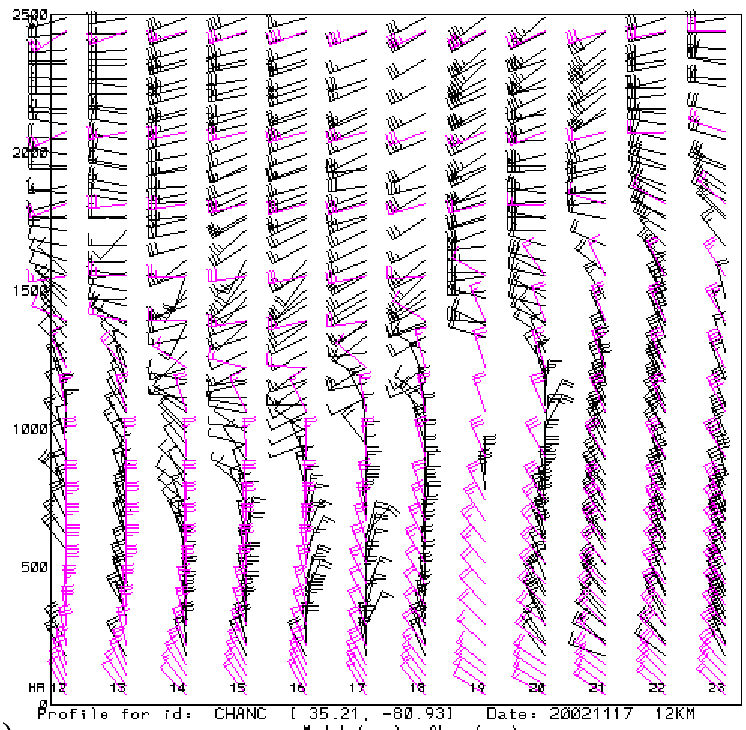


(c)

Figure 4-1 The Charlotte, NC (CHANC) profiler winds are co-plotted with the 12-km MM5 winds for (a) 12-23 UTC on January 17, 2002, (b) 00-11 UTC on January 19, 2002, and 00-11 UTC on January 20, 2002. .



(a)



(b)

Figure 4-2 The Charlotte, NC (CHANC) profiler winds are co-plotted with the 12-km MM5 winds for (a) 00-11 UTC on November 10, 2002, and (b) 12-23 UTC on November 17, 2002

5 SUMMARY

In general, the meteorological model performed quite well at the 12 km grid resolution. Most of the time the model statistics fell within the expected ranges of error. The NCDAQ believes that the meteorological model performance is adequate for this modeling exercise and should produce credible inputs for the air quality modeling for the attainment demonstration for the Metrolina area.

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Appendix I.1

Protocol for Annual MM5 Modeling in Support of VISTAS

Protocol for Annual MM5 Modeling in Support of VISTAS (Visibility Improvement – State and Tribal Association) (DRAFT)

Task 3a Deliverable

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February 9, 2004

1 Introduction

In recent years visibility concerns have come to the forefront in the air quality community. Millions of visitors to national parks in the United States have their views obstructed by pollution-induced haze. The USEPA reports that average visibility in the east has been reduced from 90 miles to 15-25 miles (http://www.epa.gov/oar/visibility/what.html). To address this issue, the USEPA in 1999 instituted policies to improve visibility in the national parks. As part of this initiative, five multi-state regional planning organizations (RPO) were formed. The RPO governing visibility issues in the southeastern US is the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) (http://www.vistas-sesarm.org/).

VISTAS recognizes the regional nature of haze, and has therefore set up a modeling approach to address the problem in the southeast US. Ultimately pollution controls will be enacted based upon chemical modeling results over the region of interest. To support this modeling effort, Baron Advanced Meteorological Systems (BAMS) is tasked with conducting the meteorological modeling. A 12-month modeling period is deemed necessary to cover an adequate range of visibility impairment. Prior to investing the resources to produce meteorological results at 36-km and 12-km resolution for the full 12-month period, BAMS executed a series of sensitivity tests to determine the optimal meteorological setup for the annual modeling. This report details the results from this sensitivity testing, leading directly to the protocol we will use for this project.

2 Description of the Meteorological Modeling Approach

The meteorological model used in this study is the PSU/NCAR Mesoscale Model (MM5 version 3.6, Grell et al., 1994, MPP version). In order to build on prior relevant MM5 modeling results funded by the EPA and other RPOs, those studies serve to establish the initial model configuration for this effort, as best can be determined from available reports. Those findings are summarized in Olerud, 2003a. The modeling results indicate that MM5 is most sensitive to the selection of planetary boundary layer (PBL) and soil schemes. Therefore a series of sensitivity tests are recommended in Olerud, 2003b. Given limited time and budget resources, a series of five sensitivity tests are laid out testing primarily the model response to the selection of PBL scheme and soil model. These are the tests:

- **px_acm**: Pleim-Xiu land surface model, asymmetric convective mixing PBL (Xiu and Pleim, 2000), interppx to link runs.
- **px_acm2**: Like px_acm, except no interppx linkage.
- **noah_mrf**: Noah land-surface scheme (Chen and Dudhi, 2001) with the medium range forecast (mrf) PBL (Hong and Pan, 1996).
- **multi_blkdr**: Multi-layer soil scheme with Blackadar PBL and Zilitinkevich thermal roughness length.
- **noah_eta-my**: Noah land-surface scheme with the ETA Mellor-Yamada PBL (IMVDIF=0).

The common options for all sensitivity tests include Kain-Fritsch 2 cumulus parameterization (Kain and Fritsch, 1993; Kain, 2002), mixed phase (Reisner 1) microphysics (Reisner et al, 1998), and Rapid Radiative Transfer Model (RRTM) radiation (Mlawer et al, 1997). Snow effects are turned on (IFSNOW=1). Note that the use of the ETA M-Y pbl scheme necessitates moist vertical diffusion being turned off. The runs are made with analysis nudging coefficients set as follows (36-km and 12-km resolutions):

Winds (aloft):	2.5E-4,1.0E-4,
Winds (surface):	2.5E-4,1.0E-4,
Temp (aloft):	2.5E-4,1.0E-4,
Temp (surface):	Not employed
Moisture (aloft):	1.0E-5,1.0E-5
Moisture (surface):	Not employed

In the cross-sensitivity plots that follow we compare the px_acm2 sensitivity run to the noah_mrf, multi_blkdr, and noah_eta-my sensitivities for episode 1. Episodes 2 and 3 are similar except px_acm will serve as the base configuration.

The runs are executed in 2-way mode with feedback turned off. The five sensitivity runs are executed for three separate episodes listed below:

- Episode 1: January 2-21, 2002
- Episode 2: July 13-28, 2001
- Episode 3: July 13-22, 1999.

Each episode is preceded by a spin-up period (7, 7, and 4 days, respectively) that will not be discussed in this report. The runs are made in 5.5-day segments, each starting at 00 UTC, with the first 12 hours of each segment serving as spin-up. Figure 1 shows the modeling domains used in this study.

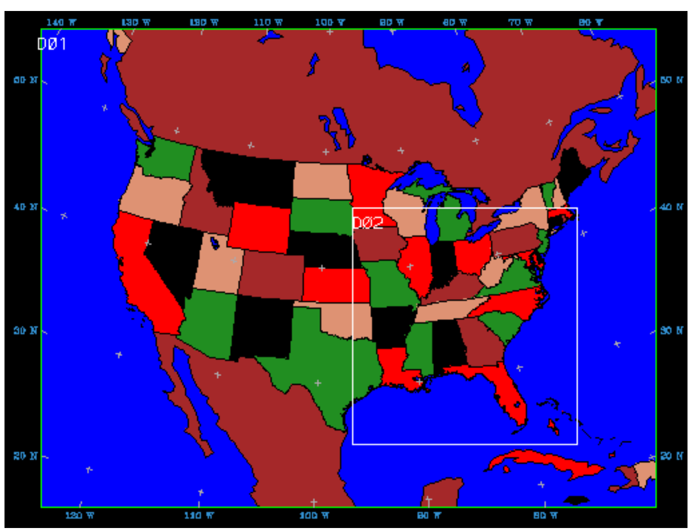

Figure 1. VISTAS 36-km/12-km MM5 modeling domains are shown.

3 Evaluation Approach

It is common in the air quality community to use surface statistics of the base meteorological variables as the dominant metrics to determine acceptable model performance. Often statistics for only temperature, mixing ratio and wind speed are calculated. Obviously it is important for the model to accurately represent these variables, but there are additional variables that also become important when one considers that the results will be used to improve visibility. As such we have added cloud cover, relative humidity, and precipitation to the performance suite. While we calculate metrics separately for wind direction and wind speed, we also calculate the mean error vector as perhaps the single best metric to quantify overall wind performance.

Recognizing that qualitative analyses of the model output are as important as standard quantitative analyses, we enable the systematic visualization of model fields with observations overlaid whenever possible. To do this we process the MM5 output through EPA's MCIP2 program. MCIP2 transforms the data into NetCDF format while also calculating a few fields (e.g. low, middle, and high CFRAC) that are not readily available in the raw MM5 output. MCIP2 also interpolates temperature and wind speed to observation height (1.5m and 10m, respectively) for more accurate evaluation. Even though MCIP2 outputs a total cloud fraction, CMAQ uses this quantity to estimate optical depth. Accordingly its value can be markedly different than what meteorologists typically regard as cloud fraction. To make things as consistent as possible between the model and observations, the cloud fractions presented in this report represent the maximum of the low, middle, and high cloud fractions. We also use MCIP2 to cull a minimum of six cells about the domain periphery to minimize edge effects. The reduced domain precisely matches the domain used in the air quality modeling. The 36-km analysis domain thus contains 148 columns, 112 rows, and 34 layers. The 12-km analysis domain covers 168 columns, 177 rows, and 34 layers.

The observations used for statistics come primarily from UCAR's ds472.0 (TDL) archive (http://dss.ucar.edu/datasets/ds472.0/). These data are quality controlled and converted to NetCDF format, thus allowing the data to be visualized on the model fields via PAVE (http://www.cep.unc.edu/empd/EDSS/pave_doc/index.shtml). Unfortunately the precipitation values in this dataset are not reliable, so we calculate precipitation statistics based on the 24-h gridded accumulations available from the Climate Prediction Center (CPC) (http://www.cpc.ncep.noaa.gov/products/precip/realtime/retro.html). These fields, originally at 0.25- degree resolution, undergo grid transformation to match our 36-km and 12-km domains. Since the CPC analyses are derived primarily from rain gauges, the statistics are only calculated over cells that MM5 deems to be land.

For aloft analyses we process standard sounding observations from the NCEP ds353.4 archive (http://dss.ucar.edu/datasets/ds353.4/). These observations are quality controlled and used to produce model/observation skewT sounding plots for selected sites. Additionally we integrate the observations into sigma levels that match the MM5 specifications, after which we can statistically analyze performance at sigma levels 9, 17, and 22 (~500m, ~1600m, ~3400m, respectively). Qualitative profiler plots showing model/observed hourly winds are also created based upon the data stored at the Forecast Systems Lab (http://www.profiler.noaa.gov/jsp/). These results, along with much more, will not be presented here. The reader is referred to the VISTAS meteorological website (http://www.baronams.com/projects/VISTAS/) for additional evaluation details and results.

The number of analysis plots available on the above website is truly daunting. To keep this report at a somewhat manageable level, we will focus primarily on cross-sensitivity plots and surface statistics. Except for precipitation (as mentioned above), these statistics are calculated at the sites (color-coded by RPO) shown in Figure 2. Statistics are calculated and stored at each observing site, and we routinely aggregate these results to produce statistical time series plots and tables for every appropriate RPO region. This approach also enables us to produce station-specific statistical quantities that can be plotted in a similar manner to Figure 2. The VISTAS web page even shows an animation of how these quantities change throughout an episode-composite day. The results shown in this document focus on statistics aggregated only over the VISTAS portion of the 12-km domain, and the US portion of the 36-km domain. The cross-sensitivity plots are shown only for the 12-km VISTAS domain.

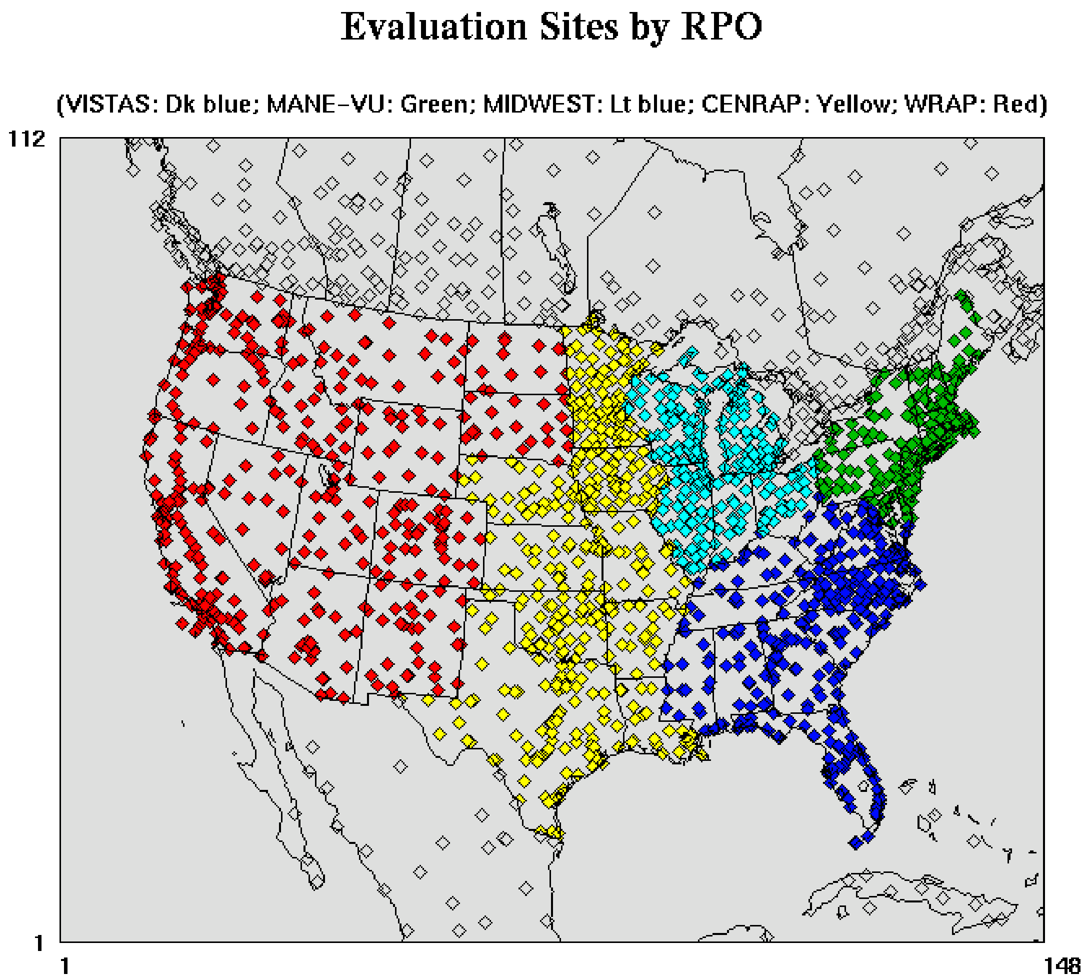

Figure 2. Surface observing network color-coded to represent Regional Planning Organization areas. Dark blue diamonds are in the VISTAS RPO, green diamonds are in the MANE-VU RPO, light blue diamonds are in the MIDWEST RPO, yellow diamonds are in the CENRAP RPO, and red diamonds are in the WRAP RPO.

4 Results

The initial results for the px_acm run for episode 1 are quite discouraging. The run showa a significant cold bias over much of the eastern US, including the VISTAS region as illustrated in figure 3. While mixing ratio, clouds, precipitation, and winds are modeled reasonably well, the large cold bias is unexpected based on prior findings from other RPO's and the EPA. Note in figure 3 that the first couple of days show very little temperature bias, but the bias increases as the mean temperature rises. After much investigation it becomes apparent that the deep soil temperature is initiated during an extreme cold event in the eastern US. Since the model soil temperatures and moisture are passed from one model segment to another via the interppx preprocessor, the cold soil acts as a continuous drag on the atmosphere that the model physics can never quite overcome.

The bias problem is significantly reduced by simply running each model segment independently, thus limiting the cold drag to actual cold conditions. Figure 4 shows the statistical time series for this new case, px_acm2. This px_acm2 configuration will henceforth be considered the base case episode 1 for cross-sensitivity purposes, while px_acm will be used for episodes 2 and 3. For the statistical difference tables that make up the bulk of the table portion of this document, we employ px_acm2 as the de facto base case.

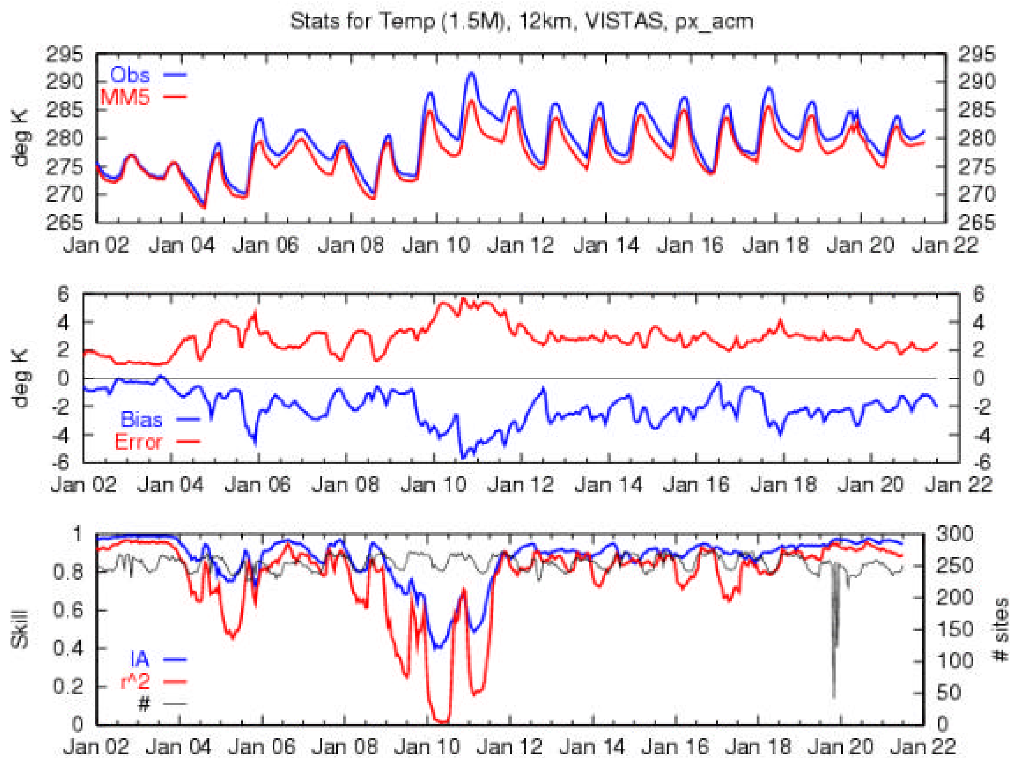

Figure 3. Episode 1 temperature (1.5 m) statistical time series plot for the 12-km VISTAS region, px_acm sensitivity. The top panel shows the mean of the observations (blue) and the model (red), the middle plot shows the model bias (blue) and the absolute error (red), while the bottom plot shows the index of agreement (blue) and coefficient of determination (red).

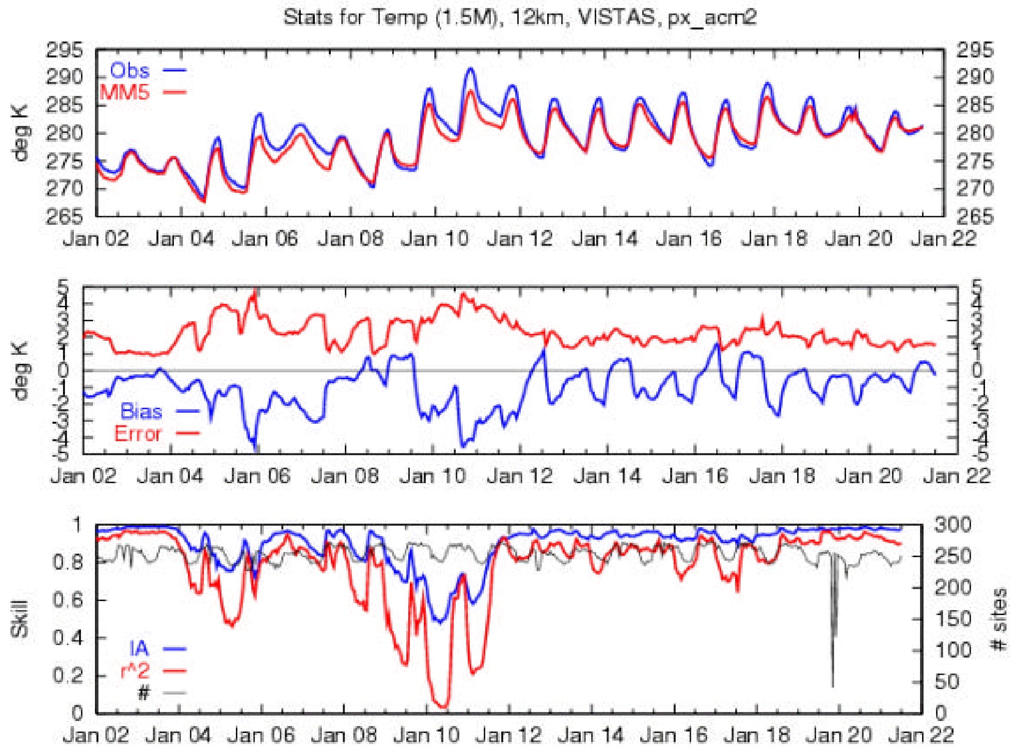

Figure 4. Episode 1 temperature (1.5 m) statistical time series plot for the 12-km VISTAS region, px_acm2 sensitivity. The top panel shows the mean of the observations (blue) and the model (red), the middle plot shows the model bias (blue) and the absolute error (red), while the bottom plot shows the index of agreement (blue) and coefficient of determination (red).

Figure 5 shows the daytime PBL heights for January 10, 2002 at 12-km resolution over the VISTAS region. It should be noted that the noah_eta-my PBL heights can erroneously become negative over small spatial areas; we set all such negative values to zero before averaging. Due to the small areal extent of these negative PBL values, we do not anticipate any qualitative assessments to be affected by those artifacts. The January 10, 2002 PBL heights are rather typical of winter PBL heights. The noah_mrf heights are significantly higher and smoother than those in the other sensitivities. Generally speaking, the noah_eta-my daytime PBL heights are lower than they are in the other sensitivity runs. The px_acm2 heights tend to be more in the middle of those extremes, though they also "bottom out" more than the other runs.

Figure 6 shows the cross-sensitivity daytime precipitation plot for this same day. The low PBL heights in the px_acm2 run are closely correlated to precipitation in the Ohio Valley, while melting snow and clouds (figure 7) might inhibit mixing over the northern Mid-Atlantic States.

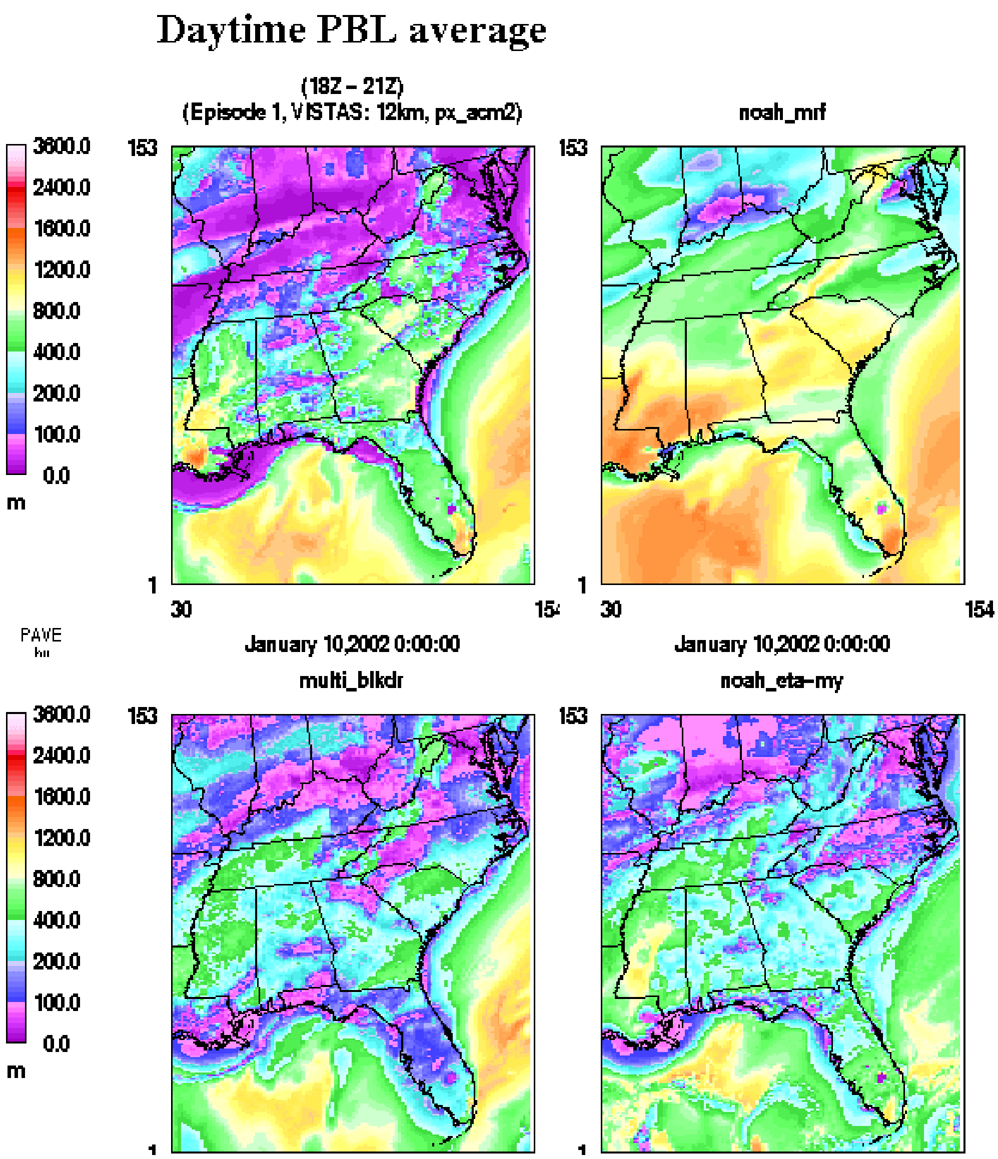

Figure 5. Daytime (18-21 UTC) average PBL heights for the 12-km VISTAS region for January 10, 2002 are displayed. The px_acm2 sensitivity is shown in the upper left, the noah_mrf in the upper right, the multi_blkdr in the lower left, and the noah_eta-my in the lower right. Note that the time value (0:00:00) is only a placeholder and has no physical meaning.

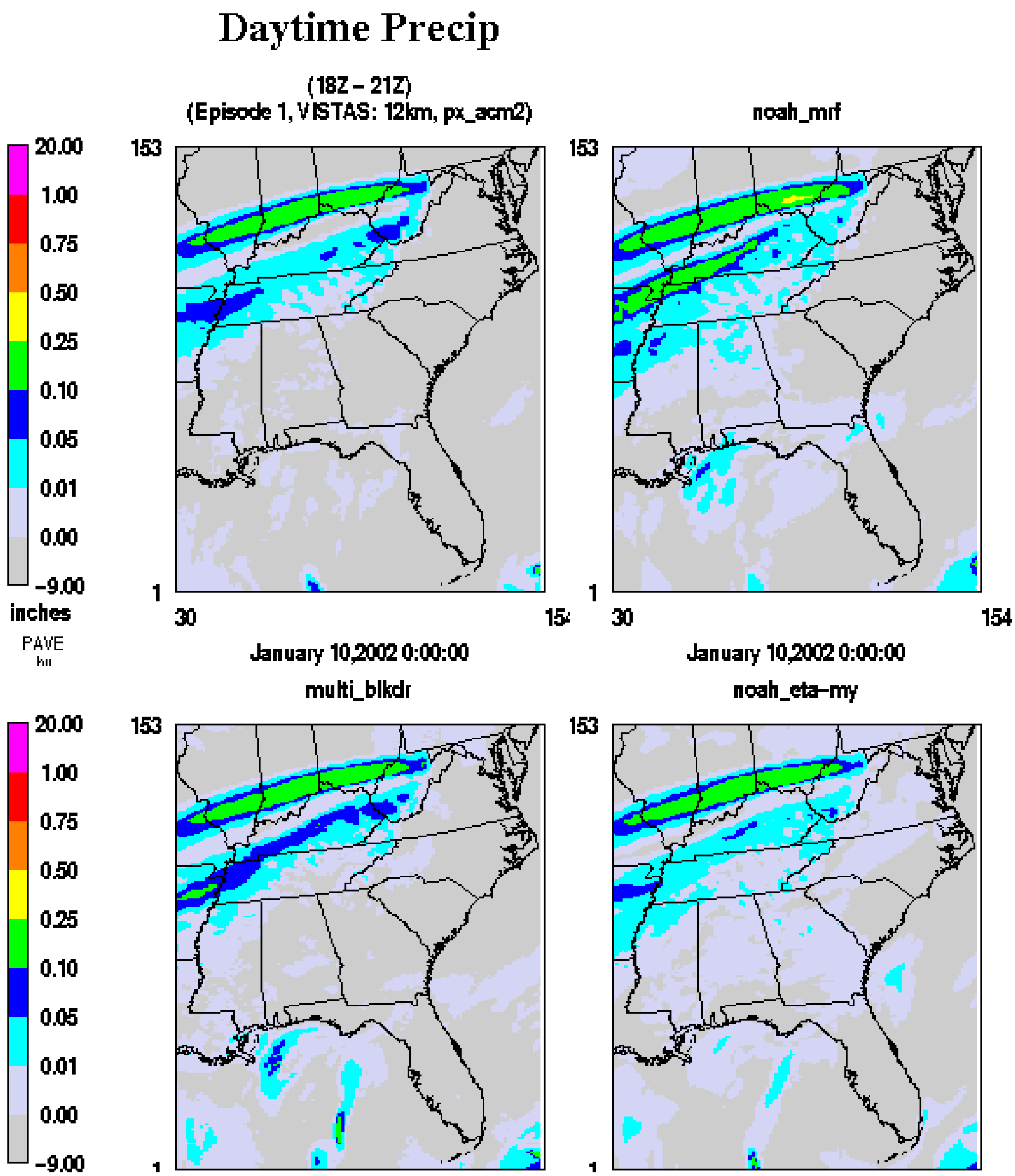

Figure 6. Like figure 5, except for precipitation.

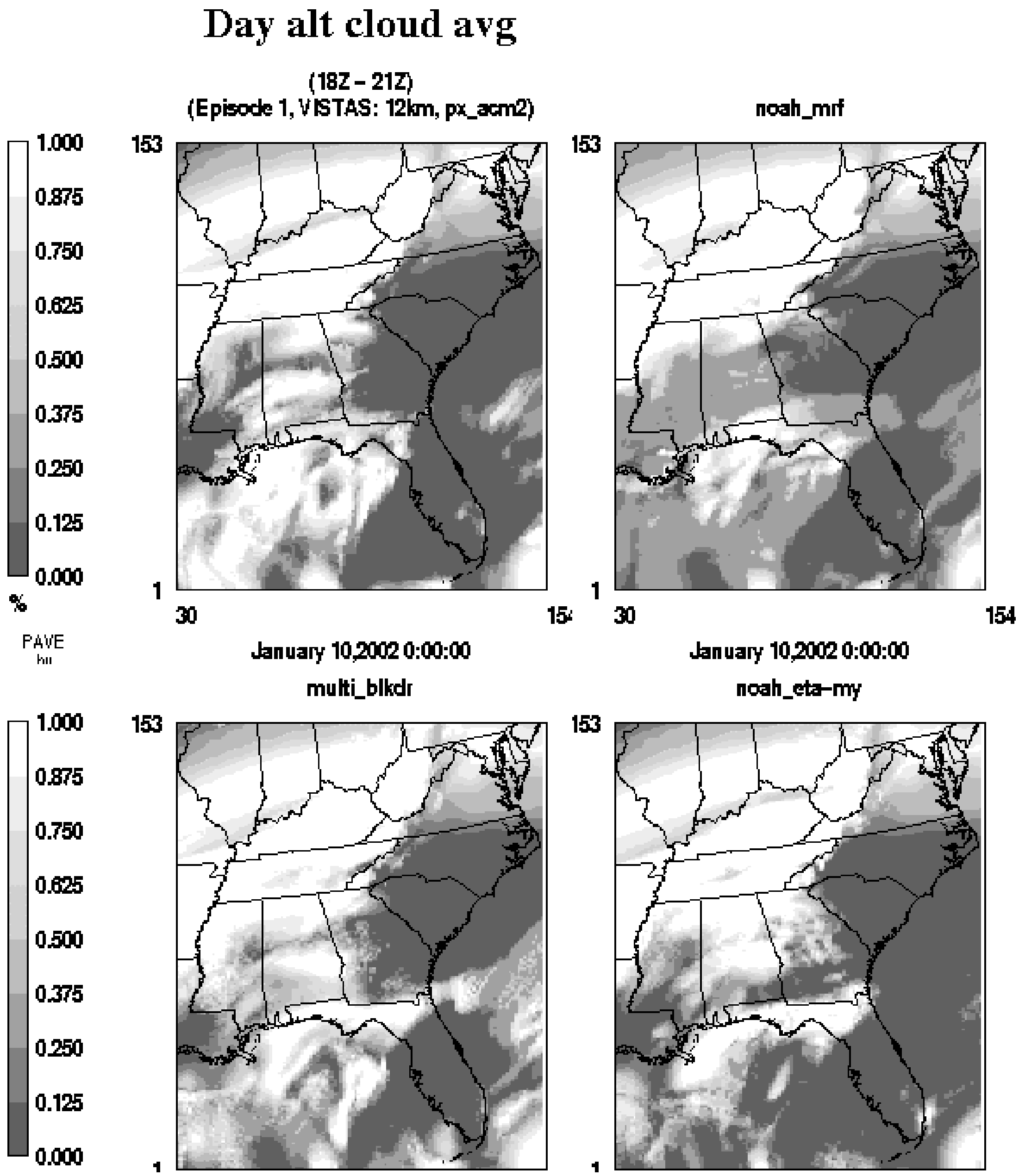

Figure 7. Like figure 5, except for cloud coverage.

Figure 8 shows the daily average temperature for this same day. Note that the px_acm2 case is generally warmer than the other cases, while the noah_eta-my run is the coldest. Figure 9 shows that for daily averaged mixing ratio the patterns are very similar for all runs. The combination of warmer daytime temperatures and similar mixing ratios results in lower daytime relative humidity for the px_acm2 case compared with the other sensitivity runs (figure 10). Finally, figure 11 shows that the daytime wind speeds are similar in all cases.

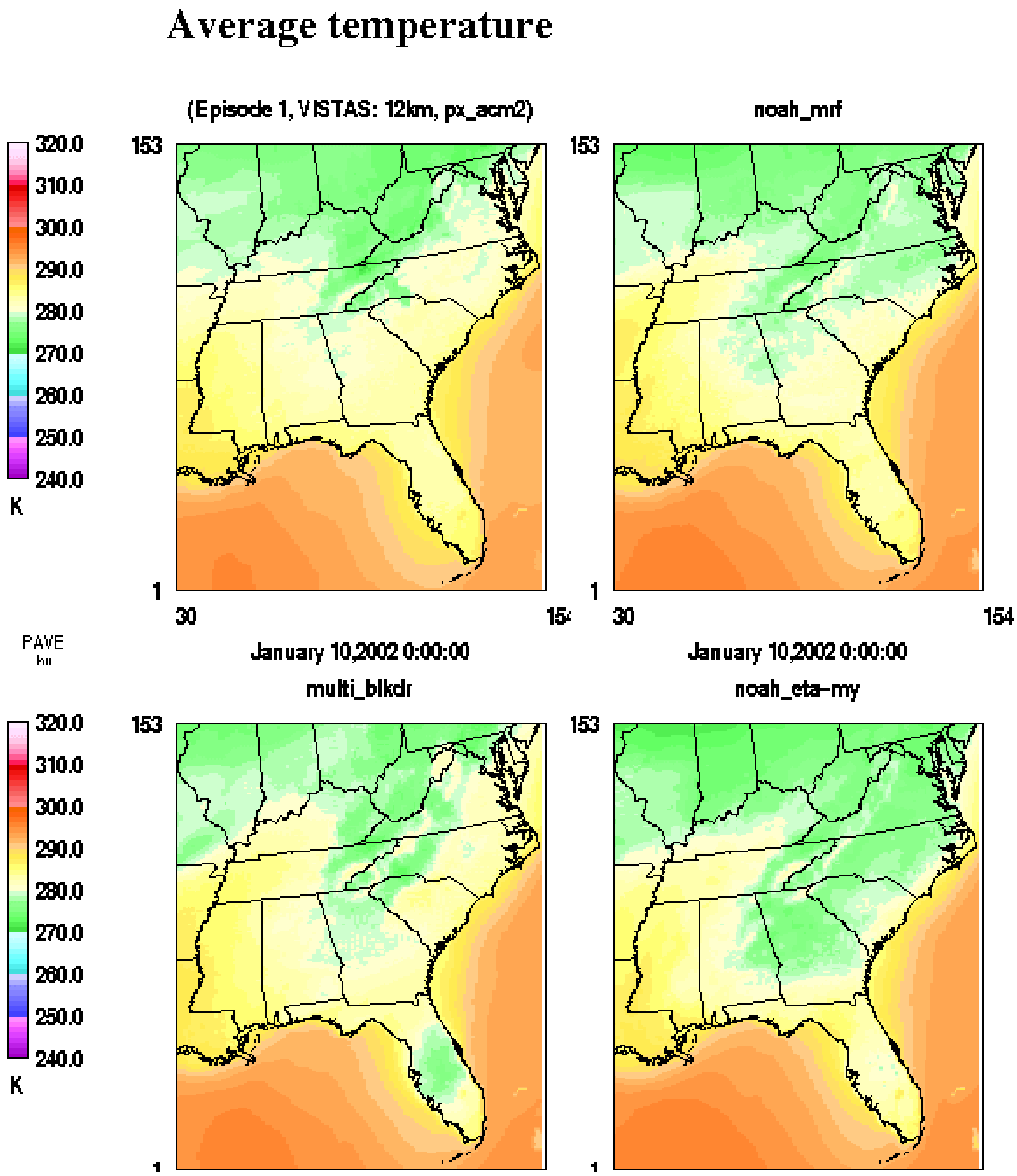

Figure 8. Like figure 5, except for daily average temperature.

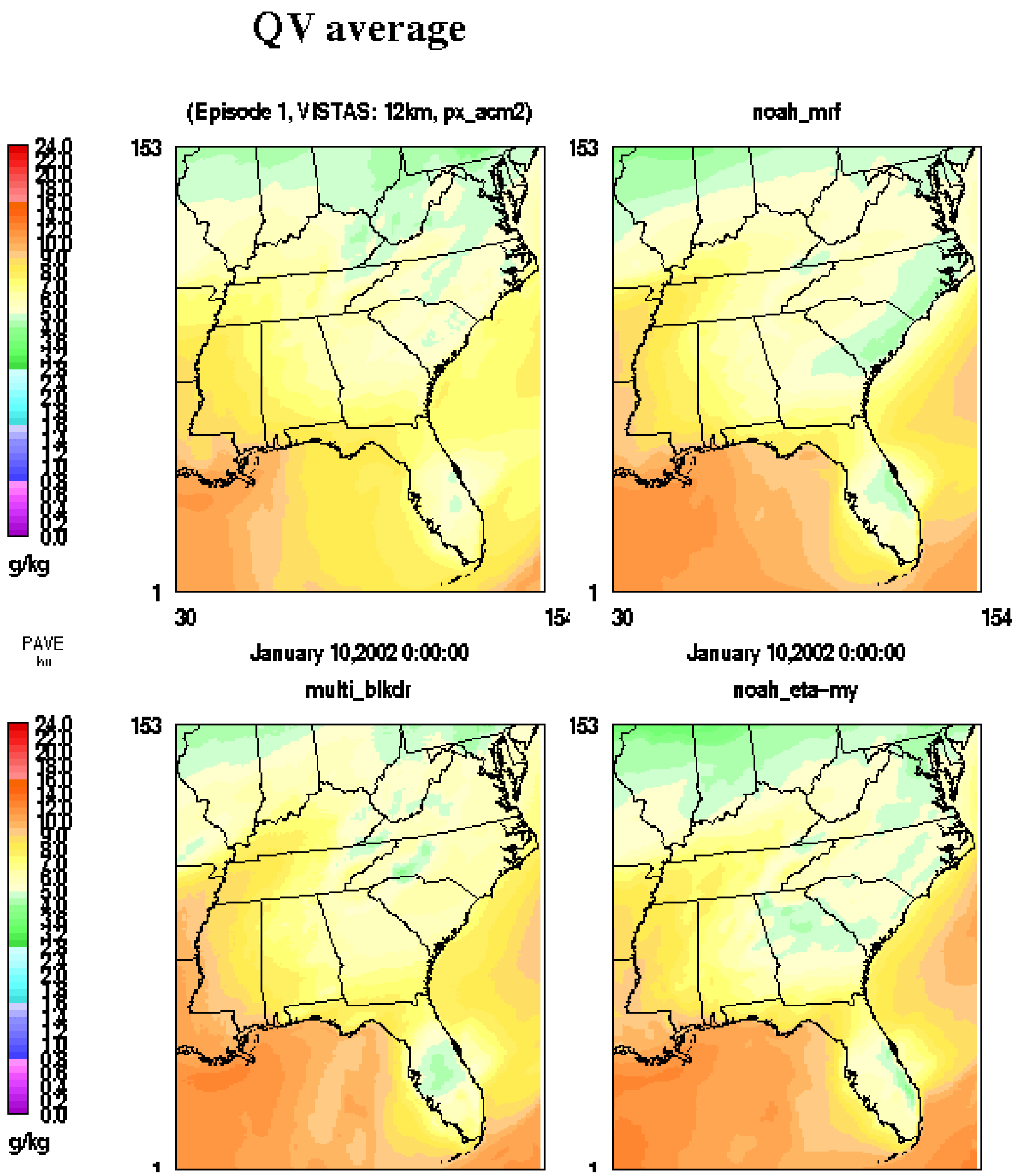

Figure 9. Like figure 5, except for daily average temperature.

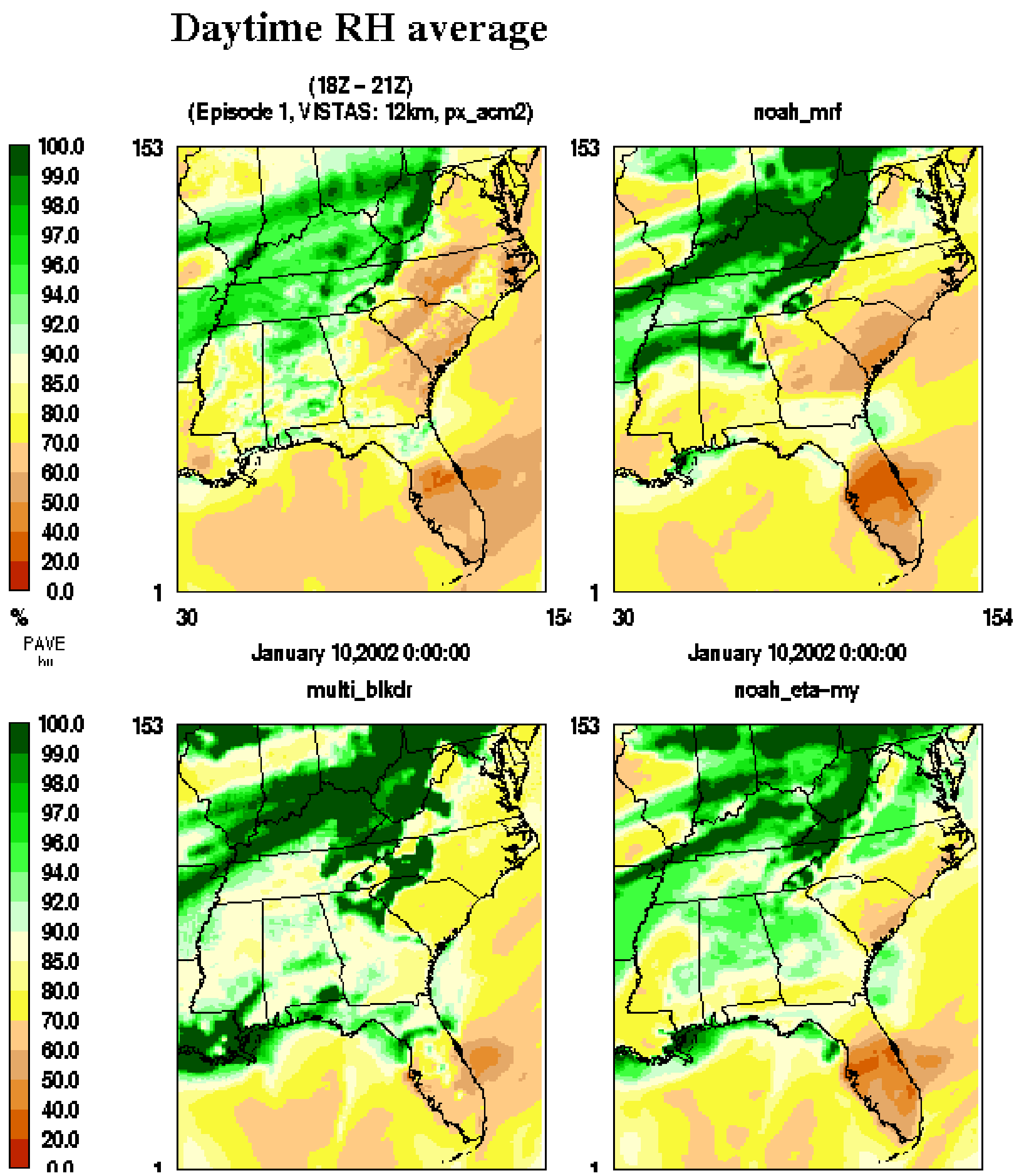

Figure 10. Like figure 5, except for relative humidity.

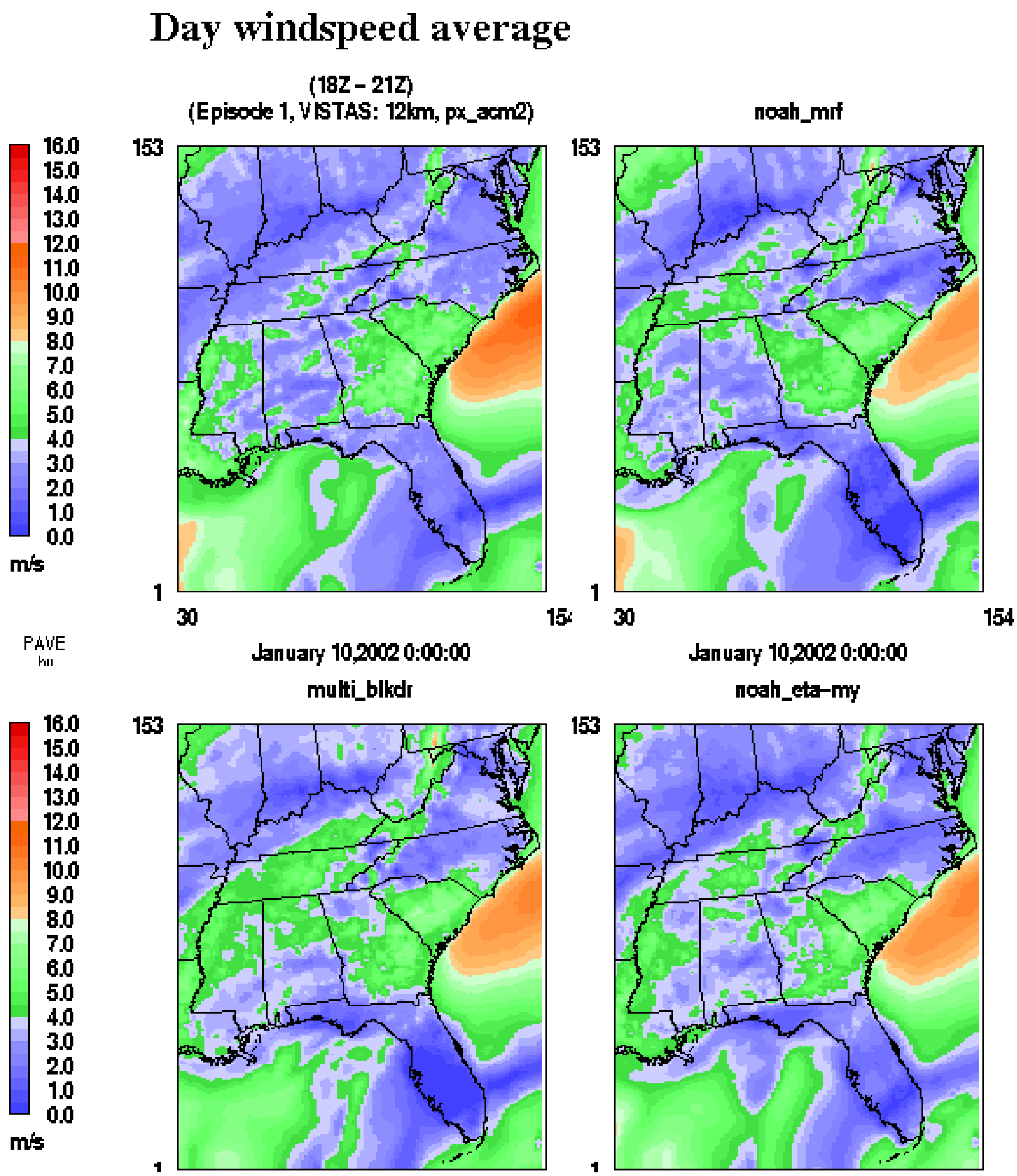

Figure 11. Like figure 5,except for wind speed.

Traditionally nighttime PBL heights have not been considered very important for air quality modeling, but they certainly may be for visibility/particulate modeling. Figure 12 shows the nighttime (07-10 UTC) PBL heights for January 10, 2002. Notice that the px_acm2 produces lower PBL heights than the rest of the sensitivity cases do, thus trapping surface-based emissions in a smaller volume of air than would occur in another MM5 configuration. The noah_mrf run again produces the highest PBL heights at night, while the multi_blkdr and noah_eta-my runs are somewhere in the middle.

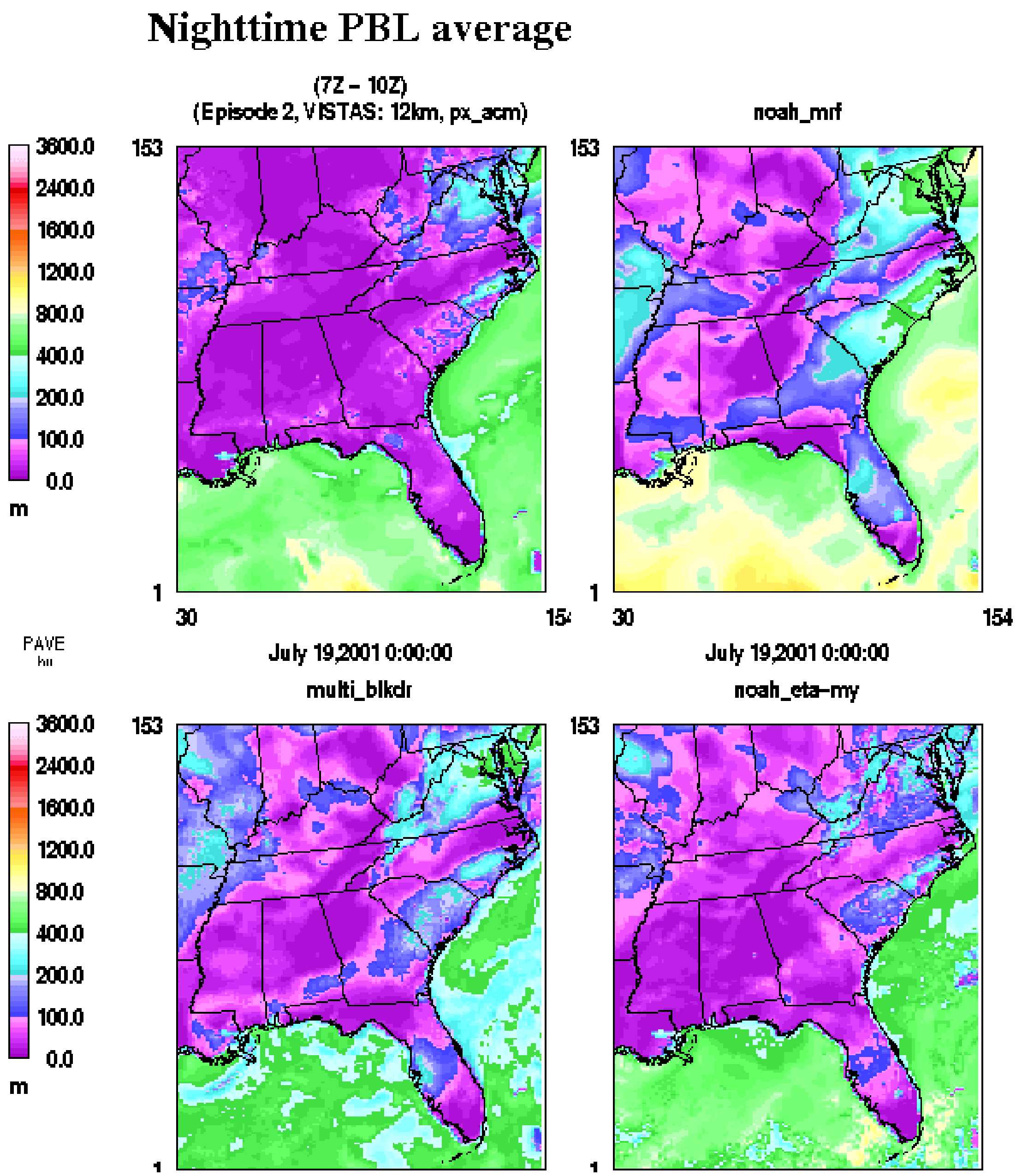

Figure 12. Nighttime (07-10 UTC) average PBL heights for the 12-km VISTAS region for January 10, 2002 are displayed. The px_acm2 sensitivity is shown in the upper left, the noah_mrf in the upper right, the multi_blkdr in the lower left, and the noah_eta-my in the lower right. Note that the time value (0:00:00) is only a placeholder and has no physical meaning.

Nighttime cloud cover is shown in figure 13. The most striking observation from this figure is the cloud deck over Tennessee in the noah_eta-my run that does not exist to the same extent in the other sensitivity runs.

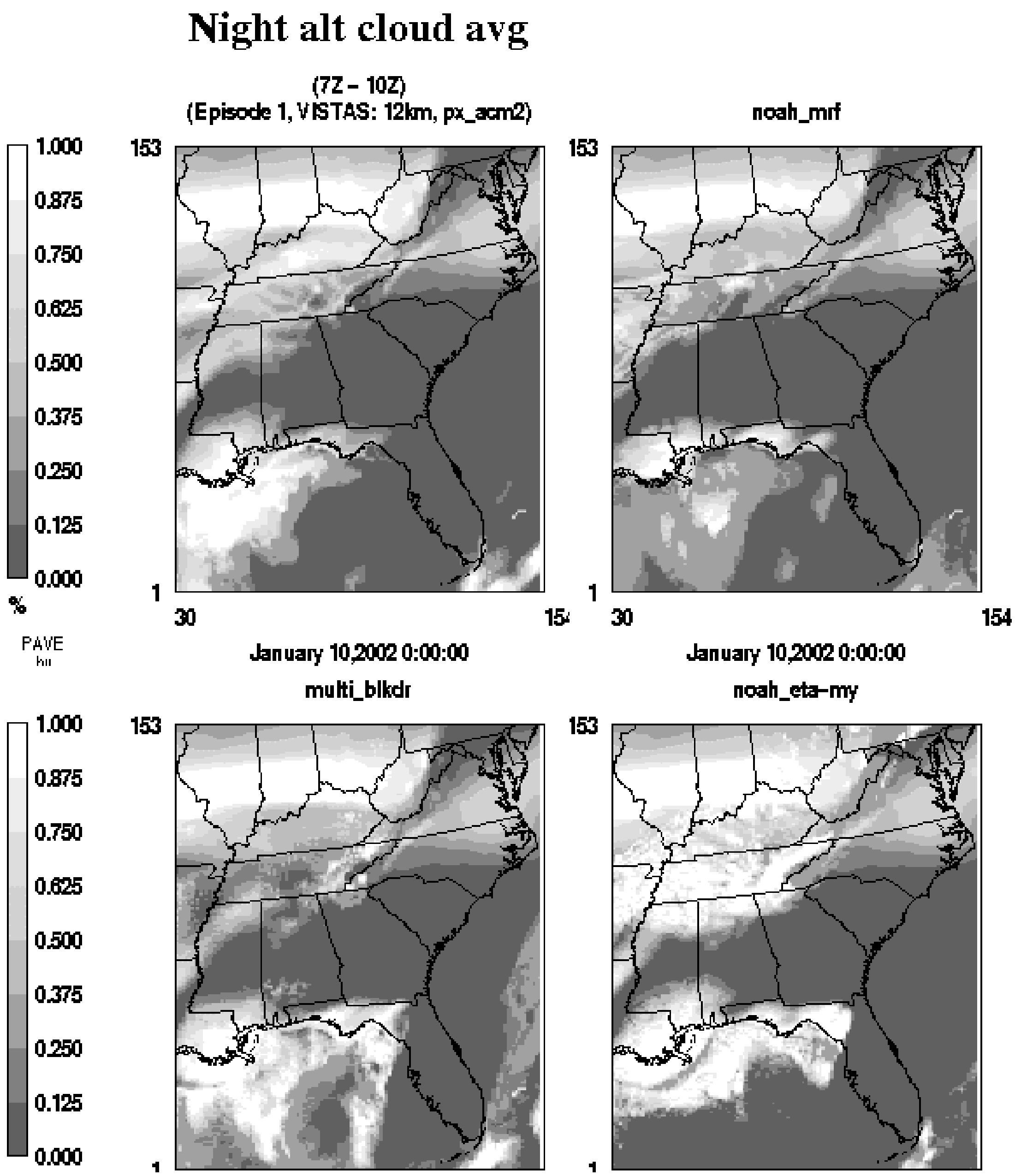

Figure 13. Like figure 12, except for cloud cover.

Figure 14 shows the nighttime relative humidity plot. One might expect that the px_acm2 case would show the highest relative humidity, given the low PBL heights as indicated by figure 12. The opposite is actually the case. The warmer temperatures in this run counteract the increased stability such that the relative humidity values are the lowest of all the runs. The noah_eta-my run easily exhibits the highest relative humidity.

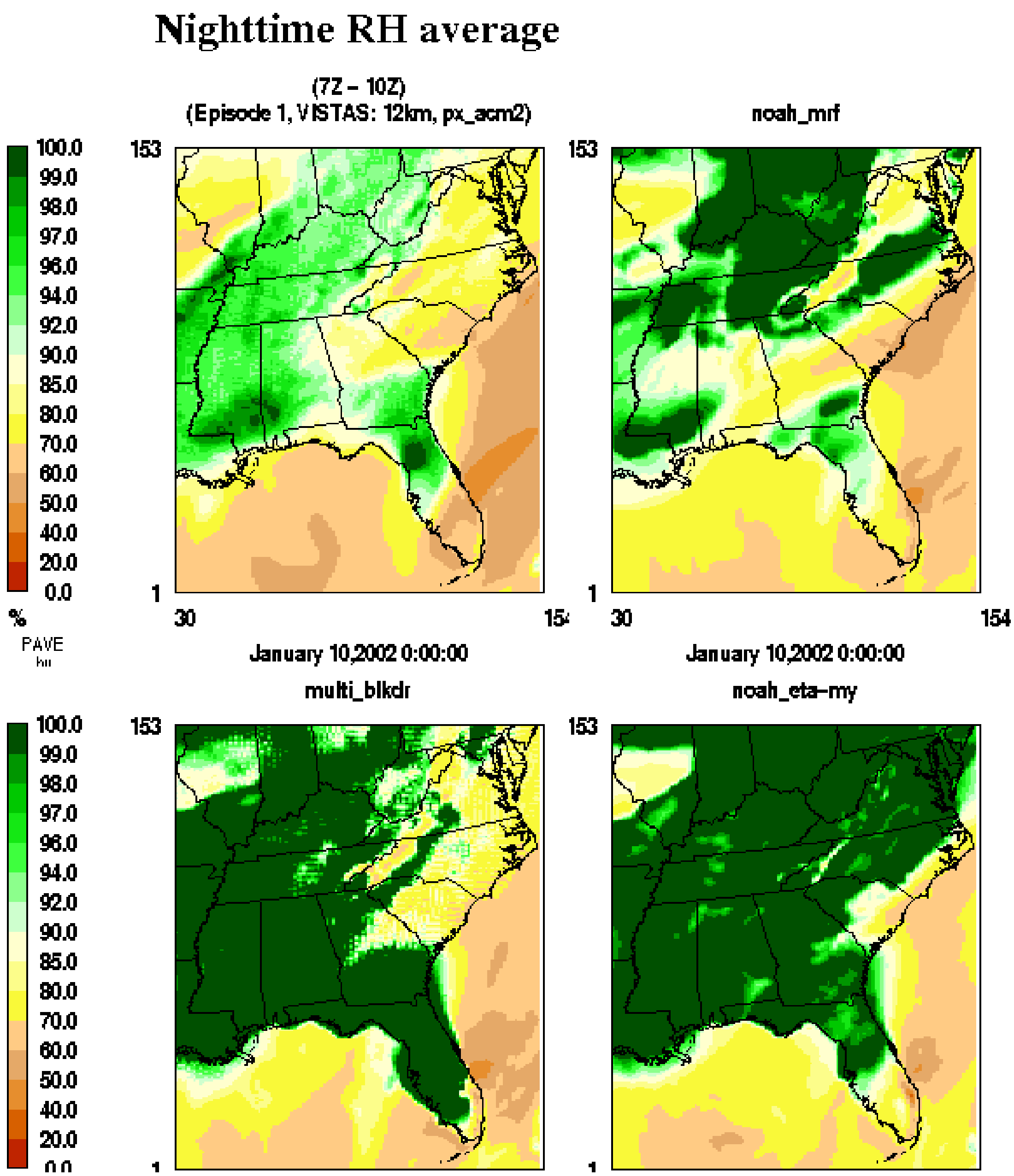

Figure 14. Like figure 12, except for relative humidity.

Figure 15 shows the nighttime wind speed. Speeds are lowest in the noah_eta-my run, followed by px_acm2, noah_mrf, and multi_blkdr. In fact, the latter two cases seem to show an inappropriate diurnal pattern in that their nighttime wind speeds are higher than their daytime wind speeds (figure 12).

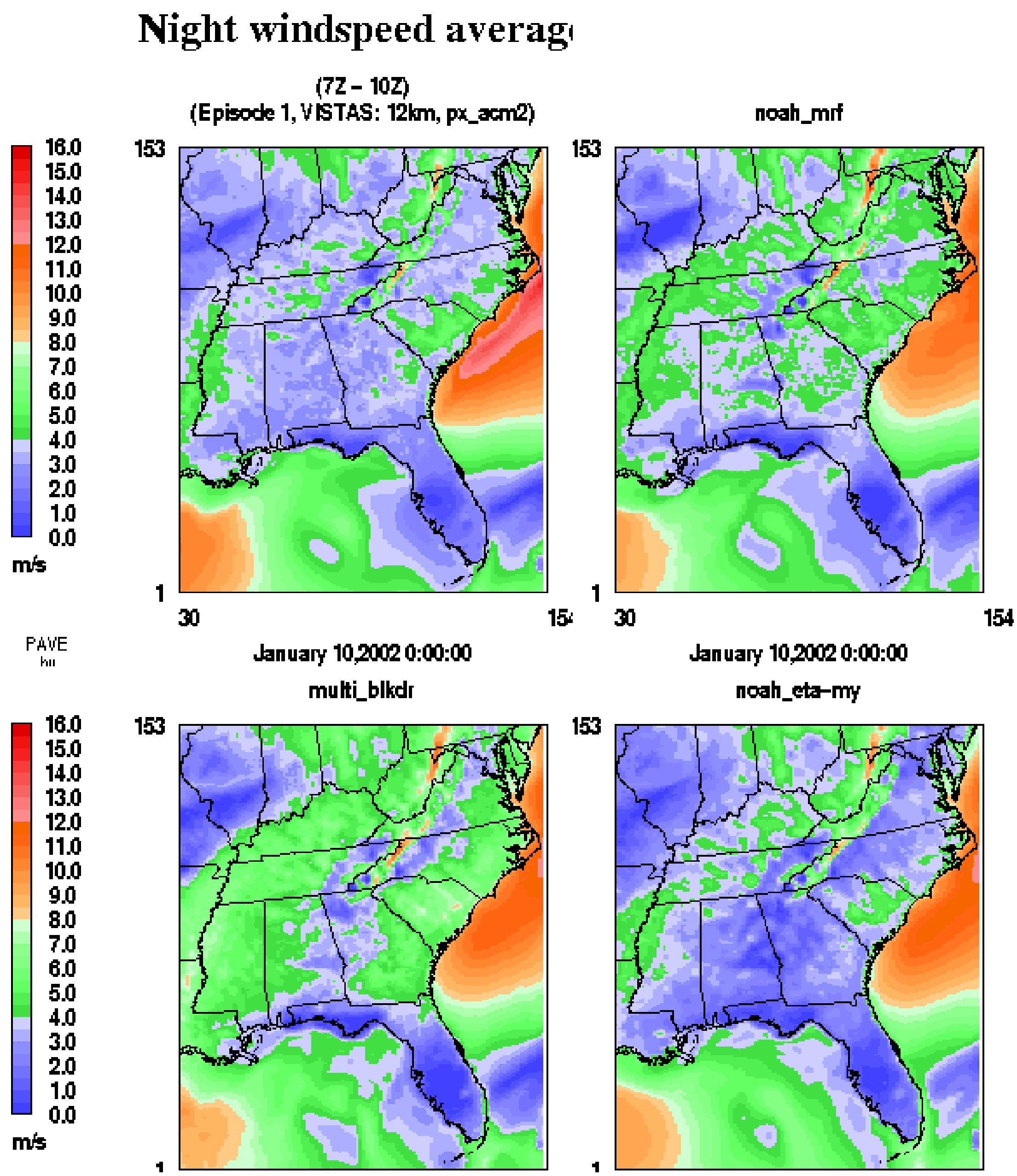

Figure 15. Like figure 12, except for wind speed.

Many of the same observations reported above are also valid for the summer episodes. To save time we will only show spatial 4-panel plots for PBL heights for a sample summer day, July 19, 2001. Figure 16 shows the daytime average, while figure 17 shows the nighttime average.

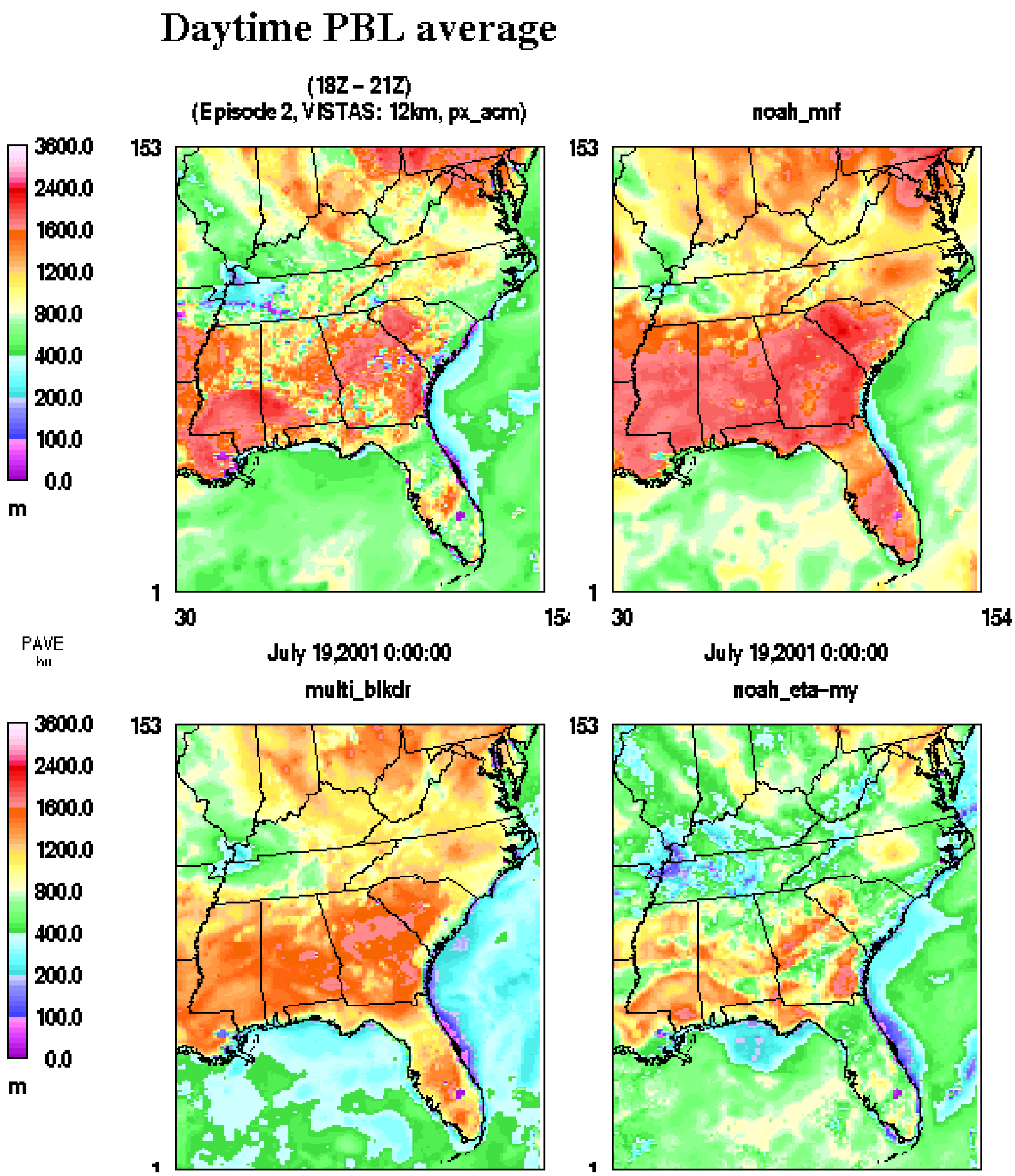

Figure 16. Daytime (18-21 UTC) average PBL heights for the 12-km VISTAS region for July 19, 2001 are displayed. The px_acm sensitivity is shown in the upper left, the noah_mrf in the upper right, the multi_blkdr in the lower left, and the noah_eta-my in the lower right. Note that the time value (0:00:00) is only a placeholder and has no physical meaning.

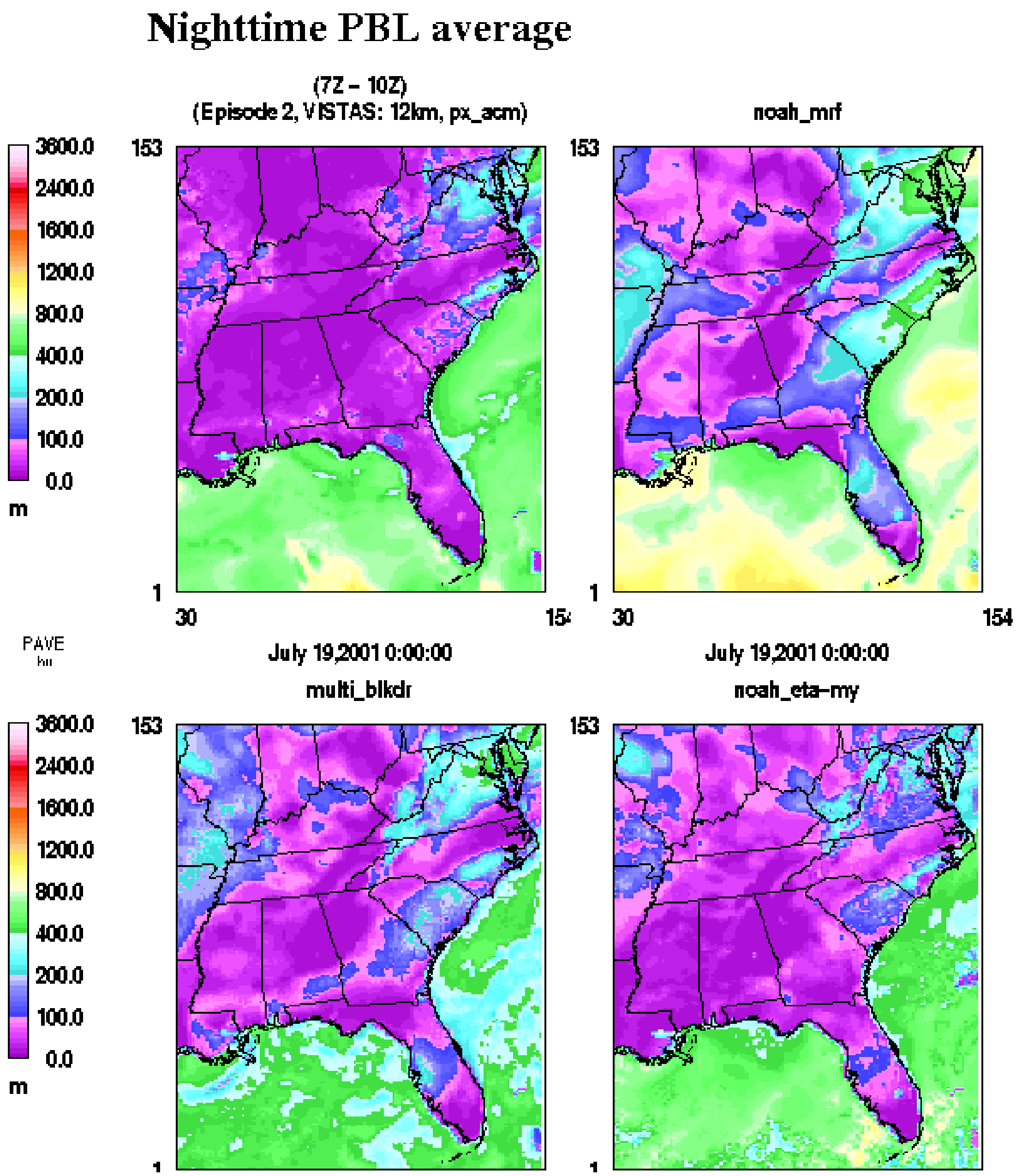

Figure 17. Nighttime (07-10 UTC) average PBL heights for the 12-km VISTAS region for July 19, 2001 are displayed. The px_acm sensitivity is shown in the upper left, the noah_mrf in the upper right, the multi_blkdr in the lower left, and the noah_eta-my in the lower right. Note that the time value (0:00:00) is only a placeholder and has no physical meaning.

Now that a qualitative understanding of these sensitivity runs has been established, the remainder of this report will focus on quantitative comparisons between the sensitivity cases. Figure 18 shows the temperature statistical time series plot for episode 1. While the general performance of the model is very similar across the sensitivity runs, close examination reveals that the px_acm2 case performs the best. Figure 19 shows the corresponding plot for episode 2. The noah_eta-my run clearly performs the worst, while the other sensitivity runs show similar performance. The episode 3 plot (not shown) reveals similar responses.

Figure 20 shows the 12-km mixing ratio statistical time series plot for episode 1 over the VISTAS region. Overall the noah_mrf case performs the best, followed by px_acm2. The multi_blkdr case is clearly the poorest performing. The corresponding episode 2 plot (figure 21) reveals a different result in that the noah_mrf case is negatively biased in mixing ratio. This weakness presumably stems from dry air being mixed down from aloft as the PBL becomes too high. The other cases are relatively similar. The negative mixing ratio bias is also evident for noah_mrf in episode 3 (not shown).

The wind direction plot for episode 1 is shown in figure 22. The direction bias and error plots show similar performance among the sensitivity cases, but the magnitude of the error vector plot (bottom panel) shows that the noah_eta-my is the best performing run, especially at night. The px_acm2 run is generally second best. Figure 23 shows that similar results are seen in episode 2, as well as in episode 3 (not shown).

The cloud cover statistical plots (figures 24-25) show very little difference in performance among the sensitivity runs. Figure 26 reveals that relative humidity for episode 1 is best modeled by either px_acm2 or noah-mrf, with the multi_blkdr case performing the worst. The episode 2 plot (figure 27) shows a strong diurnal signature with the sensitivity runs generally being negatively biased at night and positively biased during the day. The diurnal signature is interestingly the weakest for the noah_eta-my run, leading to that sensitivity possibly performing the best for this quantity. The episode 3 plot (not shown) has the noah_eta-my run displaying the poorest performance, no doubt due to its negative temperature bias.

Figure 28 shows the precipitation statistics for the full 12-km grid for episode 1. The bias blip on January 10 resulted from there being very few grid cells that actually observed measurable precipitation on that day. Sensitivity px_acm2 clearly outperforms the other cases for this episode. Figure 29 shows the corresponding plot for episode 2. Sensitivity noah_eta-my seems to be relatively unbiased, while the other sensitivity runs show a slight low bias. Nevertheless the skill plots show little difference in performance among the runs. The px_acm case appears to show slightly better results than do the other runs. Similar results are found for episode 3 (not shown).

Figure 30 is designed to show which sensitivity case statistically performs the best at each valid observation site. This particular image represents a composite of 1.5m temperatures for all hours, with absolute error being the defining metric. Note that the px_acm2 run performs best for a majority of the sites. The noah_eta-my run appears to do quite well over Florida. Figure 31 shows the corresponding plot for episode 2. Again the px_acm case seems to perform best overall, though noah_eta-my again performs best in Florida and along the southeastern coastline. The results for episode 3 (not shown) reveal no best performing sensitivity.

Figure 32 shows a similar type of plot for mixing ratio. The noah_mrf case appears to perform best for the largest number of sites, followed by the px_acm2 case. The episode 2 results (figure 33) indicate just the opposite, as the noah_eta-my or multi_blkdr cases seem to perform best for most of the sites. The episode 3 plot (not shown) is a mixed bag with the noah_eta-my and px_acm cases seemingly performing best.

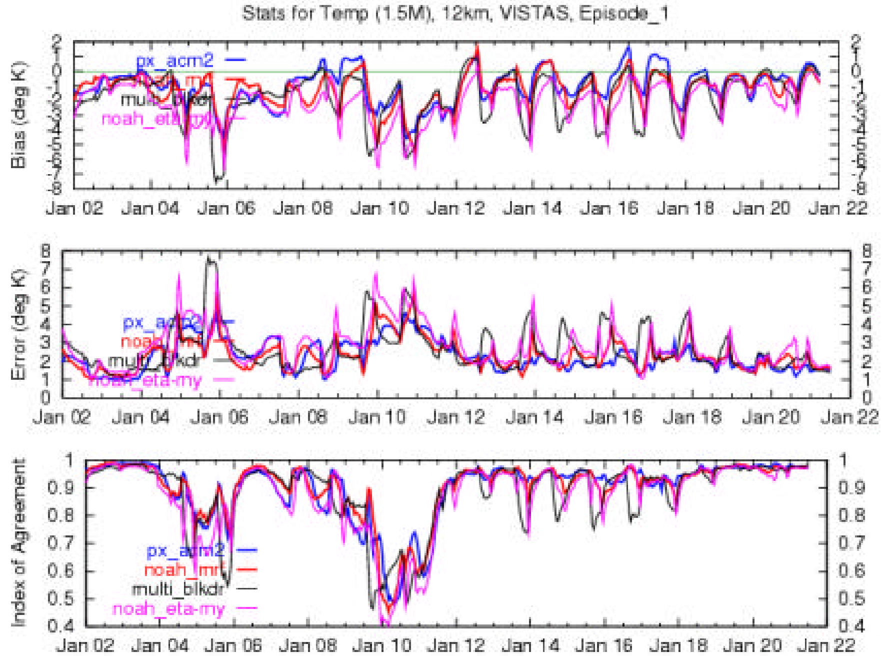

Figure 18. Episode 1 (Jan 2-21, 2002) cross-sensitivity statistical time series plot for temperature is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm2 case is shown in blue, noah_mrf in red, multi_blkdr in black, and noah_eta-my in purple.

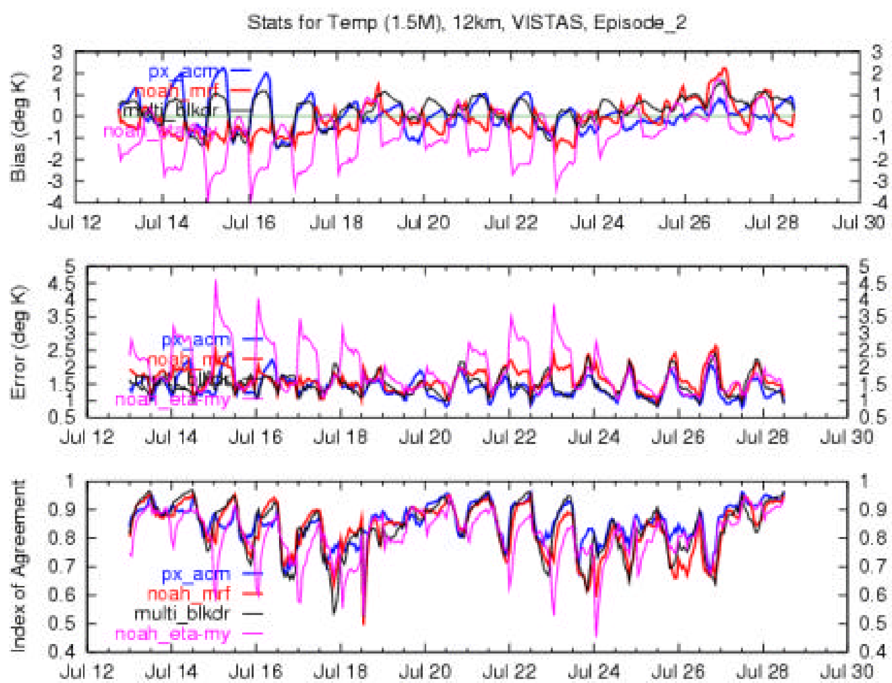

Figure 19. Episode 2 (Jul 13-28, 2001) cross-sensitivity statistical time series plot for temperature is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm case is shown in blue, noah_mrf in red, multi_blkdr in black, and noah_eta-my in purple.

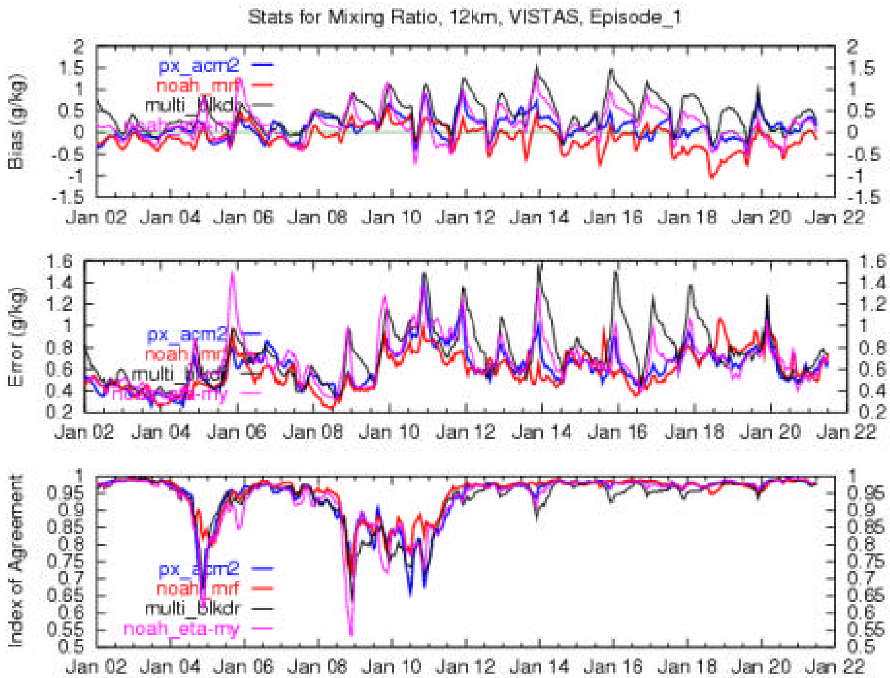

Figure 20. Episode 1 (Jan 2-21, 2002) cross-sensitivity statistical time series plot for mixing ratio is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm2 case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

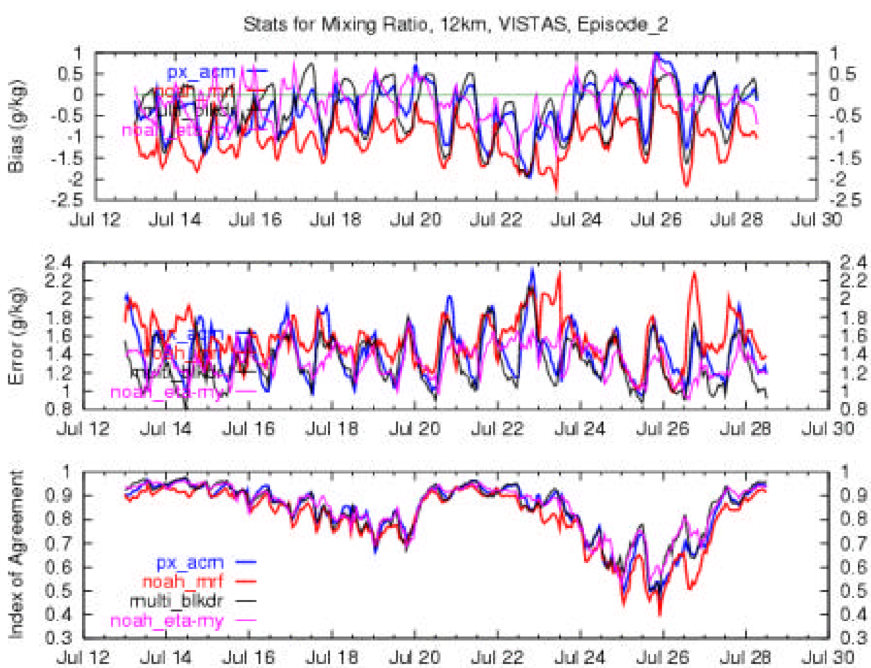

Figure 21. Episode 2 (Jul 13-28, 2001) cross-sensitivity statistical time series plot for mixing ratio is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

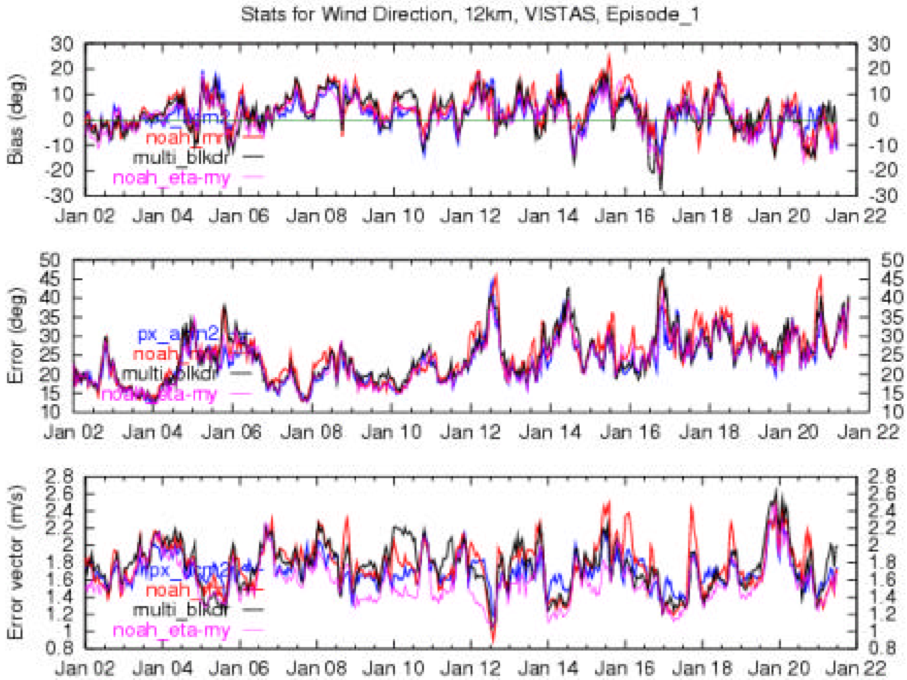

Figure 22. Episode 1 (Jan 2-21, 2002) cross-sensitivity statistical time series plot for winds is shown. The top panel shows wind direction bias, the second panel absolute wind direction error, and the bottom panel the magnitude of the error wind vector. The px_acm2 case is shown in blue, noah_mrf in red, multi_blkdr in black, and noah_eta-my in purple.

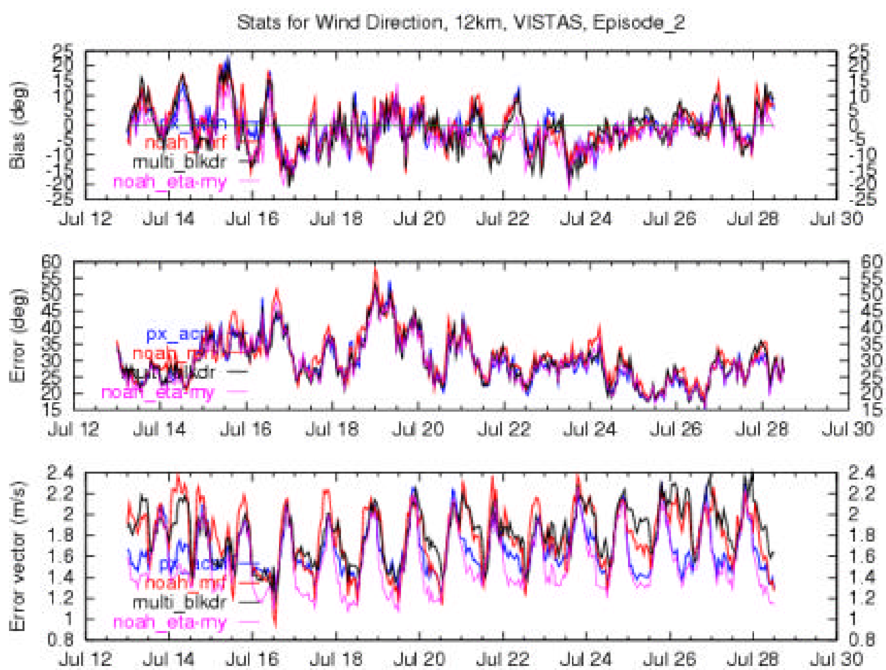

Figure 23. Episode 2 (Jul 13-28, 2001) cross-sensitivity statistical time series plot for winds is shown. The top panel shows wind direction bias, the second panel absolute wind direction error, and the bottom panel the magnitude of the error wind vector. The px_acm case is shown in blue, noah_mrf in red, multi_blkdr in black, and noah_eta-my in purple.

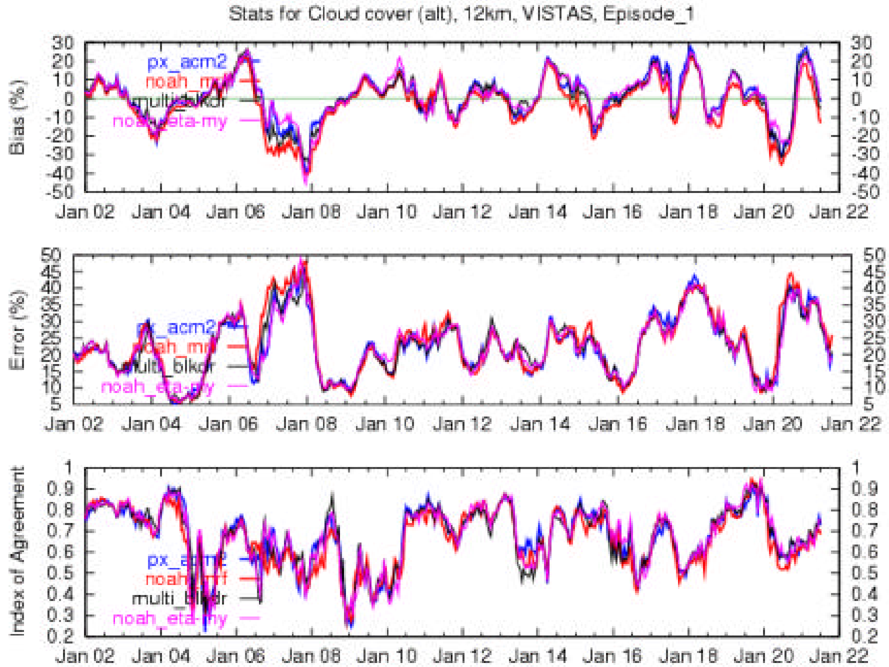

Figure 24. Episode 1 (Jan 2-21, 2002) cross-sensitivity statistical time series plot for cloud coverage is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm2 case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

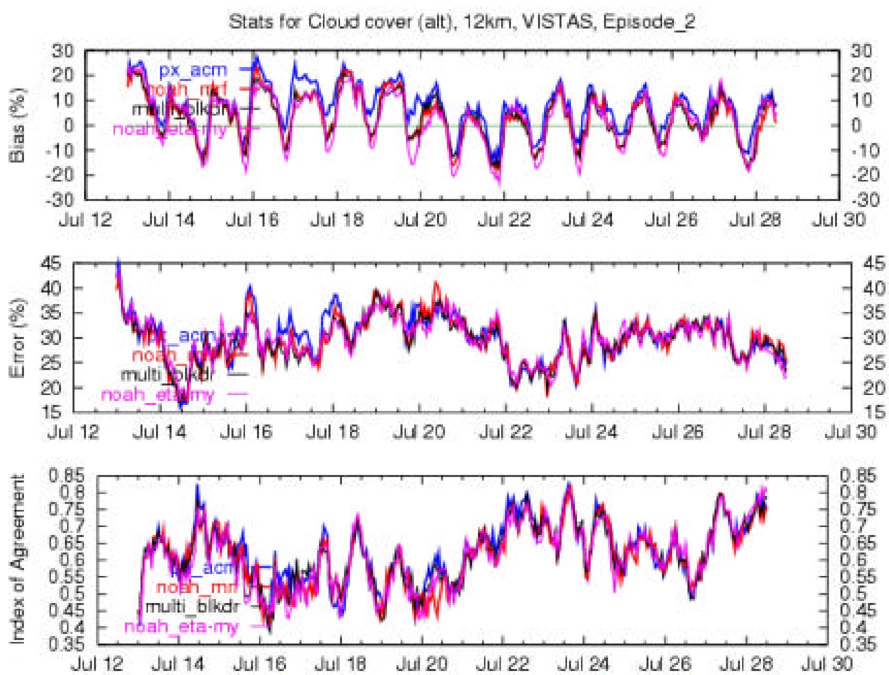

Figure 25. Episode 2 (Jul 13-28, 2001) cross-sensitivity statistical time series plot for cloud coverage is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

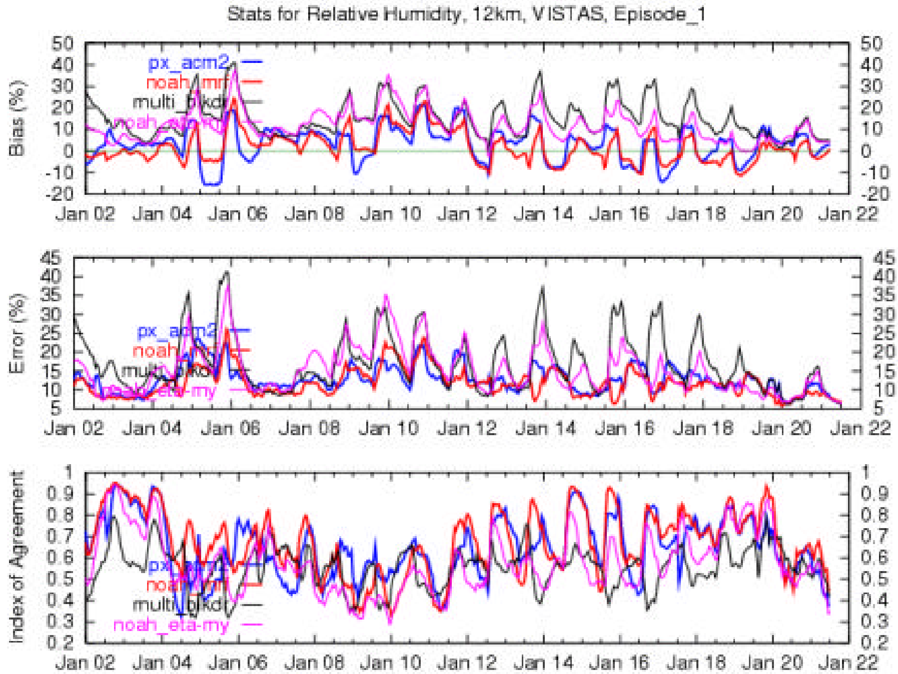

Figure 26. Episode 1 (Jan 2-21, 2002) cross-sensitivity statistical time series plot for relative humidity is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm2 case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

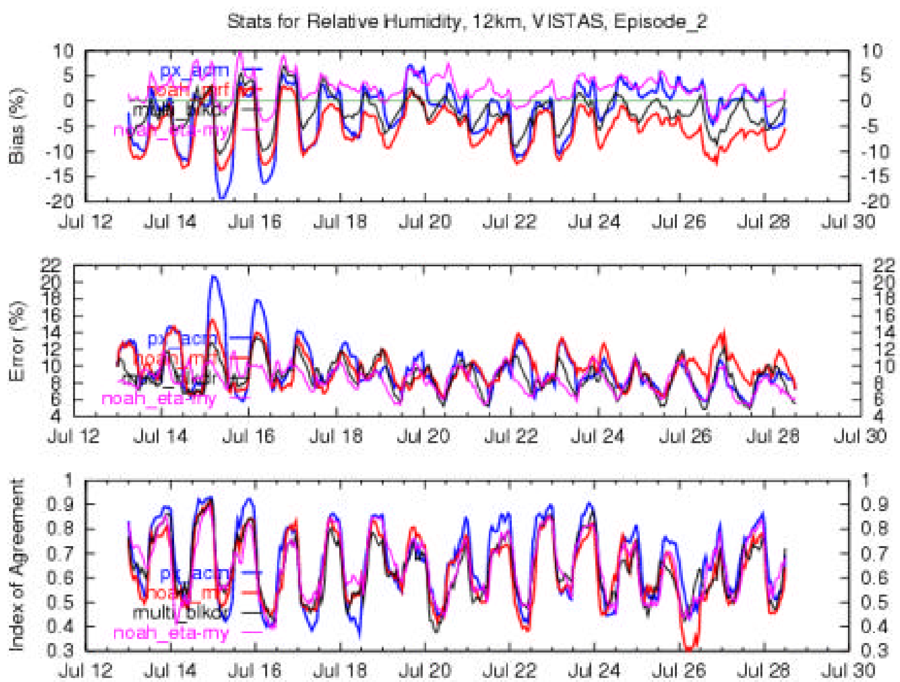

Figure 27. Episode 2 (Jul 13-28, 2001) cross-sensitivity statistical time series plot for relative humidity is shown. The top panel shows bias, the second panel absolute error, and the bottom panel index of agreement. The px_acm case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

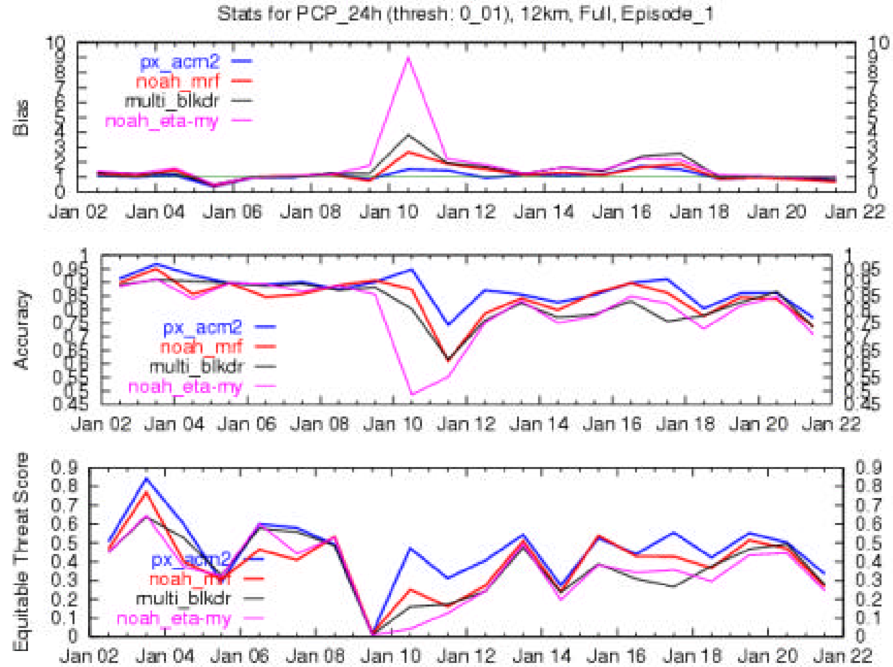

Figure 28. Episode 1 (Jan 2-21, 2002) cross-sensitivity statistical time series plot for 24-h measurable precip is shown. The top panel shows bias, the second panel accuracy, and the bottom panel equitable threat score. The px_acm2 case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

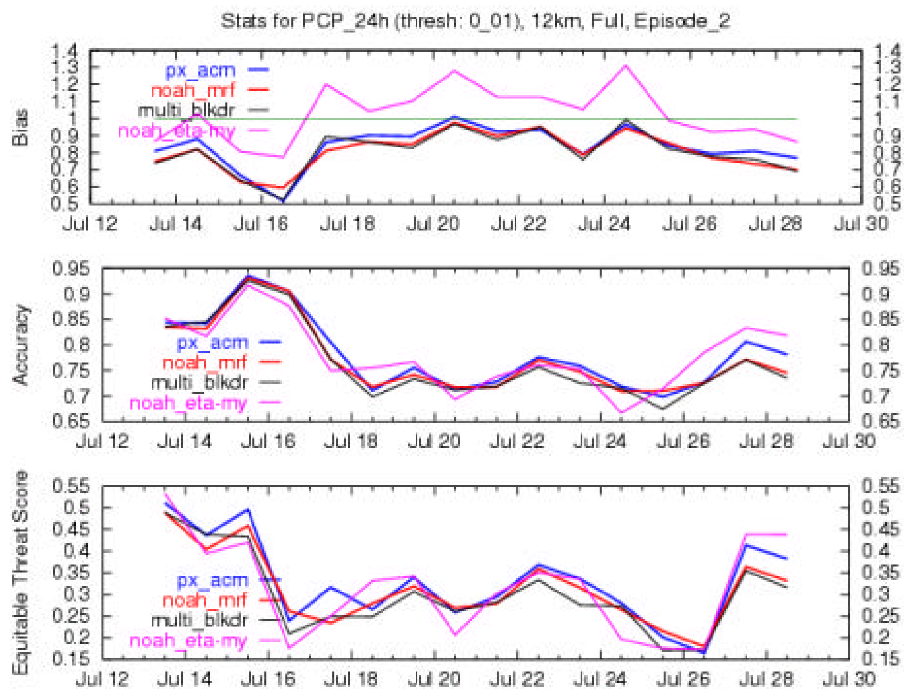

Figure 29. Episode 2 (Jul 13-28, 2001) cross-sensitivity statistical time series plot for 24-h measurable precip is shown. The top panel shows bias, the second panel accuracy, and the bottom panel equitable threat score. The px_acm case is blue, noah_mrf red, multi_blkdr black, and noah_eta-my purple.

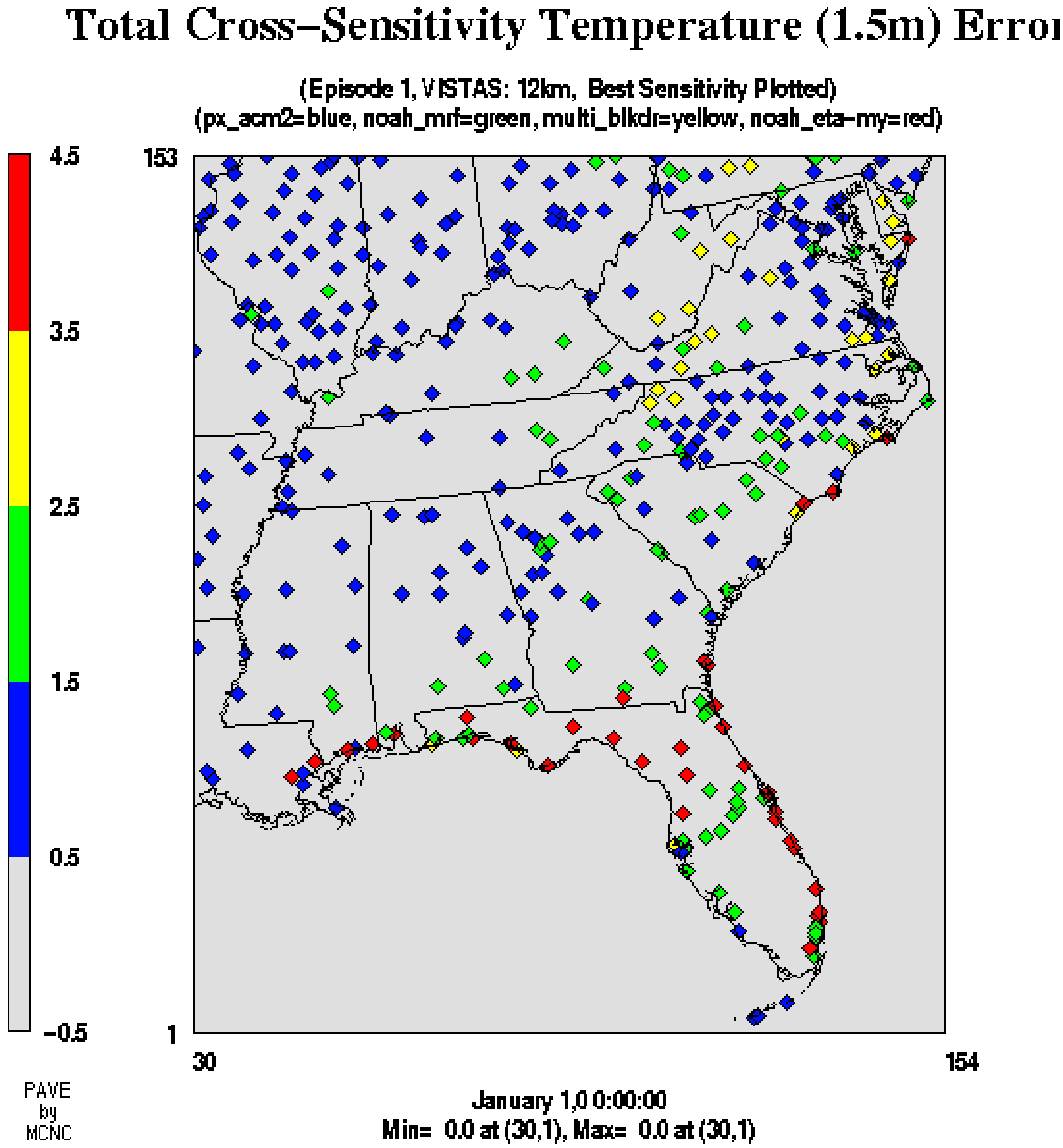

Figure 30. Episode 1 (Jan 2-21, 2002) cross-sensitivity 1.5m temperature absolute error comparison plot is shown. Stations for which px_acm2 show the smallest composite error are plotted in blue, noah_mrf in green, multi_blkdr in yellow, and noah_eta-my in red. The date/time/max/min information at the bottom of the plot serves only as placeholders and should be ignored.

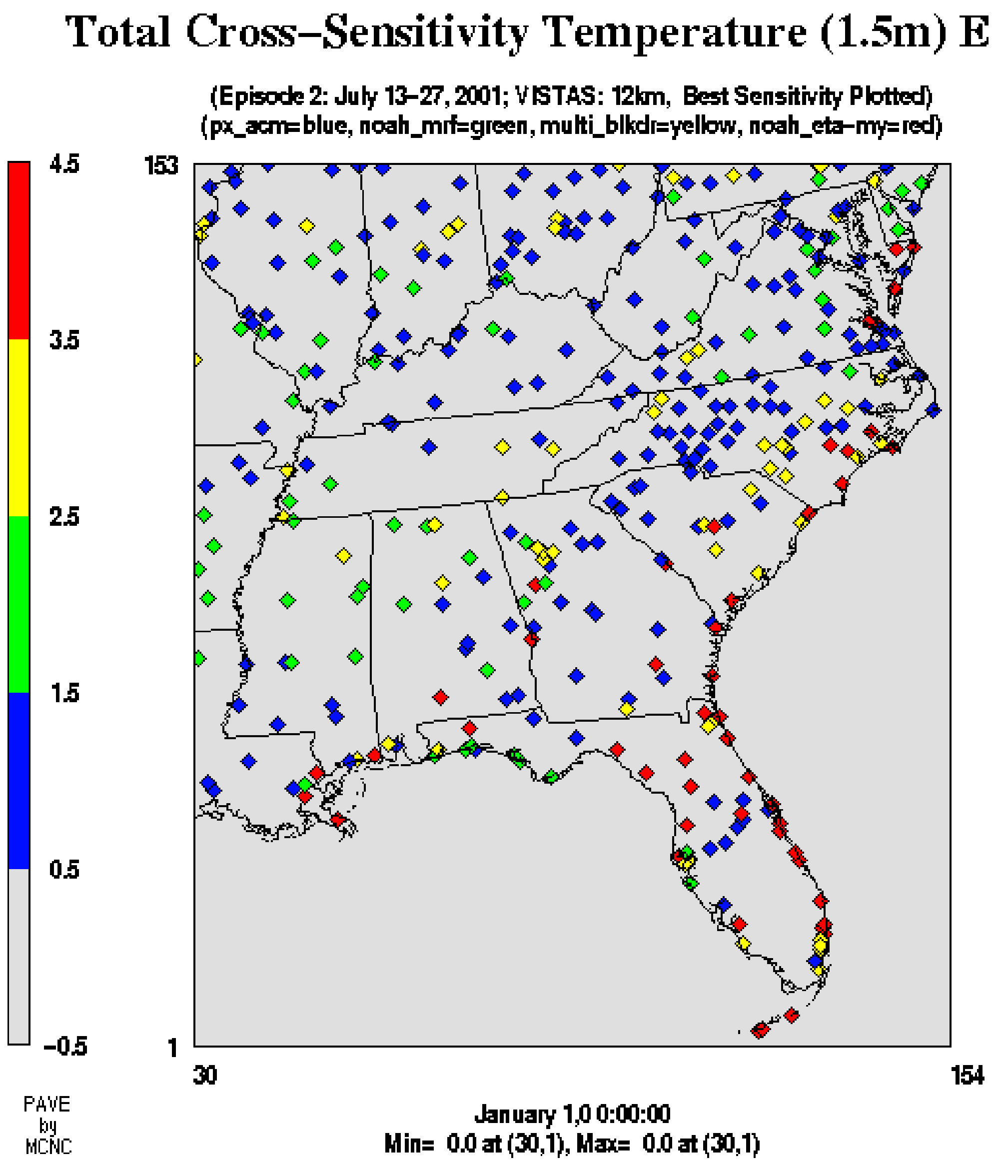

Figure 31. Episode 2 (Jul 13-28, 2001) cross-sensitivity 1.5m temperature absolute error comparison plot is shown. Stations for which px_acm2 show the smallest composite error are plotted in blue, noah_mrf in green, multi_blkdr in yellow, and noah_eta-my in red. The date/time/max/min information at the bottom of the plot serves only as placeholders and should be ignored.

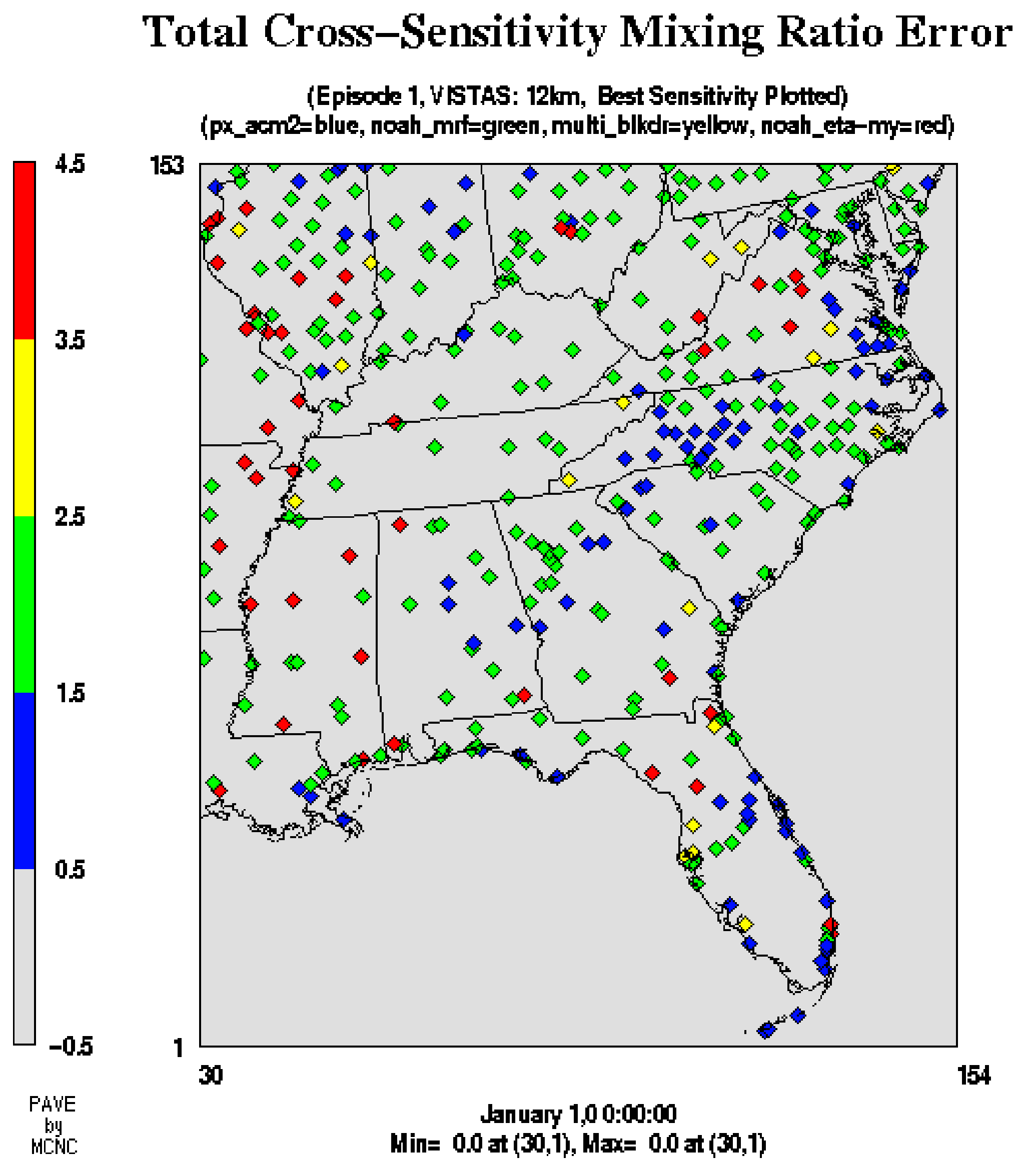

Figure 32. Episode 1 (Jan 2-21, 2002) cross-sensitivity mixing ratio absolute error comparison plot is shown. Stations for which px_acm2 show the smallest composite error are plotted in blue, noah_mrf in green, multi_blkdr in yellow, and noah_eta-my in red. The date/time/max/min information at the bottom of the plot serves only as placeholders and should be ignored.

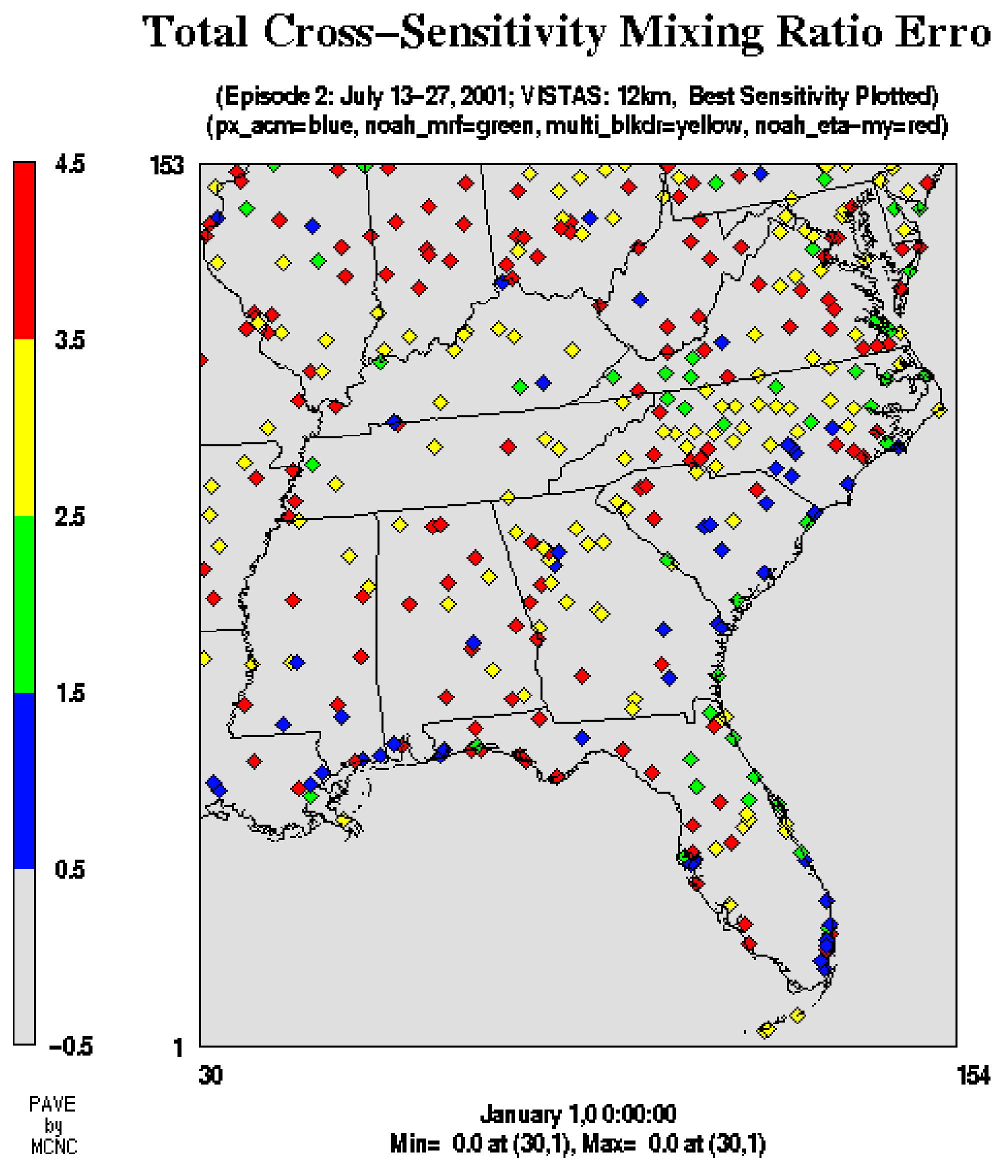

Figure 33. Episode 2 (Jul 13-28, 2001) cross-sensitivity mixing ratio absolute error comparison plot is shown. Stations for which px_acm2 show the smallest composite error are plotted in blue, noah_mrf in green, multi_blkdr in yellow, and noah_eta-my in red. The date/time/max/min information at the bottom of the plot serves only as placeholders and should be ignored.

The corresponding series of plots for the magnitude of the error wind vector (figures 34-35) show the clear superiority of the noah_eta-my runs. The px_acm(2) runs perform a distant second best for all sensitivities. The main reason why noah_eta-my performs so well is its ability to calm its wind speeds at night (figure 15) relative to the other model configurations.

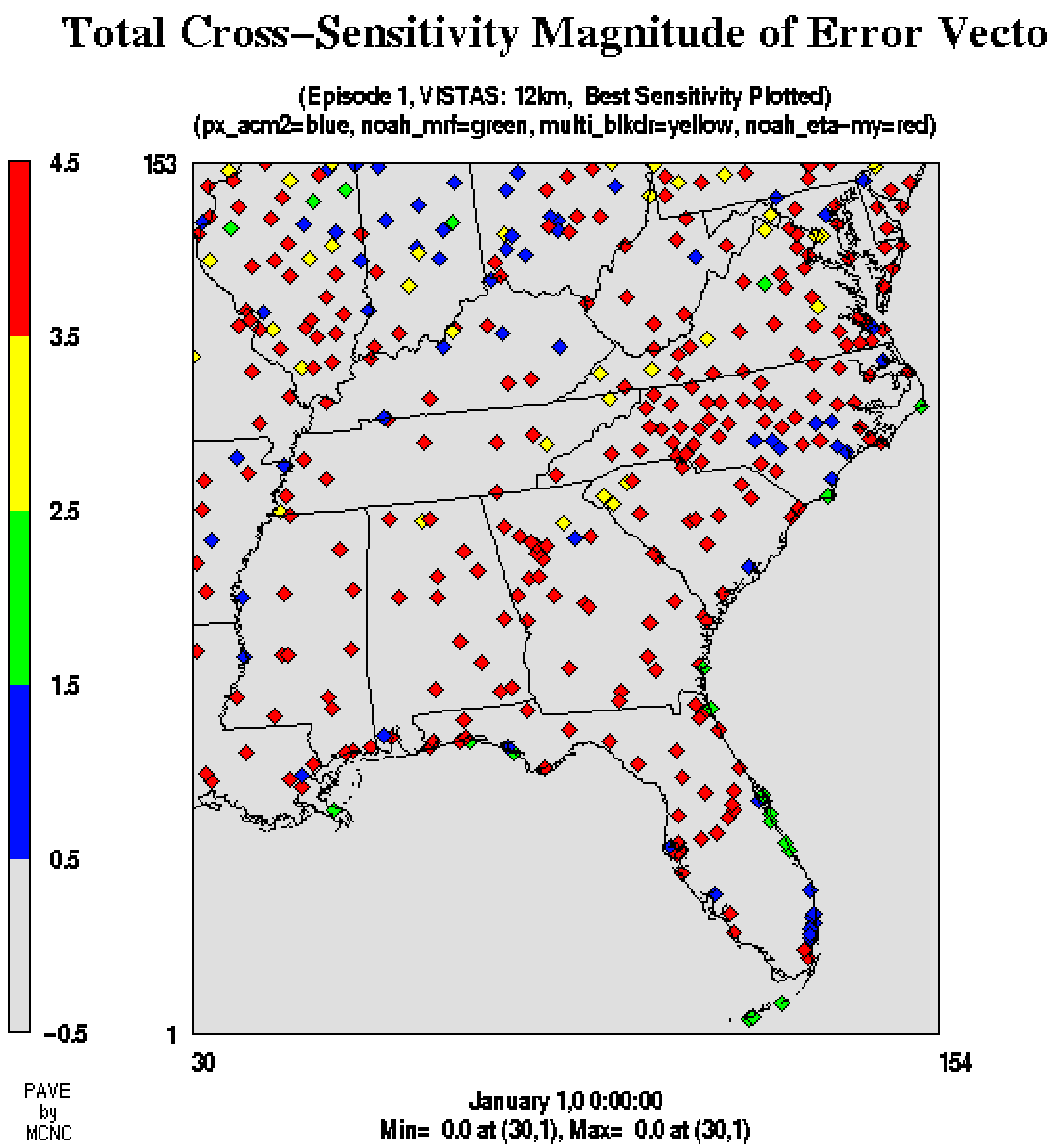

Figure 34. Episode 1 (Jan 2-21, 2002) cross-sensitivity error vector magnitude comparison plot is shown. Stations for which px_acm2 show the smallest composite error are plotted in blue, noah_mrf in green, multi_blkdr in yellow, and noah_eta-my in red. The date/time/max/min information at the bottom of the plot serves only as placeholders and should be ignored.

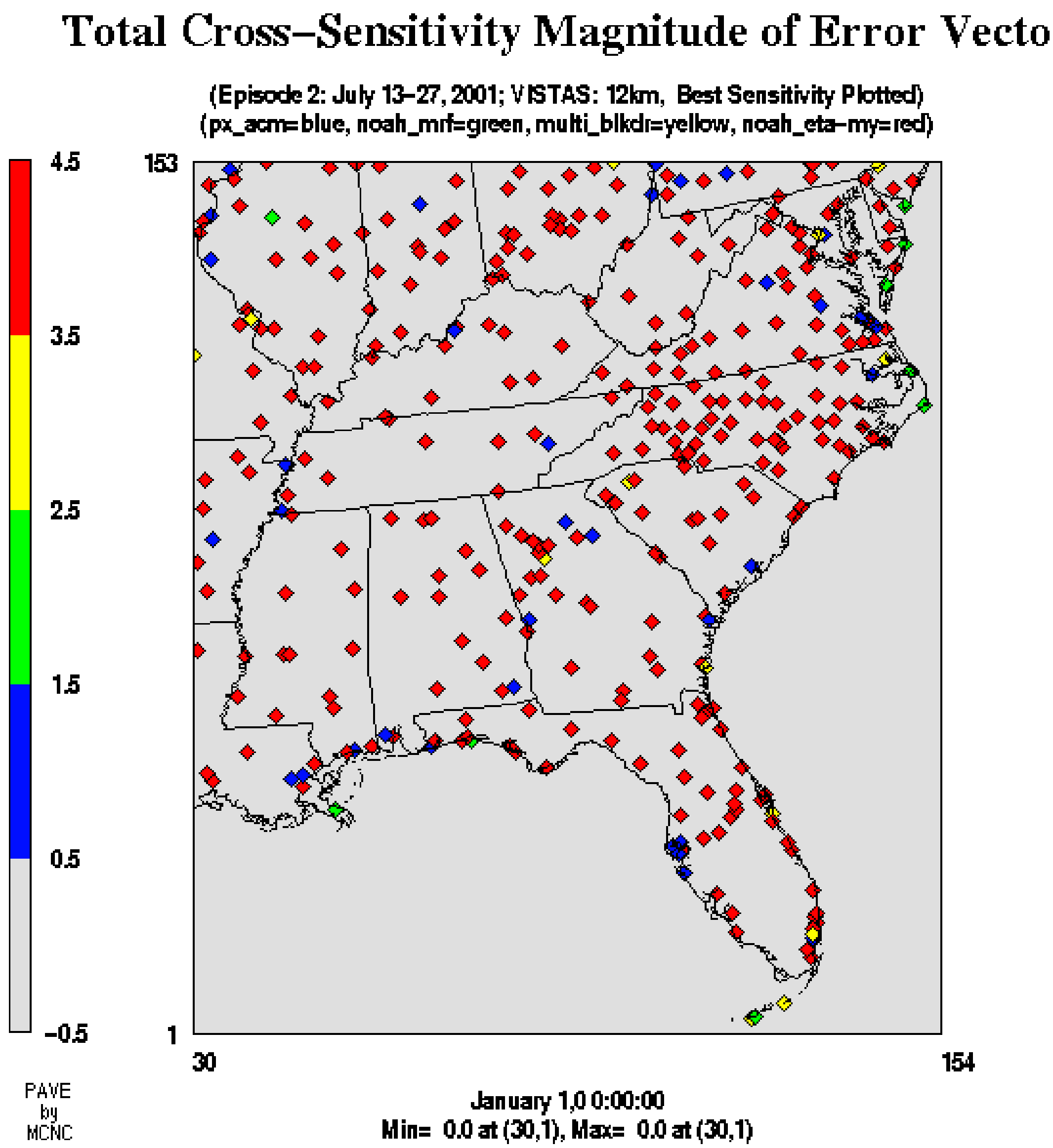

Figure 35. Episode 2 (Jul 13-28, 2001) cross-sensitivity error vector magnitude comparison plot is shown. Stations for which px_acm2 show the smallest composite error are plotted in blue, noah_mrf in green, multi_blkdr in yellow, and noah_eta-my in red. The date/time/max/min information at the bottom of the plot serves only as placeholders and should be ignored.

The remainder of this report will focus primarily on statistical tables. These tables are episode-composites and are divided into three sections. The top section contains bias, absolute error, coefficient of determination (r^2), index of agreement, and root mean square error for temperature (1.5 m), water vapor mixing ratio, relative humidity, wind speed (10 m), and cloud coverage. The second section contains additional statistics for winds, including wind direction bias, absolute wind direction error, U-wind component error, V-wind component error, and the magnitude of the average error wind vector. The latter metric is perhaps the single best means of assessing model wind performance. The final section contains precipitation statistics at various thresholds (0.01, 0.05, 0.10, 0.25, 0.5, and 1.0 inches) for daily precipitation accumulations. The metrics presented are accuracy, bias, false alarm ratio (FAR), probability of detection (POD), critical success index (CSI, i.e. threat score), equitable threat score (ETS), "true skill score" (TSS, i.e. Hanssen and Kuipers score), and Heidke skill score (HSS). These precipitation statistics are only generated for approximately the US portion of the grids; there are no RPO-specific statistics for this variable. Since an RPO-specific statistical summary is incomplete without some sort of precipitation metric, we have decided to use the precipitation statistics described above for every statistical composite we produce. The reader should understand the inconsistencies that this approach entails. Note also that the precipitation observational grids are obtained, in part, by objectively analyzing rain gauge data. This tends to "spread out" the measurable precipitation beyond where it actually occurs. Since a model does not do that, a perfect precipitation forecast might appear to be slightly low biased at the 0.01-inch threshold. At higher thresholds the number of valid occurrences may not reach a robust level.

Sensitivity px_acm2 is the base case for all of the statistical tables that follow. Table 1 shows the base case statistics for the US portion of the 36-km domain for episode 1, while table 2 reports statistics for the VISTAS 12-km domain for episode 1. Recall the meteorological statistical benchmarks reported by Emery (2001):

Wind speed:	RSME	<= 2 m/s,	Bias <= +/- 0.5 m/s,	IA >= 0.6
Wind direction:	Gross Error	<= 30 deg,	Bias <= +/- 10 deg.	
Temperature:	Gross Error	<= 2 K,	Bias <= +/- 0.5 K,	IA >= 0.8
Humidity:	Gross Error	<= 2 g/kg,	Bias <= +/- 1 g/kg,	IA >= 0.6

Note that the only metrics that fail to meet these benchmarks are temperature bias and error. It should be understood that the above benchmarks are based primarily on meteorological modeling of summertime episodes. While ideally we want less temperature bias and error, the results seen here are not unusually bad. Note that the index of agreement temperature statistic easily betters the benchmark value for both domains. No benchmarks exist for relative humidity, cloud cover, and precipitation. It is encouraging that these quantities are all relatively unbiased and appear to show reasonable skill.

Tables 3-4 show the episode 2 statistical tables for px_acm2 for the selected domains. The only base variable that fails to meet the above benchmark is wind direction gross error at 36-km resolution, and that value (32.27^o) is certainly in the ballpark. Given the weak synoptic forcing in this episode, it is likely that sub-synoptic forcing (e.g. terrain flows, thunderstorm outflows, etc…) unresolved adequately at this resolution degrades the wind direction performance. The other variables are modeled reasonably well, with a couple of possible exceptions. Note the positive cloud coverage bias (>7%) in table 4, and the positive precipitation bias at higher thresholds in both table 3 and table 4. The model appears to overestimate the extent and intensity of summertime convection. Similar results are seen for episode 3 (tables 5-6). The cloud biases are less than in episode 2, though the positive precipitation biases at higher thresholds are accentuated at 36-km resolution.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.14	2.30	0.879	0.963	3.0613
Mixing Ratio (g/kg)	0.07	0.53	0.876	0.967	0.7673
Rel. Humidity (%)	3.54	12.62	0.451	0.814	16.4208
Wind Speed (m/s)	-0.02	1.33	0.510	0.808	1.7307
Clouds (%)	-4.00	26.12	0.340	0.763	37.6462

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	1.913	25.11	1.2520	1.2552	1.7729

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.8360	1.0061	0.2760	0.7284	0.5701	0.4379	0.6102	0.6091
0.05	0.9038	1.1156	0.3204	0.7581	0.5585	0.4914	0.6898	0.6590
0.10	0.9352	1.1405	0.3308	0.7632	0.5541	0.5115	0.7187	0.6768
0.25	0.9703	1.0628	0.2959	0.7484	0.5693	0.5502	0.7309	0.7099
0.50	0.9845	1.0006	0.3133	0.6872	0.5232	0.5140	0.6792	0.6790
1.00	0.9940	0.8873	0.3833	0.5472	0.4083	0.4054	0.5446	0.5769

Table 1. Episode 1 composite statistical summary for base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.03	2.25	0.858	0.957	2.9596
Mixing Ratio (g/kg)	0.12	0.62	0.914	0.977	0.8708
Rel. Humidity (%)	3.36	12.79	0.422	0.802	16.7355
Wind Speed (m/s)	0.43	1.35	0.407	0.764	1.7320
Clouds (%)	0.95	22.80	0.419	0.809	34.9631

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	2.216	22.74	1.1604	1.2419	1.6996

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.8735	1.0329	0.2086	0.8174	0.6725	0.5513	0.7170	0.7108
0.05	0.9148	1.0648	0.2238	0.8265	0.6675	0.5955	0.7643	0.7465
0.10	0.9363	1.0381	0.2145	0.8154	0.6669	0.6159	0.7741	0.7623
0.25	0.9635	0.9532	0.1842	0.7776	0.6615	0.6343	0.7599	0.7763
0.50	0.9756	0.9480	0.2568	0.7045	0.5665	0.5511	0.6929	0.7106
1.00	0.9907	0.7899	0.3092	0.5457	0.4385	0.4337	0.5423	0.6050

Table 2. Episode 1 composite statistical summary for base case px_acm2 for the VISTAS portion of the 12-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.16	1.62	0.877	0.964	2.1443
Mixing Ratio (g/kg)	-0.17	1.47	0.809	0.947	1.9714
Rel. Humidity (%)	-0.28	9.78	0.672	0.904	13.0680
Wind Speed (m/s)	-0.20	1.24	0.429	0.772	1.6149
Clouds (%)	1.38	27.52	0.134	0.635	37.9526

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	2.010	32.37	1.2469	1.3037	1.8040

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.7375	0.8822	0.2501	0.6616	0.5420	0.3067	0.4663	0.4694
0.05	0.7578	1.0815	0.4105	0.6376	0.4415	0.2794	0.4470	0.4368
0.10	0.7807	1.2392	0.5089	0.6085	0.3732	0.2511	0.4363	0.4014
0.25	0.8387	1.5406	0.6509	0.5378	0.2685	0.2008	0.4137	0.3345
0.50	0.9052	1.6829	0.7565	0.4098	0.1803	0.1482	0.3416	0.2582
1.00	0.9715	1.5577	0.8696	0.2030	0.0862	0.0782	0.1849	0.1450

Table 3. Episode 2 composite statistical summary for base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.05	1.45	0.815	0.938	1.8473
Mixing Ratio (g/kg)	-0.17	1.38	0.749	0.924	1.7851
Rel. Humidity (%)	-0.72	9.44	0.541	0.858	12.4555
Wind Speed (m/s)	0.41	1.24	0.415	0.776	1.5632
Clouds (%)	7.27	30.11	0.170	0.660	39.2499

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-1.254	29.29	1.1294	1.2068	1.6529

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.7787	0.8714	0.1843	0.7108	0.6125	0.3855	0.5553	0.5564
0.05	0.7785	1.0044	0.3065	0.6966	0.5326	0.3524	0.5216	0.5211
0.10	0.7803	1.0860	0.3857	0.6672	0.4702	0.3176	0.4942	0.4821
0.25	0.8045	1.2707	0.5345	0.5915	0.3522	0.2503	0.4426	0.4003
0.50	0.8585	1.4779	0.6821	0.4699	0.2340	0.1784	0.3678	0.3028
1.00	0.9398	1.7059	0.8631	0.2336	0.0945	0.0774	0.1929	0.1436

Table 4. Episode 2 composite statistical summary for base case px_acm2 for the VISTAS portion of the 12-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.19	1.64	0.862	0.957	2.1492
Mixing Ratio (g/kg)	-0.25	1.49	0.771	0.934	1.9660
Rel. Humidity (%)	-0.22	9.77	0.640	0.893	12.9109
Wind Speed (m/s)	-0.34	1.24	0.490	0.801	1.6120
Clouds (%)	-0.59	26.66	0.179	0.672	36.8433

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	2.458	32.13	1.2014	1.2878	1.7612

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.7199	0.8128	0.2526	0.6075	0.5040	0.2749	0.4265	0.4313
0.05	0.7517	1.0015	0.4218	0.5791	0.4071	0.2520	0.4028	0.4026
0.10	0.7820	1.1542	0.5201	0.5539	0.3461	0.2305	0.3959	0.3746
0.25	0.8447	1.4487	0.6681	0.4808	0.2443	0.1813	0.3679	0.3070
0.50	0.9114	1.7663	0.7772	0.3936	0.1659	0.1371	0.3292	0.2412
1.00	0.9687	2.0344	0.9079	0.1874	0.0658	0.0579	0.1654	0.1095

Table 5. Episode 3 composite statistical summary for base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.18	1.52	0.821	0.933	1.9103
Mixing Ratio (g/kg)	0.01	1.35	0.488	0.833	1.7674
Rel. Humidity (%)	1.35	8.58	0.524	0.842	11.1546
Wind Speed (m/s)	0.13	1.16	0.282	0.699	1.4752
Clouds (%)	3.91	29.83	0.169	0.664	38.7202

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	1.595	34.59	1.0827	1.1372	1.5702

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.7015	0.8579	0.2708	0.6256	0.5077	0.2512	0.4006	0.4015
0.05	0.7219	0.9406	0.3852	0.5783	0.4245	0.2378	0.3791	0.3842
0.10	0.7461	0.9913	0.4560	0.5393	0.3714	0.2241	0.3651	0.3661
0.25	0.8068	1.0958	0.5801	0.4602	0.2813	0.1924	0.3351	0.3227
0.50	0.8806	1.2216	0.6944	0.3734	0.2020	0.1569	0.2986	0.2712
1.00	0.9536	1.5517	0.8494	0.2337	0.1008	0.0872	0.2037	0.1605

Table 6. Episode 3 composite statistical summary for base case px_acm2 for the VISTAS portion of the 12-km domain is shown.

To augment the statistical tables described above, we have also produced tables of statistical differences from the base case px_acm2. The table setup is precisely the same as above, but the differences reported are not simple differences. Instead we present differences designed to indicate whether the sensitivity produces better results than the base case. For some metrics (e.g. r^2, IA, CSI) larger numbers indicate improved performance. For these metrics we calculate differences: SENS – BASE. Positive results are color-coded green, indicating that the sensitivity improved performance. Negative results are color-coded red, indicating that the sensitivity degraded performance. For some other metrics (e.g. abserr, uverr, FAR) smaller numbers indicate improved performance. Thus the difference table shows BASE – SENS, and the color-coding described above still applies. Similarly the differences for the bias statistics are calculated relative to optimum performance (0 normally, 1 for precipitation). In this manner one can readily ascertain statistical benefits/disbenefits for all sensitivity runs. One should keep in mind that very small non-zero statistical changes are color-coded the same as significant changes, so the actual numerical change should be considered more important than the color-coding.

Tables 7-8 show the statistical difference results for sensitivity px_acm for episode 1. The most significant differences are found in the temperature metrics, revealing that the px_acm configuration is significantly more cold-biased than is px_acm2 for this wintertime episode. Most of the other surface variables also show degraded performance. The px_acm run does seem to very slightly improve cloud coverage and precipitation, but the improvements are very slight and are probably less meaningful than the temperature degradation. These performance patterns hold for both the US 36-km results and the VISTAS 12-km results. Tables 9-10 indicate very little performance difference between the two configurations for episode 2. Precipitation performance is slightly enhanced for this summertime period, while interestingly it actually slightly degrades in the other summertime episode (tables 11-12). Overall px_acm seems to be a less desirable configuration for annual modeling.

Tables 13-14 show the statistical difference results for the noah_mrf sensitivity for episode 1. The performance of mixing ratio and relative humidity for both grids seem to be improved slightly in this configuration. The remaining variables are degraded almost universally. Perhaps the most striking result seen in the episode 2 tables (tables 15-16) is the degraded mixing ratio performance, countermanding the wintertime result. The noah_mrf sensitivity is significantly more low-biased for this variable than is the base case px_acm2, especially for the 12-km VISTAS domain. At 36-km this seems to help the run actually improve its cloud and precipitation performance relative to the base. The 12-km results are more ambiguous for these variables. Generally similar results are found for episode 3 (tables 17-18). These findings, combined with the likelihood that the PBL heights are overestimated under this configuration, lead one to reject this configuration for annual modeling.

The multi_blkdr results for episode 1 are displayed in tables 19-20. With few exceptions this sensitivity shows degraded performance for all variables for both grid resolutions. The low temperature bias is perhaps the most significant issue with this configuration. The summertime tables for multi_blkdr (tables 21-24) show results that are generally degraded from px_acm2. This configuration clearly degrades performance compared with the base case px_acm2.

The noah_eta-my results are found in tables 25-30. As mentioned earlier this configuration tends to improve performance for winds, but the other variables tend to be degraded. Temperature especially is biased low for all grids/resolutions. Still, the superior surface wind performance of the noah_eta-my run deserves additional attention. To compare the performance of this run versus px_acm(2), we computed composite statistics at various sounding locations. These statistics considered only the 00 UTC (or 12 UTC) data in the composite. A plot of this type is shown in figure 36 for Greensboro, NC, episode 1, 00 UTC. Note that at the surface the wind errors are less in the noah_eta-my case than they are in the px_acm2 case, but for the majority of the lower portions of the atmosphere the opposite occurs. The large temperature/dew point biases/errors in the noah_eta-my are expected and corroborate what is seen in the surface statistics. Figure 37 shows that for this site similar results are found in the wind profile for a summer episode. Performance at other upper air stations vary, and for Florida stations the noah_eta-my results appear to be slightly improved over the px_acm results. Generally speaking, though, the improved wind performance for noah_eta-my appears to be relegated to the lowest model layer. For a multitude of reasons, therefore, this configuration is not recommended for the annual modeling.

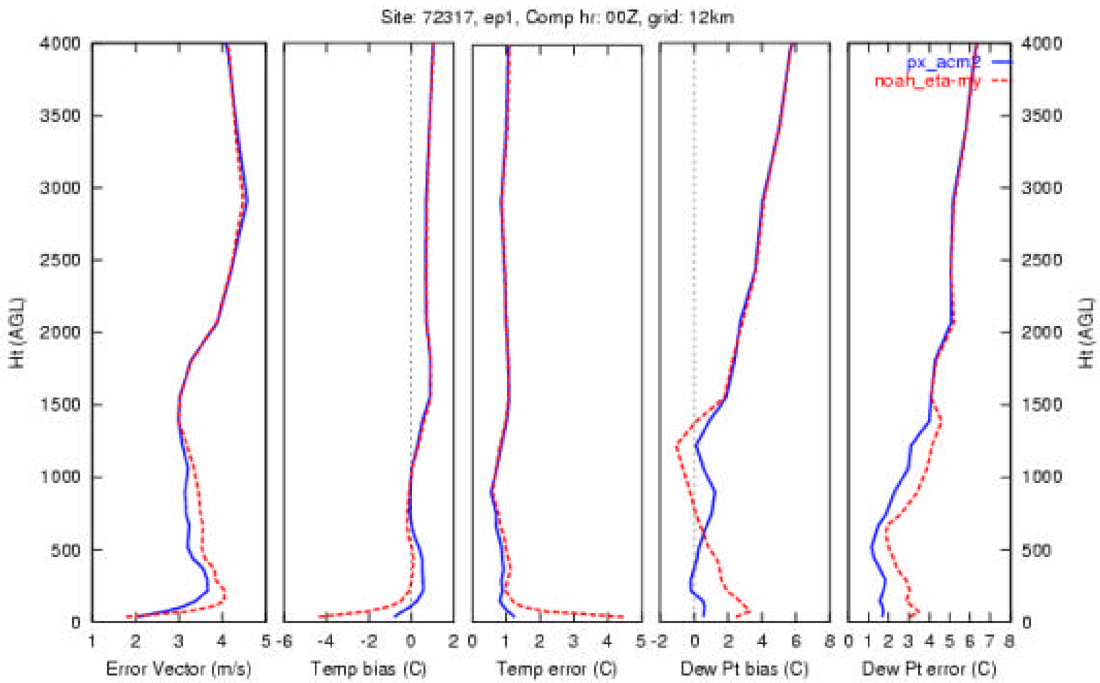

Figure 36. Episode 1 (Jan 2-21, 2002) composite vertical statistics for all 00 UTC times for Greensboro, NC are shown. The magnitude of the error vector is plotted in the leftmost panel, followed by temperature bias and error, then dew point bias and error. Blue represents the px_acm2 case, while dashed red shows the noah_eta-my results.

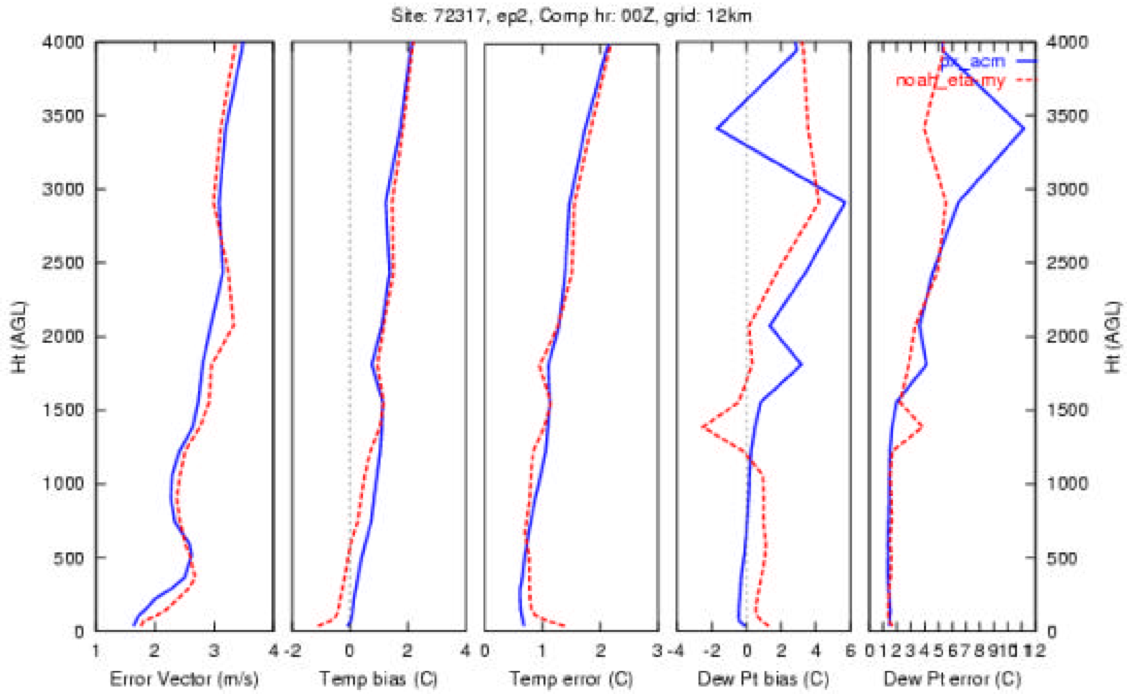

Figure 37. Episode 2 (Jul 13-28, 2001) composite vertical statistics for all 00 UTC times for Greensboro, NC are shown. The magnitude of the error vector is plotted in the leftmost panel, followed by temperature bias and error, then dew point bias and error. Blue represents the px_acm2 case, while dashed red shows the noah_eta-my results.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.92	-0.60	-0.021	-0.017	-0.6456
Mixing Ratio (g/kg)	-0.01	0.00	-0.002	-0.001	0.0023
Rel. Humidity (%)	0.26	-0.08	-0.017	-0.006	-0.1239
Wind Speed (m/s)	-0.02	-0.03	-0.022	-0.015	-0.0392
Clouds (%)	-0.23	0.12	0.002	0.001	0.0373

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.424	-0.06	-0.0205	-0.0178	-0.0270

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0035	-0.0140	0.0120	-0.0073	0.0028	0.0057	0.0008	0.0054
0.05	0.0023	0.0235	0.0104	-0.0045	0.0045	0.0057	-0.0010	0.0051
0.10	0.0014	0.0238	0.0097	-0.0051	0.0039	0.0045	-0.0029	0.0040
0.25	0.0006	0.0221	0.0103	-0.0049	0.0039	0.0042	-0.0038	0.0034
0.50	0.0000	-0.0111	0.0030	-0.0056	-0.0016	-0.0015	-0.0054	-0.0013
1.00	0.0000	-0.0051	-0.0010	-0.0041	-0.0027	-0.0028	-0.0040	-0.0028

Table 7. Episode 1 composite statistical comparison of sensitivity px_acm with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.05	-0.57	-0.015	-0.019	-0.6223
Mixing Ratio (g/kg)	0.04	-0.01	-0.006	-0.001	-0.0164
Rel. Humidity (%)	-0.28	-0.39	-0.026	-0.013	-0.5072
Wind Speed (m/s)	0.00	-0.04	-0.031	-0.019	-0.0431
Clouds (%)	0.16	0.07	0.001	0.001	0.0341

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.222	-0.24	-0.0291	-0.0208	-0.0351

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0059	0.0231	0.0219	-0.0121	0.0072	0.0125	0.0022	0.0103
0.05	0.0049	0.0370	0.0215	-0.0067	0.0112	0.0145	0.0013	0.0113
0.10	0.0024	0.0299	0.0160	-0.0073	0.0065	0.0080	-0.0031	0.0061
0.25	0.0006	-0.0251	0.0118	-0.0095	0.0007	0.0011	-0.0079	0.0008
0.50	0.0000	-0.0165	0.0041	-0.0084	-0.0030	-0.0030	-0.0079	-0.0025
1.00	-0.0001	-0.0202	0.0006	-0.0136	-0.0085	-0.0085	-0.0134	-0.0083

Table 8. Like table 7, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.04	0.05	0.004	0.002	0.0393
Mixing Ratio (g/kg)	-0.24	-0.04	0.003	-0.002	-0.0335
Rel. Humidity (%)	-1.56	-0.13	-0.003	-0.002	-0.2838
Wind Speed (m/s)	0.02	0.00	-0.001	0.000	-0.0004
Clouds (%)	0.06	-0.07	-0.002	-0.002	-0.0969

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.074	0.07	-0.0015	-0.0012	-0.0019

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0026	-0.0124	0.0068	-0.0034	0.0012	0.0043	0.0045	0.0050
0.05	0.0031	0.0170	0.0063	-0.0034	0.0019	0.0038	0.0025	0.0046
0.10	0.0032	0.0169	0.0059	-0.0010	0.0030	0.0042	0.0033	0.0053
0.25	0.0032	0.0281	0.0066	0.0002	0.0040	0.0047	0.0038	0.0064
0.50	0.0014	0.0371	0.0027	-0.0047	0.0005	0.0008	-0.0030	0.0012
1.00	0.0004	0.0356	0.0006	-0.0036	-0.0003	-0.0003	-0.0032	-0.0005

Table 9. Episode 2 composite statistical comparison of sensitivity px_acm with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.01	0.05	0.007	0.004	0.0413
Mixing Ratio (g/kg)	-0.20	-0.05	0.003	-0.002	-0.0506
Rel. Humidity (%)	-1.33	-0.13	0.004	-0.001	-0.3367
Wind Speed (m/s)	-0.02	0.00	-0.001	-0.001	-0.0069
Clouds (%)	0.07	-0.01	0.000	0.000	0.0241

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.092	0.04	-0.0035	-0.0038	-0.0051

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0029	-0.0150	0.0090	-0.0046	0.0015	0.0054	0.0055	0.0057
0.05	0.0030	-0.0130	0.0085	-0.0068	0.0010	0.0039	0.0019	0.0043
0.10	0.0040	0.0275	0.0093	-0.0071	0.0018	0.0045	0.0014	0.0052
0.25	0.0049	0.0391	0.0099	-0.0059	0.0035	0.0053	0.0014	0.0069
0.50	0.0048	0.0489	0.0119	0.0013	0.0067	0.0077	0.0064	0.0109
1.00	0.0011	0.0331	0.0047	0.0032	0.0027	0.0028	0.0042	0.0049

Table 10. Like table 9, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.14	-0.01	0.002	0.001	0.0048
Mixing Ratio (g/kg)	-0.25	-0.02	0.001	-0.002	-0.0184
Rel. Humidity (%)	-0.99	0.09	0.010	0.003	0.0700
Wind Speed (m/s)	0.01	0.00	-0.001	-0.001	0.0011
Clouds (%)	0.18	-0.15	-0.004	-0.002	-0.1736

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.009	0.08	-0.0012	-0.0004	-0.0012

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0166	0.0050	-0.0061	-0.0013	-0.0037	-0.0216	-0.0237	-0.0270
0.05	-0.0168	-0.0082	-0.0071	-0.0136	-0.0102	-0.0197	-0.0268	-0.0256
0.10	-0.0126	0.0113	-0.0130	-0.0203	-0.0145	-0.0190	-0.0286	-0.0254
0.25	-0.0067	-0.0385	-0.0312	-0.0335	-0.0250	-0.0246	-0.0384	-0.0360
0.50	0.0003	-0.1315	-0.0330	-0.0335	-0.0240	-0.0220	-0.0341	-0.0348
1.00	0.0027	0.0539	-0.0273	-0.0592	-0.0208	-0.0200	-0.0568	-0.0364

Table 11. Episode 3 composite statistical comparison of sensitivity px_acm with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.09	0.06	0.005	0.008	0.0655
Mixing Ratio (g/kg)	-0.22	0.00	-0.007	-0.004	-0.0056
Rel. Humidity (%)	1.01	0.17	0.022	0.013	0.2309
Wind Speed (m/s)	-0.03	-0.01	-0.004	-0.002	-0.0088
Clouds (%)	-0.11	-0.12	-0.002	-0.001	-0.0867

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.083	0.22	-0.0043	-0.0073	-0.0082

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0320	-0.0381	-0.0245	-0.0478	-0.0425	-0.0475	-0.0625	-0.0631
0.05	-0.0218	-0.0299	-0.0461	-0.0604	-0.0526	-0.0474	-0.0661	-0.0643
0.10	-0.0139	-0.0286	-0.0642	-0.0774	-0.0636	-0.0535	-0.0771	-0.0746
0.25	0.0057	-0.0350	-0.0865	-0.0832	-0.0664	-0.0530	-0.0770	-0.0781
0.50	0.0193	-0.0746	-0.0733	-0.0723	-0.0511	-0.0399	-0.0600	-0.0617
1.00	0.0152	0.1611	-0.0075	-0.0347	-0.0100	-0.0055	-0.0237	-0.0095

Table 12. Like table 11, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.14	-0.17	-0.012	-0.005	-0.1357
Mixing Ratio (g/kg)	0.01	0.04	0.009	0.002	0.0382
Rel. Humidity (%)	-0.40	0.22	0.006	0.000	0.3528
Wind Speed (m/s)	-0.13	-0.02	0.001	0.025	-0.0283
Clouds (%)	-2.68	-1.58	-0.042	-0.029	-1.4727

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-2.704	-0.27	-0.0108	-0.0156	-0.0187

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0153	-0.0554	-0.0359	0.0020	-0.0213	-0.0302	-0.0207	-0.0298
0.05	-0.0042	-0.0243	-0.0154	-0.0009	-0.0109	-0.0128	-0.0058	-0.0116
0.10	-0.0015	-0.0225	-0.0093	0.0042	-0.0042	-0.0050	0.0021	-0.0044
0.25	-0.0027	-0.0400	-0.0299	-0.0049	-0.0223	-0.0234	-0.0073	-0.0198
0.50	-0.0011	-0.0105	-0.0224	-0.0155	-0.0217	-0.0220	-0.0161	-0.0195
1.00	-0.0006	0.0437	-0.0464	-0.0162	-0.0290	-0.0293	-0.0167	-0.0303

Table 13. Episode 1 composite statistical comparison of sensitivity noah_mrf with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.29	-0.08	0.009	0.000	-0.0457
Mixing Ratio (g/kg)	0.00	0.04	0.007	0.002	0.0375
Rel. Humidity (%)	1.54	0.98	0.035	0.015	1.1957
Wind Speed (m/s)	0.18	-0.11	-0.060	-0.005	-0.1359
Clouds (%)	-1.84	-0.72	-0.027	-0.016	-0.5780

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-1.433	-1.71	-0.0155	-0.0637	-0.0575

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0325	-0.0745	-0.0657	-0.0137	-0.0561	-0.0767	-0.0549	-0.0671
0.05	-0.0071	-0.0054	-0.0174	-0.0144	-0.0221	-0.0258	-0.0196	-0.0207
0.10	-0.0041	0.0143	-0.0089	-0.0203	-0.0198	-0.0217	-0.0214	-0.0168
0.25	-0.0015	0.0054	-0.0103	-0.0054	-0.0107	-0.0114	-0.0066	-0.0087
0.50	0.0002	-0.0472	0.0152	-0.0214	-0.0055	-0.0053	-0.0201	-0.0044
1.00	-0.0003	0.0821	-0.0289	0.0315	0.0073	0.0070	0.0309	0.0068

Table 14. Like table 13, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.37	-0.27	-0.021	-0.005	-0.3041
Mixing Ratio (g/kg)	-0.67	-0.05	0.017	-0.005	-0.0018
Rel. Humidity (%)	-2.50	-0.02	0.016	-0.002	0.3326
Wind Speed (m/s)	-0.31	-0.20	-0.104	-0.047	-0.2402
Clouds (%)	0.83	0.50	0.005	0.001	0.6075

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-1.086	-0.53	-0.0358	-0.0394	-0.0531

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0003	-0.0157	0.0042	-0.0082	-0.0034	-0.0009	-0.0015	-0.0010
0.05	0.0058	0.0206	0.0109	-0.0007	0.0058	0.0085	0.0079	0.0103
0.10	0.0076	0.0410	0.0145	-0.0027	0.0072	0.0100	0.0077	0.0127
0.25	0.0150	0.1450	0.0331	-0.0045	0.0179	0.0214	0.0130	0.0292
0.50	0.0151	0.3081	0.0500	-0.0064	0.0243	0.0272	0.0098	0.0403
1.00	0.0047	0.2763	0.0575	0.0378	0.0318	0.0324	0.0419	0.0542

Table 15. Episode 2 composite statistical comparison of sensitivity noah_mrf with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.08	-0.18	-0.026	0.001	-0.2689
Mixing Ratio (g/kg)	-0.90	-0.18	-0.008	-0.024	-0.2066
Rel. Humidity (%)	-4.76	-0.32	0.041	-0.015	-0.0816
Wind Speed (m/s)	0.29	-0.27	-0.195	-0.084	-0.3222
Clouds (%)	4.64	0.49	-0.013	-0.007	0.5665

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.317	-1.61	-0.0994	-0.0984	-0.1397

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0069	-0.0472	0.0095	-0.0306	-0.0180	-0.0136	-0.0147	-0.0143
0.05	0.0031	-0.0423	0.0149	-0.0213	-0.0042	0.0013	-0.0043	0.0015
0.10	0.0049	0.0566	0.0143	-0.0201	-0.0021	0.0026	-0.0049	0.0030
0.25	0.0085	0.0674	0.0179	-0.0098	0.0065	0.0097	0.0028	0.0124
0.50	0.0094	0.0540	0.0288	0.0238	0.0217	0.0232	0.0316	0.0327
1.00	0.0023	-0.0311	0.0312	0.0583	0.0249	0.0248	0.0591	0.0419

Table 16. Like table 15, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.25	-0.13	-0.017	0.000	-0.1497
Mixing Ratio (g/kg)	-0.74	-0.08	0.020	-0.009	-0.0576
Rel. Humidity (%)	-3.06	0.00	0.018	-0.001	0.1712
Wind Speed (m/s)	-0.32	-0.20	-0.084	-0.038	-0.2410
Clouds (%)	-1.72	-0.03	-0.008	-0.007	-0.0666

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.471	-0.27	-0.0195	-0.0240	-0.0309

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0017	-0.0352	0.0089	-0.0194	-0.0096	-0.0037	-0.0055	-0.0047
0.05	0.0086	-0.0425	0.0190	-0.0082	0.0051	0.0103	0.0075	0.0130
0.10	0.0110	0.0771	0.0229	-0.0123	0.0066	0.0115	0.0048	0.0150
0.25	0.0154	0.1750	0.0351	-0.0134	0.0145	0.0185	0.0055	0.0261
0.50	0.0144	0.3705	0.0420	-0.0240	0.0165	0.0193	-0.0077	0.0293
1.00	0.0073	0.6216	0.0406	0.0000	0.0184	0.0194	0.0074	0.0341

Table 17. Episode 3 composite statistical comparison of sensitivity noah_mrf with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.13	0.01	-0.032	0.008	-0.0685
Mixing Ratio (g/kg)	-0.95	-0.11	0.010	-0.036	-0.1291
Rel. Humidity (%)	-2.84	-0.35	0.028	-0.003	-0.3691
Wind Speed (m/s)	-0.17	-0.30	-0.159	-0.085	-0.3600
Clouds (%)	2.88	0.55	0.001	-0.004	1.1355

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	1.036	-1.65	-0.0814	-0.0266	-0.0759

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0044	-0.0586	0.0225	-0.0248	-0.0064	0.0065	0.0080	0.0083
0.05	0.0116	-0.0506	0.0250	-0.0089	0.0067	0.0147	0.0141	0.0190
0.10	0.0112	-0.0575	0.0244	-0.0085	0.0069	0.0129	0.0104	0.0171
0.25	0.0111	0.0901	0.0257	-0.0171	0.0043	0.0091	-0.0004	0.0128
0.50	0.0100	0.1478	0.0306	-0.0124	0.0088	0.0117	-0.0004	0.0173
1.00	0.0047	0.1971	0.0281	0.0083	0.0138	0.0145	0.0130	0.0242

Table 18. Like table 17, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.36	-0.22	-0.023	-0.010	-0.3301
Mixing Ratio (g/kg)	-0.31	-0.14	-0.033	-0.017	-0.1974
Rel. Humidity (%)	-11.03	-4.38	-0.080	-0.147	-5.0237
Wind Speed (m/s)	-0.26	-0.05	-0.002	0.024	-0.0604
Clouds (%)	2.38	-1.57	-0.042	-0.020	-1.3545

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-1.938	-0.38	-0.0476	-0.0389	-0.0611

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0282	-0.1382	0.0682	0.0220	-0.0318	-0.0495	-0.0275	-0.0496
0.05	-0.0058	-0.0490	0.0231	0.0065	-0.0124	-0.0152	-0.0017	-0.0138
0.10	-0.0028	-0.0385	0.0168	0.0060	-0.0085	-0.0099	0.0021	-0.0087
0.25	-0.0012	-0.0291	0.0154	0.0036	-0.0080	-0.0086	0.0023	-0.0072
0.50	-0.0004	-0.0099	0.0091	-0.0025	-0.0068	-0.0069	-0.0028	-0.0060
1.00	-0.0001	-0.0284	0.0009	-0.0183	-0.0106	-0.0106	-0.0182	-0.0108

Table 19. Episode 1 composite statistical comparison of sensitivity multi_blkdr with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.75	-0.38	-0.025	-0.017	-0.5501
Mixing Ratio (g/kg)	-0.30	-0.12	-0.008	-0.007	-0.1244
Rel. Humidity (%)	-11.86	-4.44	-0.072	-0.159	-5.5613
Wind Speed (m/s)	-0.04	-0.09	-0.003	0.019	-0.1052
Clouds (%)	0.45	-0.03	-0.003	-0.002	-0.0372

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.167	-1.15	-0.0333	-0.0397	-0.0518

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0496	-0.1959	0.1099	0.0200	-0.0707	-0.1048	-0.0620	-0.0935
0.05	-0.0072	-0.0412	0.0260	0.0032	-0.0174	-0.0219	-0.0067	-0.0175
0.10	-0.0035	-0.0233	0.0168	0.0005	-0.0119	-0.0139	-0.0038	-0.0108
0.25	-0.0017	0.0177	0.0156	-0.0007	-0.0108	-0.0117	-0.0026	-0.0089
0.50	-0.0010	0.0061	0.0137	-0.0084	-0.0132	-0.0137	-0.0091	-0.0115
1.00	-0.0003	0.0150	0.0154	-0.0021	-0.0075	-0.0076	-0.0022	-0.0074

Table 20. Like table 19, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.02	-0.14	-0.019	-0.006	-0.1609
Mixing Ratio (g/kg)	0.15	-0.02	-0.030	-0.010	-0.0399
Rel. Humidity (%)	-0.65	-0.48	-0.032	-0.021	-0.2737
Wind Speed (m/s)	0.10	-0.12	-0.073	-0.018	-0.1302
Clouds (%)	0.04	0.91	0.011	0.005	0.9705

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.841	-0.24	-0.0488	-0.0678	-0.0828

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0254	0.0395	0.0400	-0.0073	-0.0257	-0.0413	-0.0487	-0.0499
0.05	-0.0254	-0.0682	0.0421	-0.0083	-0.0276	-0.0377	-0.0411	-0.0475
0.10	-0.0229	-0.0816	0.0399	-0.0125	-0.0276	-0.0342	-0.0382	-0.0449
0.25	-0.0107	-0.0272	0.0284	-0.0350	-0.0250	-0.0263	-0.0426	-0.0373
0.50	0.0007	0.1146	0.0144	-0.0505	-0.0176	-0.0169	-0.0471	-0.0261
1.00	0.0023	0.1937	-0.0100	-0.0116	0.0019	0.0023	-0.0092	0.0040

Table 21. Episode 2 composite statistical comparison of sensitivity multi_blkdr with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.22	-0.02	-0.019	0.002	-0.0627
Mixing Ratio (g/kg)	-0.23	0.05	-0.009	-0.002	0.0662
Rel. Humidity (%)	-1.53	0.68	0.060	0.014	1.1438
Wind Speed (m/s)	-0.11	-0.23	-0.108	-0.044	-0.2627
Clouds (%)	4.25	0.65	-0.007	-0.004	0.8315

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.872	-0.25	-0.0930	-0.1375	-0.1640

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0136	-0.0485	-0.0018	-0.0381	-0.0276	-0.0261	-0.0280	-0.0276
0.05	-0.0051	-0.0353	-0.0016	-0.0291	-0.0162	-0.0142	-0.0204	-0.0156
0.10	-0.0035	0.0398	0.0015	-0.0260	-0.0139	-0.0125	-0.0203	-0.0145
0.25	-0.0005	0.0463	0.0024	-0.0245	-0.0101	-0.0089	-0.0196	-0.0114
0.50	0.0020	0.0806	0.0027	-0.0294	-0.0089	-0.0078	-0.0242	-0.0113
1.00	0.0059	0.2326	-0.0171	-0.0067	0.0065	0.0074	-0.0005	0.0128

Table 22. Like table 21, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.16	-0.03	-0.011	-0.001	-0.0470
Mixing Ratio (g/kg)	-0.12	0.01	-0.016	-0.008	0.0215
Rel. Humidity (%)	-0.31	-0.16	-0.026	-0.015	-0.0298
Wind Speed (m/s)	0.10	-0.13	-0.081	-0.017	-0.1462
Clouds (%)	-2.60	0.38	0.001	-0.002	0.2603

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-1.000	-0.37	-0.0601	-0.0617	-0.0861

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0193	0.0011	0.0256	-0.0200	-0.0250	-0.0310	-0.0386	-0.0391
0.05	-0.0119	-0.0047	0.0197	-0.0240	-0.0213	-0.0230	-0.0308	-0.0299
0.10	-0.0080	0.0283	0.0177	-0.0335	-0.0220	-0.0220	-0.0348	-0.0296
0.25	0.0034	0.1115	0.0018	-0.0394	-0.0115	-0.0095	-0.0310	-0.0138
0.50	0.0079	0.2509	-0.0122	-0.0374	-0.0009	0.0008	-0.0274	0.0011
1.00	0.0052	0.5231	-0.0052	-0.0403	-0.0036	-0.0028	-0.0345	-0.0050

Table 23. Episode 3 composite statistical comparison of sensitivity multi_blkdr with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.14	0.07	-0.009	0.007	0.0185
Mixing Ratio (g/kg)	-0.40	-0.02	-0.004	-0.006	-0.0280
Rel. Humidity (%)	-0.41	-0.12	0.014	0.008	-0.0297
Wind Speed (m/s)	0.02	-0.22	-0.119	-0.050	-0.2555
Clouds (%)	2.84	0.87	0.013	0.006	1.2969

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.528	0.09	-0.0884	-0.0628	-0.1066

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0069	-0.1108	-0.0247	-0.0624	-0.0319	-0.0115	-0.0155	-0.0148
0.05	0.0041	-0.1003	-0.0205	-0.0445	-0.0159	-0.0040	-0.0137	-0.0052
0.10	0.0012	-0.0871	-0.0066	-0.0415	-0.0174	-0.0108	-0.0239	-0.0145
0.25	0.0001	0.0839	0.0063	-0.0417	-0.0187	-0.0157	-0.0333	-0.0223
0.50	0.0033	0.1390	0.0062	-0.0492	-0.0176	-0.0153	-0.0412	-0.0232
1.00	0.0033	0.2018	-0.0040	-0.0250	-0.0033	-0.0026	-0.0210	-0.0045

Table 24. Like table 23, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.30	-0.90	-0.046	-0.030	-1.1408
Mixing Ratio (g/kg)	-0.06	-0.08	-0.022	-0.007	-0.0803
Rel. Humidity (%)	-10.88	-4.71	-0.077	-0.125	-5.2197
Wind Speed (m/s)	-0.06	0.03	0.026	0.028	0.0442
Clouds (%)	1.19	-0.98	-0.016	-0.011	-0.2897

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.668	0.35	0.0371	0.0318	0.0487

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0434	-0.2155	-0.0990	0.0351	-0.0465	-0.0732	-0.0418	-0.0747
0.05	-0.0015	-0.0123	-0.0063	0.0013	-0.0036	-0.0043	-0.0008	-0.0039
0.10	0.0003	0.0009	0.0015	0.0011	0.0017	0.0017	0.0013	0.0015
0.25	-0.0001	0.0093	0.0016	-0.0050	-0.0019	-0.0018	-0.0047	-0.0016
0.50	-0.0002	-0.0047	-0.0015	-0.0056	-0.0041	-0.0042	-0.0056	-0.0036
1.00	-0.0001	-0.0142	-0.0051	-0.0132	-0.0095	-0.0096	-0.0132	-0.0098

Table 25. Episode 1 composite statistical comparison of sensitivity noah_eta-my with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.08	-0.56	-0.012	-0.018	-0.7253
Mixing Ratio (g/kg)	-0.07	-0.06	-0.010	-0.003	-0.0629
Rel. Humidity (%)	-8.65	-2.57	-0.041	-0.092	-3.3834
Wind Speed (m/s)	0.29	0.09	0.050	0.042	0.1122
Clouds (%)	-0.05	0.00	0.001	0.001	-0.0017

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.568	-0.15	0.0837	0.0833	0.1179

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0759	-0.3018	-0.1553	0.0315	-0.1011	-0.1512	-0.0944	-0.1393
0.05	-0.0080	-0.0418	-0.0277	0.0018	-0.0196	-0.0244	-0.0087	-0.0195
0.10	-0.0023	-0.0065	-0.0088	-0.0040	-0.0090	-0.0103	-0.0060	-0.0079
0.25	-0.0009	0.0020	-0.0058	-0.0039	-0.0067	-0.0071	-0.0045	-0.0054
0.50	-0.0007	0.0135	-0.0115	-0.0010	-0.0073	-0.0077	-0.0017	-0.0064
1.00	-0.0002	0.0539	-0.0179	0.0221	0.0065	0.0063	0.0217	0.0061

Table 26. Like table 25, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.15	-0.71	-0.043	-0.022	-0.8789
Mixing Ratio (g/kg)	0.00	0.05	0.009	0.003	0.0895
Rel. Humidity (%)	-5.67	-0.74	0.032	-0.008	-0.5429
Wind Speed (m/s)	-0.24	0.00	0.026	0.002	-0.0108
Clouds (%)	-0.54	0.45	-0.006	-0.008	0.2731

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	1.138	0.31	0.0335	0.0337	0.0475

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0176	0.1064	-0.0459	0.0344	-0.0036	-0.0269	-0.0293	-0.0321
0.05	-0.0149	-0.1029	-0.0288	0.0265	-0.0046	-0.0146	-0.0062	-0.0180
0.10	-0.0181	-0.1142	-0.0304	0.0150	-0.0128	-0.0197	-0.0122	-0.0255
0.25	-0.0085	-0.0389	-0.0208	-0.0193	-0.0169	-0.0182	-0.0264	-0.0256
0.50	0.0045	0.1814	-0.0016	-0.0465	-0.0104	-0.0091	-0.0393	-0.0139
1.00	0.0040	0.3590	0.0130	-0.0311	-0.0014	-0.0006	-0.0268	-0.0010

Table 27. Episode 2 composite statistical comparison of sensitivity noah_eta-my with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.81	-0.45	-0.025	-0.014	-0.6594
Mixing Ratio (g/kg)	0.04	0.05	-0.001	0.003	0.0776
Rel. Humidity (%)	-1.75	1.04	0.105	0.029	1.7577
Wind Speed (m/s)	0.29	0.09	0.023	0.019	0.0956
Clouds (%)	4.90	0.36	-0.013	-0.007	0.4730

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-1.641	0.26	0.0688	0.0883	0.1115

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0024	0.0915	-0.0481	0.0853	0.0290	0.0056	0.0073	0.0059
0.05	-0.0126	-0.1823	-0.0444	0.0737	0.0113	-0.0074	0.0121	-0.0081
0.10	-0.0169	-0.1763	-0.0389	0.0592	0.0027	-0.0113	0.0109	-0.0131
0.25	-0.0111	-0.0996	-0.0201	0.0189	-0.0054	-0.0098	0.0012	-0.0125
0.50	0.0045	0.1230	0.0012	-0.0375	-0.0091	-0.0072	-0.0288	-0.0105
1.00	0.0101	0.4790	0.0112	-0.0519	-0.0057	-0.0035	-0.0401	-0.0060

Table 28. Like table 27, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-1.08	-0.65	-0.052	-0.022	-0.7857
Mixing Ratio (g/kg)	0.24	0.07	0.013	0.006	0.1111
Rel. Humidity (%)	-5.41	-0.81	0.018	-0.011	-0.8111
Wind Speed (m/s)	-0.23	-0.02	0.032	0.000	-0.0192
Clouds (%)	-3.24	0.25	-0.004	-0.005	0.0162

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	1.051	0.49	0.0283	0.0293	0.0407

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0211	0.1203	-0.0560	0.0376	-0.0031	-0.0305	-0.0353	-0.0385
0.05	-0.0115	-0.0834	-0.0240	0.0222	-0.0018	-0.0099	-0.0033	-0.0128
0.10	-0.0108	-0.0680	-0.0201	0.0081	-0.0076	-0.0118	-0.0076	-0.0157
0.25	-0.0009	0.0351	-0.0070	-0.0215	-0.0093	-0.0088	-0.0200	-0.0128
0.50	0.0058	0.2353	-0.0001	-0.0527	-0.0102	-0.0087	-0.0441	-0.0137
1.00	0.0061	0.5801	0.0139	-0.0332	0.0012	0.0022	-0.0267	0.0038

Table 29. Episode 3 composite statistical comparison of sensitivity noah_eta-my with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.52	-0.27	-0.052	-0.005	-0.4031
Mixing Ratio (g/kg)	-0.12	0.00	-0.003	0.000	-0.0028
Rel. Humidity (%)	-1.43	-0.02	0.022	0.006	-0.1437
Wind Speed (m/s)	-0.03	0.03	0.033	0.014	0.0470
Clouds (%)	0.01	1.11	0.020	0.010	1.3794

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.358	0.67	0.0526	0.0891	0.1007

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0031	0.0764	-0.0417	0.1071	0.0419	0.0064	0.0095	0.0082
0.05	-0.0133	-0.1067	-0.0382	0.0940	0.0256	0.0017	0.0218	0.0022
0.10	-0.0267	-0.1942	-0.0475	0.0579	0.0005	-0.0175	-0.0013	-0.0237
0.25	-0.0168	-0.0750	-0.0384	-0.0136	-0.0223	-0.0264	-0.0309	-0.0380
0.50	0.0068	0.1725	0.0080	-0.0444	-0.0108	-0.0077	-0.0331	-0.0115
1.00	0.0093	0.5063	0.0305	-0.0444	0.0012	0.0034	-0.0339	0.0056

Table 30. Like table 29, except for 12-km VISTAS domain.

5 Auxiliary Results

The results from the five main sensitivity runs indicate that the px_acm2 configuration is overall the preferred option for annual modeling. Still there are numerous model options that are not tested in the above configurations. Accordingly we have conducted a variety of auxiliary sensitivity tests with limited analyses. These include:

- **px_acm3**: Like px_acm2, except with soil moisture/temperature initialization for P-X soil layer 2 from EDAS soil layer 3 (40-100 cm).
- **px_acm4**: Like px_acm2, except it uses the SFCFDDA file from RAWINS and MMINPUT files processed using RAWINS data rather than REGRID data.
- **px_acm5**: Like px_acm2, except it uses Reisner 2 microphysics rather than Reisner 1.
- **px_acm6**: Like px_acm2, except analysis nudging strengths aloft for wind/temps are increased from 2.5E-4, 1.0E-4 (36/12 km) to 3.0E-4, 3.0E-4.
- **px_acm7**: Like px_acm2, except the SFCFDDA files from RAWINS are used instead of those from LITTLE_R.
- **px_acm8**: Like px_acm2, except the MMINPUT files are processed using data from LITTLE_R rather than from REGRID.
- **px_acm9**: Like px_acm3, except the initialization for soil temperature/moisture is based on a 25% weighting of EDAS soil layer 1 (0-10 cm) values and a 75% weighting from EDAS soil layer 3 (40-100 cm). Code supplied by Aijun Xiu; executed for episode 3 only.
- **px_acm_n**: Like px_acm2, except surface analysis nudging is turned on for temp/moisture at a strength of 2.5E-4, 1.0E-4 (36, 12 km temps) and 1.0E-4, 1.0E-4 (36, 12 km moisture).
- **px_acm_n2**: Like px_acm_n, except surface analysis nudging for moisture ss reduced to 1.0E-5, 1.0E-5 (36, 12 km). Run only for episode 2.
- **s0px_acm2**: Like px_acm2, except snow cover effects are not considered (IFSNOW=0) as opposed to IFSNOW=1 in px_acm2. Run only for episode 1.
- **s2px_acm2**: Like px_acm2, except the simple snow model is employed (IFSNOW=2) as opposed to IFSNOW=1 in px_acm2. Run only for episode 1.
- **n0_px_acm2**: Like px_acm2, except soil moisture nudging is turned off.

For the most part the analyses of these runs will be statistical and will follow the statistical table format detailed in the prior section. The goal is to quickly determine whether the option being tested proves beneficial. The analyses are limited to the wintertime episode 1 and the longer of the two summertime episodes, episode 2. Recall that the px_acm2 run, while performing the best of the original five sensitivities, failed to meet the statistical "benchmark" for temperature for episode 1. The px_acm3 configuration is an attempt to rectify this bias by initializing the model from the single most appropriate EDAS soil layer (40-100 cm). This run included an error correction pass that reduced the effect of "missing" values in the EDAS data set. Tables 31-32 show the results of this sensitivity for episode 1 for both grid resolutions modeled. Note the vast improvement in temperature bias in both tables. Most of the other variables are relatively unaffected.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.65	0.17	-0.002	0.003	0.2029
Mixing Ratio (g/kg)	0.05	0.00	-0.002	0.000	-0.0035
Rel. Humidity (%)	2.53	0.18	0.025	0.015	0.1032
Wind Speed (m/s)	-0.03	0.02	0.010	0.009	0.0192
Clouds (%)	-0.02	-0.01	0.001	0.000	0.0497

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.643	-0.02	0.0072	0.0026	0.0070

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0028	-0.0257	-0.0101	0.0082	-0.0014	-0.0038	0.0007	-0.0037
0.05	-0.0016	-0.0193	-0.0075	0.0047	-0.0026	-0.0034	0.0019	-0.0031
0.10	-0.0012	-0.0252	-0.0086	0.0069	-0.0023	-0.0030	0.0048	-0.0026
0.25	-0.0007	-0.0199	-0.0092	0.0039	-0.0038	-0.0041	0.0031	-0.0035
0.50	-0.0002	-0.0251	-0.0083	0.0086	0.0000	-0.0001	0.0082	-0.0001
1.00	0.0000	0.0152	-0.0014	0.0081	0.0039	0.0038	0.0081	0.0039

Table 31. Episode 1 composite statistical comparison of sensitivity px_acm3 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.96	0.13	-0.004	0.002	0.1753
Mixing Ratio (g/kg)	0.03	0.00	0.003	0.001	0.0160
Rel. Humidity (%)	3.05	0.39	0.043	0.025	0.2853
Wind Speed (m/s)	-0.09	0.00	0.022	0.011	0.0014
Clouds (%)	0.19	-0.09	-0.002	-0.001	-0.0258

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.913	0.13	0.0089	-0.0115	-0.0025

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0028	-0.0285	-0.0119	0.0100	-0.0021	-0.0049	0.0013	-0.0041
0.05	-0.0013	-0.0182	-0.0076	0.0059	-0.0019	-0.0029	0.0027	-0.0023
0.10	-0.0013	-0.0242	-0.0105	0.0079	-0.0024	-0.0034	0.0049	-0.0026
0.25	-0.0009	0.0187	-0.0113	0.0043	-0.0044	-0.0050	0.0029	-0.0038
0.50	-0.0004	0.0186	-0.0093	0.0049	-0.0022	-0.0026	0.0043	-0.0021
1.00	-0.0002	0.0146	-0.0105	0.0016	-0.0032	-0.0032	0.0015	-0.0031

Table 32. Like table 31, except for 12-km VISTAS domain.

Unfortunately the improvements noted in the wintertime episode do not translate to the summer episode (tables 33-34). In fact the results indicate a degraded bias result, with the temperatures more significantly cold-biased for both resolutions modeled. The remaining variables tend to be relatively unaffected, generally showing a very slight degradation in performance. If this sensitivity had produced superior results for all episodes, we would recommend further efforts to possibly improve the initialization of the P-X module in MM5. Given the ad hoc nature of this sensitivity test that only yields mixed-bag results at best, we do not recommend applying this approach for the annual modeling.

An alternative approach to using LITTLE_R in the MM5 preprocessing stream is to use RAWINS. Functionally they serve the same purpose, which is to use observations to “improve” the first-guess and analysis fields that drive MM5. NCAR recommends that users employ LITTLE_R, which is a newer, more flexible program, but also somewhat more difficult to implement. (Unfortunately when this project started the documentation for LITTLE_R was less than stellar. The updated documentation indicates that upper air data “probably should” be added to the **sfc_obs** files; we plan to do just that for the annual modeling, but these tests will not have that “benefit”.) Prior modeling results found little difference between using these programs and not using them at all. To use P-X in the recommended manner (i.e. with indirect soil nudging) requires that the SFCFDDA file be available, which necessitates running one of those objective analysis preprocessors. The px-acm2 configuration used LITTLE_R only for that purpose. The px_acm4 configuration is actually a two-fold sensitivity in that it tests the effects of 1) running RAWINS rather than LITTLE_R to generate the SFCFDDA files, and 2) using objective analysis (RAWINS, in this case) output as input to INTERPF, as opposed to using REGRID output. Tables 35-36 show the results for the wintertime episode. In general we see improvement for most of the variables, especially for the VISTAS 12-km domain. Precipitation results are very slightly degraded, but not significantly so. The summertime results for this sensitivity are shown in tables 37-38, and they indicate no clear overall improvement/degradation.

The Reisner 2 microphysics package is sophisticated and computationally expensive, but is believed to incorporate the appropriate science necessary to properly model precipitation over a variety of conditions. Tables 39-40 show the statistical differences for the wintertime episode. Interestingly enough this px_acm5 sensitivity yields improved temperature and cloud coverage performance, but the precipitation skill scores show a very slight degradation. Summertime performance for this sensitivity (tables 41-42) show generally degraded performance. These results do not justify the increased computational/storage cost of implementing Reisner 2 microphysics.

Sensitivity test px_acm6 is designed to show the effects of nudging strength. The very slight increase in nudging strength at 36-km is not expected to have a large effect on the results, and the episode 1 statistical difference table (table 43) bears this out. The 12-km results (table 44) are a little more interesting since the nudging strength aloft is increased more dramatically. The idea is that above the planetary boundary layer synoptic conditions prevail, thus making analysis nudging at a reasonably strong level appropriate. In the boundary layer itself the wind nudging is kept at a relatively weak level. We do note an improvement in the temperature and precipitation metrics, but a slight degradation in mixing ratio and winds. The summer case expectedly reveals little change at 36-km resolution (table 45), while the 12-km results (table 46) show decreased skill for almost all variables, with temperature and winds being the notable exceptions. Overall it is hard to justify this configuration as an improvement over the base case.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.62	-0.23	-0.018	-0.007	-0.2704
Mixing Ratio (g/kg)	-0.25	-0.03	-0.006	-0.004	-0.0304
Rel. Humidity (%)	-0.09	-0.18	-0.009	-0.003	-0.2014
Wind Speed (m/s)	0.00	-0.01	-0.008	-0.005	-0.0114
Clouds (%)	0.15	0.06	0.001	0.001	-0.0039

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.147	0.07	-0.0061	-0.0036	-0.0068

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0068	-0.0401	0.0033	-0.0273	-0.0168	-0.0126	-0.0159	-0.0149
0.05	0.0005	0.0599	0.0060	-0.0292	-0.0110	-0.0069	-0.0160	-0.0085
0.10	0.0043	0.0794	0.0079	-0.0297	-0.0071	-0.0034	-0.0162	-0.0044
0.25	0.0075	0.1285	0.0101	-0.0305	-0.0022	0.0003	-0.0184	0.0004
0.50	0.0061	0.1842	0.0082	-0.0326	-0.0025	-0.0010	-0.0245	-0.0016
1.00	0.0031	0.2807	0.0104	-0.0232	-0.0004	0.0001	-0.0198	0.0003

Table 33. Episode 2 composite statistical comparison of sensitivity px_acm3 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.37	-0.05	-0.006	-0.001	-0.0514
Mixing Ratio (g/kg)	-0.08	0.01	0.001	0.001	0.0144
Rel. Humidity (%)	0.60	-0.11	-0.005	-0.002	-0.0932
Wind Speed (m/s)	0.01	0.00	-0.011	-0.006	-0.0085
Clouds (%)	-0.25	0.09	0.003	0.003	0.0358

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.273	-0.07	-0.0054	-0.0047	-0.0071

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0050	-0.0409	0.0094	-0.0255	-0.0141	-0.0099	-0.0107	-0.0103
0.05	0.0019	-0.0455	0.0138	-0.0246	-0.0068	-0.0014	-0.0076	-0.0015
0.10	0.0050	0.0672	0.0159	-0.0252	-0.0039	0.0015	-0.0077	0.0017
0.25	0.0080	0.0981	0.0162	-0.0267	-0.0009	0.0031	-0.0110	0.0040
0.50	0.0071	0.1388	0.0097	-0.0312	-0.0031	-0.0008	-0.0203	-0.0012
1.00	0.0051	0.2605	-0.0003	-0.0361	-0.0067	-0.0056	-0.0299	-0.0096

Table 34. Like table 33, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.08	0.07	0.004	0.002	0.0950
Mixing Ratio (g/kg)	-0.02	0.01	0.003	0.000	0.0093
Rel. Humidity (%)	-0.18	0.09	0.009	0.003	0.1488
Wind Speed (m/s)	0.02	-0.03	-0.024	-0.010	-0.0397
Clouds (%)	-0.22	-0.15	-0.006	-0.003	-0.2251

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.255	-0.62	-0.0339	-0.0300	-0.0452

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0033	-0.0153	-0.0087	0.0022	-0.0041	-0.0062	-0.0035	-0.0061
0.05	-0.0010	-0.0074	-0.0042	0.0004	-0.0026	-0.0031	-0.0009	-0.0028
0.10	-0.0010	-0.0073	-0.0050	-0.0009	-0.0039	-0.0044	-0.0018	-0.0038
0.25	-0.0001	0.0203	0.0032	-0.0110	-0.0043	-0.0042	-0.0104	-0.0036
0.50	0.0000	-0.0346	0.0079	-0.0170	-0.0055	-0.0054	-0.0165	-0.0048
1.00	0.0001	-0.0264	0.0130	-0.0051	0.0028	0.0028	-0.0049	0.0028

Table 35. Episode 1 composite statistical comparison of sensitivity px_acm4 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.05	0.05	0.009	0.002	0.0709
Mixing Ratio (g/kg)	0.03	0.01	0.002	0.001	0.0147
Rel. Humidity (%)	0.12	0.11	0.008	0.003	0.1409
Wind Speed (m/s)	-0.01	0.00	0.003	0.001	0.0005
Clouds (%)	0.34	0.25	0.006	0.003	0.2262

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.039	0.04	-0.0010	0.0036	0.0019

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0035	-0.0029	-0.0061	-0.0040	-0.0071	-0.0092	-0.0072	-0.0077
0.05	-0.0002	0.0202	0.0049	-0.0106	-0.0034	-0.0032	-0.0081	-0.0025
0.10	-0.0019	0.0205	-0.0001	-0.0162	-0.0110	-0.0117	-0.0155	-0.0091
0.25	-0.0018	-0.0322	0.0004	-0.0259	-0.0186	-0.0192	-0.0253	-0.0147
0.50	0.0001	-0.0513	0.0145	-0.0250	-0.0083	-0.0081	-0.0237	-0.0068
1.00	-0.0004	0.0103	-0.0209	-0.0097	-0.0145	-0.0146	-0.0098	-0.0143

Table 36. Like table 35, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.10	0.01	0.005	0.001	0.0265
Mixing Ratio (g/kg)	0.02	0.01	0.003	0.001	0.0200
Rel. Humidity (%)	0.18	0.22	0.016	0.005	0.3339
Wind Speed (m/s)	-0.01	-0.03	-0.030	-0.016	-0.0438
Clouds (%)	0.05	-0.13	-0.004	-0.003	-0.1747

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.087	-0.91	-0.0344	-0.0341	-0.0484

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0027	-0.0096	0.0060	-0.0020	0.0018	0.0044	0.0048	0.0051
0.05	0.0030	0.0180	0.0063	-0.0040	0.0016	0.0036	0.0021	0.0043
0.10	0.0002	0.0281	0.0000	-0.0137	-0.0052	-0.0041	-0.0098	-0.0053
0.25	0.0033	0.0683	0.0031	-0.0193	-0.0031	-0.0019	-0.0132	-0.0026
0.50	0.0018	0.0780	-0.0014	-0.0213	-0.0050	-0.0044	-0.0182	-0.0068
1.00	0.0012	0.0465	0.0179	0.0211	0.0118	0.0118	0.0219	0.0202

Table 37. Episode 2 composite statistical comparison of sensitivity px_acm4 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.18	0.01	0.003	0.002	0.0145
Mixing Ratio (g/kg)	-0.06	0.02	0.004	0.002	0.0246
Rel. Humidity (%)	0.37	0.14	0.009	0.003	0.2255
Wind Speed (m/s)	0.01	0.00	-0.008	-0.005	-0.0036
Clouds (%)	0.50	0.01	-0.001	-0.001	0.0901

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.021	-0.16	-0.0117	-0.0020	-0.0094

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0002	-0.0212	0.0081	-0.0104	-0.0033	0.0002	0.0000	0.0003
0.05	0.0014	-0.0212	0.0079	-0.0131	-0.0031	-0.0001	-0.0034	0.0000
0.10	0.0010	0.0379	0.0057	-0.0174	-0.0055	-0.0030	-0.0088	-0.0035
0.25	0.0060	0.0729	0.0120	-0.0196	-0.0005	0.0025	-0.0079	0.0033
0.50	0.0076	0.1079	0.0156	-0.0131	0.0048	0.0067	-0.0034	0.0096
1.00	0.0050	0.1819	0.0174	0.0015	0.0082	0.0090	0.0066	0.0154

Table 38. Like table 37, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.12	0.07	0.003	0.002	0.0972
Mixing Ratio (g/kg)	-0.01	0.00	0.000	0.000	0.0004
Rel. Humidity (%)	-0.01	-0.06	-0.001	0.000	-0.0488
Wind Speed (m/s)	0.00	0.01	0.001	0.001	0.0018
Clouds (%)	2.28	0.95	0.024	0.017	0.6766

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.046	-0.01	0.0017	0.0008	0.0018

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0031	-0.0799	0.0283	-0.0408	-0.0094	-0.0030	-0.0190	-0.0029
0.05	0.0033	0.0860	0.0247	-0.0329	-0.0025	0.0001	-0.0228	0.0001
0.10	0.0018	0.0700	0.0190	-0.0265	-0.0017	-0.0006	-0.0213	-0.0005
0.25	0.0007	0.0505	0.0169	-0.0186	-0.0002	0.0002	-0.0168	0.0001
0.50	-0.0003	-0.0442	0.0046	-0.0269	-0.0133	-0.0132	-0.0264	-0.0117
1.00	-0.0001	-0.0325	-0.0015	-0.0213	-0.0126	-0.0126	-0.0212	-0.0129

Table 39. Episode 1 composite statistical comparison of sensitivity px_acm5 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.07	0.05	0.003	0.001	0.0578
Mixing Ratio (g/kg)	-0.01	0.00	0.000	0.000	-0.0024
Rel. Humidity (%)	0.01	-0.02	0.006	0.002	-0.0119
Wind Speed (m/s)	0.00	0.00	0.001	0.000	0.0018
Clouds (%)	-1.42	0.26	0.011	0.005	0.1818

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.055	-0.02	0.0006	0.0017	0.0016

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0059	-0.0605	0.0509	-0.0538	-0.0044	0.0049	-0.0200	0.0040
0.05	0.0037	0.0531	0.0305	-0.0292	0.0019	0.0053	-0.0169	0.0041
0.10	0.0014	0.0130	0.0232	-0.0271	-0.0025	-0.0010	-0.0204	-0.0008
0.25	-0.0006	-0.0400	0.0103	-0.0232	-0.0104	-0.0104	-0.0215	-0.0079
0.50	0.0001	-0.0454	0.0133	-0.0217	-0.0067	-0.0065	-0.0205	-0.0055
1.00	0.0001	-0.0020	0.0067	0.0038	0.0053	0.0053	0.0040	0.0052

Table 40. Like table 39, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.07	-0.03	-0.002	-0.001	-0.0285
Mixing Ratio (g/kg)	0.01	-0.02	-0.004	-0.002	-0.0248
Rel. Humidity (%)	-0.20	-0.12	-0.009	-0.003	-0.1517
Wind Speed (m/s)	-0.02	0.00	-0.001	-0.002	-0.0034
Clouds (%)	-0.30	-0.11	-0.001	0.000	-0.2593

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.122	-0.02	0.0000	-0.0005	-0.0003

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0066	-0.0324	0.0013	-0.0232	-0.0150	-0.0121	-0.0151	-0.0143
0.05	-0.0023	0.0426	0.0000	-0.0252	-0.0122	-0.0099	-0.0177	-0.0122
0.10	0.0006	0.0525	0.0006	-0.0250	-0.0092	-0.0072	-0.0175	-0.0092
0.25	0.0046	0.1108	0.0029	-0.0344	-0.0072	-0.0052	-0.0249	-0.0074
0.50	0.0060	0.1887	0.0071	-0.0354	-0.0037	-0.0022	-0.0272	-0.0034
1.00	0.0024	0.2219	0.0059	-0.0210	-0.0017	-0.0013	-0.0184	-0.0021

Table 41. Episode 2 composite statistical comparison of sensitivity px_acm5 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.04	0.00	0.001	-0.001	-0.0038
Mixing Ratio (g/kg)	0.00	-0.02	-0.003	-0.001	-0.0145
Rel. Humidity (%)	-0.21	-0.06	-0.006	-0.003	-0.0767
Wind Speed (m/s)	0.01	0.00	-0.004	-0.001	-0.0015
Clouds (%)	-0.90	-0.13	0.001	0.001	-0.3080

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.189	-0.06	-0.0011	-0.0002	-0.0008

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0087	-0.0369	0.0034	-0.0273	-0.0186	-0.0169	-0.0180	-0.0177
0.05	-0.0034	-0.0169	0.0002	-0.0176	-0.0102	-0.0093	-0.0130	-0.0101
0.10	-0.0022	0.0294	-0.0004	-0.0185	-0.0095	-0.0084	-0.0140	-0.0097
0.25	0.0020	0.0616	0.0029	-0.0252	-0.0075	-0.0055	-0.0172	-0.0070
0.50	0.0073	0.1220	0.0128	-0.0214	0.0011	0.0032	-0.0112	0.0046
1.00	0.0038	0.1704	0.0055	-0.0149	-0.0001	0.0006	-0.0106	0.0011

Table 42. Like table 41, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.01	0.00	0.000	0.000	0.0053
Mixing Ratio (g/kg)	0.00	0.00	0.000	0.000	-0.0009
Rel. Humidity (%)	0.07	0.07	0.003	0.002	0.0799
Wind Speed (m/s)	-0.02	0.00	-0.002	-0.002	-0.0041
Clouds (%)	-0.03	0.02	0.001	0.000	0.0167

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.145	-0.04	-0.0006	-0.0011	-0.0011

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0001	0.0034	0.0010	-0.0014	-0.0003	0.0000	-0.0006	0.0000
0.05	0.0003	0.0041	0.0013	-0.0012	0.0002	0.0004	-0.0007	0.0003
0.10	0.0004	0.0025	0.0023	0.0009	0.0021	0.0021	0.0013	0.0019
0.25	0.0002	0.0000	0.0018	0.0019	0.0023	0.0024	0.0020	0.0019
0.50	-0.0001	-0.0105	-0.0025	0.0046	0.0012	0.0011	0.0045	0.0010
1.00	0.0000	0.0031	-0.0021	0.0000	-0.0009	-0.0010	0.0000	-0.0010

Table 43. Episode 1 composite statistical comparison of sensitivity px_acm6 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.16	0.11	0.008	0.004	0.1259
Mixing Ratio (g/kg)	-0.03	-0.03	-0.010	-0.003	-0.0530
Rel. Humidity (%)	0.33	0.38	0.023	0.011	0.4391
Wind Speed (m/s)	0.11	-0.01	-0.026	-0.017	-0.0069
Clouds (%)	0.28	-0.19	-0.006	-0.003	-0.1165

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	1.201	-0.22	-0.0119	0.0096	-0.0012

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0051	0.0104	0.0108	0.0028	0.0097	0.0132	0.0090	0.0108
0.05	0.0041	0.0060	0.0110	0.0070	0.0128	0.0151	0.0104	0.0118
0.10	0.0041	-0.0031	0.0119	0.0149	0.0187	0.0208	0.0170	0.0158
0.25	0.0012	0.0277	-0.0022	0.0204	0.0132	0.0136	0.0197	0.0100
0.50	0.0006	0.0197	-0.0140	0.0483	0.0218	0.0216	0.0466	0.0177
1.00	-0.0001	0.0324	-0.0090	0.0149	0.0058	0.0057	0.0148	0.0056

Table 44. Like table 43, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.00	0.00	0.001	0.001	0.0059
Mixing Ratio (g/kg)	-0.01	-0.01	-0.002	-0.001	-0.0132
Rel. Humidity (%)	-0.06	0.01	0.001	0.001	0.0190
Wind Speed (m/s)	0.00	0.00	-0.001	-0.001	-0.0023
Clouds (%)	0.01	-0.14	-0.003	-0.003	-0.2124

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.026	-0.12	-0.0029	-0.0027	-0.0039

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0005	0.0045	-0.0019	0.0017	0.0002	-0.0007	-0.0008	-0.0008
0.05	-0.0023	-0.0094	-0.0042	0.0009	-0.0019	-0.0031	-0.0028	-0.0038
0.10	-0.0031	-0.0116	-0.0057	-0.0014	-0.0038	-0.0048	-0.0050	-0.0061
0.25	-0.0018	-0.0141	-0.0041	-0.0014	-0.0027	-0.0031	-0.0033	-0.0043
0.50	-0.0015	-0.0280	-0.0046	-0.0011	-0.0028	-0.0030	-0.0027	-0.0046
1.00	-0.0005	-0.0485	-0.0017	0.0037	-0.0001	-0.0002	0.0030	-0.0003

Table 45. Episode 2 composite statistical comparison of sensitivity px_acm6 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.07	0.04	0.007	0.004	0.0450
Mixing Ratio (g/kg)	-0.53	-0.26	-0.081	-0.034	-0.3480
Rel. Humidity (%)	-2.23	-0.75	-0.035	-0.020	-1.0033
Wind Speed (m/s)	0.13	0.01	-0.015	-0.004	0.0137
Clouds (%)	-2.24	-2.06	-0.039	-0.025	-2.9210

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.618	-1.08	-0.0026	0.0070	0.0034

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0258	0.0287	-0.0392	-0.0118	-0.0306	-0.0478	-0.0512	-0.0515
0.05	-0.0290	-0.0430	-0.0461	-0.0185	-0.0374	-0.0508	-0.0534	-0.0577
0.10	-0.0311	-0.0461	-0.0518	-0.0304	-0.0443	-0.0548	-0.0618	-0.0659
0.25	-0.0251	-0.0470	-0.0517	-0.0462	-0.0445	-0.0494	-0.0666	-0.0658
0.50	-0.0170	-0.0812	-0.0497	-0.0518	-0.0387	-0.0409	-0.0653	-0.0610
1.00	-0.0069	-0.2206	-0.0253	-0.0186	-0.0152	-0.0160	-0.0252	-0.0280

Table 46. Like table 45, except for 12-km VISTAS domain.

Recall from the discussion of sensitivity px_acm4 that a slight improvement was found by using RAWINS output to drive both INTERPF and MM5. Since that sensitivity involved changing two variables at once, we do not know which change (or both) led to the improvement. Sensitivities px_acm7 and px_acm8 are designed to answer that question. In px_acm7 we change only the SFCFDDA file that MM5 reads in, using the RAWINS output rather than LITTLE_R output. Tables 47-50 show the results for both grids and for both episodes. Very slight performance degradation is seen in all tables. Tables 51-54 show the results for px_acm8, a sensitivity in which LITTLE_R outputs are used as inputs both to MM5 and INTERPF. While the wintertime tables show very slight performance degradation for precipitation, the remaining variables show universal improvement. Similar improvements are seen in the summertime cases with no performance degradation in the precipitation statistics. This configuration appears to be an improvement over the base case and should be incorporated into the annual modeling protocol.

The MM5 (http://www.mmm.ucar.edu/mm5/documents/MM5_tut_Web_notes/MM5/mm5.html) documentation states that the IFSNOW option applies when the LSM is not used. So this flag was not deemed to be important for P-X applications. Of course when MM5 documentation refers to the LSM it normally means the NOAH LSM, not the P-X LSM. So we performed a couple of wintertime only sensitivities to determine the effect the IFSNOW flag may have on a P-X run. Table 55 shows the results for the 36-km domain if the IFSNOW flag is set to 0. Note the bias improvement of 0.07 ^{o}C for temperature for this sensitivity s0px_acm2. Perhaps snow effects are being double-counted in P-X if this flag is turned on? The other variables are relatively unaffected, though it is interesting to note the almost universal slight degradation of precipitation skill. Since snow is a relatively rare occurrence in the VISTAS domain, little change is seen at 12-km resolution for the VISTAS domain, as illustrated in table 56.

Tables 57-58 show the statistical difference tables for the s2px_acm2 configuration. This sensitivity turns the simple snow model on. These runs are very cold-biased, even for the 12-km VISTAS domain. Clearly this configuration is not recommended for annual modeling.

Tables 59-60 show the shorter summertime episode (episode 3) results for the px_acm9 sensitivity. The idea for this test is to see if an integration of EDAS soil temperature/moisture might yield similar wintertime benefits that we saw in the px_acm3 sensitivity, while not showing the degraded summertime performance that prior sensitivity showed. Admittedly more work could be done along these lines, but the results for this px_acm9 sensitivity show the summertime performance degradation we had hoped would not exist. This configuration is not recommended for annual modeling.

The next few sensitivity runs quantify the effects of nudging temperature/moisture near the surface. One advantage of the P-X module is that it allows indirect soil moisture nudging to be applied, thereby in essence "nudging" the lowest layers of the atmosphere without the instabilities that might result from directly applying surface analysis nudging of temperature/moisture. To quantify the effects this indirect soil nudging has on the results, we turned it off in sensitivity n0px_acm2 and applied the model only for episode 2 at 36-km resolution (table 61). Not surprisingly we see general performance degradation, though the character of the simulation is not changed dramatically. For example, the temperature error metric still shows better performance than what we saw in the noah_mrf, multi_blkdr, and noah_eta-my runs (tables 15, 21, and 27, respectively).

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.00	-0.01	0.000	0.000	-0.0029
Mixing Ratio (g/kg)	0.00	0.00	-0.001	0.000	-0.0009
Rel. Humidity (%)	-0.05	0.01	0.000	0.000	0.0095
Wind Speed (m/s)	0.00	-0.04	-0.028	-0.013	-0.0470
Clouds (%)	0.05	0.01	0.001	0.000	0.0226

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.017	-0.77	-0.0373	-0.0370	-0.0525

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0002	0.0014	0.0000	-0.0010	-0.0006	-0.0006	-0.0008	-0.0006
0.05	-0.0001	-0.0008	-0.0005	0.0000	-0.0003	-0.0003	-0.0001	-0.0003
0.10	0.0005	0.0020	0.0023	0.0013	0.0023	0.0024	0.0017	0.0021
0.25	0.0001	0.0022	0.0015	0.0000	0.0010	0.0010	0.0001	0.0008
0.50	-0.0001	-0.0000	-0.0003	-0.0013	-0.0010	-0.0010	-0.0012	-0.0008
1.00	0.0000	0.0152	-0.0025	0.0071	0.0028	0.0027	0.0071	0.0028

Table 47. Episode 1 composite statistical comparison of sensitivity px_acm7 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.00	0.00	0.000	0.000	0.0019
Mixing Ratio (g/kg)	-0.01	0.00	0.000	0.000	-0.0027
Rel. Humidity (%)	-0.16	0.01	0.003	0.000	0.0066
Wind Speed (m/s)	-0.01	-0.01	-0.004	-0.004	-0.0074
Clouds (%)	-0.19	0.05	0.002	0.001	0.0657

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.013	-0.17	-0.0064	-0.0081	-0.0104

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0006	-0.0033	-0.0019	0.0007	-0.0009	-0.0014	-0.0005	-0.0012
0.05	-0.0004	-0.0021	-0.0013	0.0002	-0.0009	-0.0011	-0.0002	-0.0009
0.10	-0.0001	0.0020	0.0004	-0.0011	-0.0005	-0.0005	-0.0010	-0.0004
0.25	-0.0005	-0.0074	-0.0006	-0.0066	-0.0052	-0.0054	-0.0065	-0.0041
0.50	0.0003	0.0029	0.0023	0.0044	0.0043	0.0043	0.0045	0.0035
1.00	-0.0001	0.0189	-0.0088	0.0059	0.0003	0.0002	0.0058	0.0002

Table 48. Like table 47, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.00	-0.01	-0.001	0.000	-0.0153
Mixing Ratio (g/kg)	0.06	0.01	0.003	0.000	0.0100
Rel. Humidity (%)	0.26	0.04	0.003	0.001	0.0765
Wind Speed (m/s)	-0.01	-0.04	-0.033	-0.018	-0.0484
Clouds (%)	-0.18	-0.13	-0.002	-0.002	-0.1188

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.023	-1.18	-0.0404	-0.0433	-0.0592

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0025	-0.0088	-0.0005	-0.0071	-0.0050	-0.0045	-0.0055	-0.0053
0.05	-0.0026	0.0117	-0.0031	-0.0103	-0.0066	-0.0065	-0.0097	-0.0080
0.10	-0.0043	0.0104	-0.0083	-0.0152	-0.0104	-0.0108	-0.0165	-0.0139
0.25	-0.0018	0.0062	-0.0060	-0.0114	-0.0063	-0.0064	-0.0119	-0.0090
0.50	-0.0012	-0.0166	-0.0047	-0.0039	-0.0033	-0.0035	-0.0050	-0.0053
1.00	-0.0002	-0.0326	0.0014	0.0066	0.0018	0.0017	0.0062	0.0030

Table 49. Episode 2 composite statistical comparison of sensitivity px_acm7 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.01	-0.01	-0.003	-0.002	-0.0171
Mixing Ratio (g/kg)	0.04	0.01	0.000	0.001	0.0203
Rel. Humidity (%)	0.30	0.06	0.002	0.000	0.1136
Wind Speed (m/s)	-0.01	0.00	-0.007	-0.004	-0.0082
Clouds (%)	-0.15	-0.14	-0.004	-0.003	-0.1314

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.086	-0.39	-0.0154	-0.0095	-0.0174

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0013	0.0000	-0.0015	-0.0012	-0.0018	-0.0025	-0.0025	-0.0025
0.05	-0.0011	0.0012	-0.0013	-0.0021	-0.0020	-0.0023	-0.0026	-0.0024
0.10	-0.0008	0.0025	-0.0011	-0.0028	-0.0020	-0.0021	-0.0028	-0.0025
0.25	-0.0005	0.0070	-0.0013	-0.0049	-0.0024	-0.0024	-0.0044	-0.0030
0.50	-0.0010	-0.0050	-0.0033	-0.0034	-0.0027	-0.0028	-0.0043	-0.0041
1.00	0.0001	-0.0088	0.0031	0.0065	0.0025	0.0025	0.0065	0.0043

Table 50. Like table 49, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.22	0.15	0.008	0.004	0.1800
Mixing Ratio (g/kg)	-0.02	0.01	0.002	0.000	0.0076
Rel. Humidity (%)	0.35	0.32	0.021	0.010	0.4144
Wind Speed (m/s)	0.02	0.02	0.010	0.007	0.0180
Clouds (%)	0.03	0.05	0.003	0.001	0.1037

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.237	0.19	0.0098	0.0129	0.0161

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0043	-0.0168	-0.0107	0.0013	-0.0059	-0.0085	-0.0054	-0.0082
0.05	-0.0015	-0.0107	-0.0059	0.0007	-0.0036	-0.0043	-0.0012	-0.0039
0.10	-0.0009	-0.0110	-0.0055	0.0010	-0.0032	-0.0037	-0.0002	-0.0032
0.25	0.0003	0.0225	0.0078	-0.0078	0.0005	0.0008	-0.0069	0.0006
0.50	-0.0003	-0.0312	0.0004	-0.0220	-0.0126	-0.0126	-0.0217	-0.0111
1.00	0.0000	-0.0233	0.0014	-0.0132	-0.0068	-0.0068	-0.0131	-0.0069

Table 51. Episode 1 composite statistical comparison of sensitivity px_acm8 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.08	0.11	0.011	0.003	0.1407
Mixing Ratio (g/kg)	0.01	0.01	0.002	0.001	0.0141
Rel. Humidity (%)	0.49	0.27	0.016	0.008	0.3229
Wind Speed (m/s)	-0.01	0.01	0.009	0.004	0.0087
Clouds (%)	0.52	0.29	0.006	0.003	0.2435

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.108	0.24	0.0045	0.0133	0.0127

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0021	-0.0001	-0.0031	-0.0032	-0.0044	-0.0056	-0.0047	-0.0047
0.05	-0.0003	0.0141	0.0030	-0.0077	-0.0029	-0.0028	-0.0061	-0.0022
0.10	-0.0016	0.0194	0.0005	-0.0147	-0.0095	-0.0100	-0.0138	-0.0077
0.25	-0.0015	-0.0226	-0.0015	-0.0198	-0.0153	-0.0159	-0.0195	-0.0121
0.50	0.0002	-0.0344	0.0115	-0.0150	-0.0032	-0.0031	-0.0140	-0.0026
1.00	-0.0005	-0.0239	-0.0158	-0.0287	-0.0246	-0.0246	-0.0287	-0.0244

Table 52. Like table 51, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.06	0.07	0.011	0.003	0.0879
Mixing Ratio (g/kg)	0.00	0.00	0.002	0.000	0.0121
Rel. Humidity (%)	-0.13	0.23	0.014	0.005	0.3027
Wind Speed (m/s)	0.00	0.01	0.008	0.005	0.0113
Clouds (%)	0.33	0.19	0.004	0.002	0.2725

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.250	0.26	0.0091	0.0118	0.0148

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0040	0.0122	0.0014	0.0104	0.0077	0.0074	0.0088	0.0086
0.05	0.0011	-0.0235	-0.0002	0.0136	0.0064	0.0052	0.0094	0.0063
0.10	-0.0018	-0.0272	-0.0032	0.0094	0.0016	0.0004	0.0045	0.0005
0.25	-0.0019	-0.0089	-0.0049	-0.0044	-0.0039	-0.0042	-0.0060	-0.0059
0.50	-0.0023	-0.0344	-0.0080	-0.0054	-0.0055	-0.0058	-0.0076	-0.0088
1.00	0.0002	-0.0058	0.0064	0.0109	0.0048	0.0048	0.0109	0.0082

Table 53. Episode 2 composite statistical comparison of sensitivity px_acm8 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.04	0.04	0.008	0.003	0.0389
Mixing Ratio (g/kg)	-0.02	0.02	0.002	0.002	0.0233
Rel. Humidity (%)	0.07	0.17	0.012	0.004	0.2162
Wind Speed (m/s)	0.01	0.01	0.004	0.002	0.0100
Clouds (%)	0.49	0.02	-0.002	-0.002	0.1619

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.079	0.17	0.0072	0.0065	0.0098

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0027	-0.0030	0.0043	0.0012	0.0033	0.0051	0.0053	0.0054
0.05	0.0013	-0.0017	0.0038	-0.0036	0.0001	0.0015	0.0005	0.0017
0.10	0.0012	0.0188	0.0039	-0.0074	-0.0014	0.0000	-0.0026	-0.0001
0.25	0.0033	0.0476	0.0063	-0.0144	-0.0016	0.0002	-0.0071	0.0003
0.50	0.0051	0.0777	0.0098	-0.0111	0.0023	0.0037	-0.0043	0.0053
1.00	0.0055	0.2039	0.0188	0.0003	0.0086	0.0094	0.0059	0.0162

Table 54. Like table 53, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.07	0.03	0.000	0.001	0.0466
Mixing Ratio (g/kg)	-0.01	0.00	-0.001	0.000	-0.0007
Rel. Humidity (%)	-0.08	-0.02	0.000	0.000	-0.0138
Wind Speed (m/s)	0.01	0.01	0.001	0.001	0.0017
Clouds (%)	0.20	0.03	0.001	0.001	0.0607

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.040	-0.01	0.0007	0.0002	0.0007

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0014	-0.0095	-0.0044	0.0025	-0.0012	-0.0022	-0.0005	-0.0022
0.05	-0.0009	-0.0076	-0.0038	0.0010	-0.0021	-0.0025	-0.0004	-0.0023
0.10	-0.0003	-0.0057	-0.0020	0.0015	-0.0005	-0.0007	0.0010	-0.0006
0.25	-0.0001	-0.0003	-0.0006	-0.0005	-0.0006	-0.0006	-0.0005	-0.0006
0.50	-0.0001	-0.0013	0.0002	-0.0016	-0.0008	-0.0008	-0.0015	-0.0007
1.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 55. Episode 1 composite statistical comparison of sensitivity s0px_acm with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.01	0.01	0.001	0.000	0.0150
Mixing Ratio (g/kg)	0.00	0.00	0.000	0.000	-0.0005
Rel. Humidity (%)	-0.01	-0.01	0.000	-0.001	-0.0059
Wind Speed (m/s)	0.00	0.00	0.001	0.000	-0.0002
Clouds (%)	-0.05	0.04	0.001	0.001	0.0520

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.000	0.01	0.0001	-0.0001	-0.0001

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0008	-0.0032	-0.0021	0.0004	-0.0012	-0.0018	-0.0009	-0.0016
0.05	-0.0001	-0.0013	-0.0004	0.0005	0.0000	-0.0001	0.0004	-0.0001
0.10	-0.0001	-0.0007	-0.0004	0.0002	-0.0001	-0.0002	0.0001	-0.0001
0.25	-0.0002	-0.0001	-0.0010	-0.0010	-0.0014	-0.0015	-0.0011	-0.0012
0.50	0.0001	-0.0030	0.0014	-0.0009	0.0003	0.0002	-0.0008	0.0002
1.00	-0.0001	0.0021	-0.0013	0.0004	-0.0002	-0.0002	0.0004	-0.0002

Table 56. Like table 55, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.91	-0.70	-0.046	-0.025	-0.9534
Mixing Ratio (g/kg)	0.02	-0.02	-0.016	-0.005	-0.0415
Rel. Humidity (%)	-0.03	-0.33	-0.048	-0.021	-0.5583
Wind Speed (m/s)	0.00	-0.02	-0.019	-0.011	-0.0332
Clouds (%)	-0.13	0.17	0.004	0.002	0.1250

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.189	-0.09	-0.0204	-0.0149	-0.0249

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0035	-0.0093	0.0109	-0.0048	0.0037	0.0064	0.0023	0.0061
0.05	0.0017	0.0188	0.0078	-0.0042	0.0029	0.0038	-0.0014	0.0034
0.10	0.0011	0.0164	0.0069	-0.0032	0.0031	0.0035	-0.0016	0.0031
0.25	0.0004	0.0180	0.0077	-0.0047	0.0023	0.0025	-0.0039	0.0020
0.50	-0.0001	-0.0105	0.0016	-0.0065	-0.0029	-0.0029	-0.0064	-0.0025
1.00	0.0000	-0.0091	0.0006	-0.0051	-0.0025	-0.0026	-0.0050	-0.0026

Table 57. Episode 1 composite statistical comparison of sensitivity s2px_acm with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.92	-0.79	-0.108	-0.043	-1.3572
Mixing Ratio (g/kg)	0.11	-0.04	-0.015	-0.003	-0.0642
Rel. Humidity (%)	-1.17	-1.13	-0.085	-0.045	-1.5513
Wind Speed (m/s)	0.01	-0.03	-0.030	-0.017	-0.0378
Clouds (%)	-0.05	0.10	0.002	0.001	0.0779

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.138	-0.33	-0.0272	-0.0155	-0.0299

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	0.0044	0.0137	0.0107	0.0001	0.0078	0.0110	0.0065	0.0090
0.05	0.0029	0.0156	0.0109	-0.0007	0.0075	0.0094	0.0032	0.0073
0.10	0.0011	0.0073	0.0056	0.0000	0.0040	0.0047	0.0014	0.0036
0.25	0.0002	-0.0050	0.0029	-0.0013	0.0010	0.0011	-0.0009	0.0008
0.50	0.0000	-0.0050	0.0012	-0.0025	-0.0008	-0.0009	-0.0023	-0.0007
1.00	-0.0001	-0.0041	-0.0014	-0.0039	-0.0030	-0.0030	-0.0038	-0.0029

Table 58. Like table 57, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.42	-0.12	-0.009	-0.004	-0.1230
Mixing Ratio (g/kg)	-0.08	0.01	0.000	0.000	0.0113
Rel. Humidity (%)	0.00	-0.08	-0.006	-0.002	-0.0670
Wind Speed (m/s)	-0.01	-0.01	-0.005	-0.005	-0.0098
Clouds (%)	-0.09	-0.03	-0.002	0.000	-0.0983

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.139	0.05	-0.0036	-0.0039	-0.0053

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0049	-0.0160	-0.0015	-0.0132	-0.0098	-0.0084	-0.0108	-0.0105
0.05	0.0000	-0.0220	0.0020	-0.0125	-0.0052	-0.0033	-0.0072	-0.0043
0.10	0.0011	0.0376	0.0016	-0.0163	-0.0056	-0.0040	-0.0107	-0.0052
0.25	0.0034	0.0449	0.0062	-0.0062	0.0017	0.0027	-0.0017	0.0038
0.50	0.0019	0.0502	0.0047	-0.0031	0.0020	0.0024	-0.0009	0.0036
1.00	0.0013	0.1032	0.0068	0.0036	0.0039	0.0040	0.0049	0.0071

Table 59. Episode 3 composite statistical comparison of sensitivity px_acm9 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.57	-0.23	-0.063	-0.021	-0.3328
Mixing Ratio (g/kg)	-0.07	0.02	0.005	0.002	0.0325
Rel. Humidity (%)	-0.70	-0.25	-0.014	-0.008	-0.2777
Wind Speed (m/s)	-0.01	-0.03	-0.021	-0.013	-0.0265
Clouds (%)	-0.06	0.11	0.003	0.002	0.1224

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.142	0.12	-0.0143	-0.0077	-0.0154

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0054	-0.0321	0.0023	-0.0216	-0.0133	-0.0087	-0.0114	-0.0112
0.05	-0.0005	-0.0424	0.0047	-0.0219	-0.0098	-0.0054	-0.0105	-0.0070
0.10	0.0014	-0.0461	0.0048	-0.0206	-0.0078	-0.0043	-0.0108	-0.0057
0.25	0.0046	0.0522	0.0093	-0.0123	-0.0006	0.0017	-0.0044	0.0023
0.50	0.0040	0.0653	0.0105	-0.0079	0.0021	0.0033	-0.0028	0.0050
1.00	0.0022	0.1121	0.0077	-0.0058	0.0023	0.0027	-0.0034	0.0044

Table 60. Like table 59, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.09	-0.07	-0.010	-0.002	-0.0789
Mixing Ratio (g/kg)	-0.08	-0.09	-0.021	-0.007	-0.1060
Rel. Humidity (%)	-0.51	-0.45	-0.018	-0.006	-0.4458
Wind Speed (m/s)	0.00	0.00	-0.002	-0.001	-0.0039
Clouds (%)	0.04	0.00	0.000	-0.001	0.0099

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.048	-0.12	-0.0029	-0.0032	-0.0043

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0030	-0.0048	-0.0022	-0.0056	-0.0049	-0.0052	-0.0063	-0.0061
0.05	-0.0013	0.0071	-0.0014	-0.0057	-0.0035	-0.0033	-0.0051	-0.0041
0.10	-0.0013	0.0051	-0.0026	-0.0056	-0.0036	-0.0036	-0.0058	-0.0046
0.25	0.0002	0.0279	-0.0022	-0.0130	-0.0045	-0.0041	-0.0111	-0.0058
0.50	0.0014	0.0497	0.0006	-0.0111	-0.0019	-0.0015	-0.0090	-0.0023
1.00	0.0009	0.0776	0.0014	-0.0079	-0.0008	-0.0007	-0.0071	-0.0012

Table 61. Episode 2 composite statistical comparison of sensitivity n0px_acm2 with base case px_acm2 for the US portion of the 36-km domain is shown.

As mentioned above instabilities can sometimes result when the thermodynamic variables (t, q) are nudged in the boundary layer. In a test performed years ago using Blackadar mixing we saw checkerboard daytime PBL height patterns that were obviously wrong. Heights varied in adjacent cells from ~2500 m to ~40 m to ~2500 m and so on. The warning against nudging temperature/moisture in the boundary layer appears to be only passed down by word of mouth; no warning appears to exist in the MM5 documentation. In fact, the sample deck in the documentation has FDDA turned off completely, but if it were turned on the default would be for surface analysis nudging of temperature/moisture to be enabled. Might the warnings against this be outdated? To test this we have conducted two sensitivities. Both tests have temperature nudging at the same strength as wind nudging in the boundary layer. The first test (px_acm_n) has moisture nudged at 1.0E-4 for both 36-km and 12-km resolutions, while the second test (px_acm_n2) reduces the moisture nudging strength to the default value of 1.0E-5 for both grids. Aloft we keep the nudging strengths the same as in the base case. Note that the low values for moisture nudging aloft make sense given the discontinuous nature of moisture aloft. There is no guarantee that the moisture from an observed sounding is actually representative of the synoptic conditions. At the surface, however, mixing ratio is a much more continuous quantity and theoretically could be nudged at a higher strength.

With the daytime checkerboard PBL pattern in mind, we checked the PBL heights from px_acm_n to see if similar instabilities exist. We could find not find them. Tables 62-63 show the statistical difference results for this sensitivity for the wintertime episode 1. Note the general improvement in the surface statistics, especially the temperature bias for both grids. Precipitation skill is relatively unaffected. The episode 2 results (tables 64-65) show a different story. This sensitivity improves the error statistics for temperature, mixing ratio, and relative humidity, and the winds are only slightly affected. But look at the precipitation statistics! The runs are significantly biased high at all thresholds, especially in the 36-km grid. Accordingly all of the precipitation skill metrics, with the exception of course of probability of detection, show degraded performance. Apparently the surface nudging is causing some sort of convective instabilities that are not evident to a significant extent in the winter.

Perhaps the convective instabilities might go away if the moisture nudging coefficients are reduced to the default values. Tables 66-67 show the results for the px_acm_n2 sensitivity for episode 2. The bias overestimation improves over px_acm_n, but it still shows a significant degradation compared with our original base case. It should be noted that if we did not consider precipitation statistics we would probably consider these last two sensitivities to be the most appealing of all the sensitivities tested. Fortunately that is not the case here. We should also note that the precipitation instabilities are relatively subtle and might not be found by simply looking at a PAVE/RIP animation of model precipitation.

To further investigate the precipitation patterns of all the sensitivities tested, we have developed a 4-panel episode-composite approach. The upper left panel contains the total observed precipitation for the episode. The upper right panel shows the total modeled precipitation for the sensitivity being examined, while the lower left panel shows the difference between the total modeled precipitation and the observed. Finally, for all non-base case runs, the lower right panel shows the difference between the sensitivity and the base case px_acm2. Figure 38 shows the episode 1 36-km precipitation composite plot for the base case. The general precipitation patterns are captured nicely by the px_acm2 configuration, though there are places where the model underestimates total precipitation (e.g. northwest coastline) and places where the model overestimates total precipitation (e.g. eastern South Carolina). Figure 39 shows the corresponding plot for the 12-km grid. Again the model does a decent job in the general placement and magnitude of the precipitation, though certain precipitation bands are slightly displaced.

Figures 40-41 show the px_acm total precipitation plots for the px_acm case. The results are similar to the px_acm2 case, though less precipitation falls in this sensitivity, presumably due to the cold bias seen in this run. Figures 42-43 show the episode 1 plots for noah_mrf. The results are different from the base case but not particularly striking. Figures 44-45 show that the corresponding plots for the multi_blkdr runs exhibit large areas of slightly increased precipitation compared with the base case. This is very similar to the noah_eta-my results shown in figures 46-47.

The base case results for episode 2 (figures 48-49) are less encouraging. The px_acm2 run shows a clear positive accumulation bias at both grid resolutions. The bias is probably manageable, but it is certainly something to consider when analyzing air quality runs driven by this meteorology. The px_acm (figures 50-51), noah_mrf (figures 52-53), multi_blkdr (figures 54-55), and noah_eta-my (figures 56-57) results all are qualitatively similar. Perhaps the model triggers convection a little too easily.

The Reisner 2 (px_acm5) plots are shown in figures 58-61. This sensitivity tends to produce slightly less total precipitation than the base case, though the character of the run is essentially unchanged. The same can be said for the px_acm8 results shown in figures 62-65. The wintertime plots for px_acm_n (figures 66-67) are also very similar to the base case. The summertime px_acm_n plots (figures 68-69) are another matter entirely!

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.27	0.47	0.039	0.012	0.5621
Mixing Ratio (g/kg)	-0.07	0.17	0.065	0.017	0.2255
Rel. Humidity (%)	0.38	4.66	0.293	0.105	5.9568
Wind Speed (m/s)	-0.05	0.04	0.025	0.014	0.0433
Clouds (%)	0.26	-0.04	-0.002	0.000	-0.0581

Wind stats	bias	abserr	Uerr	verr	uverr
Wind (deg, m/s)	-0.586	0.07	0.0133	0.0093	0.0160

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0018	-0.0310	-0.0095	0.0126	0.0016	-0.0007	0.0047	-0.0007
0.05	-0.0049	-0.0512	-0.0211	0.0102	-0.0091	-0.0117	0.0023	-0.0106
0.10	-0.0027	-0.0503	-0.0180	0.0122	-0.0062	-0.0077	0.0077	-0.0068
0.25	-0.0008	-0.0434	-0.0148	0.0141	-0.0018	-0.0023	0.0126	-0.0019
0.50	-0.0003	-0.0328	-0.0101	0.0120	0.0009	0.0008	0.0115	0.0007
1.00	-0.0002	0.0406	-0.0171	0.0091	-0.0027	-0.0028	0.0089	-0.0029

Table 62. Episode 1 composite statistical comparison of sensitivity px_acm_n with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.20	0.39	0.040	0.013	0.4709
Mixing Ratio (g/kg)	-0.04	0.14	0.033	0.009	0.1789
Rel. Humidity (%)	-0.06	3.25	0.225	0.080	4.2115
Wind Speed (m/s)	-0.03	0.03	0.031	0.014	0.0386
Clouds (%)	-0.55	-0.21	-0.005	-0.002	-0.1870

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.313	0.17	0.0263	0.0129	0.0273

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0012	-0.0229	-0.0081	0.0095	0.0005	-0.0012	0.0033	-0.0010
0.05	-0.0020	-0.0258	-0.0109	0.0081	-0.0030	-0.0045	0.0035	-0.0036
0.10	-0.0028	-0.0303	-0.0163	0.0064	-0.0077	-0.0095	0.0019	-0.0073
0.25	-0.0026	0.0294	-0.0237	0.0007	-0.0152	-0.0166	-0.0022	-0.0127
0.50	-0.0001	0.0099	-0.0034	0.0042	0.0008	0.0006	0.0040	0.0005
1.00	0.0002	0.0750	-0.0040	0.0483	0.0289	0.0288	0.0480	0.0275

Table 63. Like table 62, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.02	0.21	0.029	0.009	0.2498
Mixing Ratio (g/kg)	-0.45	0.34	0.080	0.018	0.4189
Rel. Humidity (%)	-3.58	2.54	0.174	0.042	3.5250
Wind Speed (m/s)	0.06	0.01	0.002	0.009	0.0041
Clouds (%)	-0.56	-0.79	-0.020	-0.021	-0.4014

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.106	-0.41	-0.0204	-0.0090	-0.0206

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0874	-0.3281	-0.1617	0.1888	-0.0090	-0.1196	-0.1430	-0.1542
0.05	-0.1698	-0.9034	-0.1832	0.1689	-0.0712	-0.1464	-0.1463	-0.2021
0.10	-0.1863	-1.1667	-0.1762	0.1491	-0.0871	-0.1379	-0.1289	-0.1980
0.25	-0.1372	-1.4409	-0.1362	0.0971	-0.0788	-0.0992	-0.0691	-0.1501
0.50	-0.0651	-1.3678	-0.0949	0.0436	-0.0543	-0.0616	-0.0274	-0.0987
1.00	-0.0131	-1.0558	-0.0411	0.0305	-0.0171	-0.0187	0.0167	-0.0327

Table 64. Episode 2 composite statistical comparison of sensitivity px_acm_n with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.02	0.23	0.053	0.018	0.2624
Mixing Ratio (g/kg)	-0.35	0.28	0.068	0.019	0.3339
Rel. Humidity (%)	-2.14	1.89	0.167	0.044	2.6796
Wind Speed (m/s)	0.06	0.04	0.023	0.017	0.0440
Clouds (%)	-1.97	-2.41	-0.056	-0.050	-1.9282

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.675	0.35	0.0223	0.0377	0.0428

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0568	-0.1110	-0.1403	0.1264	-0.0155	-0.0987	-0.1078	-0.1106
0.05	-0.1082	-0.4847	-0.1632	0.0930	-0.0680	-0.1368	-0.1294	-0.1664
0.10	-0.1177	-0.5577	-0.1613	0.0774	-0.0781	-0.1313	-0.1208	-0.1681
0.25	-0.0976	-0.6405	-0.1305	0.0488	-0.0702	-0.0963	-0.0808	-0.1335
0.50	-0.0508	-0.6025	-0.0801	0.0248	-0.0427	-0.0517	-0.0337	-0.0779
1.00	-0.0127	-0.5768	-0.0120	0.0516	0.0006	-0.0012	0.0371	-0.0020

Table 65. Like table 64, except for 12-km VISTAS domain.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	0.11	0.26	0.034	0.011	0.3233
Mixing Ratio (g/kg)	0.05	0.09	0.016	0.005	0.1248
Rel. Humidity (%)	-0.94	1.85	0.114	0.036	2.6266
Wind Speed (m/s)	0.08	0.01	0.004	0.012	0.0078
Clouds (%)	0.83	-0.44	-0.017	-0.015	-0.4841

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	-0.162	-0.51	-0.0240	-0.0119	-0.0252

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0431	-0.0421	-0.0993	0.0930	-0.0051	-0.0628	-0.0705	-0.0772
0.05	-0.0849	-0.4172	-0.1192	0.0673	-0.0485	-0.0898	-0.0829	-0.1180
0.10	-0.0867	-0.4984	-0.1138	0.0470	-0.0584	-0.0857	-0.0763	-0.1175
0.25	-0.0545	-0.5351	-0.0804	0.0199	-0.0470	-0.0570	-0.0437	-0.0831
0.50	-0.0236	-0.4618	-0.0528	-0.0009	-0.0308	-0.0341	-0.0257	-0.0533
1.00	-0.0040	-0.3357	-0.0159	0.0138	-0.0052	-0.0059	0.0094	-0.0101

Table 66. Episode 2 composite statistical comparison of sensitivity px_acm_n2 with base case px_acm2 for the US portion of the 36-km domain is shown.

Total stats	bias	abserr	r2	ia	rmse
Temperature (K)	-0.04	0.25	0.055	0.020	0.2906
Mixing Ratio (g/kg)	0.10	0.09	0.007	0.006	0.1162
Rel. Humidity (%)	0.17	1.70	0.138	0.048	2.3239
Wind Speed (m/s)	0.04	0.03	0.024	0.016	0.0392
Clouds (%)	-0.16	-1.09	-0.029	-0.022	-0.9229

Wind stats	bias	abserr	uerr	verr	uverr
Wind (deg, m/s)	0.727	0.46	0.0204	0.0353	0.0398

Pcp Threshold (in)	Acc	Bias	FAR	POD	CSI	ETS	TSS	HSS
0.01	-0.0338	0.1227	-0.0763	0.0330	-0.0232	-0.0612	-0.0654	-0.0666
0.05	-0.0554	-0.1760	-0.0937	0.0115	-0.0517	-0.0840	-0.0820	-0.0979
0.10	-0.0559	-0.1935	-0.0921	0.0010	-0.0555	-0.0798	-0.0784	-0.0978
0.25	-0.0365	-0.1856	-0.0653	-0.0087	-0.0411	-0.0511	-0.0512	-0.0681
0.50	-0.0143	-0.1517	-0.0309	-0.0022	-0.0177	-0.0204	-0.0178	-0.0300
1.00	-0.0019	-0.0956	-0.0007	0.0117	0.0015	0.0011	0.0094	0.0020

Table 67. Like table 66, except for 12-km VISTAS domain.

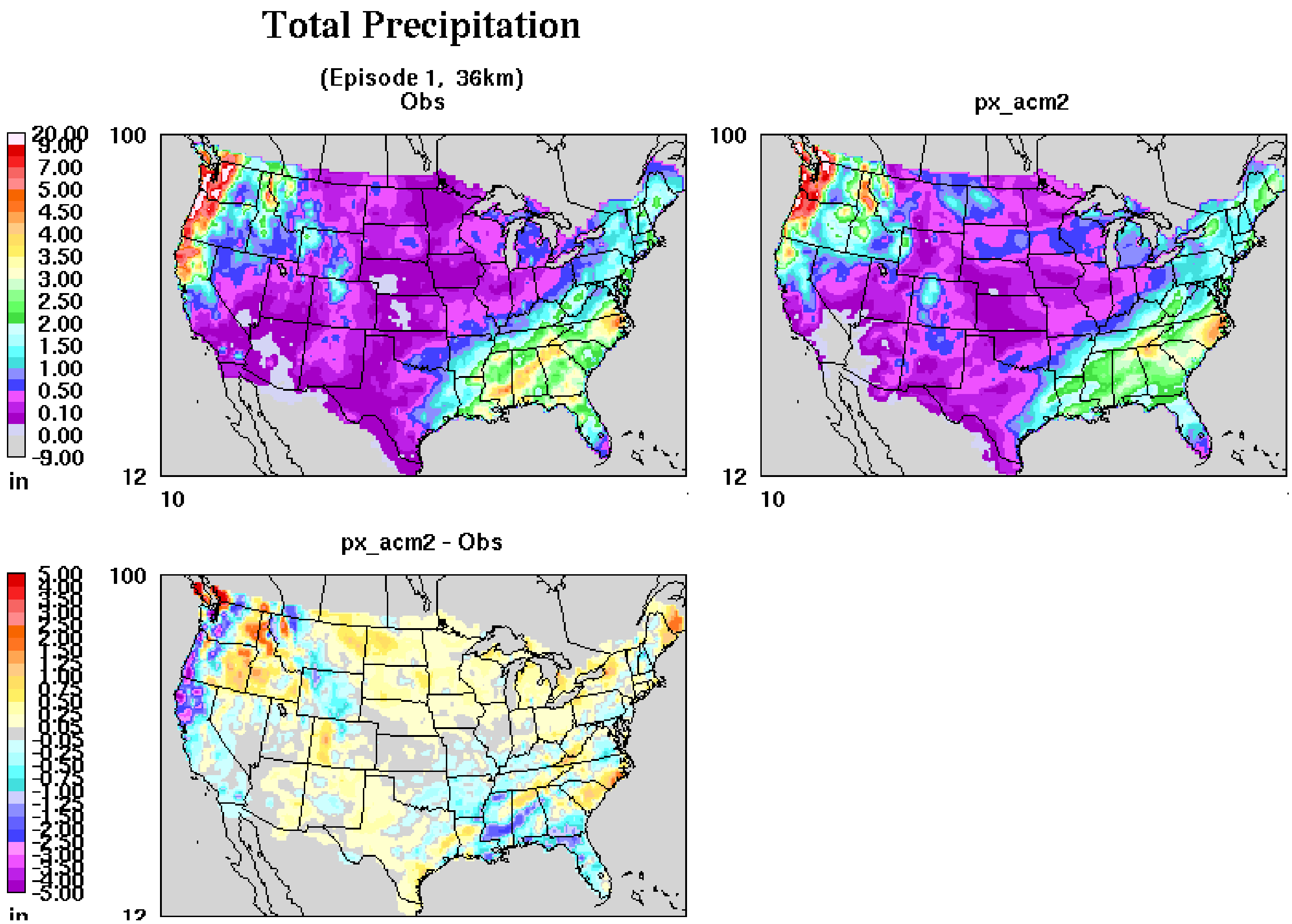

Figure 38. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the base case px_acm2 model configuration. The lower left plot shows the difference plot of the top panels.

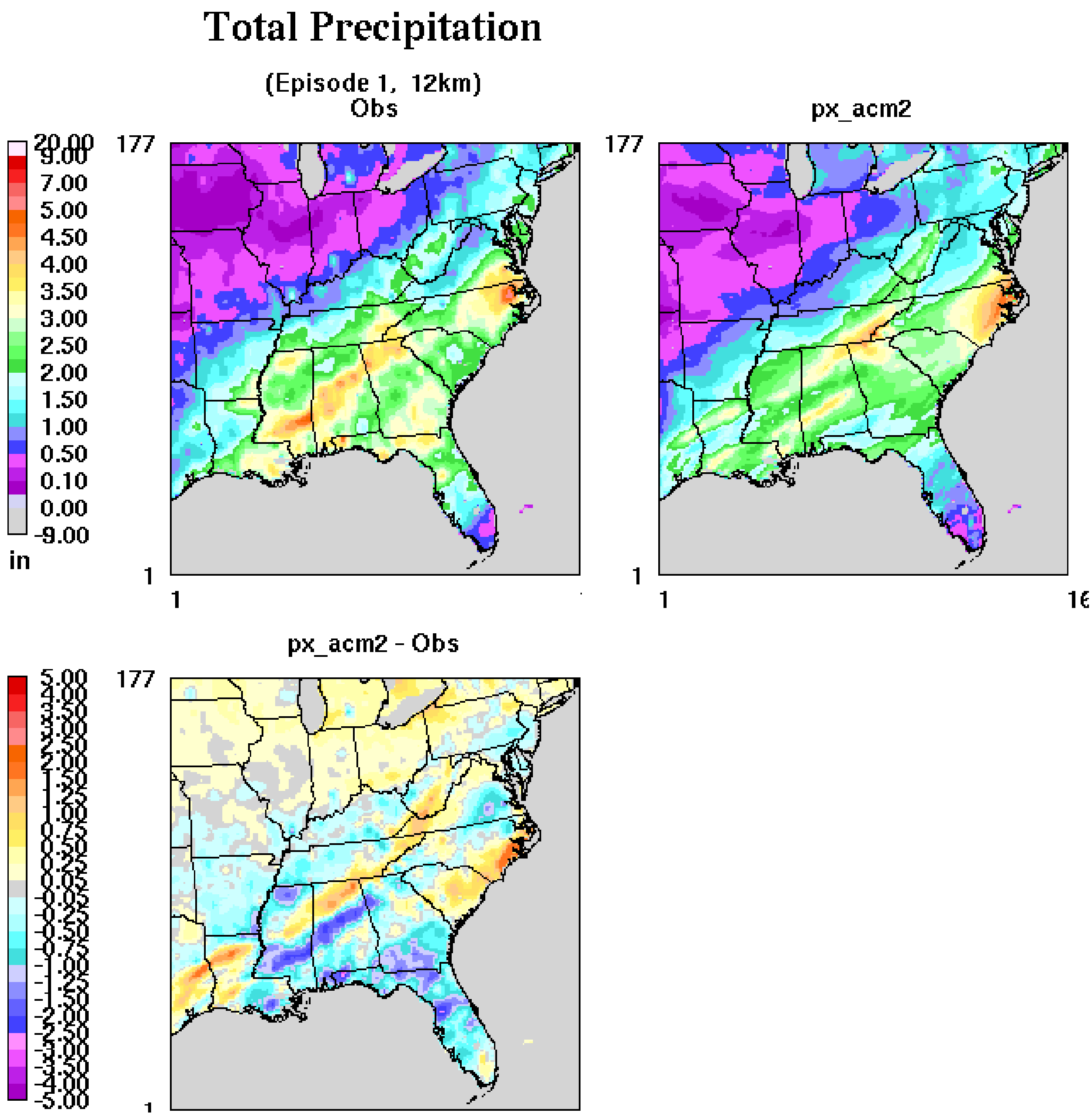

Figure 39. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the base case px_acm2 model configuration, and the lower left plot shows the difference plot between the model and the observations.

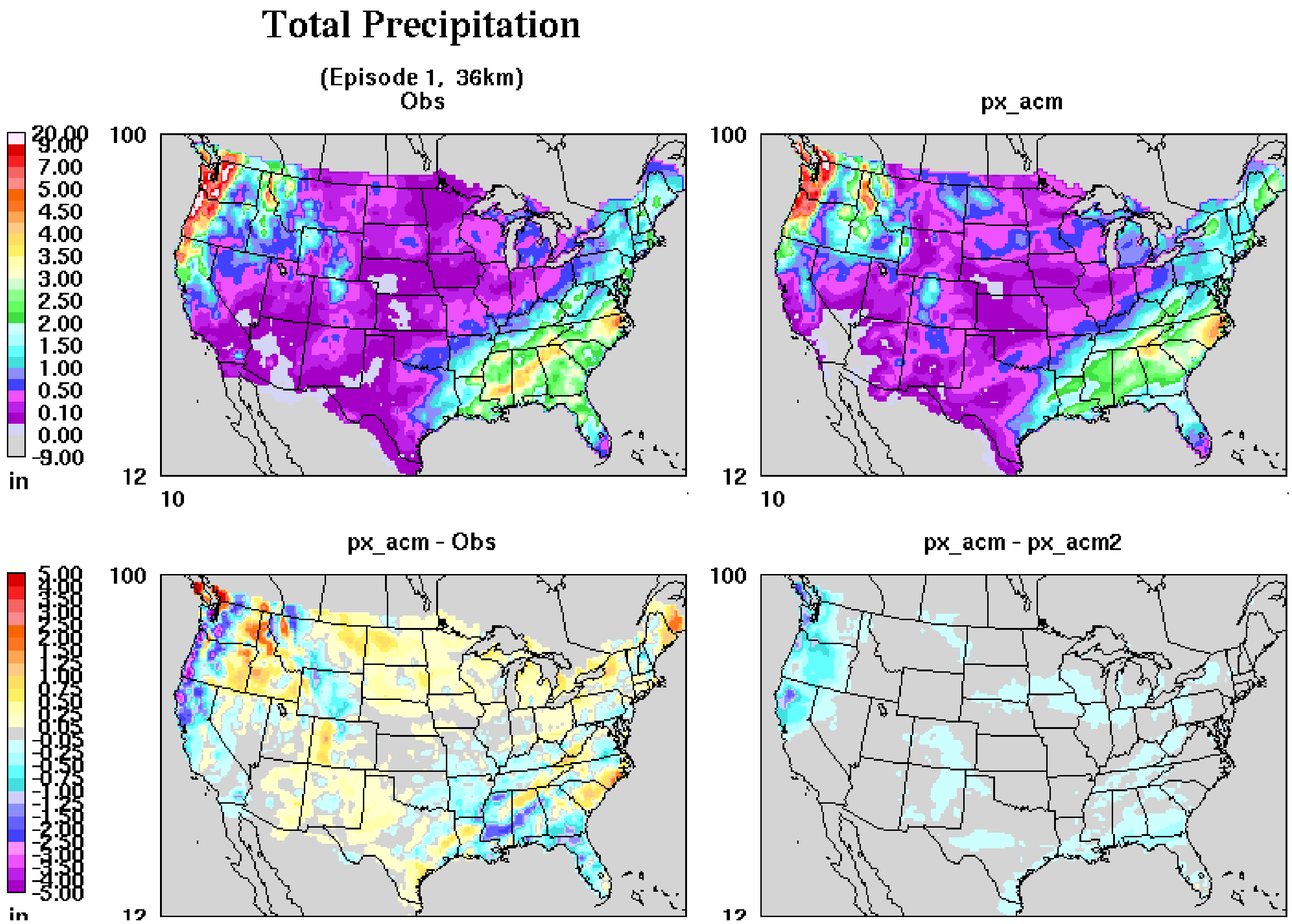

Figure 40. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm sensitivity and the px_acm2 base case.

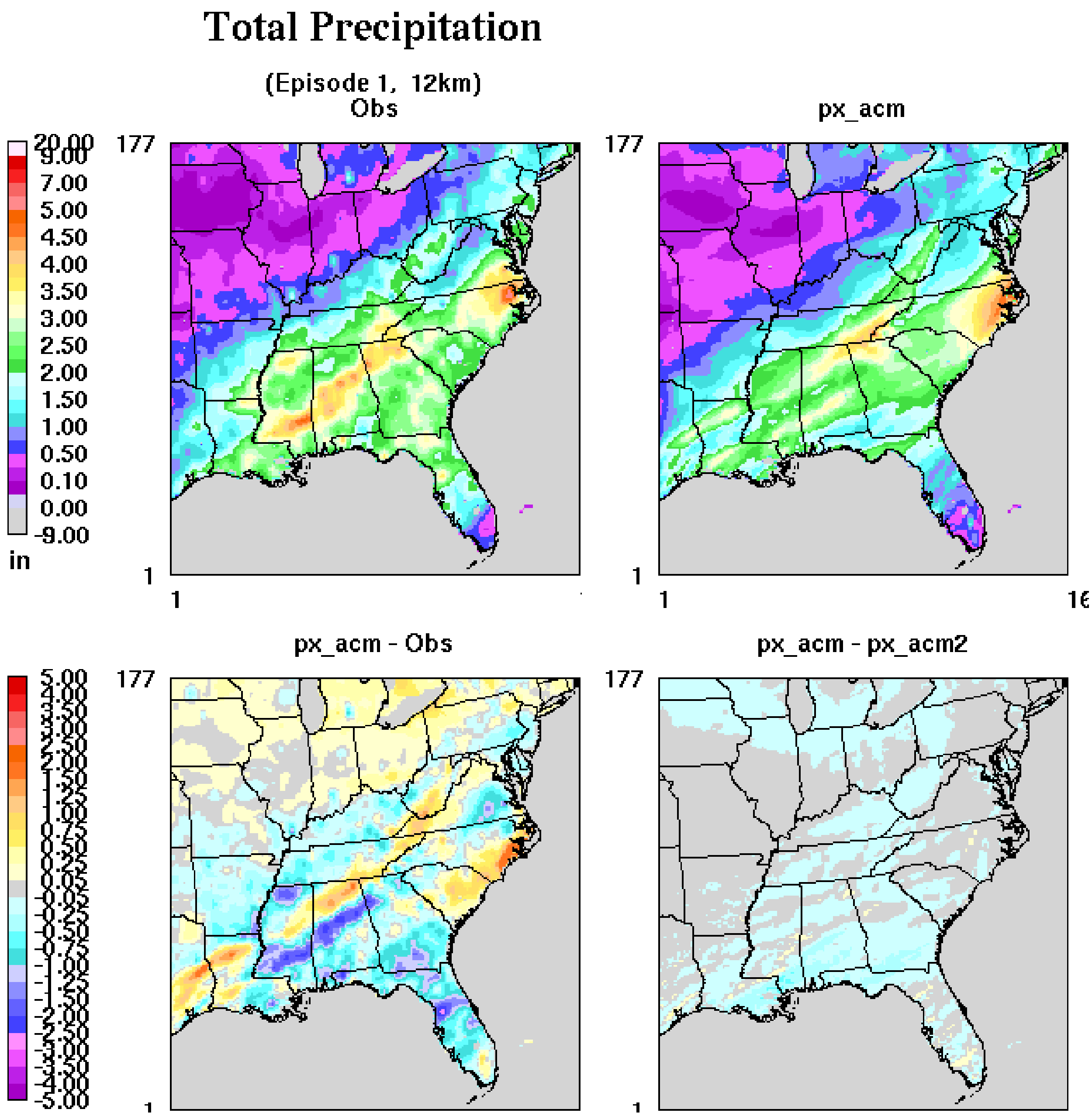

Figure 41. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm sensitivity and the px_acm2 base case.

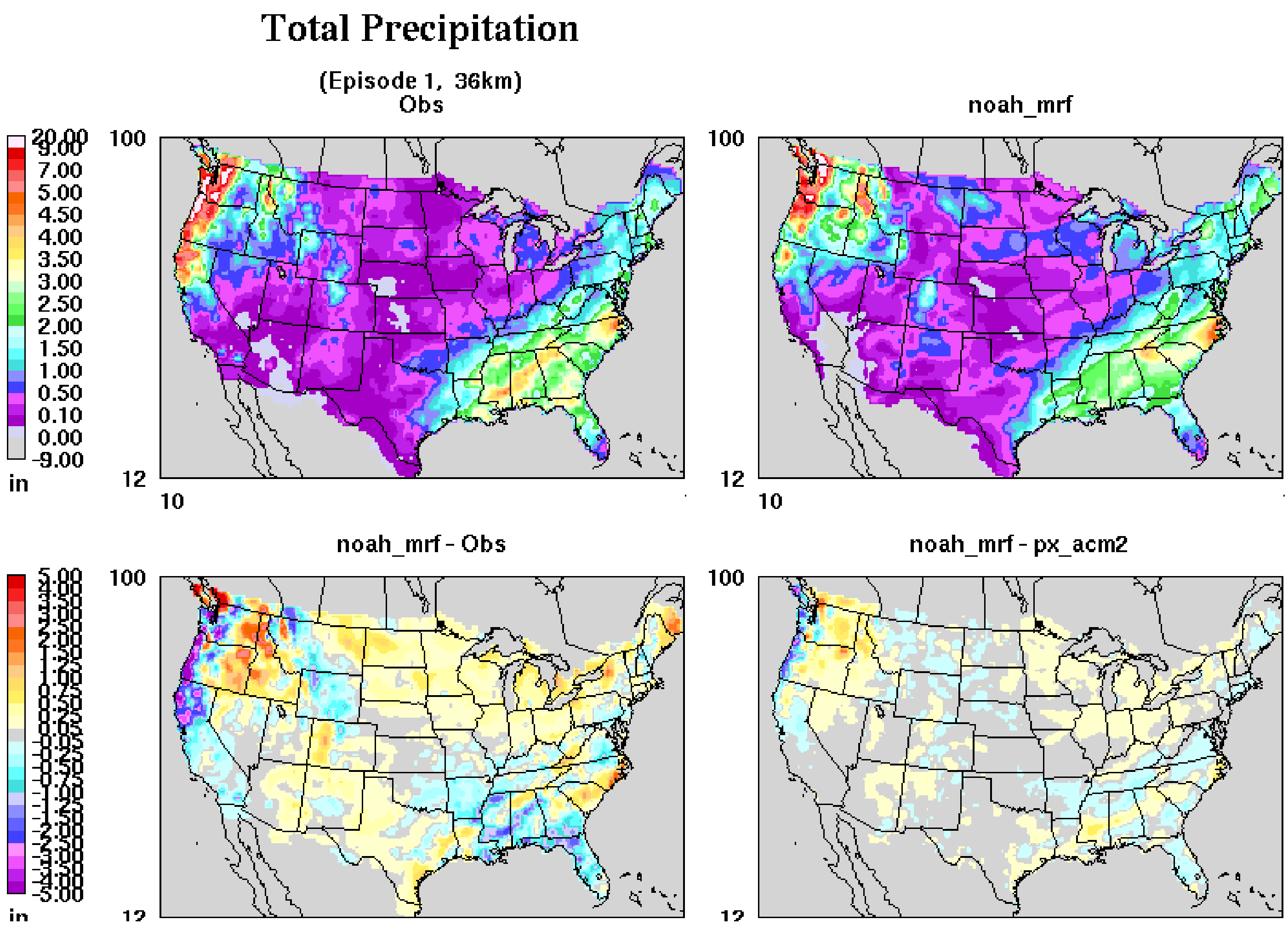

Figure 42. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_mrf model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_mrf sensitivity and the px_acm2 base case.

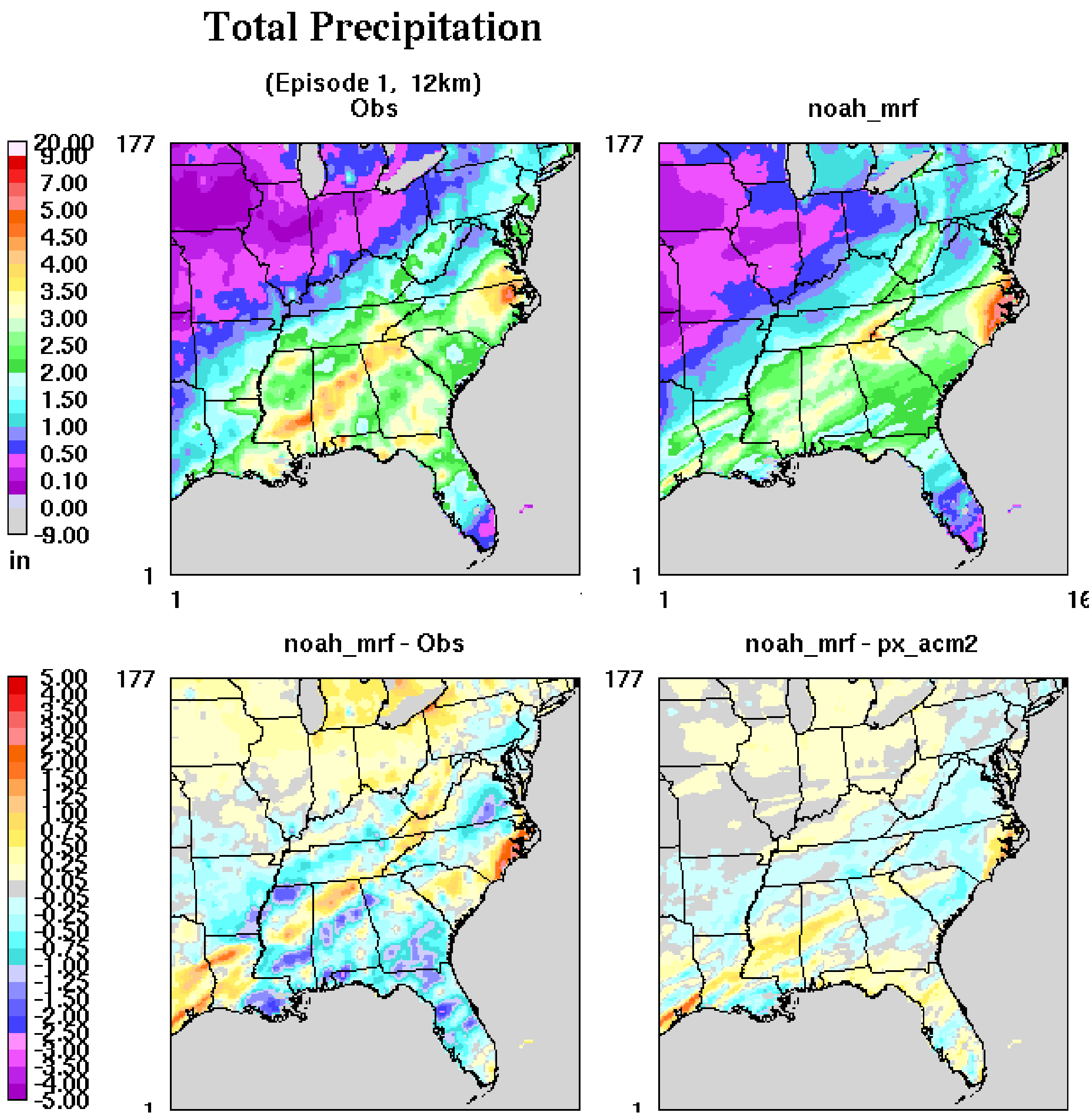

Figure 43. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_mrf model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_mrf sensitivity and the px_acm2 base case.

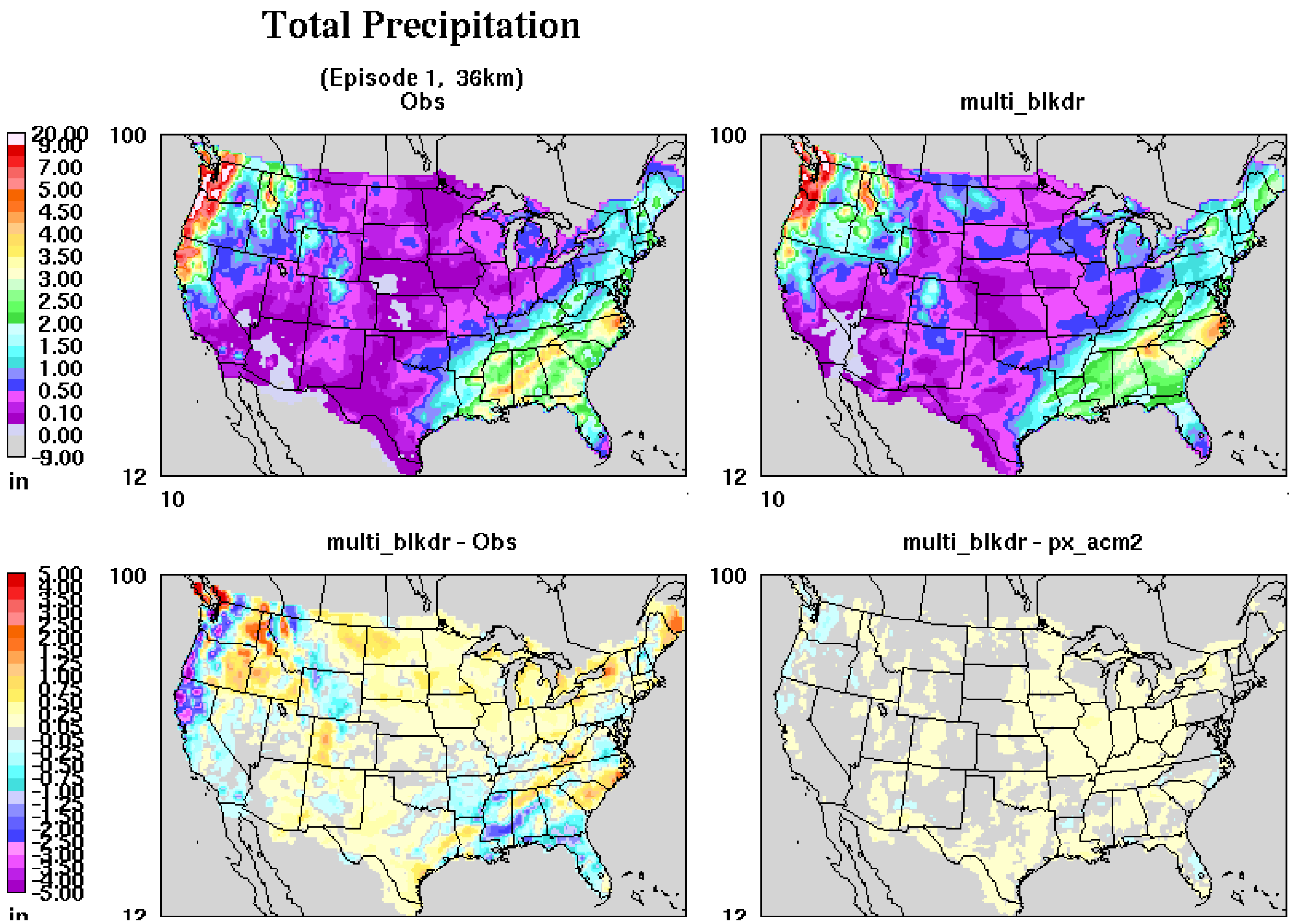

Figure 44. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the multi_blkdr model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the multi_blkdr sensitivity and the px_acm2 base case.

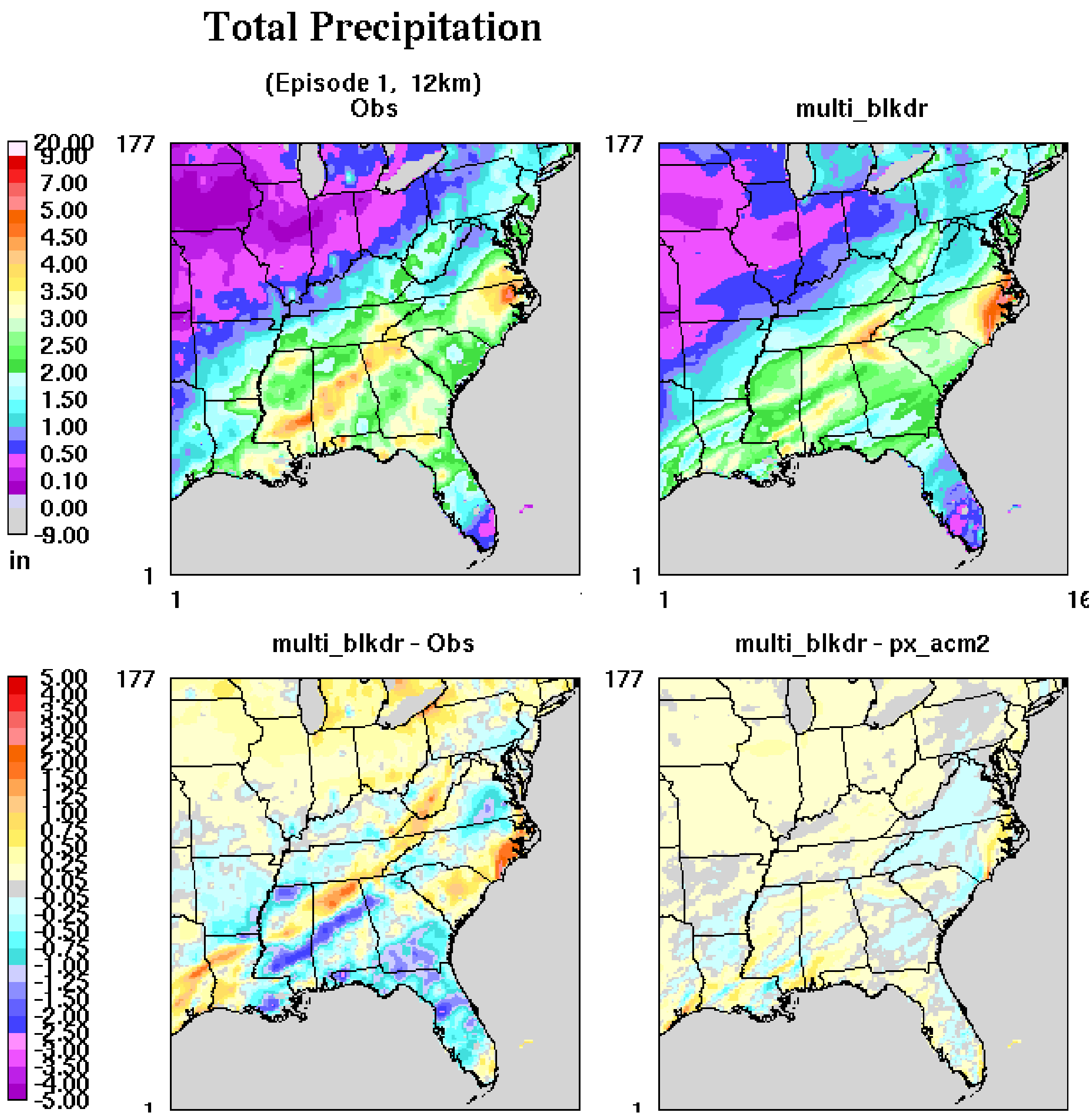

Figure 45. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the multi_blkdr model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the multi_blkdr sensitivity and the px_acm2 base case.

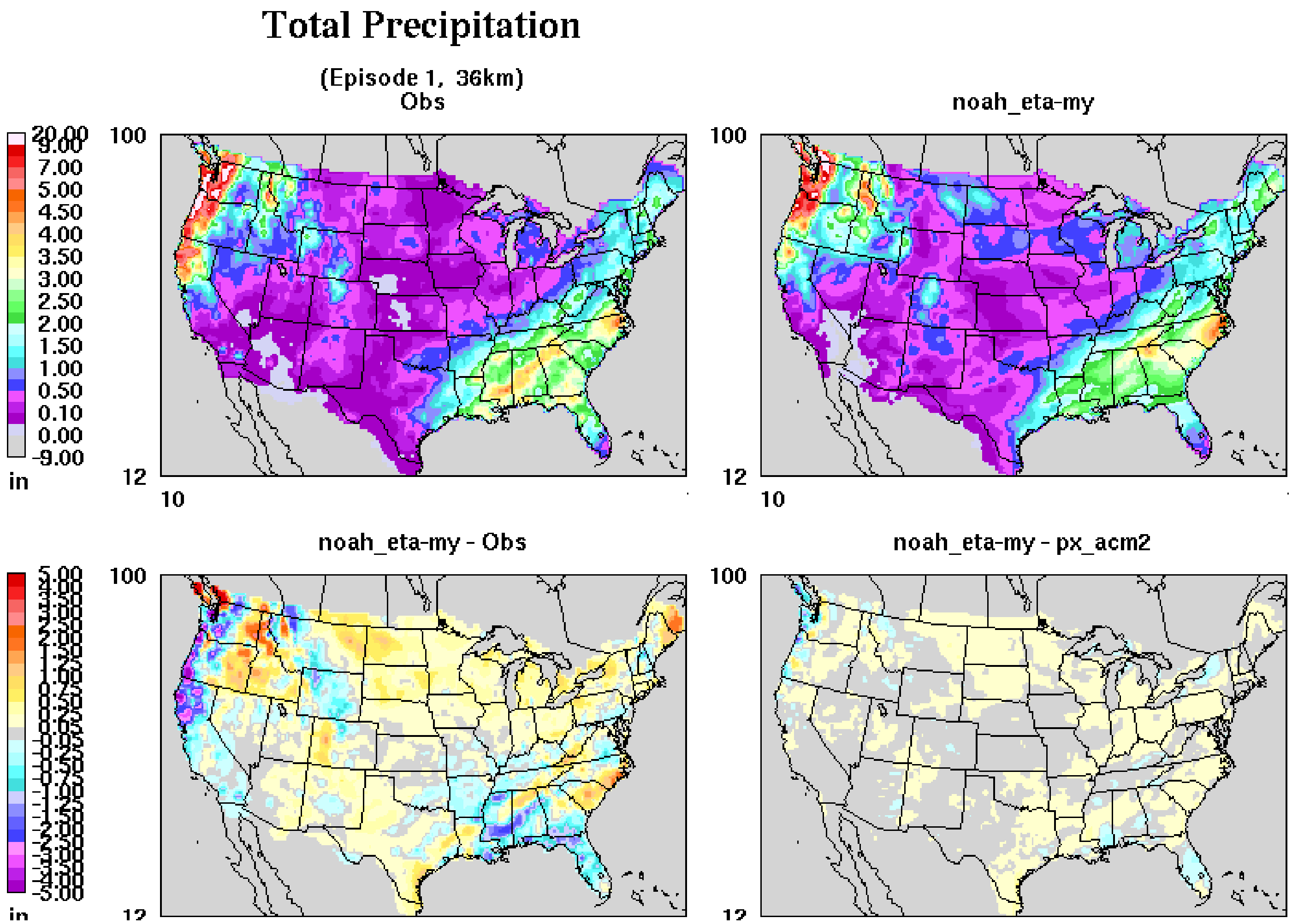

Figure 46. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_eta-my model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_eta-my sensitivity and the px_acm2 base case.

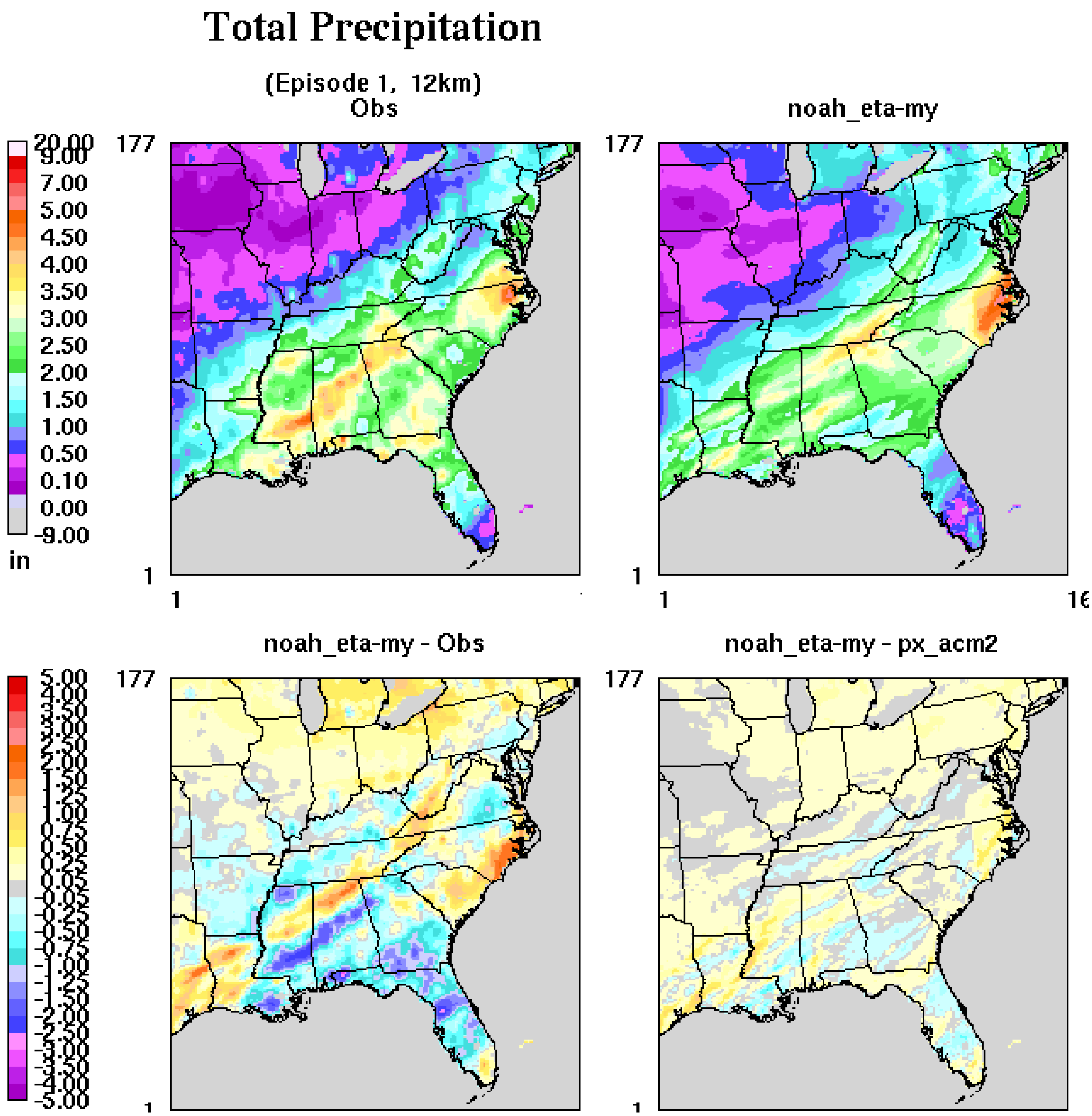

Figure 47. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_eta-my model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_eta-my sensitivity and the px_acm2 base case.

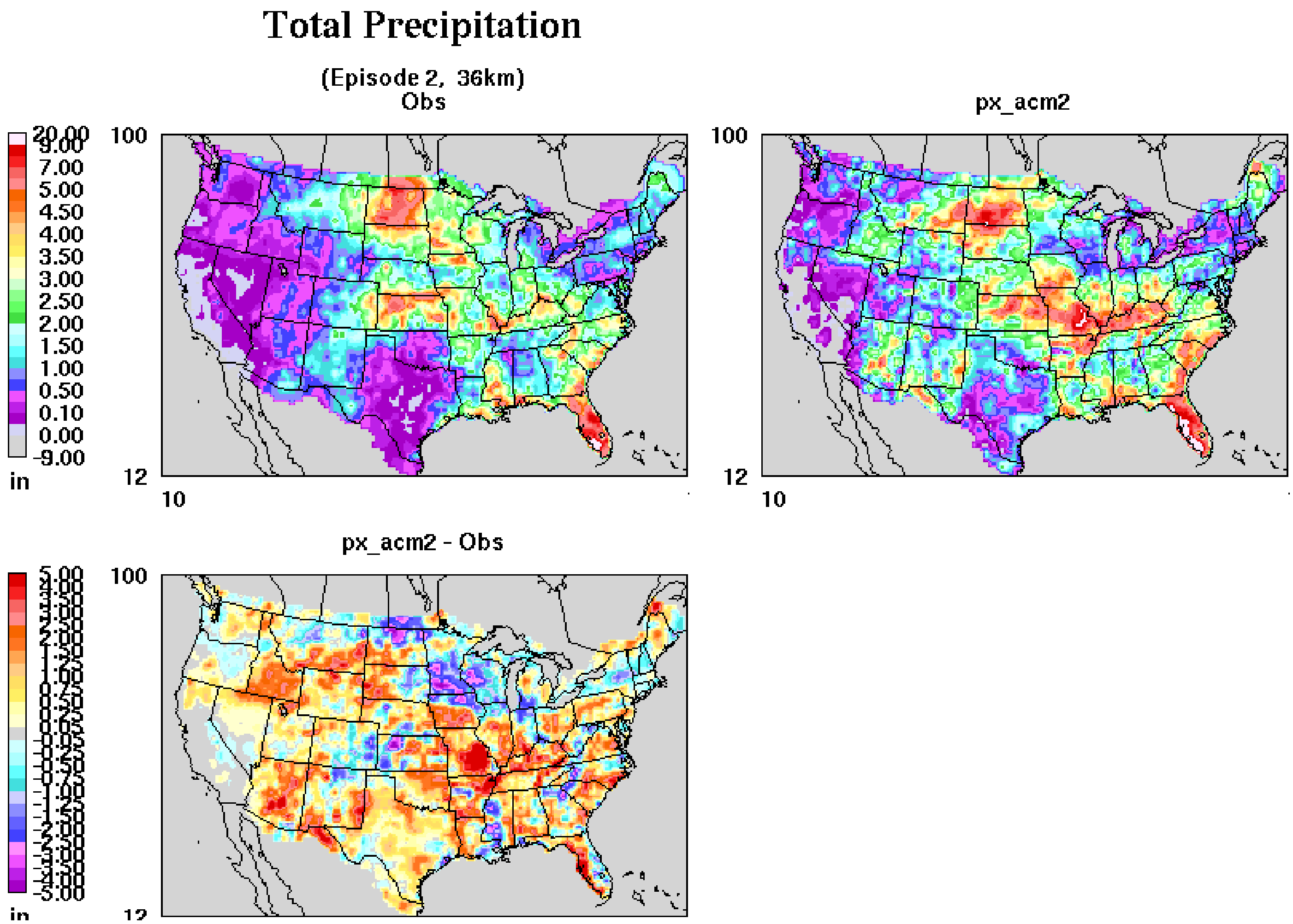

Figure 48. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the base case px_acm2 model configuration. The lower left plot shows the difference plot of the top panels.

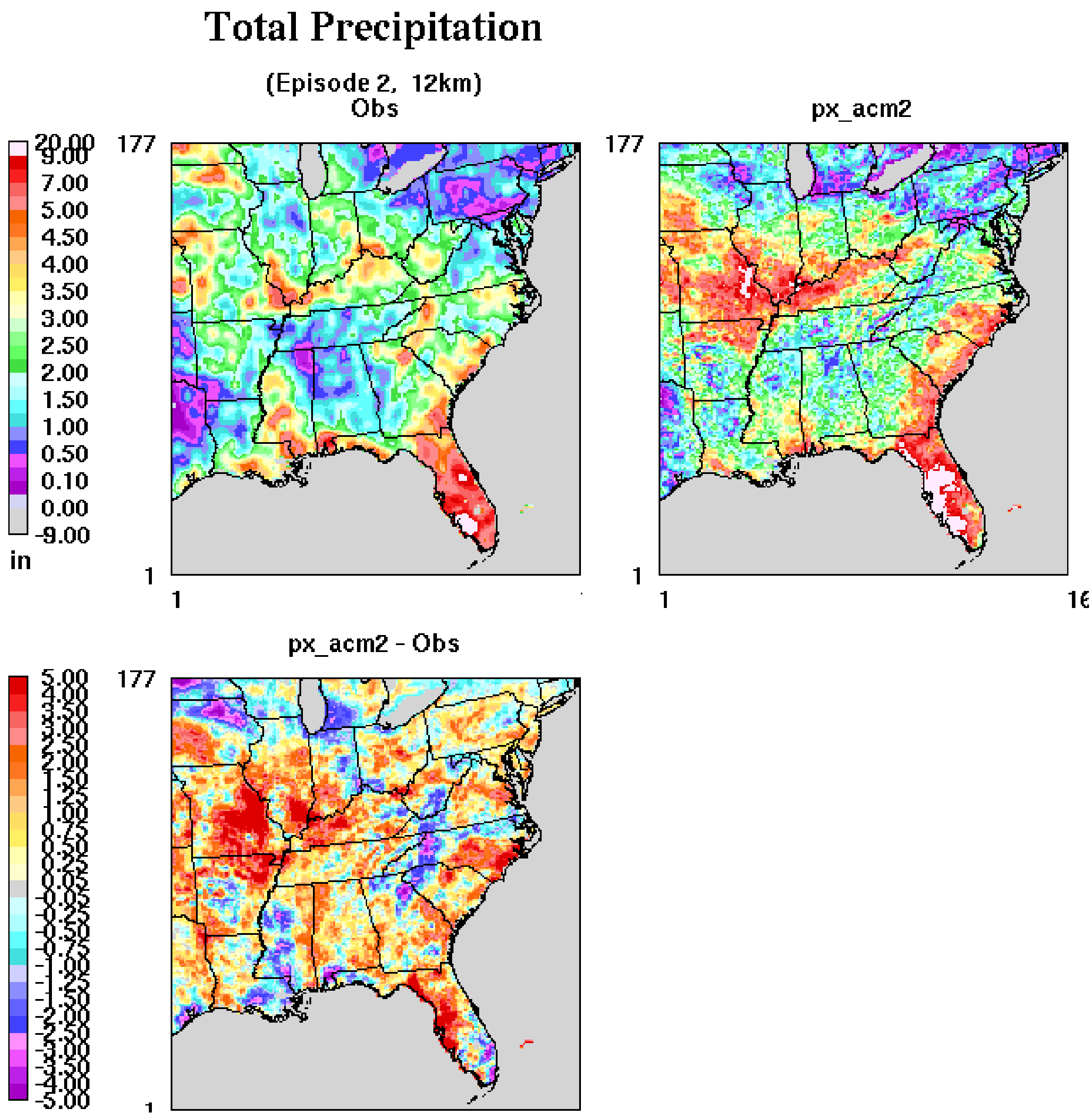

Figure 49. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the base case px_acm2 model configuration. The lower left plot shows the difference plot of the top panels.

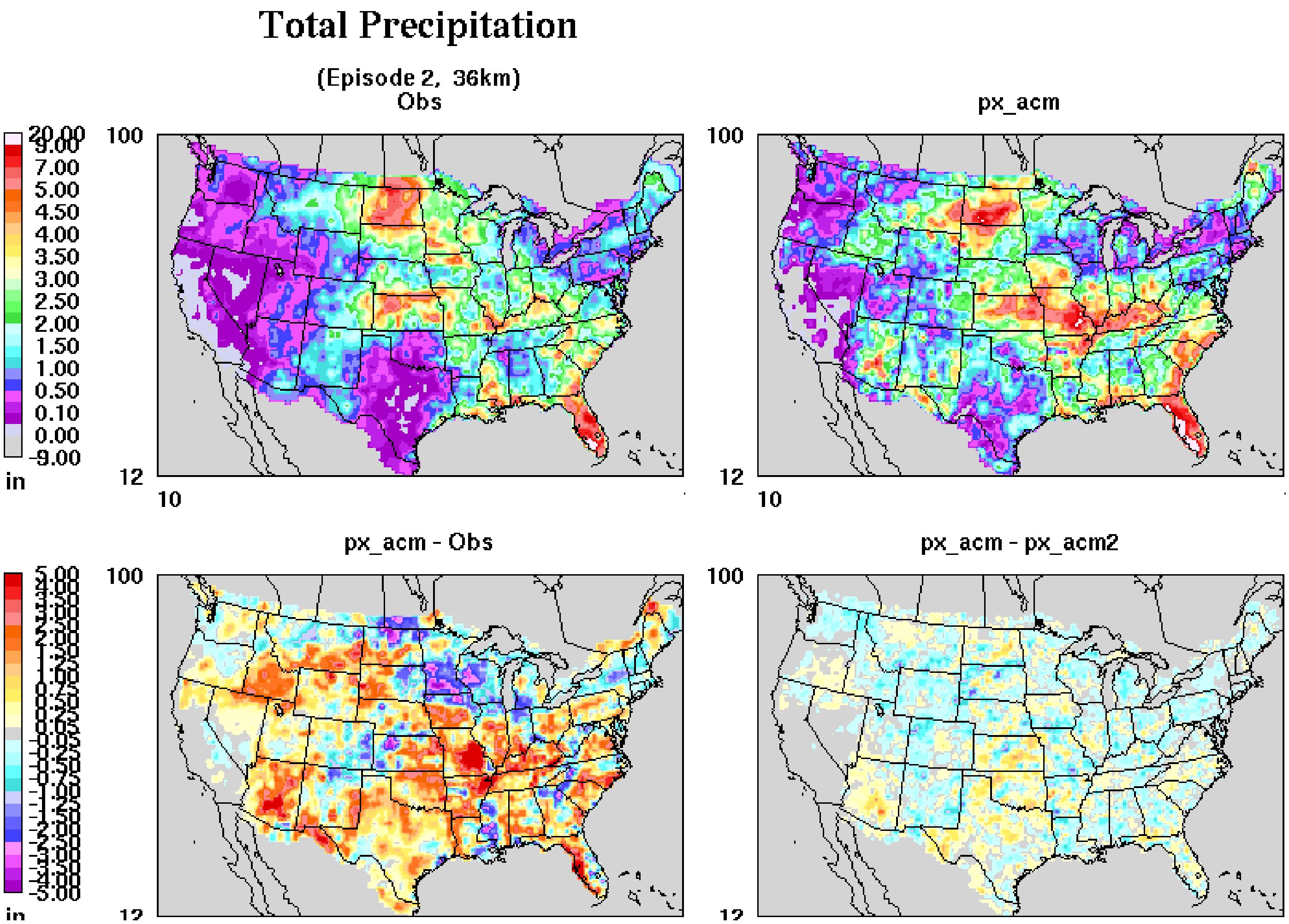

Figure 50. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm sensitivity and the px_acm2 base case.

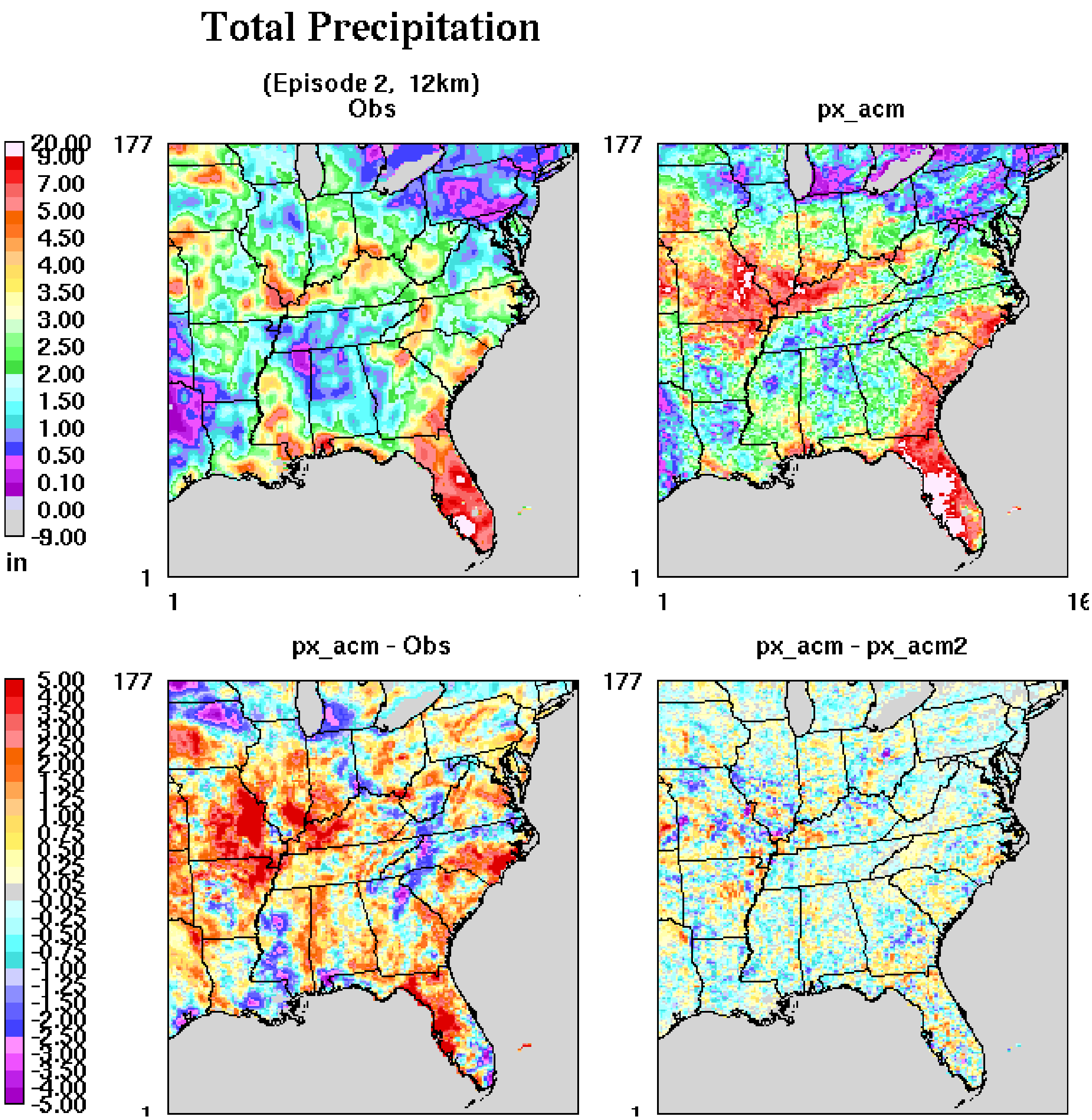

Figure 51. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm sensitivity and the px_acm2 base case.

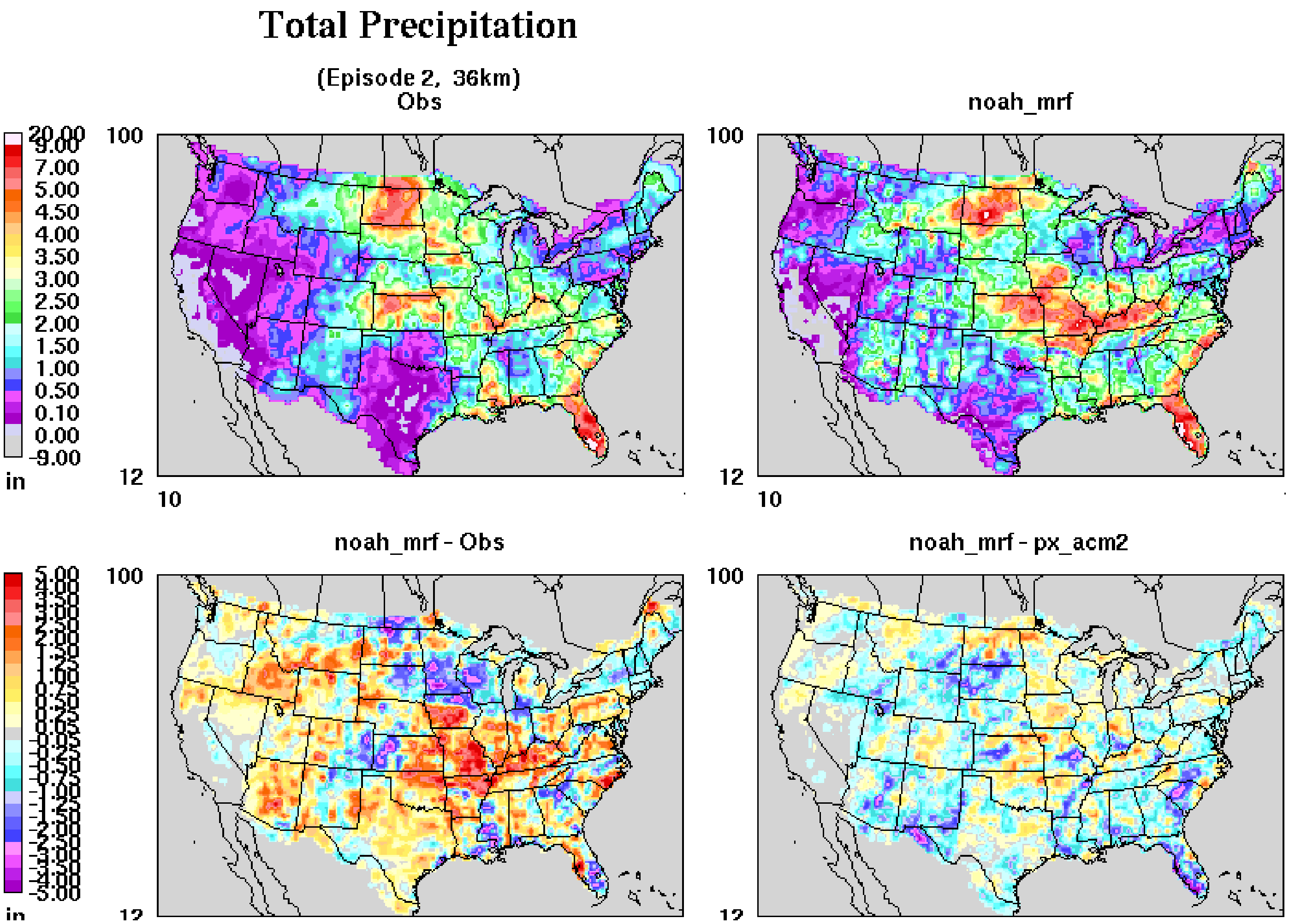

Figure 52. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_mrf model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_mrf sensitivity and the px_acm2 base case.

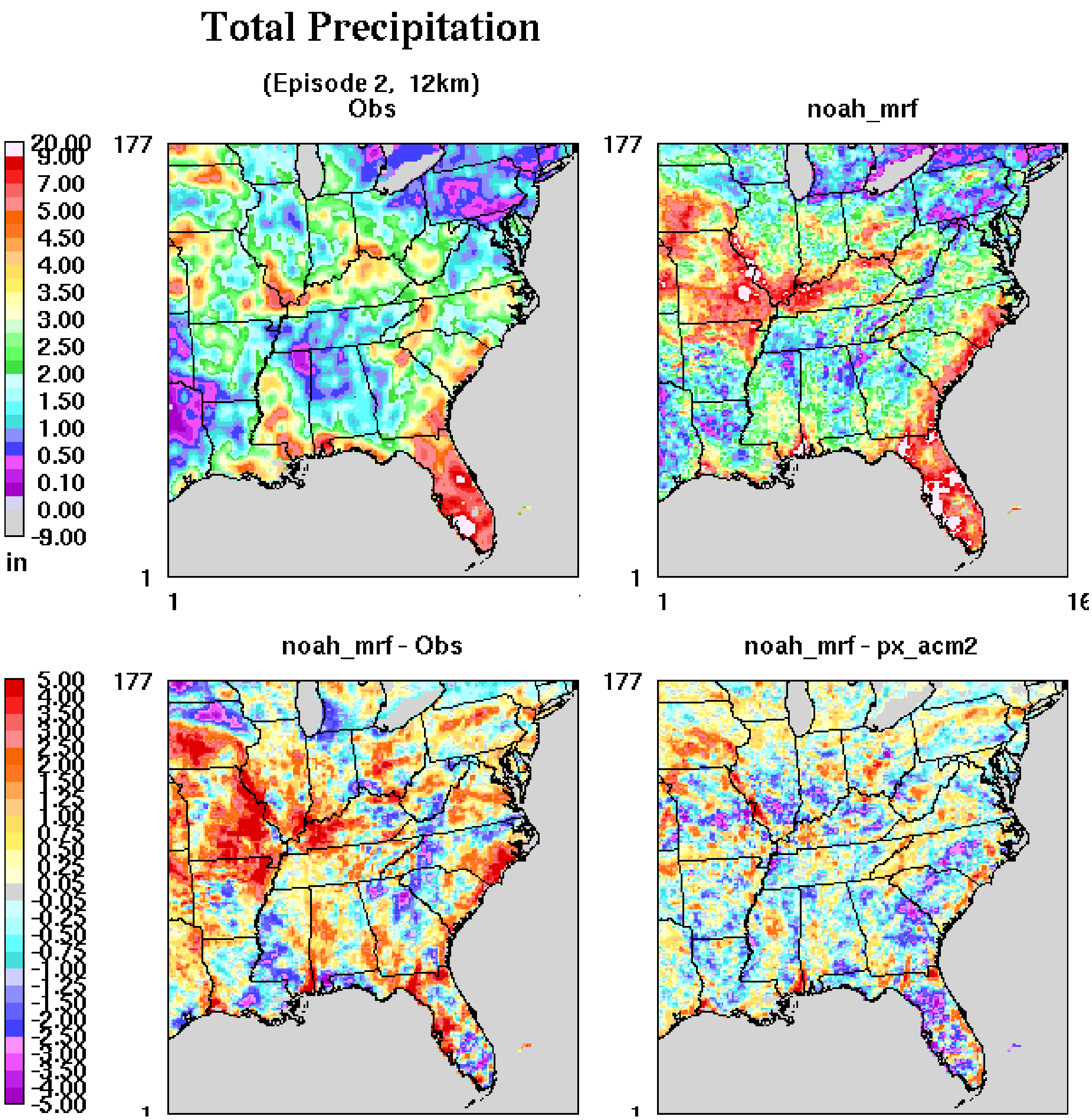

Figure 53. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_mrf model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_mrf sensitivity and the px_acm2 base case.

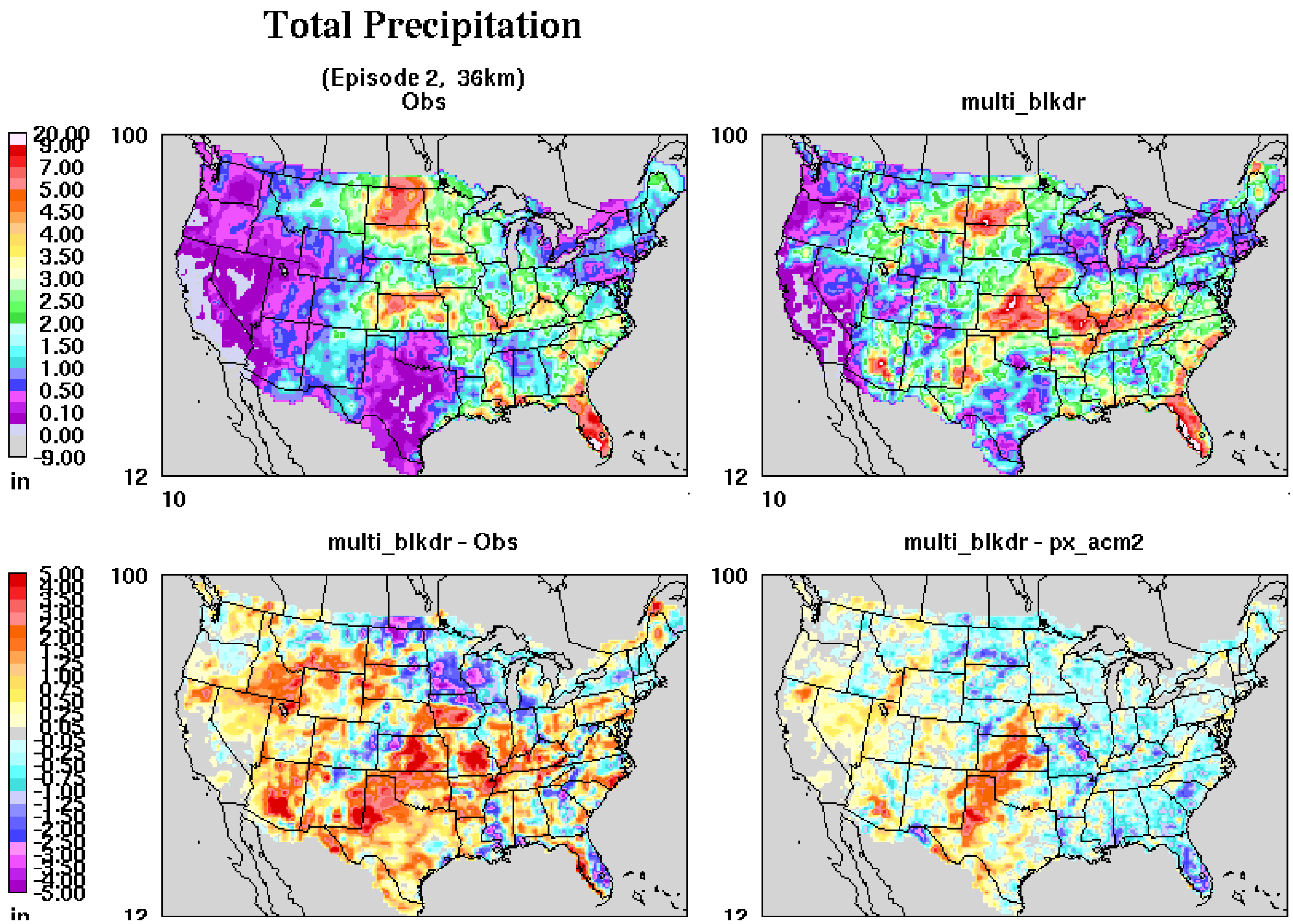

Figure 54. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the multi_blkdr model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the multi_blkdr sensitivity and the px_acm2 base case.

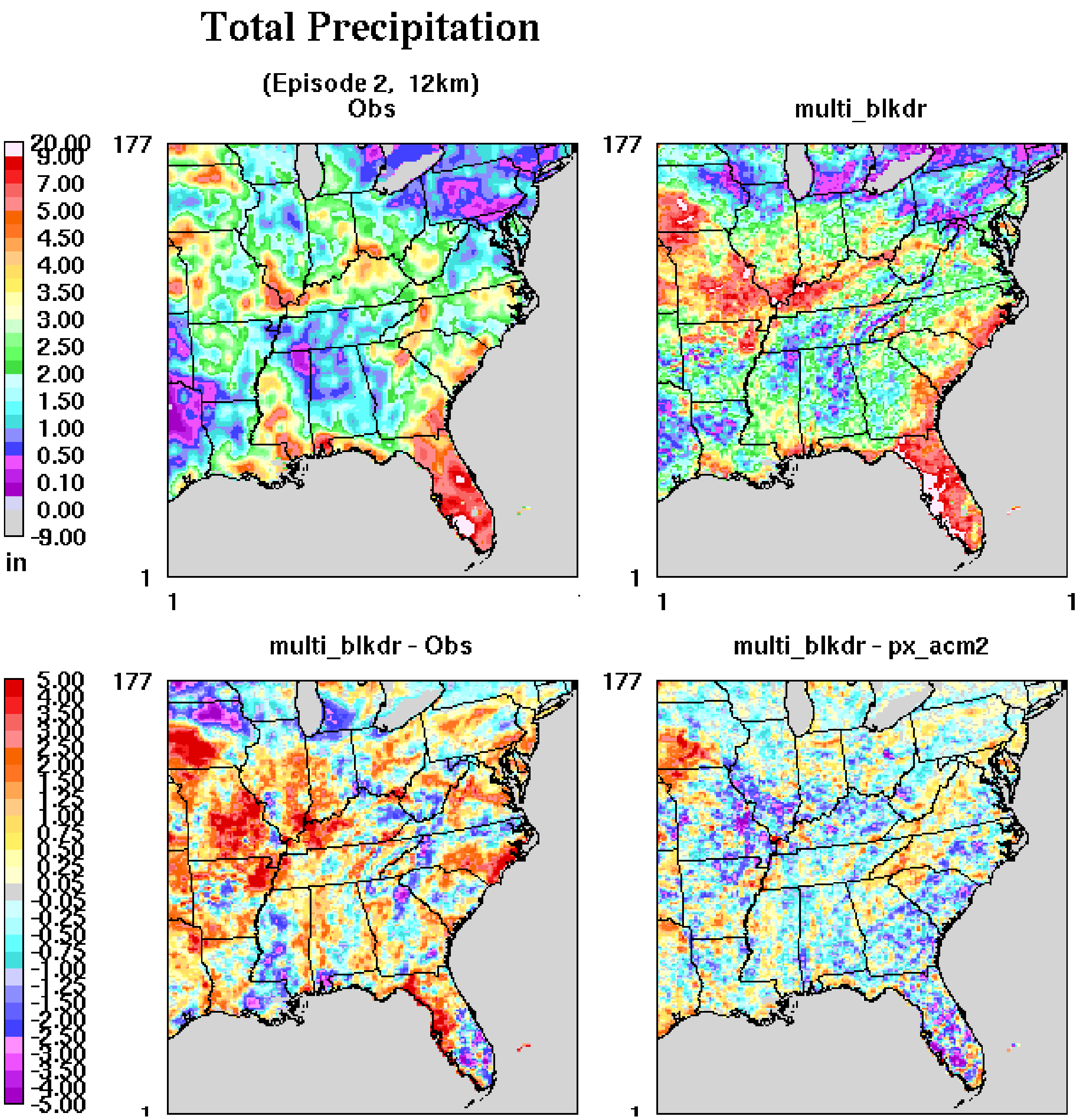

Figure 55. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the multi_blkdr model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the multi_blkdr sensitivity and the px_acm2 base case.

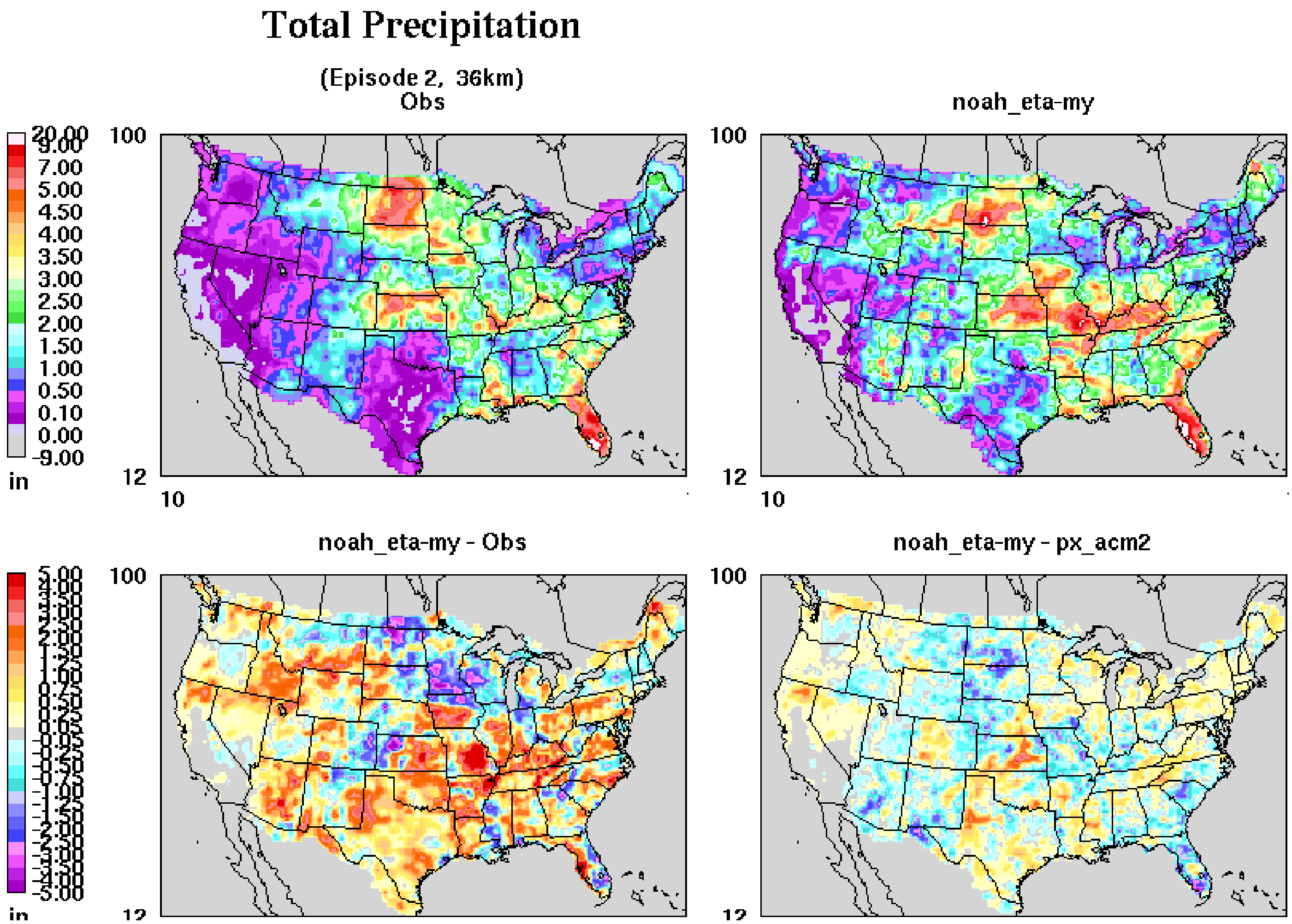

Figure 56. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_eta-my model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_eta-my sensitivity and the px_acm2 base case.

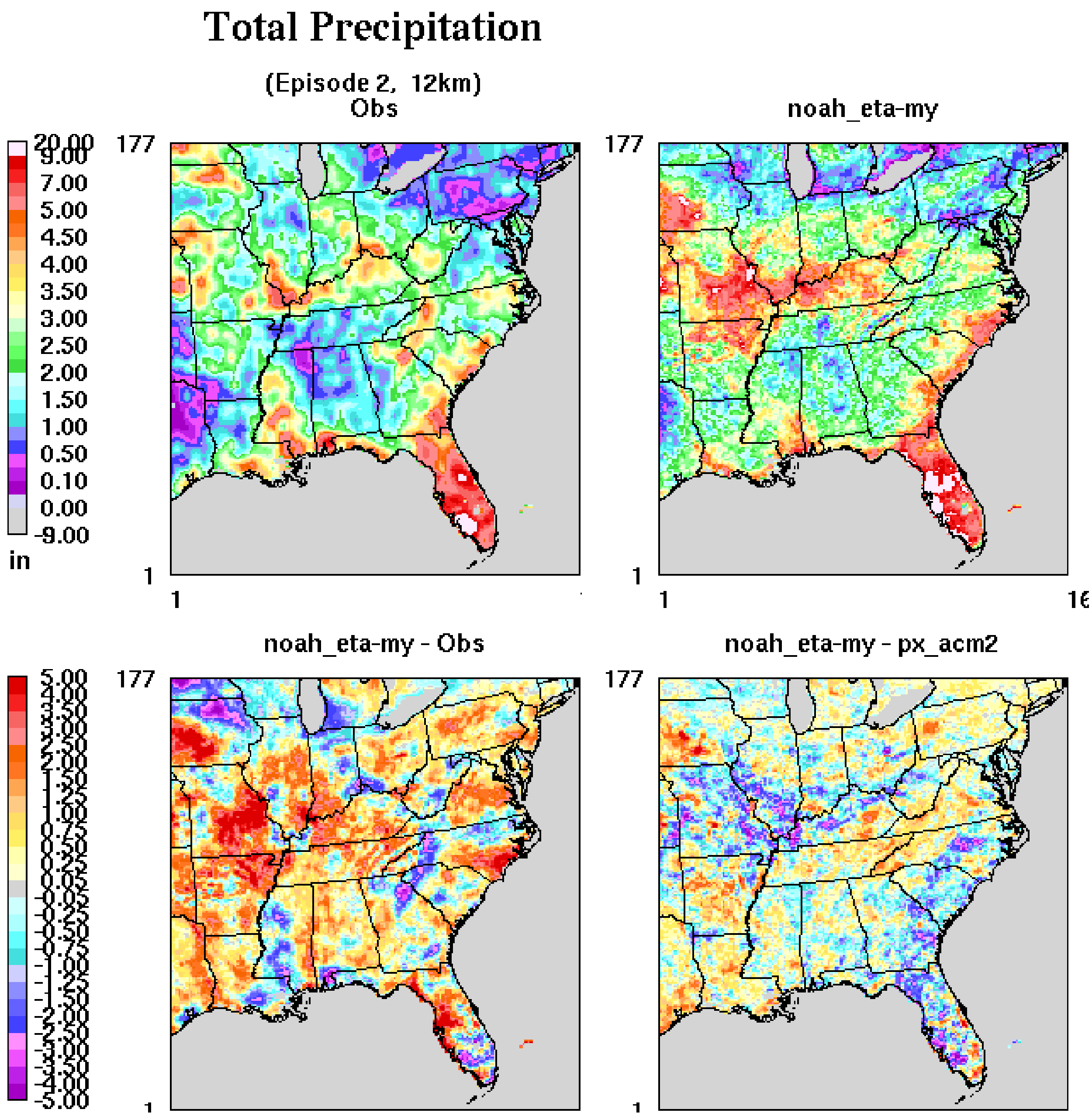

Figure 57. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the noah_eta-my model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the noah_eta-my sensitivity and the px_acm2 base case.

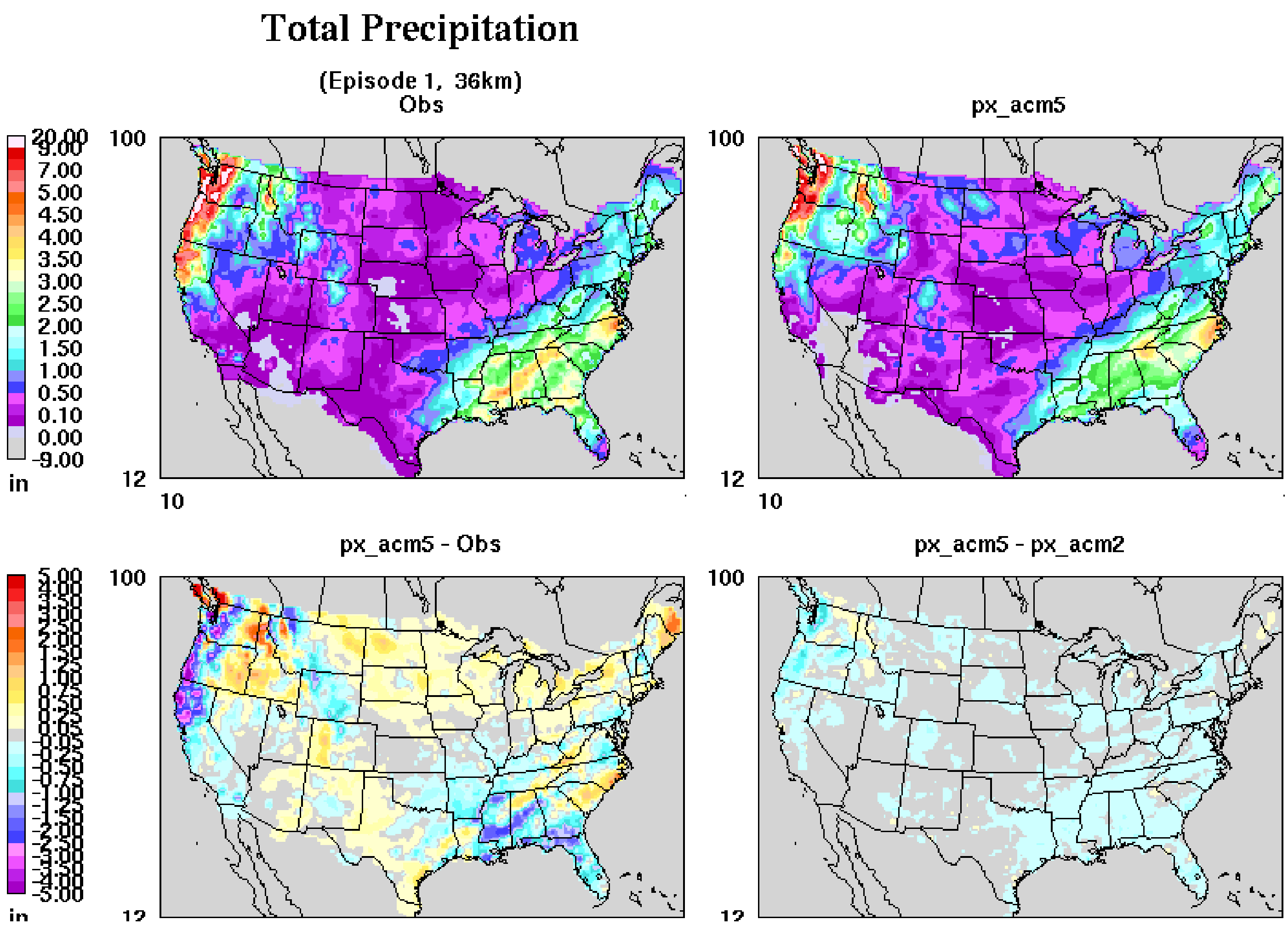

Figure 58. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm5 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm5 sensitivity and the px_acm2 base case.

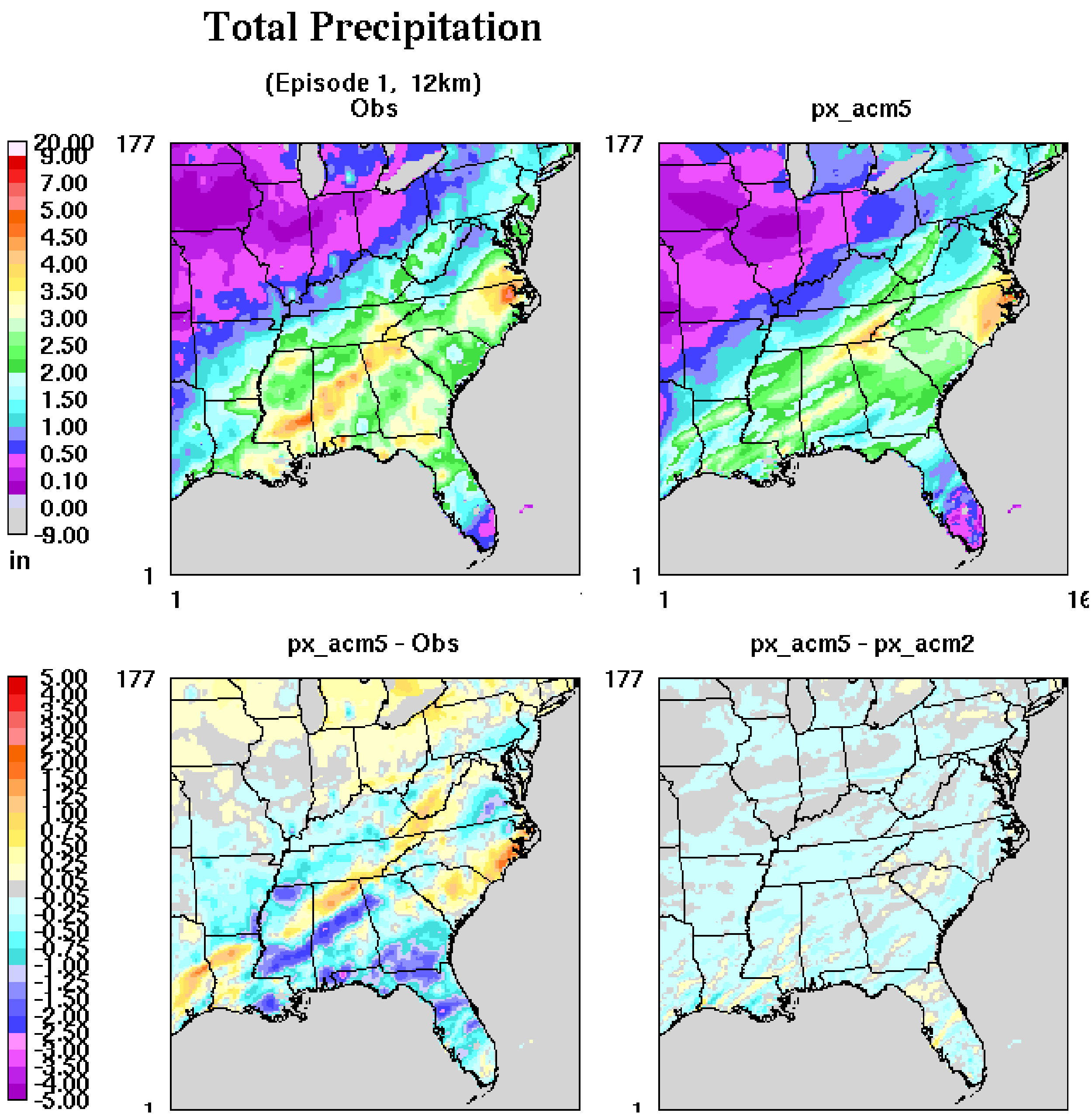

Figure 59. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm5 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm5 sensitivity and the px_acm2 base case.

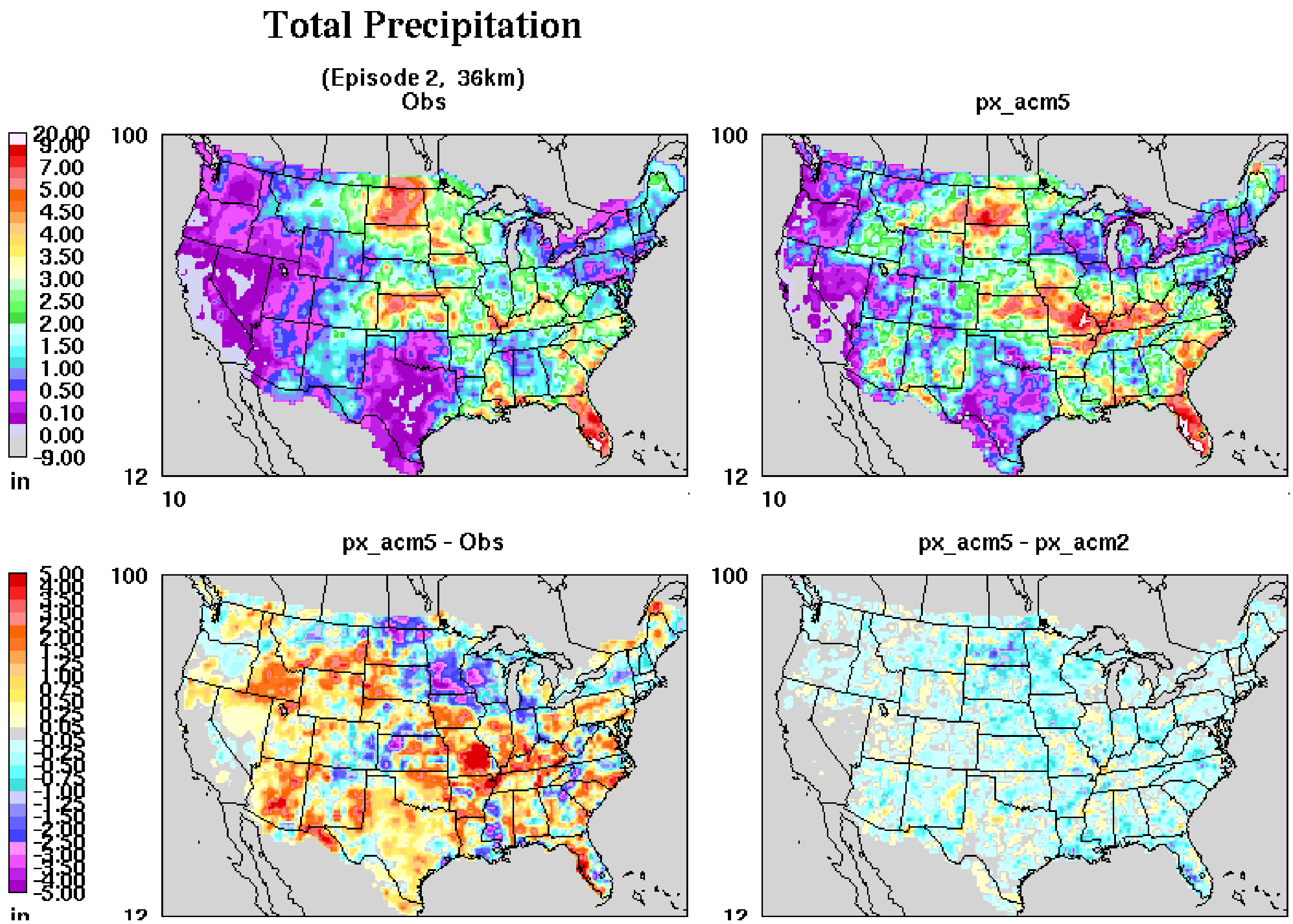

Figure 60. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm5 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm5 sensitivity and the px_acm2 base case.

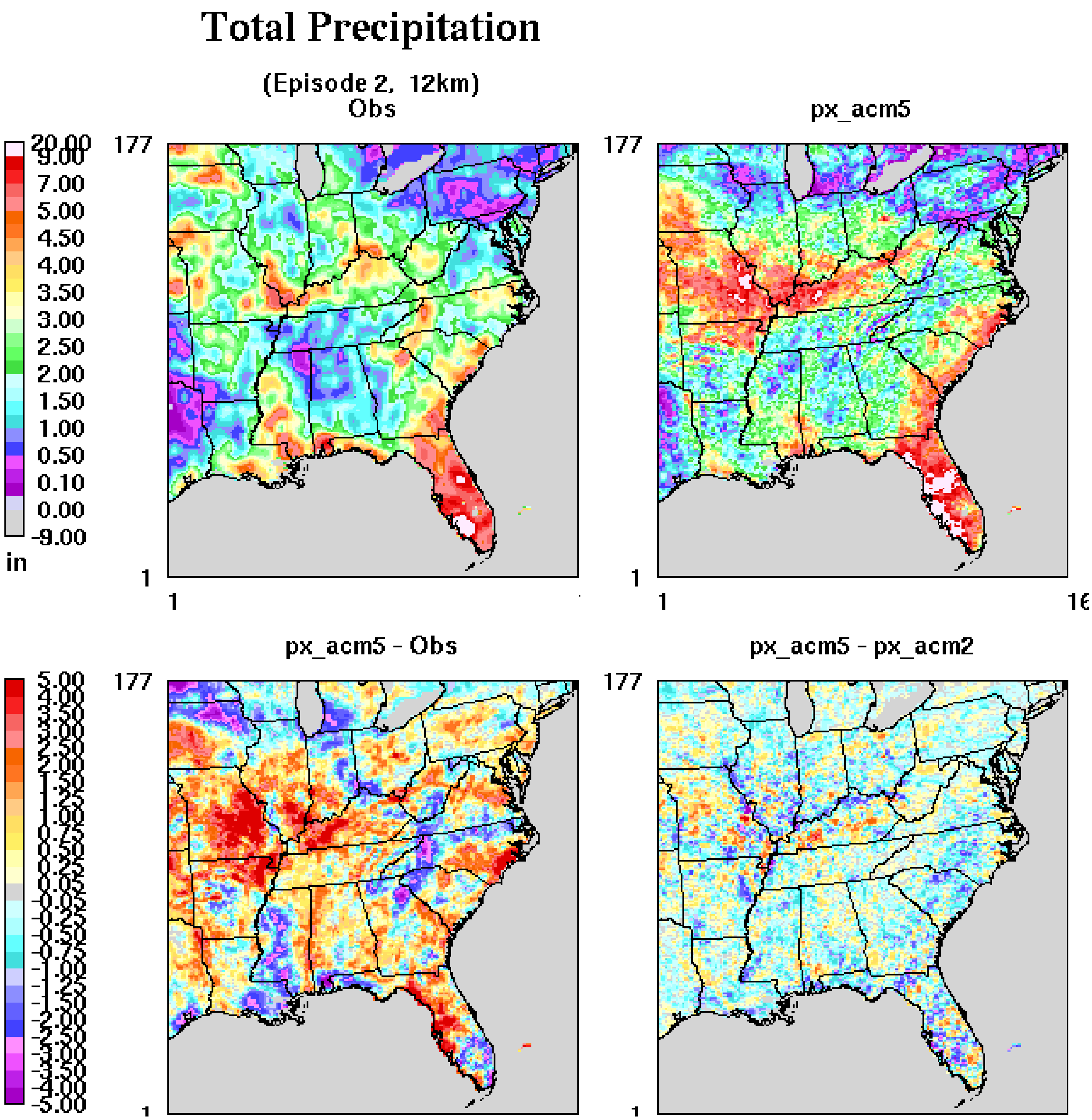

Figure 61. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm5 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm5 sensitivity and the px_acm2 base case.

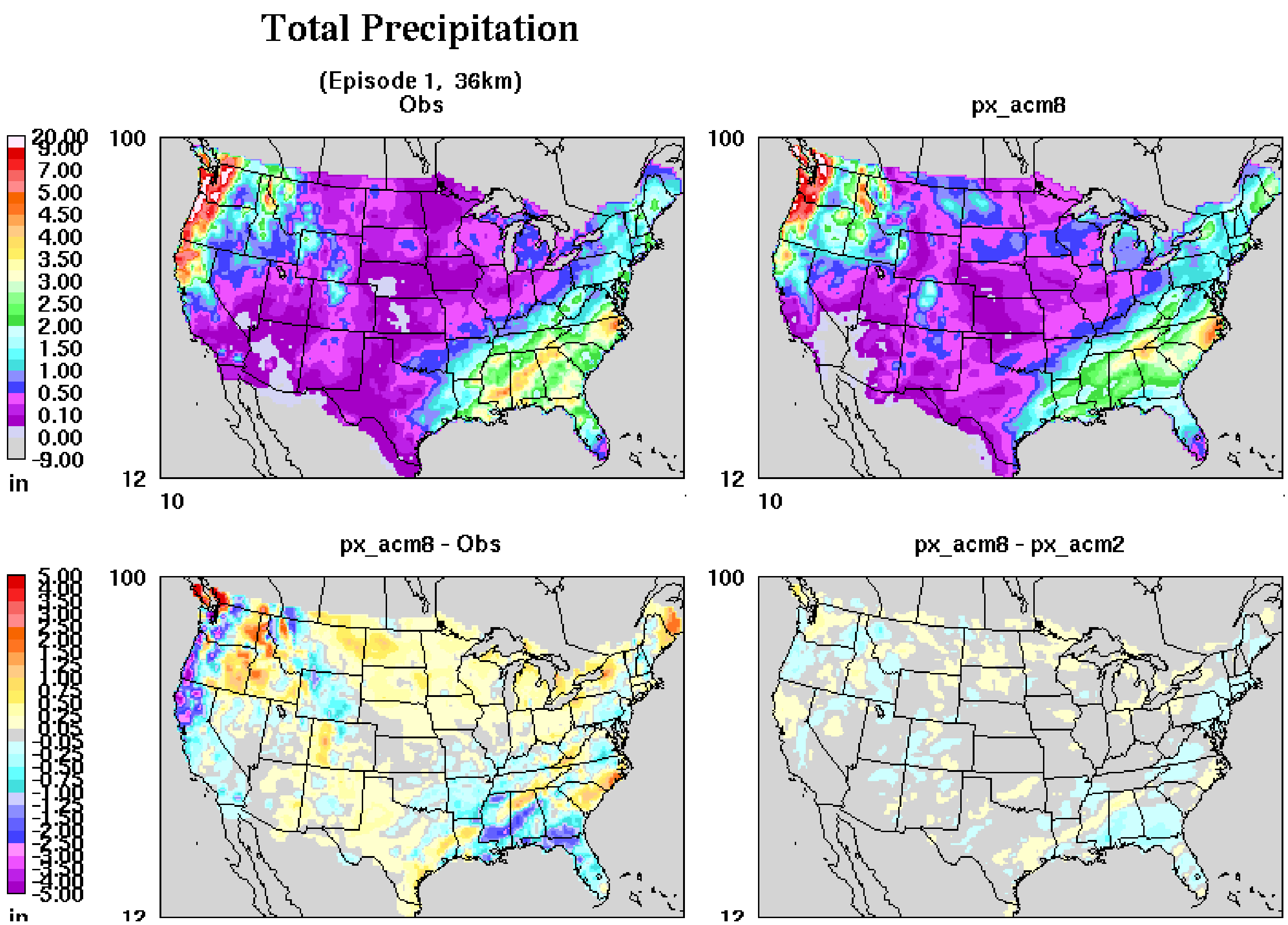

Figure 62. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm8 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm8 sensitivity and the px_acm2 base case.

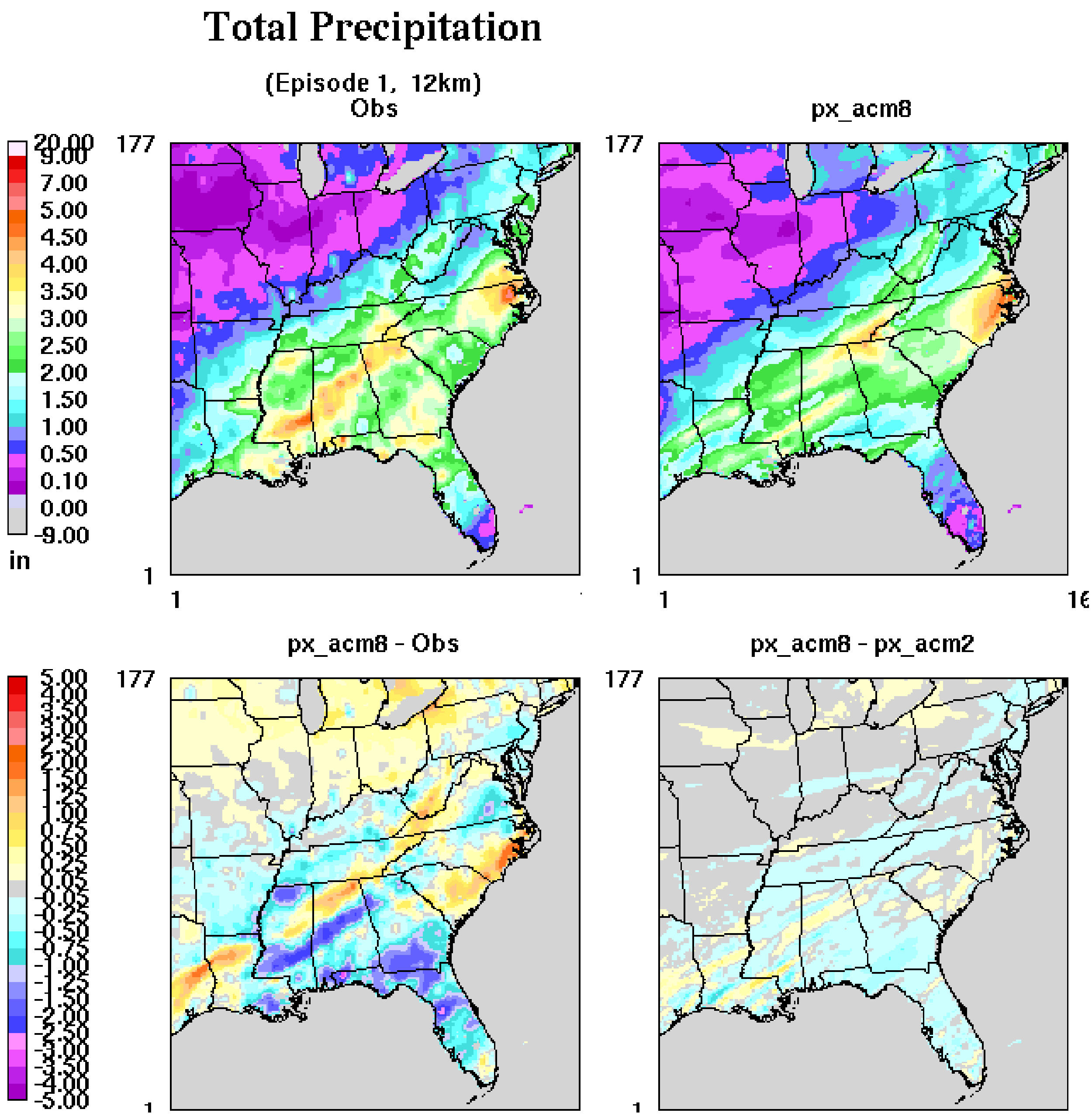

Figure 63. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm8 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm8 sensitivity and the px_acm2 base case.

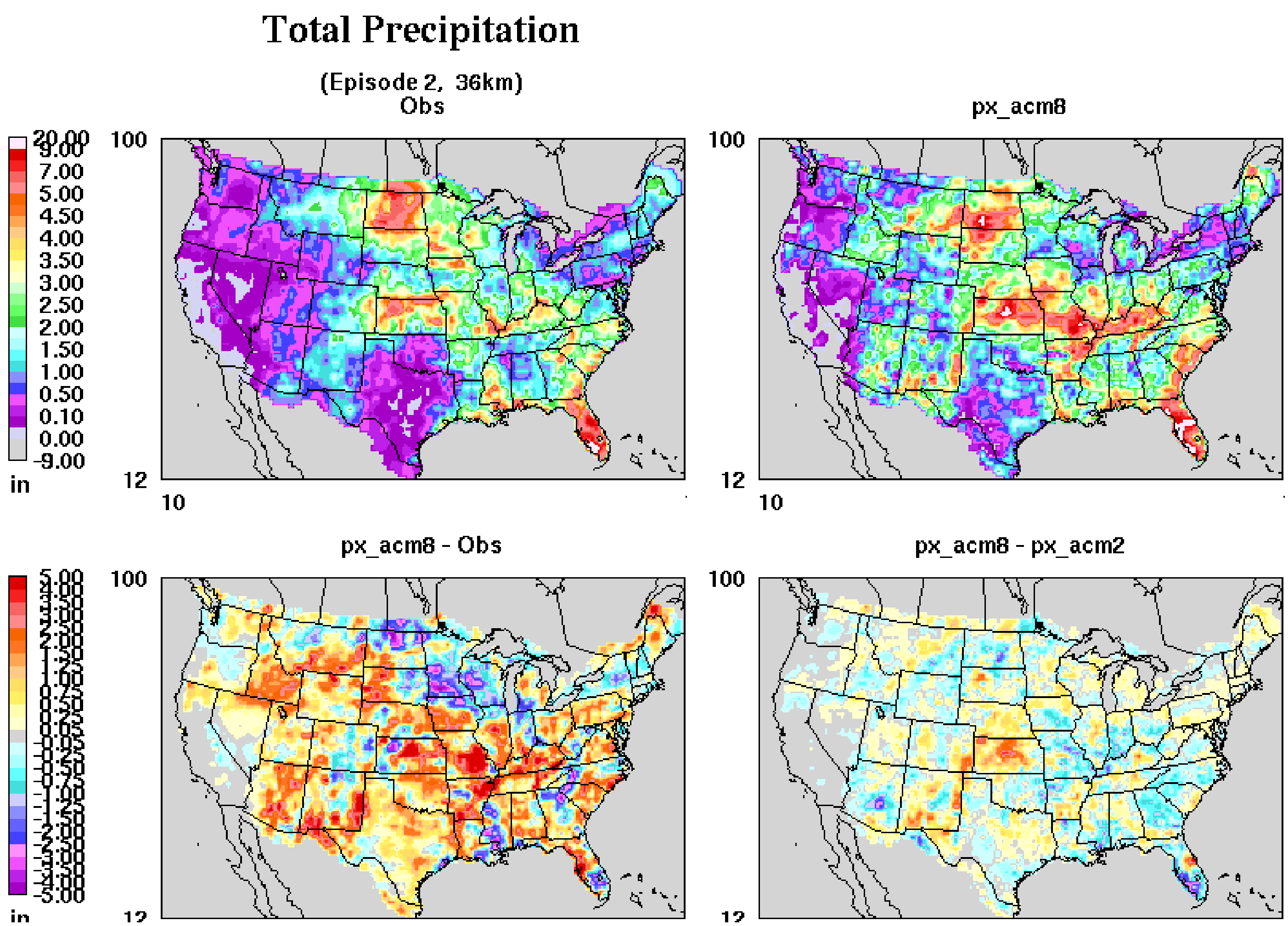

Figure 64. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm8 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm8 sensitivity and the px_acm2 base case.

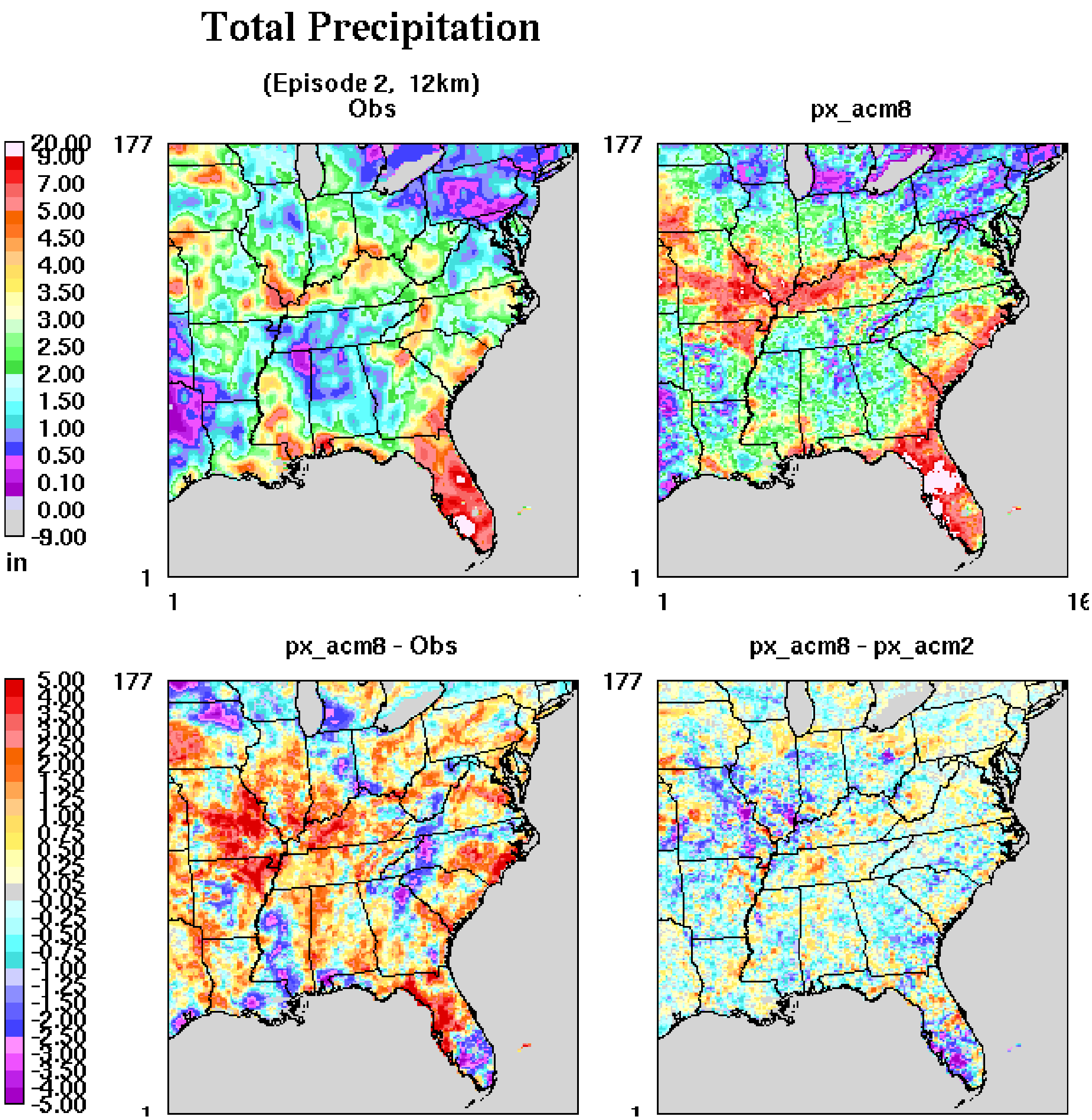

Figure 65. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm8 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm8 sensitivity and the px_acm2 base case.

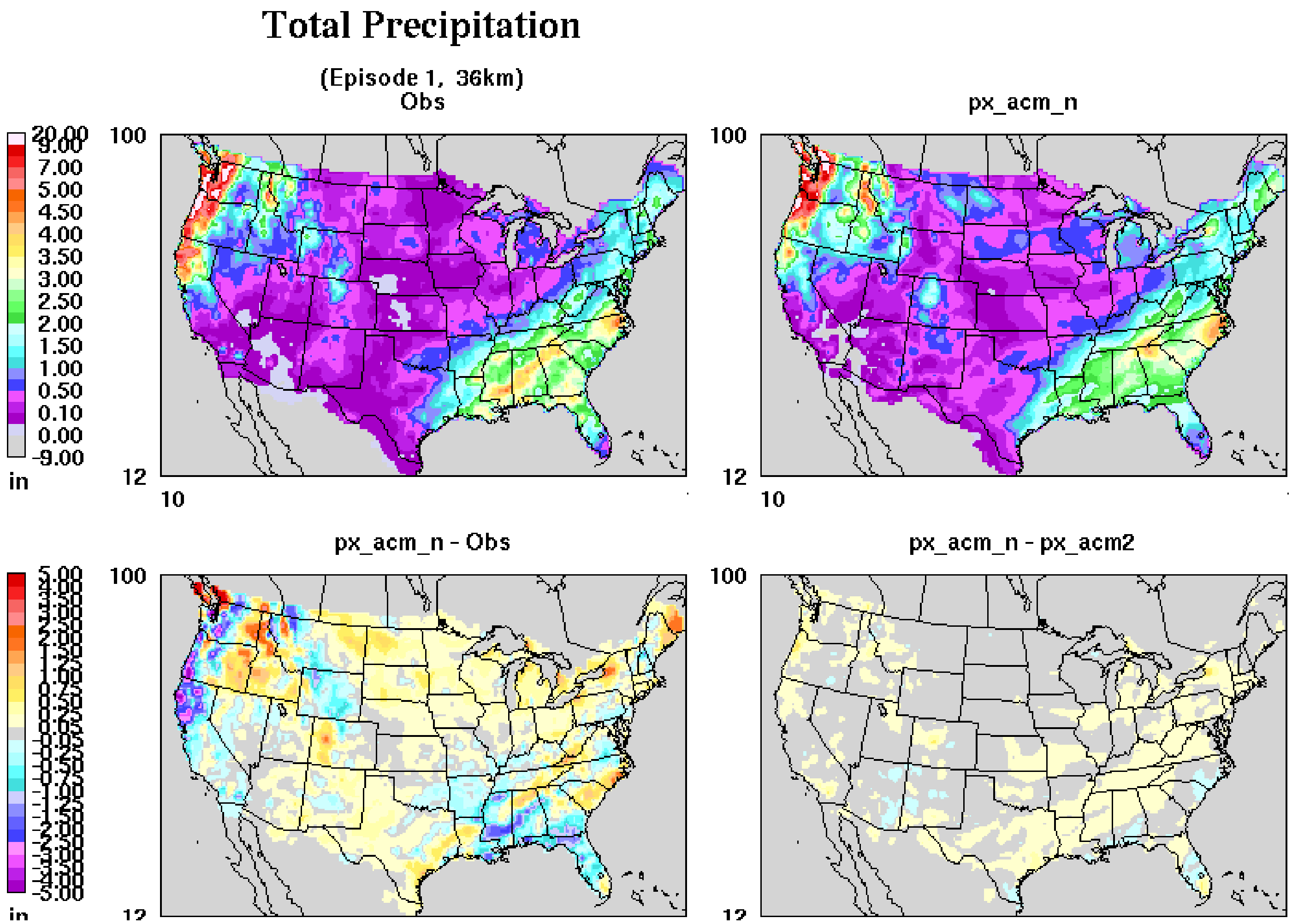

Figure 66. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm_n model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm_n sensitivity and the px_acm2 base case.

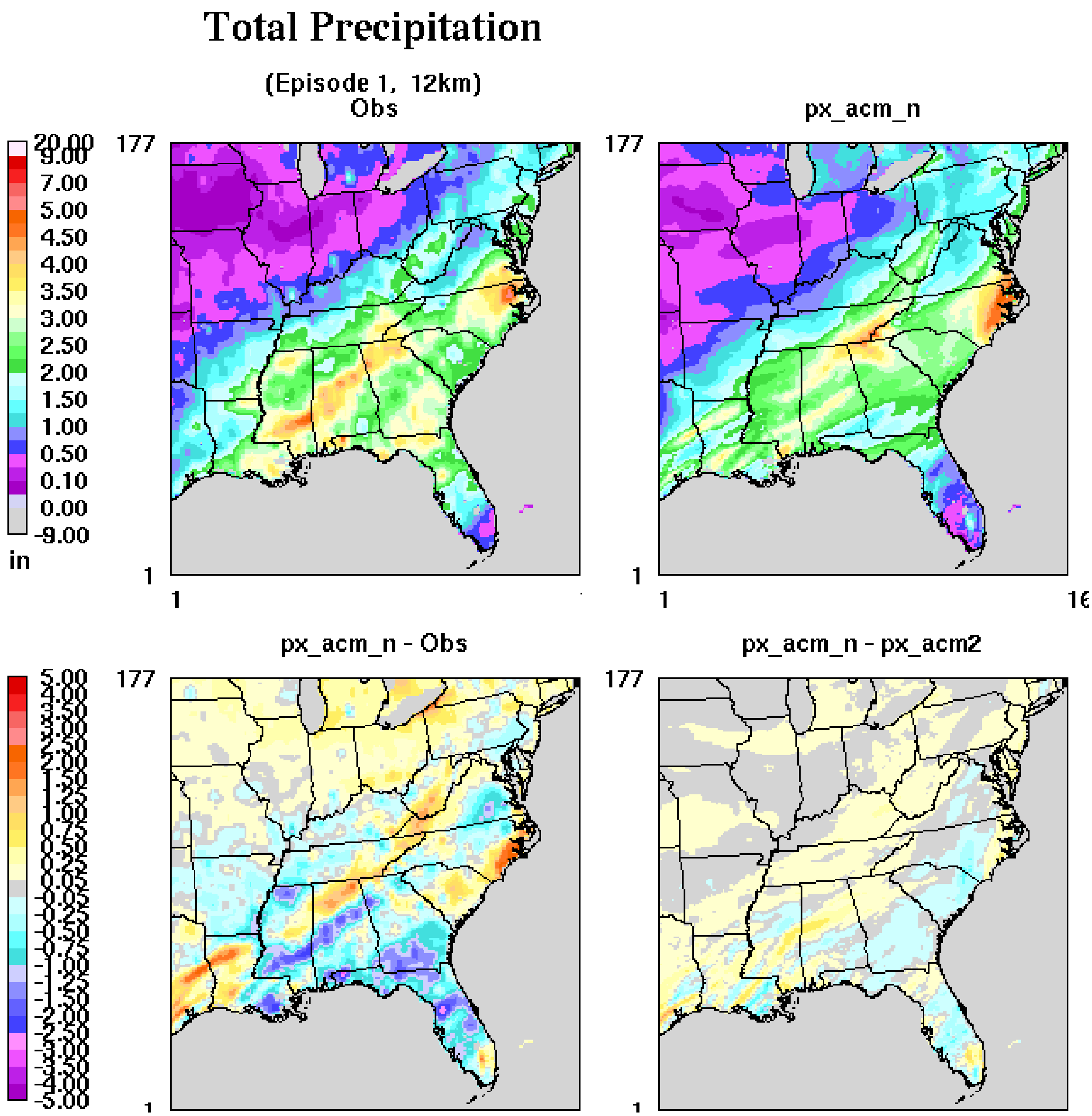

Figure 67. Episode 1 (Jan 2-21, 2002) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm_n model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm_n sensitivity and the px_acm2 base case.

Note the explosion of precipitation that nudging temperature/moisture in the boundary layer produces in figures 68-69. The problem is lessoned somewhat by reducing the nudging strength of moisture (px_acm_n2, figures 70-71), but the accumulation bias already evident in the base case is exacerbated nonetheless. We might be able to get away with a px_acm_n or px_acm_n2 configuration in the winter, but definitely not in the summer. To avoid these potential precipitation artifacts altogether, we recommend not nudging temperature or moisture in the boundary layer at all.

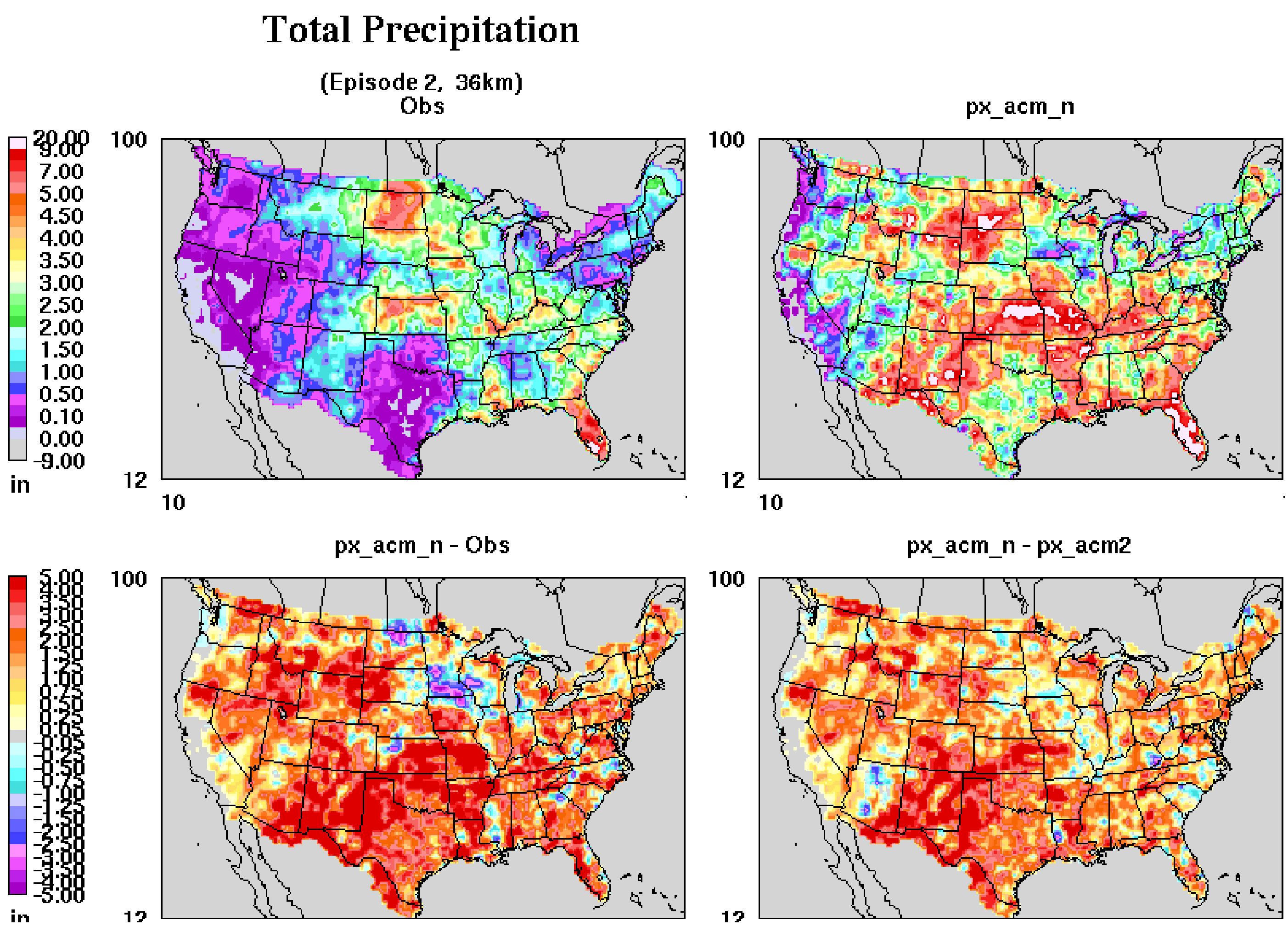

Figure 68. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm_n model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm_n sensitivity and the px_acm2 base case.

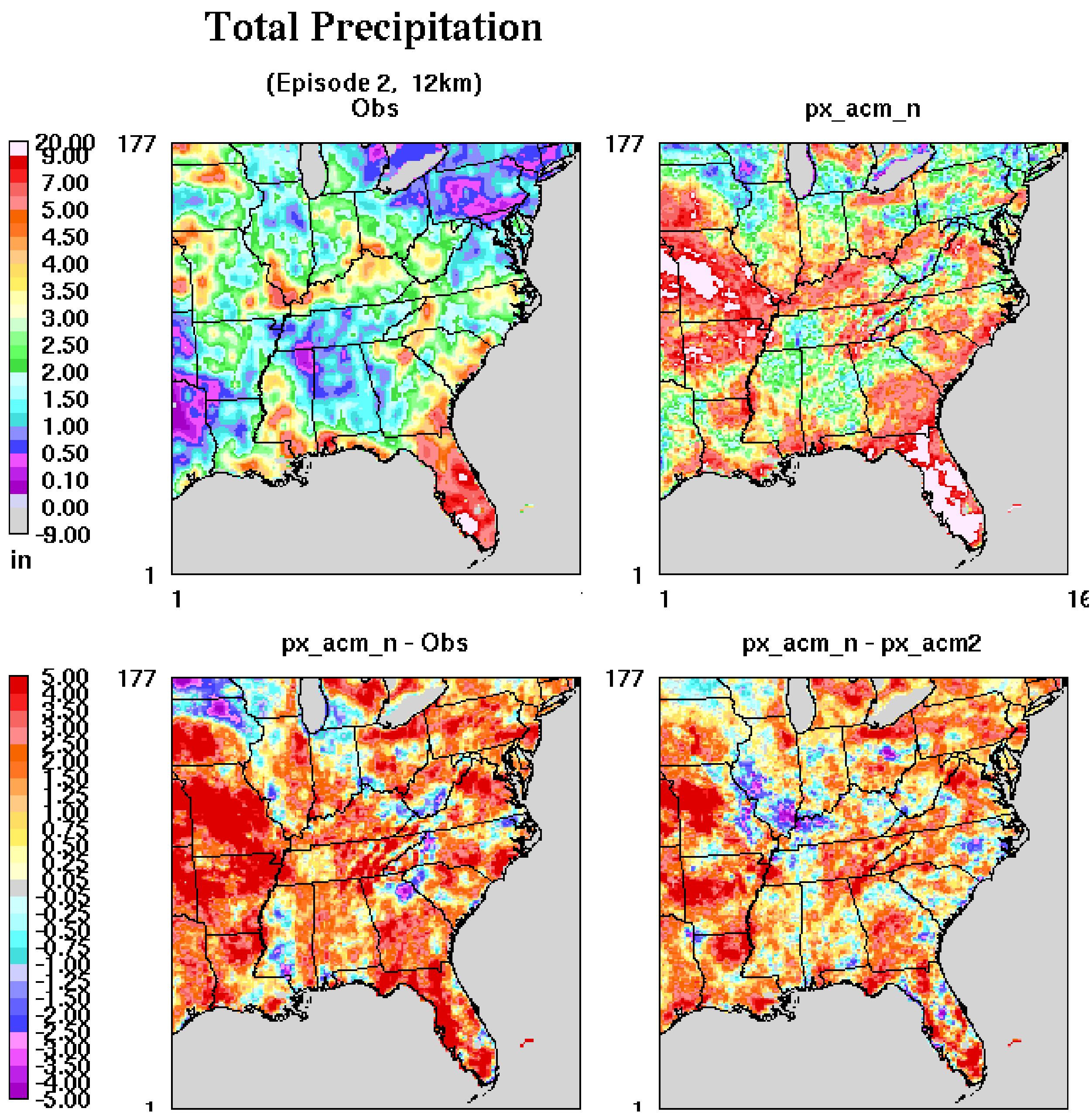

Figure 69. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm_n model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm_n sensitivity and the px_acm2 base case.

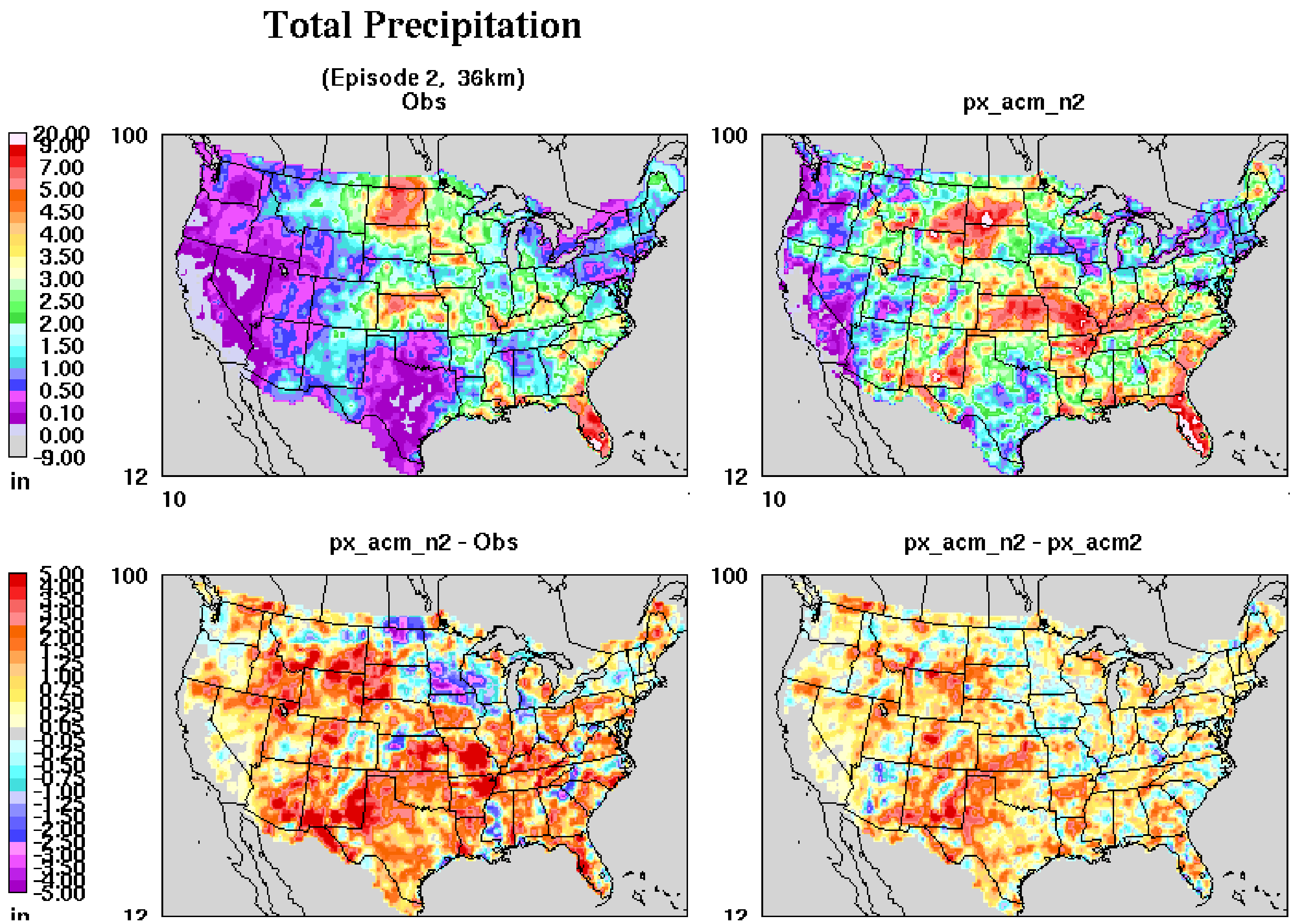

Figure 70. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 36-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm_n2 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm_n2 sensitivity and the px_acm2 base case.

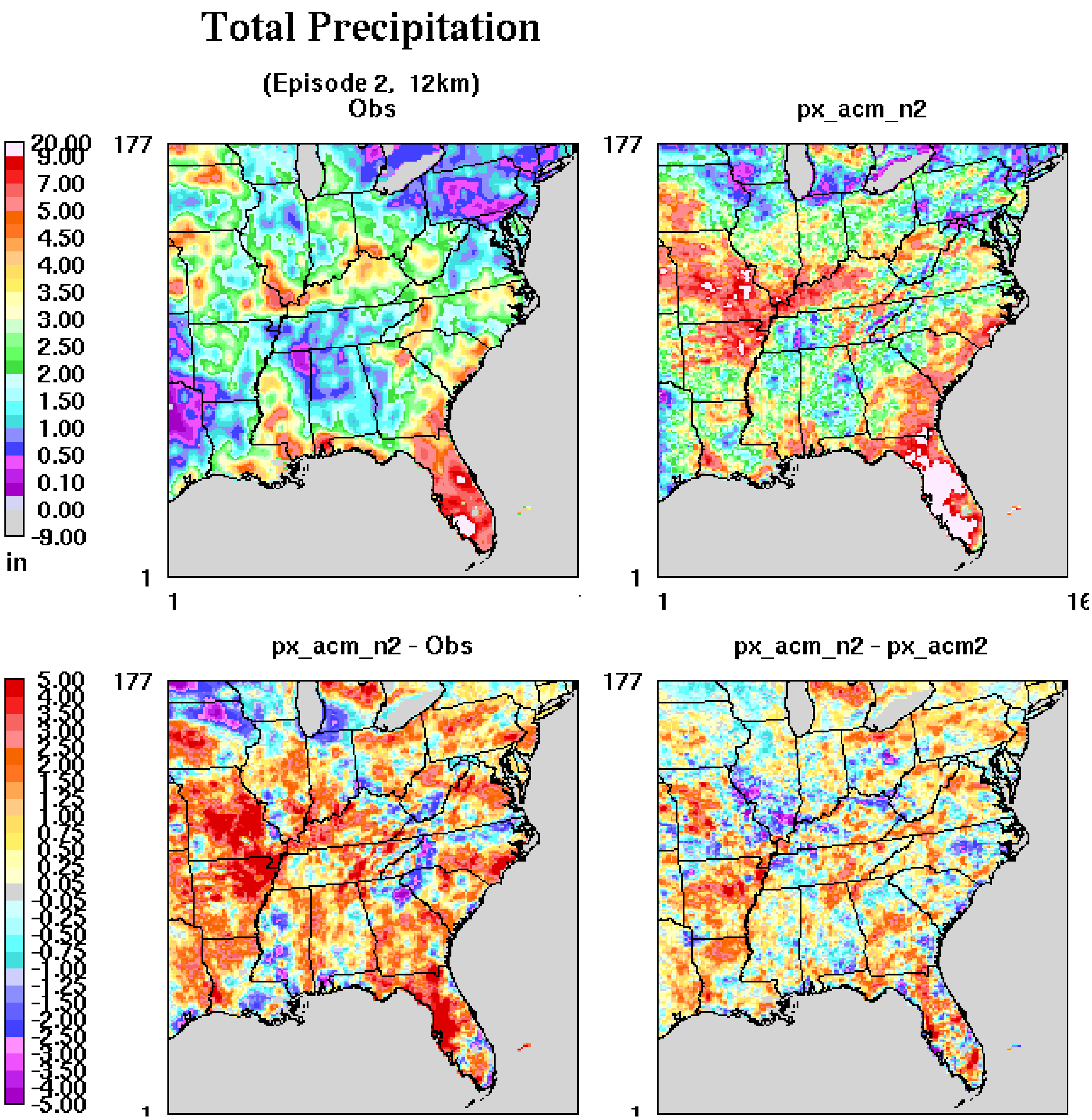

Figure 71. Episode 2 (Jul 13-28, 2001) composite precipitation for the US land-portion of the 12-km domain is shown. The top left panel displays the accumulated precipitation generated from the Climate Prediction Center gridded precipitation datasets. The top right panel shows the corresponding plot for the px_acm_n2 model configuration, and the lower left plot shows the difference plot between the model and the observations. The bottom right plot shows the difference between the px_acm_n2 sensitivity and the px_acm2 base case.

6 Conclusions from Sensitivity Modeling

Considering only the original four (five, including px_acm2) sensitivity runs mandated under VISTAS Met task 2d, the px_acm2 run performs best overall. This conclusion is the result of a rather exhaustive quantitative and qualitative assessment of these sensitivity runs over three episodes. While the statistical performance for px_acm2 for certain quantities might be surpassed by other model configurations (e.g. noah_eta-my winds), it seldom performs the poorest of the five original sensitivities tested.

A few general conclusions can be drawn about these initial sensitivity tests. They are:

- PBL heights are consistently highest in the noah_mrf simulations, while the noah_eta-my runs consistently produce the lowest daytime PBL heights. At night the px_acm(2) PBL heights are usually lowest.
- Surface winds are consistently best represented by the noah_eta-my runs, in large part because that configuration appropriately produces the calmest winds at night.
- The px_acm2 temperatures are modeled better than all other configurations for the winter episode, including px_acm. The noah_eta-my runs consistently show the most extreme low temperature bias of all configurations for all episodes.
- All configurations other than noah_eta-my exhibit similar performance in modeling measurable 24-h precipitation. The noah_eta-my runs produce more precipitation coverage and are generally slightly less skilled than the other sensitivities, especially for the winter episode. The runs all seem to produce too much accumulated precipitation in the summer.

The auxiliary tests show that using LITTLE_R output to drive INTERPF (px_acm8) produces slightly beneficial results. In essence px_acm8 is the "best and final" configuration. Our recommendation for the annual modeling effort, therefore, is to implement the px_acm8 configuration. These tests also reveal that MM5 seems to suffer from a wintertime cold bias. All of our configurations yielded that signature. While the px_acm8 set-up produces the best results of the credible configurations, the cold bias still remains. The problem seems to be most acute whenever the temperature changes significantly over the course of a 5-5 day segment. More effort from the MM5 community at large needs to be made to correct this bias, but at present it appears that these transient cold bias signatures are unavoidable.

7 Methodology for Annual Modeling Effort

With the sensitivity runs completed, we can establish the procedures we will use to execute/analyze MM5 for the annual modeling study period.

A. Modeling Approach

For the sensitivity modeling we used the MPP implementation of MM5 version 3.6.1. It is important to note that considerable effort was expended to port EPA's MPP version of the Pleim-Xiu LSM into the 3.6.1 MM5 code. A few other modifications were made to the code to allow MPP, most notably modifications to the Kain-Fritsch 2 cumulus parameterization module. This version was kept frozen throughout the course of the sensitivity testing. Since then a new minor-release version of MM5 (v3.6.2) has been released. According to NCAR's release notes, the only changes in the actual MM5 code that could possibly affect our modeling results involve seasonal vegetative adjustments and sea ice treatments. The vegetative adjustments have already been implemented in our version of the code, and the sea ice issue is likely to have negligible effects on our results. Considering the resources required to test the v3.6.2 code with all of our modifications added, and considering the expected negligible effects of these modifications, for the annual modeling effort we will implement the v3.6.1 code used in the sensitivity modeling. The preprocessor code, however, could affect results positively. Therefore we will use the latest v3.6.2 releases of those codes.

In the sensitivity modeling we generally executed MM5 in 5.5-day segments starting at 00Z, and we will continue this approach for the annual modeling. Though our modeling period is all of 2002, we will begin our simulations at 00Z December 17, 2001. This allows the air quality team to "spin-up" CMAQ (or another air quality model) for up to two weeks before our period of interest. It requires 76 5.5-day segments to process the entire year, assuming a 12-hr overlap between runs. Realizing that new runs may at some point be needed, we will assign a "case" tag to each file associated with a particular segment. This tag includes the start date/year of the segment, as well as "v02_aaa" ("v" for VISTAS, "02" for 2002, and "aaa" indicating the first meteorological run). The segments align as follows:

Date tag	Duration		Date Tag	Duration
dec17_01	00Z Dec 17, 2001 – 12Z Dec 22, 2001		jun25_02	00Z Jun 25, 2002 – 12Z Jun 30, 2002
dec22_01	00Z Dec 22, 2001 – 12Z Dec 27, 2001		jun30_02	00Z Jun 30, 2002 – 12Z Jul 5, 2002
dec27_01	00Z Dec 27, 2001 – 12Z Jan 1, 2002		jul05_02	00Z Jul 5, 2002 – 12Z Jul 10, 2002
jan01_02	00Z Jan 1, 2002 – 12Z Jan 6, 2002		jul10_02	00Z Jul 10, 2002 – 12Z Jul 15, 2002
jan06_02	00Z Jan 6, 2002 – 12Z Jan 11, 2002		jul15_02	00Z Jul 15, 2002 – 12Z Jul 20, 2002
jan11_02	00Z Jan 11, 2002 – 12Z Jan 16, 2002		jul20_02	00Z Jul 20, 2002 – 12Z Jul 25, 2002
jan16_02	00Z Jan 16, 2002 – 12Z Jan 21, 2002		jul25_02	00Z Jul 25, 2002 – 12Z Jul 30, 2002
jan21_02	00Z Jan 21, 2002 – 12Z Jan 26, 2002		jul30_02	00Z Jul 30, 2002 – 12Z Aug 4, 2002
jan26_02	00Z Jan 26, 2002 – 12Z Jan 31, 2002		aul04_02	00Z Aug 4, 2002 – 12Z Aug 9, 2002
jan31_02	00Z Jan 31, 2002 – 12Z Feb 5, 2002		aug09_02	00Z Aug 9, 2002 – 12Z Aug 14, 2002
feb05_02	00Z Feb 5, 2002 – 12Z Feb 10, 2002		aug14_02	00Z Aug 14, 2002 – 12Z Aug 19, 2002
feb10_02	00Z Feb 10, 2002 – 12Z Feb 15, 2002		aug19_02	00Z Aug 19, 2002 – 12Z Aug 24, 2002
feb15_02	00Z Feb 15, 2002 – 12Z Feb 20, 2002		aug24_02	00Z Aug 24, 2002 – 12Z Aug 29, 2002
feb20_02	00Z Feb 20, 2002 – 12Z Feb 25, 2002		aug29_02	00Z Aug 29, 2002 – 12Z Sep 3, 2002
feb25_02	00Z Feb 25, 2002 – 12Z Mar 2, 2002		sep03_02	00Z Sep 3, 2002 – 12Z Sep 8, 2002
mar02_02	00Z Mar 2, 2002 – 12Z Mar 7, 2002		sep08_02	00Z Sep 8, 2002 – 12Z Sep 13, 2002
mar07_02	00Z Mar 7, 2002 – 12Z Mar 12, 2002		sep13_02	00Z Sep 13, 2002 – 12Z Sep 18, 2002
mar12_02	00Z Mar 12, 2002 – 12Z Mar 17, 2002		sep18_02	00Z Sep 18, 2002 – 12Z Sep 23, 2002
mar17_02	00Z Mar 17, 2002 – 12Z Mar 22, 2002		sep23_02	00Z Sep 23, 2002 – 12Z Sep 28, 2002
mar22_02	00Z Mar 22, 2002 – 12Z Mar 27, 2002		sep28_02	00Z Sep 28, 2002 – 12Z Oct 2, 2002
mar27_02	00Z Mar 27, 2002 – 12Z Apr 1, 2002		oct03_02	00Z Oct 3, 2002 – 12Z Oct 8, 2002
apr01_02	00Z Apr 1, 2002 – 12Z Apr 6, 2002		oct08_02	00Z Oct 8, 2002 – 12Z Oct 13, 2002
apr06_02	00Z Apr 6, 2002 – 12Z Apr 11, 2002		oct13_02	00Z Oct 13, 2002 – 12Z Oct 18, 2002
apr11_02	00Z Apr 11, 2002 – 12Z Apr 16, 2002		oct18_02	00Z Oct 18, 2002 – 12Z Oct 23, 2002
apr16_02	00Z Apr 16, 2002 – 12Z Apr 21, 2002		oct23_02	00Z Oct 23, 2002 – 12Z Oct 27, 2002
apr21_02	00Z Apr 21, 2002 – 12Z Apr 26, 2002		oct28_02	00Z Oct 28, 2002 – 12Z Nov 2, 2002
apr26_02	00Z Apr 26, 2002 – 12Z May 1, 2002		nov02_02	00Z Nov 2, 2002 – 12Z Nov 7, 2002
may01_02	00Z May 1, 2002 – 12Z May 6, 2002		nov07_02	00Z Nov 7, 2002 – 12Z Nov 12, 2002
may06_02	00Z May 6, 2002 – 12Z May 11, 2002		nov12_02	00Z Nov 12, 2002 – 12Z Nov 17, 2002
may11_02	00Z May 11, 2002 – 12Z May 16, 2002		nov17_02	00Z Nov 17, 2002 – 12Z Nov 22, 2002
may16_02	00Z May 16, 2002 – 12Z May 21, 2002		nov22_02	00Z Nov 22, 2002 – 12Z Nov 27, 2002
may21_02	00Z May 21, 2002 – 12Z May 26, 2002		nov27_02	00Z Nov 27, 2002 – 12Z Dec 2, 2002
may26_02	00Z May 26, 2002 – 12Z May 31, 2002		dec02_02	00Z Dec 2, 2002 – 12Z Dec 7, 2002
may31_02	00Z May 31, 2002 – 12Z Jun 5, 2002		dec07_02	00Z Dec 7, 2002 – 12Z Dec 12, 2002
jun05_02	00Z Jun 5, 2002 – 12Z Jun 10, 2002		dec12_02	00Z Dec 12, 2002 – 12Z Dec 17, 2002
jun10_02	00Z Jun 10, 2002 – 12Z Jun 15, 2002		dec17_02	00Z Dec 17, 2002 – 12Z Dec 22, 2002
jun15_02	00Z Jun 15, 2002 – 12Z Jun 20, 2002		dec22_02	00Z Dec 22, 2002 – 12Z Dec 27, 2002
jun20_02	00Z Jun 20, 2002 – 12Z Jun 25, 2002		dec27_02	00Z Dec 27, 2002 – 12Z Jan 1, 2003

B. Model Execution

To prepare the MM5 input files we execute the MM5v3.6.2 preprocessor system. The general flow stream is as follows:

Processor	Function	Execution Schedule
TERRAIN	Prepare time-independent grid information	Once
REGRID (Pregrid)	Extract files from EDAS analyses at 3-hr (sfc) and 12-hr (3D) temporal resolution	Monthly
REGRID (Regridder)	Translates pregrid output onto TERRAIN grids	6 days
FETCH (adp_sfc)	Creates surface/ship data at 3-hr resolution	Monthly (nominal 3-day chunks)
FETCH (adp_upa)	Creates upper air data (cat with sfc data) at 3-hr resolution	Monthly (nominal 15-day chunks)
LITTLE_R	Uses FETCH output to "improve" REGRID output	6 days
INTERPF	Translates LITTLE_R output to MM5 vertical coordinate system	6 days
MM5	Creates hourly gridded meteorological files	5.5 days

Terrain

Terrain is processed using the 2 min (~4 km) global land-use data set for both the 36-km and 12-km domains. The 36-km grid is the national RPO domain, and the 12-km domain is identical to what was used in the sensitivity modeling. Note that we have selected the "BotSoil" option per EPA's example. The exact details are found in the terrain.namelist file that is included in the Appendix 9A.

REGRID (pregrid)

Since the EDAS files (ds609.2 from NCAR) are archived in month chunks (half month 3D analyses files), we process these files through pregrid at monthly intervals. We use the standard GRID vtables to process four types of files: 1) FILE*, 2) SNOW*, 3) SOIL*, and 4) SST*, each at 3-hourly resolution. An example pregrid namelist file is shown in Appendix 9B.

REGRID (regridder)

The output of pregrid is interpolated to the MM5 grids for each modeled segment by regridder. Note that these input grids cover 6 days rather than 5.5 days due to an INTERPF requirement. Separate regridder runs are made for both the 36-km and 12-km grids, and the temporal resolution is 3 hours. An example regridder namelist file is shown in Appendix 9C. We have implemented one minor change from the methodology used in the sensitivity tests, that being that the climatological albedo file (used by the NOAH LSM) is not processed for the annual run.

FETCH (adp_sfc)

The adp_sfc preprocessor converts surface and ship data files (ds464.0) into a format that can be read by LITTLE_R (Objective Analysis). The surface data are stored in five or six day chunks so that a month of data is always included in six data sets, while the ship data are in monthly chunks. We have discovered that adp_sfc might not work correctly if we try to process too long a time span, so we limit our processing to 3 or 4 day periods. So we execute adp_sfc ten times for both the surface data and the ship data. Hourly output files are produced, though we only use the 3-hourly files. The surface and ship data are concatenated, and eventually the upper air data are also concatenated at the end of the data file. The preprocessing for the sensitivity runs did not include upper air data in the surface_obs files. An example namelist for adp_sfc is shown in Appendix 9D.

FETCH (adp_upa)

The adp_upa preprocessor converts upper air data files (ds353.4) into a format that can be read by LITTLE_R. The upper air data are stored in monthly segments, and we process the data in half-month intervals one after the other. The output interval is typically 6-hourly. We concatenate the surface/ship data into these data sets, so the output upper-air_obs files are actually at 3-hour intervals. An example namelist for adp_upa is shown in Appendix 9E.

LITTLE_R (Objective Analysis)

LITTLE_R performs internal quality control on the observational data produced by FETCH and uses these data to “improve” the REGRID output fields. Our auxiliary sensitivity tests indicate that this provides a discernable improvement in the MM5 predictions, so unlike the base sensitivity runs we will use the LITTLE_R output as input to INTERPF. LITTLE_R needs to be executed for both the 36-km and 12-km grids. This processor produces SFCFDDA files that directly feed into MM5. An example LITTLE_R namelist file is shown in Appendix 9F.

INTERPF

INTERPF converts the LITTLE_R output into the 34-sigma layers that have become the RPO standard. Because the LOWBDY files require a full day (00Z-21Z) to produce output, this preprocessor, as well as REGRID and LITTLE_R, needs to be run for a full six days to allow MM5 to execute the desired 5.5 days. An example INTERPF namelist is included in Appendix 9G.

MM5

The sensitivity tests described earlier in this document enables us to define the likely optimal model configuration we will implement for the annual run. One expected minor change from px_acm8 is that the RADFRQ interval is decreased from 30 minutes to 15. In summary here are the key parameters:

36-km domain: 129x165x34 (N-S dot cells, W-E dot cells, vertical levels)
12-km domain: 190x181x34 (N-S dot cells, W-E dot cells, vertical levels)
2-way nesting, no feedback, 90-second outer grid time step, 7920 minutes total, hourly output

LSM:	Pleim-Xiu (independent segments initiated from EDAS soil quantities)
PBL:	Asymmetric Convective Model (ACM)
Radiation scheme:	Rapid Radiative Transfer Model (RRTM)
Cumulus scheme:	Kain-Fritsch 2
Snow:	Snow effects on (IFSNOW=1)
SST:	Varying (ISSTVAR=1)
Analysis nudging:	2.5E-4 (36-km sfc/aloft winds, temps aloft only)
	1.0E-4 (12-km sfc/aloft winds, temps aloft only)
	1.0E-5 (36-km/12-km mixing ratio, aloft only)

Appendix 9H shows an example mmlif file.

The MM5 output files are broken down into daily chunks to keep the output files from becoming too large. The default is for MM5 to name the outer 36-km grid as domain "1", while the 12-km grid is referred to as domain "2". This is what the 36-km files are named by default:

MMOUT_DOMAIN1_00	(initial hour 0 only)
MMOUT_DOMAIN1_01	(hours 1-24, inclusive)
MMOUT_DOMAIN1_02	(hours 25-48, inclusive)
MMOUT_DOMAIN1_03	(hours 49-72, inclusive)
MMOUT_DOMAIN1_04	(hours 73-96, inclusive)
MMOUT_DOMAIN1_05	(hours 97-120, inclusive)
MMOUT_DOMAIN1_06	(hours 121-132, inclusive)

When the model files are sent to the air quality team they will have the date/case tag added as previously described. So for the model run that initiates on March 17, 2002, a file might be named MMOUT_DOMAIN2_04.mar17_02.v02_aaa. This file contains 12-km MM5 output data for the time period 01Z March 20, 2002 through 00Z March 21, 2002 from the run that started at 00Z March 17, 2002.

C. Model Evaluation Procedures

A variety of evaluation procedures have been established for this project (see http://www.baronams.com/projects/VISTAS/reports/VISTAS_TASK1.pdf). The results will be transmitted to the TAWG and other interested parties via the VISTAS meteorological web page (http://www.baronams.com/projects/VISTAS/select_annual_product.html). Here is a summary of the evaluation products that will be available on that web site:

1) Surface Products
    a. Spatial Plots
    b. Timeseries Plots
    c. Combination Plots
2) Aloft Products
    a. Spatial Plots
    b. Sounding Plots
    c. Profiler Plots
3) Statistical Products
    a. Surface Statistical Timeseries
    b. Aloft Statistical Timeseries
    c. Statistical Tables
4) Monthly Products
    a. Spatial Statistical Plots
    b. Spatial Summary Plots
    c. Monthly "Bakergram" Plots
    d. Annual "Bakergram" Plots
    e. Monthly Summary Statistics

In many of the web forms the user is asked to select options from a few drop-down menus. Here is a summary of the most common menus:

1) Region, or areal extent of results
    a. VISTAS (VISTAS RPO, valid for both 36-km and 12-km grids)
    b. Full (Entire grid, valid for both grids)
    c. US (All US stations, 36-km stats only)
    d. MANE-VU (MANE-VU RPO, 36-km only)
    e. MIDWEST (MIDWEST RPO, 36-km only)
    f. CENRAP (CENRAP RPO, 36-km only)
        i. CENRAP_N (Northern portion of CENRAP)
        ii. CENRAP_S (Southern portion of CENRAP)
    g. WRAP (WRAP RPO, 36-km only)
        i. WRAP_N (Northern portion of WRAP)
        ii. WRAP_S (Southern portion of WRAP)

2) Sensitivity
    a. v02_aaa (for Vistas '02, initial met/emis/air_quality)

3) Scale
    a. 12km (12-km grid)
    b. 36km (36-km grid)

4) 5-day segment (Segment identifier, MonDD_YY)
    a. dec17_01 (Segment from Dec 17, 2001, 12Z to Dec 22, 2001, 12Z)
    b. dec22_01 (Segment from Dec 22, 2001, 12Z to Dec 27, 2001, 12Z)

c. …
d. dec27_02 (Last segment, Dec 27, 2002, 12Z to Jan 1, 2003, 12Z)

A brief summary of each product type is given below.

Surface Products (Spatial Plots)

Spatial plots of key surface variables are available at 6-hrly intervals. Variables include:

1) Temperature (1.5 m), with TDL obs overlaid.
2) Mixing Ratio, with TDL obs overlaid.
3) Winds, vectors (with a very light wind speed background) at an MCIP2-derived 10 meter (observational) height. Not available for 36-km Full region (too busy).
4) Cloud fraction (CFRAC in MCIP2.1). The overlaid obs come from the TDL surface reports and represent the maximum of the low-, middle-, and high- observed cloud coverage. The black and white color scale is designed to mimic (sort of) satellite imagery.
5) Cloud fraction (alt). Like the above cloud fraction, except we take the maximum of the MCIP2.1 low, middle, and high clouds to represent the total model cloud fraction. This is the preferred variable from a meteorological perspective.
6) 6-hrly accumulated precipitation, with TDL obs overlaid. Be warned that in the TDL obs it is impossible to differentiate "missing" precipitation values from "No precip" reports. So use these images qualitatively with that realization.
7) Relative humidity, with TDL obs overlaid.
8) Temperature (layer 1), with TDL obs overlaid.
9) PBL heights.

Surface Products (Timeseries Plots)

Time series plots of key meteorological variables are available for a number of important sites. Note that no 12-km plots are available for stations outside of the 12-km grid. Plots are available for the following scales:

1) 12KM: 12-km grid (includes aloft trace where applicable)
2) 36KM: 36-km grid (includes aloft trace where applicable)
3) 36_12KM: 36-km/12-km results co-plotted. (no aloft traces)

Surface Products (Combination Plots)

Model/observed (or analyzed) fields are plotted next to each other. These animations are region independent. Here are the available fields:

1) pcp24: 24-hr accumulated precipitation ending at 12Z daily. Observed values derive from the Climate Prediction Center.
2) ir_sat: Model cfrac (alt) is compared with GOES 8 infrared imagery at 00Z and 12Z.

3) slp: The Unisys surface analyses are compared with a RIP-generated analyses. Note that the plotted precipitation is qpr, the total precipitation hydrometeor mixing ratio. The scale for this variable does **not** match the analyzed precipitation, and in fact there are times, especially in the summer, in which actual modeled precipitation falls below the lower range of the qpr scale.

4) vis_sat: Model cfrac (alt) is compared with GOES 8 visible imagery daily at 18Z.

Aloft Products (Spatial Plots)

This product shows spatial plots for the basic meteorological variables at layers 9 (sigma 0.94-0.93, midpoint ~500m), 17 (sigma 0.82-0.80, midpoint ~1600m), and 22 (sigma 0.65-0.60, midpoint ~3400m). The observations are integrated through the depth of the sigma layers. Note that only full grid images are produced. Here are the available variables:

1) Temperature
2) Mixing ratio
3) Winds

Aloft Products (Sounding Plots)

This product shows sounding plot animations for selected upper air observing sites. Observations are co-plotted, and soundings are available from the surface to 100 mb as well as from the surface to 500 mb.

Aloft Products (Profiler Plots)

This product shows profiler plot wind animations for selected profiler sites in the southeastern US up to a height of 2500 AGL. Individual images show 12 hours of data, from 00-11Z or 12-23Z.

Statistical Products (Surface Statistical Timeseries)

Statistical metrics are plotted on a three-panel image. For most variables the top panel shows the mean obs (blue) and the mean model (red), the second panel shows the bias (blue) and absolute error (red), while the third panel shows the Index of Agreement (IA, in blue), the coefficient of determination (r^2, in red), and the number of valid obs/model pairs (#, thin black, right axis). Wind direction plots differ from the above paradigm in that the number of valid obs/model pairs appears in the top panel, and more importantly in that the third panel shows the U/V wind component absolute error and bias. The three-panel precipitation plots are vastly different in description from the other variable. The top panel shows precipitation accuracy (“Acc”, in blue), false alarm ratio (“FAR”, in red), probability of detection (“POD”, in black), and bias (“Bias”, right axis, in magenta). A thin green line marks the 1.0 level (right axis), the “perfect” precipitation bias level. The second panel shows the following skill measures: Threat score (“Threat”, in blue), the Equitable Threat Score (“ETS”, in red), the True Skill Score (or Hanssen and Kuipers score, “TSS”, in black), and Heidke Skill Score (“HSS”, in magenta). Before describing the third panel, we need to define a few terms. Measurable precipitation, by definition, matches or exceeds 0.01 inches. A “Hit” means that the model predicted measurable precipitation and measurable precipitation actually occurred. A “Miss” means the model failed to predict measurable precipitation when measurable precipitation occurred. A “False” means that the model predicted measurable precipitation when none actually occurred. Finally, a “Zero” means that the model and observations both indicated no measurable precipitation. The third panel thus shows the number of “Hits” (blue), “Misses” (red), and “Falses” (black) plotted using the left axis, and the number of “Zeroes” (magenta) plotted using the right axis. All of the metrics plotted in the first two panels are calculated based on the numbers plotted in this third panel. A final note about precipitation metrics needs to be made. It is possible to calculate these metrics using a threshold other than 0.01, which we indeed will do. A higher threshold can yield insight into the ability of the model to accurately handle more significant precipitation events. The downside of using higher thresholds is that some of the metrics (especially “Bias”) may end up being calculated with smallish numbers in its denominator, thus enabling the metric to at times reach very high numbers, essentially blowing the scale for other time periods. The third panel plot then becomes a useful surrogate to gauge model performance.

Here are the available statistical time series variables:

1) Temperature (1.5m)
2) Mixing Ratio
3) Wind Speed (10m)
4) Wind Direction
5) Cloud Fraction (orig): (From MCIP2.1 CFRAC)
6) Cloud Fraction (alt): (preferred)
7) Relative Humidity
8) Temperature (layer 1)
9) Wind Speed (layer 1)
10) 24-hr precipitation (0.01 in threshold):
    i. These stats are calculated using the Climate Prediction Center (CPC) gridded precipitation fields (0.25x0.25 degree resolution) regridded to match our 36km and 12km grids. The stats are then calculated on a cell by cell basis. Since the CPC fields are mainly for the US, we applied a mask (Figure 72) to only consider grid points near the US, and another mask to only consider land points in the calculations.
11) 24-hr precipitation (0.05 in threshold)
12) 24-hr precipitation (0.10 in threshold)
13) 24-hr precipitation (0.25 in threshold)
14) 24-hr precipitation (0.50 in threshold)
15) 24-hr precipitation (1.00 in threshold)

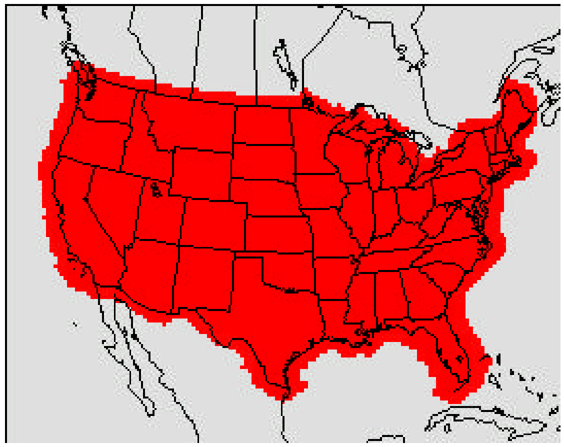

Figure 72. Mask for precipitation stats (36km).

Statistical Products (Aloft Statistical Timeseries)

This product shows the 3-panel statistical time series plots for our three aloft sigma layers (09, 17, and 22). Here are the available variables:

1) Temperature (K)
2) Mixing Ratio (g/kg)
3) Wind Speed (m/s)
4) Wind Direction (degrees)

Statistical Products (Statistical Tables)

This product shows region-specific statistical tables for all applicable surface variables other than precipitation. The data are parsed temporally such that:

1) All hours are considered
2) Only 00Z-11Z ("nighttime") hours are considered
3) Only 12Z-23Z ("daytime") hours are considered

The variable/stat labels are very cryptic. Here's how to interpret them:
Variables in first part of table:

1) TMP-1.5m: Temperature at 1.5 m (deg K)
2) QV: Mixing ratio (g/kg)
3) RH: Relative humidity (%)
4) WSPD-10m: Wind speed reduced by MCIP2 to 10m observational height (m/s)
5) SPD-lyr1: Layer 1 wind speed (m/s)
6) CLD: Cloud cover – original (%) (use CLD2 instead)
7) CLD2: Cloud cover – alternate (%)
8) TMP-lyr1: Layer 1 temperature (deg K) (use TMP-1.5m instead)

Labels in first part of table:

1) obsmean: Average of observations
2) modmean: Average of model predictions
3) bias: Simple bias
4) abserr: Absolute error
5) r2: Coefficient of determination
6) ia: Index of Agreement
7) rmse: Root Mean Square Error
8) nbias: Normalized bias
9) jtot: Number of valid obs/model pairs for stats

The WDIR (wind direction, degrees) metric has its own label structure:

1) obsmean: Average of observations
2) modmean: Average of model predictions
3) bias: Simple bias (Should be ignored for this discontinuous measure)
4) abserr: Absolute error
5) ubias: Simple bias for U-wind component (m/s)
6) vbias: Simple bias for V-wind component (m/s)
7) uerr: Absolute error of U-wind component (m/s)
8) verr: Absolute error of V-wind component (m/s)
9) newtot: Number of valid obs/model pairs for wind direction
10) dbias: Correct direction bias (Use instead of bias!)

Monthly Products (Spatial Statistical Plots)

This page shows basic statistical metrics (bias, absolute error) plotted on a per station basis. The idea is to graphically display these metrics so that the analyst can see the spatial pattern of model bias/error. There are two forms of these plots. The string "TOTAL" in the variable name designates the first of the forms. The resultant plot shows the metric calculated over all valid times. If the string "TOTAL" does not appear in the variable name, then a 24-hr animation appears. The first plot (hour 0) in the animation shows the metric calculated over all valid 00Z times, the second plot (hour 1) shows the metric calculated over all valid 01Z times, and so on through 23Z. This enables one to see the average diurnal/spatial variation of the metrics. Since only the hour field has meaning in these plots (and not even the hour has meaning in the "TOTAL" plots), we've arbitrarily set the Julian date for display to be January 1, 0000, and the "TOTAL" plots have an arbitrarily defined hour of 0. These are only placeholders so that we can use PAVE to visualize the results.

The naming convention for the variables that can be displayed has already partially been described. In review, variable names that have "BIAS" in them display the bias metric, while variable names that have "ERR" in them display the absolute error metric. If "TOTAL" appears in the variable name, a single plot showing the metric for all valid hours will be displayed at the arbitrarily defined time of Jan 1, 0000, 00Z. If "TOTAL" does not appear in the variable name, then an animation of the metric will appear cycling from 00Z-23Z, Jan 1, 0000. The actual variable to be plotted is listed first in the variable name string. They are:

1) CLD: Cloud cover (orig), as defined in spatial plots (%).
2) CLD2: Cloud cover (alt)
3) DIR: Wind direction (degrees)
4) Q: Water vapor mixing ratio (g/kg)
5) RH: Relative humidity (%)
6) SPD…10M: Wind speed reduced by MCIP2 to 10m obs height (m/s)
7) SPD…LYR1: Layer 1 wind speed (m/s)
8) T…1P5M: Temperature reduced by MCIP2 to 1.5m obs height (K)
9) T…LYR1: Layer 1 temperature (K)
10) UV: This is a unique variable in that only "ERR" is plotted. UV_ERR can be interpreted as the average magnitude of the error vector, defined as the square root of (U_ERR^2+V_ERR^2). This metric essentially combines wind speed error and wind direction error into one quantifiable metric.

Monthly Products (Spatial Summary Plots)

This product is designed to show daily summary information for a few of the key meteorological variables. Whenever possible the observations are overlaid onto the MM5 predicted fields. Generally speaking for each variable a 24-hr average (01Z-00Z), a "daytime" average (18Z-21Z) and a "nighttime" average (07Z-10Z) are generated. For temperature the "daytime" average is replaced by a daily maximum, and the "nighttime" average is replaced with the daily minimum. For precipitation a 24-hr accumulation ending at 00Z is created, as well as a "daytime" accumulation that we define to be 18Z-00Z. Since observations may include missing data, we require at least 3 (out of 4) valid observations per "daytime"/"nighttime" block, and 22 valid observations for the daily averages. These fields are generated for all regions. Here are the variables available for the three output averages:

1) Temperature (deg K)
2) Mixing Ratio (g/kg)
3) Precipitation (in)
4) Relative Humidity (%)
5) PBL height (m), with no obs overlay.
6) Wind Vectors with a wind speed (m/s) background
7) Cloud cover (alt)

Monthly Products (Monthly "Bakergram" Plots)

This product shows key statistical quantities summarized in a tile plot following the paradigm Kirk Baker developed for his "Mosaic" plots. This particular product has hours (00Z-23Z, top to bottom) as the y-axis and day of month (1-31, left to right) as the x-axis, as illustrated in figure 73.

We produce bias, error, and index of agreement plots for the following variables:

1) Temperature (deg K)
2) Mixing Ratio (g/kg)
3) Relative Humidity (%)
4) Cloud cover – alt (%)
5) Wind Speed (m/s)
6) Wind direction (degrees), bias and error only

Additionally we produce a plot showing the magnitude of error vector (m/s).

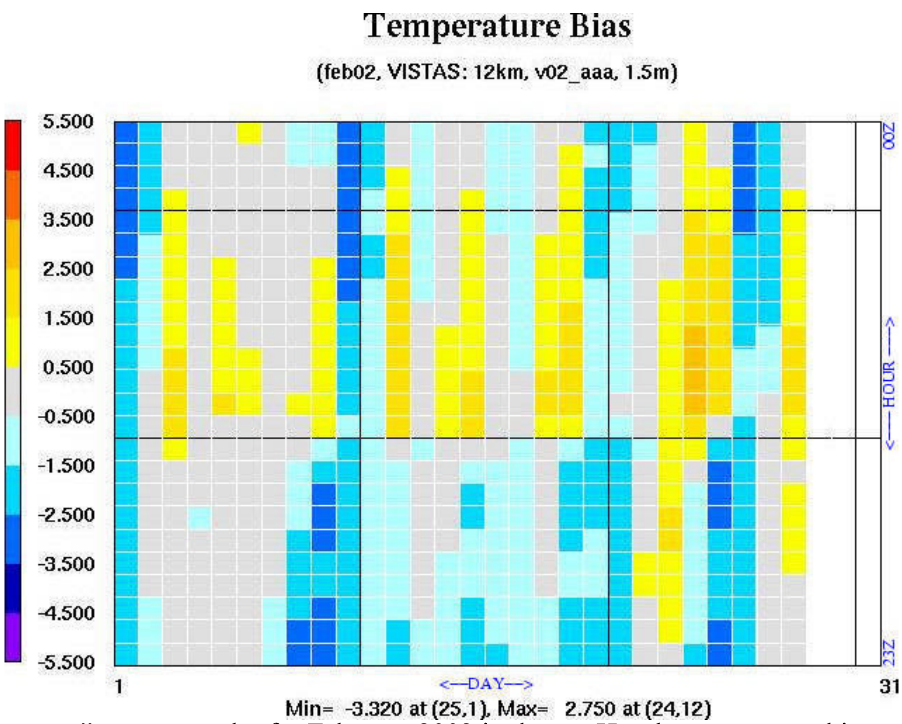

Figure 73. "Bakergram" prototype plot for February 2002 is shown. Hourly temperature biases (K) are plotted for the 12-km VISTAS region. The upper left tile represents the average bias in the selected region for 00Z, February 1, 2002. Hours increase from 00Z at the top to 23Z at the bottom, while the day of the month increases from 1 on the left to 31 on the right. Missing periods (e.g. Feb 29-31) are set to the default white background.

Monthly Products (Annual "Bakergram" Plots)

This page shows key statistical quantities summarized in a tile plot following the paradigm Kirk Baker developed for his "Mosaic" plots. This particular product has days (1-31, top to bottom) as the y-axis and month (1-12, left to right) as the x-axis, creating a calendar effect as illustrated in figure 3. (This particular example only shows the first six months of the year.) The available variables exactly match the variable list from the Monthly "Bakergram" Plot list.

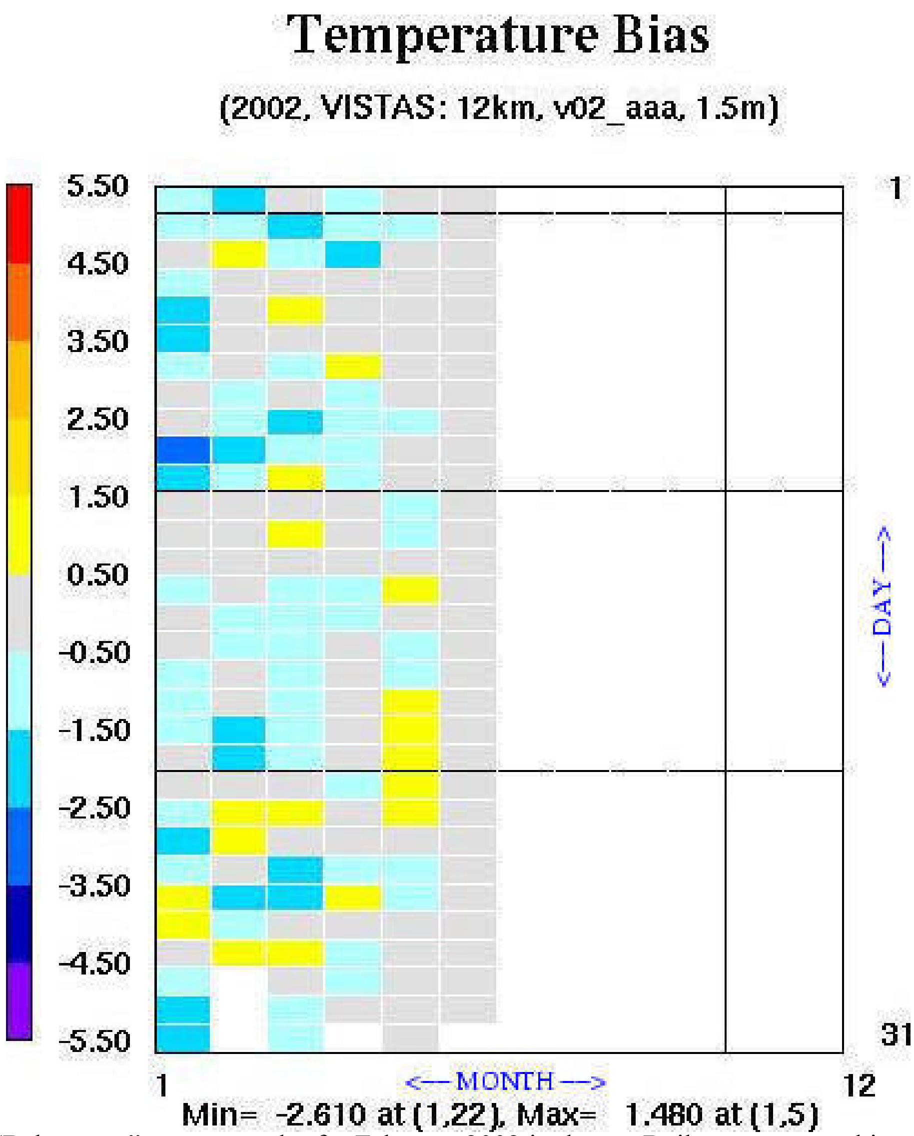

Figure 74. "Bakergram" prototype plot for February 2002 is shown. Daily temperature biases (K) are plotted for the 12-km VISTAS region. The upper left tile represents the average bias in the selected region for January 1, 2002. Days of month increase from 1 at the top to 31 at the bottom, while the month increases from 1 (January) on the left to 12 (December) on the right. Missing periods (e.g. Feb 29-31, Apr 31) are set to the default white background.

Monthly Products (Monthly Summary Statistical Tables)

This product is analogous to the 5-day segment statistical tables, except it covers a full month. These also include precipitation performance metrics when applicable.

Monthly Products (Monthly Accumulated Precipitation)

This product is analogous to the precipitation combination plots, except precipitation will be accumulated over monthly intervals.

D. Computing Resources

Except for the TERRAIN preprocessor and a few miscellaneous analysis routines, we anticipate using MCNC-GTEC's Linux cluster, which is a 64-node IBM X335's with dual 2.8Ghz Xeon processors, 4GB of memory, 40GB online storage. The actual MM5 runs will be run in MPP mode using 32 processors. Since TERRAIN did not readily work on the cluster, it was easier to run that processor on a 300 MHZ SGI machine.

Once runs are completed, we will archive the model inputs/outputs onto 100/200 GB LTO tapes. Additionally we will make triplicate copies of those files onto 250 GB FireWire/USB 2.0 external drives.

E. Project Schedule

Here are some key deliverable dates in the project:

Draft Protocol Approved:	Dec 12, 2003
Annual Modeling Begins:	Dec 15, 2003
First 6 Months MM5 Completed:	Jan 30, 2004
Website for Annual Products:	Feb 5, 2004
Revised Protocol:	Feb 11, 2004
First 6 Months MM5 Results to Air Quality Team:	Feb 19, 2004
MM5 Runs Completed:	Mar 1, 2004
MM5 Evaluation Completed:	Mar 19, 2004
Delivery of Second 6 Months to Air Quality Team:	Mar 19, 2004
Documentation of Annual Run:	Jun 30, 2004

8 References

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9 Appendices

A. Terrain namelist

```
&MAPBG
 PHIC  =   40.0,
 XLONC =  -97.0,
 IEXP  =    .F.,
 AEXP  =   144.,
 IPROJ = 'LAMCON',
 &END
 &DOMAINS
 MAXNES =    2,
 NESTIX =  129,   190,  136,  181,  211, 221,
 NESTJX =  165,   181,  181,  196,  211, 221,
 DIS    =  36.,  12.,   9.,  3.0,  1.0, 1.0,
 NUMNC  =    1,    1,    2,    3,    4,   5,
 NESTI  =    1,   18,   28,   35,   45,  50,
 NESTJ  =    1,   84,   25,   65,   55,  50,
 RID    =  1.5,  1.5,  1.5,  3.1,  2.3,  2.3,
 NTYPE  =    5,    5,    4,    6,    6,   6,
 NSTTYP=     1,    2,    2,    2,    2,   2,
 &END
 &OPTN
 IFTER   = .TRUE.,
 IFANAL  = .F.,
 ISMTHTR =  2 ,
 IFEZFUG = .F.,
 IFTFUG  = .F.,
 IFFUDG  = .F.,
 IPRNTD  = .F.,
 IPRTHT  = .F.,
 IPRINT  =  0,
 FIN     = 200., 100., 100., 100., 100., 100.,
 TRUELAT1=33.,
 TRUELAT2=45.,
 IFILL   = .TRUE.,
 LSMDATA = .TRUE.,
 VEGTYPE = 1,
 VSPLOT  = .TRUE.,
 IEXTRA  = .TRUE.,
 &END
 &FUDGE
 IFFUG   = .F.,.F.,
 NDFUG   = 0,0,
 IFUG(1,1)=  200*0,
 IFUG(1,2)=  200*0,
 JFUG(1,1)=  200*0,
 JFUG(1,2)=  200*0,
 LNDFUG(1,1)= 200*0,
 LNDFUG(1,2)= 200*0,
 &END
 &FUDGET
 NFUGBOX = 2
STARTLAT=45.0,44.0,
 ENDLAT  =46.5,45.0,
 STARTLON=-95.0,-79.8,
 ENDLON  =-92.6,-78.5,
 &END
 &EZFUDGE
 HTPS(441) =  -.001
 HTPS(550) =  183.
 HTPS(587) =  177.
 HTPS(618) =  176.
 HTPS(613) =  174.
 HTPS(645) =   75.
```

```
HTPS(480) = 1897.
HTPS(500) = 1281.
&END
&DATANAME
TERNAME = 'Data/DEM_60M_GLOBAL ',
        'Data/DEM_30M_GLOBAL ',
        'Data/DEM_10M_GLOBAL ',
        'Data/DEM_05M_GLOBAL ',
        'Data/DEM_02M_GLOBAL ',
        'Data/DEM_30S_GLOBAL ',
LNDNAME = 'Data/LANDUSE.60     ',
        'Data/LANDUSE.30     ',
        'Data/LANDUSE.10     ',
        '                    ',
        '                    ',
        '                    ',
LWNAME  = 'Data/LWMASK-USGS.60 ',
        'Data/LWMASK-USGS.30 ',
        'Data/LWMASK-USGS.10 ',
        'Data/LWMASK-USGS.05 ',
        'Data/LWMASK-USGS.02 ',
        'Data/LWMASK-USGS.30s',
VGNAME  = 'Data/VEG-USGS.60    ',
        'Data/VEG-USGS.30    ',
        'Data/VEG-USGS.10    ',
        'Data/VEG-USGS.05    ',
        'Data/VEG-USGS.02    ',
        'Data/VEG-USGS.30s   ',
SONAME  = 'Data/SOILCATB.60    ',
        'Data/SOILCATB.30    ',
        'Data/SOILCATB.10    ',
        'Data/SOILCATB.05    ',
        'Data/SOILCATB.02    ',
        'Data/SOILCATB.30s   ',
VFNAME  = 'Data/VEG-FRACTION.10',
TSNAME  = 'Data/SOILTEMP.60    ',
&END
```

B. Pregrid script

```
#!/bin/csh -f
  set echo

  set MON_PROC = jan02
  set OLD_PROC = dec01
  set OYR      = 2001
  set OMM_PROC = 12

#
# Put your input files for pregrid into the directory you specify as DataDir:
#

#set DataDir = /usr/tmp/username/REGRID
set DataDir = /scratch/olerud/pregrid/${MON_PROC}

if (! -e $DataDir) mkdir -p $DataDir

rm -rf $DataDir/*AWIP*
cp /scratch/olerud/ds609.2/${MON_PROC}/*_3Danal/*AWIP* $DataDir/
cp /scratch/olerud/ds609.2/${MON_PROC}/*_SFanal/*AWIP* $DataDir/

#
# Specify the source of 3-d analyses
#


#   set SRC3D = ON84  # Old ON84-formatted NCEP GDAS analyses
#  set SRC3D = NCEP  # Newer GRIB-formatted NCEP GDAS analyses
```

```
  set SRC3D = GRIB  # Many GRIB-format datasets

#  InFiles:  Tell the program where you have put the analysis files,
#  and what you have called them.   If SRC3D has the value "GRIB",
#  then the Vtables you specify below in the script variable VT3D will
#  be used to interpret the files you specify in the ${InFiles} variable.

#   set InFiles = ( ${DataDir}/NCEP* )
   set InFiles = ( ${DataDir}/*AWIP* )
#
# Specify the source of SST analyses
#

#  set SRCSST = ON84
#  set SRCSST = NCEP
#  set SRCSST = NAVY
  set SRCSST = $SRC3D

#
#  InSST: Tell the program where the files with SST analyses are.  Do
#  this only if SST analyses are coming from files not named above in
#  InFiles.  If SRCSST has the value "GRIB", then the Vtables you
#  specify below in the script variable VTSST will be used to interpret
#  the files you specify in the ${InSST} variable.
#

  set InSST = ()

#
# Select the source of snow-cover analyses (entirely optional)
#

   set SRCSNOW = $SRC3D
#  set SRCSNOW = ON84
#  set SRCSNOW = GRIB

#  InSnow:  Set InSnow only if the snow-cover analyses are from files
#  not listed in InFiles.  If SRCSNOW has the value "GRIB", then the
#  Vtables you specify below in the script variable VTSNOW will be used
#  to interpret the files you specify in the ${InSnow} variable.

   set InSnow = ()

#
# Select the source of soil model analyses (entirely optional)
#

   set SRCSOIL = $SRC3D

#  InSoil:  Set InSoil only if the soil analyses are from files
#  not listed in InFiles.  If SRCSOIL has the value "GRIB", then the
#  Vtables you specify below in the script variable VTSOIL will be
#  used to interpret the files you specify in the ${InSoil} variable.

   set InSoil = ()

#
#  Build the Namelist
#
if ( -e ./pregrid.namelist ) then
   rm ./pregrid.namelist
endif
cat << End_Of_Namelist | sed -e 's/#.*//; s/  *$//' > ./pregrid.namelist
&record1
#
# Set the starting date of the time period you want to process:
#
 START_YEAR  = 2001   # Year (Four digits)
 START_MONTH = 12     # Month ( 01 - 12 )
 START_DAY   = 31     # Day ( 01 - 31 )
```

```
 START_HOUR  = 15     # Hour ( 00 - 23 )

 END_YEAR  = 2002   # Year (Four digits)
 END_MONTH = 01     # Month ( 01 - 12 )
 END_DAY   = 31     # Day ( 01 - 31 )
 END_HOUR  = 21     # Hour ( 00 - 23 )
#
# Define the time interval to process.
#
 INTERVAL =  10800 # Time interval (seconds) to process.
                 # This is most sanely the same as the time interval for
                   # which the analyses were archived, but you can really
                   # set this to just about anything, and pregrid will
                   # interpolate in time and/or skip over time periods for
                   # your regridding pleasure.

/
End_Of_Namelist

#
#  Tell the pregrid programs which Vtables to use.  Do this only
#  if you have selected GRIB-formatted input using SRC___ = GRIB above.
#  The directories referenced here are relative to REGRID/pregrid/.
#
#  The Vtable files specified in VT3D will be applied to the files
#  specified in the InFiles variable.  Similarly, the Vtable files
#  specified in VTSST, VTSNOW, and VTSOIL will be applied to the files
#  listed above in InSST, InSNOW, and InSoil, respectively.
#
#   set VT3D = ( grib.misc/Vtable.NNRP3D )
#   set VTSST = ( grib.misc/Vtable.NNRPSST )
#   set VTSNOW = ( grib.misc/Vtable.xxxxSNOW )
#   set VTSOIL = ( grib.misc/Vtable.xxxxSOIL )

   set VT3D   = ( grib.misc/Vtable.AWIP3D )
   set VTSST  = ( grib.misc/Vtable.AWIPSST )
   set VTSNOW = ( grib.misc/Vtable.AWIPSNOW )
   set VTSOIL = ( grib.misc/Vtable.AWIPSOIL )

########################################################################
########################################################################
######                                                          ######
######                  END USER MODIFICATION                   ######
######                                                          ######
########################################################################
########################################################################

if ( ! $?SRC3D ) then
   set SRC3D
endif
if ( ! $?SRCSST ) then
   set SRCSST
endif
if ( ! $?SRCSNOW ) then
   set SRCSNOW
endif
if ( ! $?SRCSOIL ) then
   set SRCSOIL
endif
if ( ! $?VTSOIL ) then
   set VTSOIL
endif
if ( ! $?VTSNOW ) then
   set VTSNOW
endif
if ( ! $?VTSST ) then
   set VTSST
endif
if ( ! $?VT3D ) then
   set VT3D
endif
```

```
if ( ! $?InFiles ) then
   set InFiles = ()
endif
if ( ! $?InSST ) then
   set InSST = ()
endif
if ( ! $?InSnow ) then
   set InSnow = ()
endif
if ( ! $?InSoil ) then
   set InSoil = ()
endif

if ( $SRCSST == $SRC3D) then
   if ( $#InSST == 0 ) then
      set InSST = ( ${InFiles} )
   endif
endif

if ( $SRCSNOW == $SRC3D) then
   if ( $#InSnow == 0 ) then
      set InSnow = ( ${InFiles} )
   endif
endif

if ( $SRCSOIL == $SRC3D) then
   if ( $#InSoil == 0 ) then
      set InSoil = ( ${InFiles} )
   endif
endif

set LETTERS = ( A B C D E F G H I J K L M N O P Q R S T U V W X Y Z )

foreach SourceType ( 3D SST SNOW SOIL)

  printf "\nProcessing for SourceType = %s\n\n" $SourceType

  if ( ( $SourceType == SOIL ) && ( $SRCSOIL == ON84) ) then
    printf "\n\nSoil fields not available in ON84 Dataset.\n"
    printf "Do not request soil fields or select another source for soil fields.\n\n"
    exit (1)
  endif

  if ( ( $SourceType == SOIL ) && ( $SRCSOIL == NCEP) ) then
    printf "\n\nSoil fields not available in NCEP GDAS Dataset."
    printf "Do not request soil fields or select another source for soil fields.\n\n"
    exit (1)
  endif

###############################################################################

  if ( ( ( $SourceType == 3D   ) && ( $SRC3D   == ON84) ) || \
       ( ( $SourceType == SST  ) && ( $SRCSST  == ON84) ) || \
       ( ( $SourceType == SNOW ) && ( $SRCSNOW == ON84) ) ) then

    printf "\n\nStarting ON84 processing for type %s\n\n" $SourceType
#
#  Go down to the "on84" directory.
#
    printf "cd %s\n\n" `pwd`/on84
    cd on84
#
#  Remove whatever files may be leftover from a prior job.  Redirect
#  printout to supress warnings if there is nothing to remove.
#
    rm ON84FILE* >&! /dev/null
    rm PSST:*    >&! /dev/null
    rm PSNOW:*   >&! /dev/null
    rm -f pregrid.namelist
    rm -f Vtable
#
```

```
#  Build the Vtable:
#
    touch Vtable
    if ($SourceType == 3D) then
       cat Vtable.ON84 >> Vtable
    else if ($SourceType == SST) then
       cat Vtable.SST >> Vtable
    else if ($SourceType == SNOW) then
       cat Vtable.SNOW >> Vtable
    endif
#
#  Link the requested input files to "ON84FILE.A", "ON84FILE.B", etc.
#
    set Num = 0
    if ($SourceType == 3D) then
       foreach file ( $InFiles )
          @ Num ++
         printf "       ln -s   %s   %s\n" $file ON84FILE${LETTERS[$Num]}
          ln -s $file ON84FILE${LETTERS[$Num]}
       end
    endif

    if ($SourceType == SST) then
       foreach file ( $InSST )
          @ Num ++
         printf "       ln -s   %s   %s\n" $file ON84FILE${LETTERS[$Num]}
          ln -s $file ON84FILE${LETTERS[$Num]}
       end
    endif

    if ($SourceType == SNOW) then
       foreach file ( $InSnow )
          @ Num ++
         printf "       ln -s   %s   %s\n" $file ON84FILE${LETTERS[$Num]}
          ln -s $file ON84FILE${LETTERS[$Num]}
       end
    endif
#
# Link the pregrid.namelist file and run the program.
#
    ln -s ../pregrid.namelist pregrid.namelist
    ./pregrid_on84.exe
#
# Move the output up to the "pregrid" directory.
#
    if ($SourceType == 3D) then
       foreach file ( ON84:* )
         printf "       mv %s ../%s\n" $file $file
          mv $file ..
       end
    else if ($SourceType == SST) then
       foreach file ( SST:* )
         printf "       mv %s ../ON84_%s\n" $file $file
          mv $file ../ON84_$file
       end
    else if ($SourceType == SNOW) then
       foreach file ( SNOW:* )
         printf "       mv %s ../ON84_%s\n" $file $file
          mv $file ../ON84_$file
       end
    endif
#
# Go back up to the "pregrid" directory.
#
    printf "\ncd %s\n" `pwd`/..
    cd ..

    printf "\nDone with ON84 processing for type %s\n\n" $SourceType
  endif

################################################################################
```

```
  if ( ( ( $SourceType == 3D   ) && ( $SRC3D   == NCEP) ) || \
       ( ( $SourceType == SST  ) && ( $SRCSST  == NCEP) ) || \
       ( ( $SourceType == SNOW ) && ( $SRCSNOW == NCEP) ) ) then
#
#  Go down to the "ncep.grib" directory.
#
    printf "\ncd %s\n" `pwd`/ncep.grib
    cd ncep.grib
#
#  Remove whatever files may be leftover from a prior job.  Redirect
#  printout to supress warnings if there is nothing to remove.
#
    rm GRIBFILE*             >&! /dev/null
    rm -f pregrid.namelist
    rm -f Vtable
#
#  Build the Vtable:
#
    touch Vtable
    if ($SourceType == 3D) then
       cat Vtable.NCEP >> Vtable
    else if ($SourceType == SST) then
       cat Vtable.SST >> Vtable
    else if ($SourceType == SNOW) then
       cat Vtable.SNOW >> Vtable
    endif
#
#  Link the requested input files to "GRIBFILE.A", "GRIBFILE.B", etc.
#
    set Num = 0
    if ( $SourceType == 3D ) then
       foreach file ( $InFiles )
          @ Num ++
          ln -s $file GRIBFILE${LETTERS[$Num]}
       end
    endif
    if ($SourceType == SST) then
       foreach file ( $InSST )
          @ Num ++
          ln -s $file GRIBFILE${LETTERS[$Num]}
       end
    endif
    if ($SourceType == SNOW) then
       foreach file ( $InSnow )
          @ Num ++
          ln -s $file GRIBFILE${LETTERS[$Num]}
       end
    endif
#
# Link the pregrid.namelist file and run the program.
#
    ln -s ../pregrid.namelist pregrid.namelist
    ./pregrid_ncep.exe
#
# Move the output up to the "pregrid" directory.
#
    if ($SourceType == 3D) then
       mv NCEP:* ..
    else if ($SourceType == SST) then
       foreach file ( SST:* )
          mv $file ../NCEP_$file
       end
    else if ($SourceType == SNOW) then
       foreach file ( SNOW:* )
          mv $file ../NCEP_$file
       end
    endif
#
# Go back up to the "pregrid" directory.
#
```

```
    echo "cd `pwd`/.."
    cd ..

  endif

################################################################################

  if ( ($SourceType == SST) && ( $SRCSST == NAVY ) ) then

    printf "\n\nStarting NAVYSST processing.\n\n"
#
#  Go down to the "navysst" directory.
#
     echo "cd `pwd`/navysst"
     cd navysst
#
#  Remove whatever files may be leftover from a prior job.  Redirect
#  printout to supress warnings if there is nothing to remove.
#
     rm -f pregrid.namelist
     rm NAVYFILE*        >&! /dev/null
#
#  Link the requested files to "NAVYFILE.A", "NAVYFILE.B", etc.
#
     set Num = 0
     foreach file ( $InSST )
        @ Num ++
        ln -s ${file} NAVYFILE${LETTERS[$Num]}
     end
#
# Link the pregrid.namelist file and run the program.
#
     ln -s ../pregrid.namelist pregrid.namelist
     ./pregrid_navy.exe

#
# Move the output files up to the "pregrid" directory.
#
     foreach file ( SST:* )
        mv $file ../NAVY_$file
     end
#
# Go back up to the "pregrid" directory.
#
     echo "cd `pwd`/.."
     cd ..

     printf "\n\nDone with NAVYSST processing.\n\n"

  endif

################################################################################

  if ( ( ( $SourceType == 3D   ) && ( $SRC3D   == GRIB) ) || \
       ( ( $SourceType == SST  ) && ( $SRCSST  == GRIB) ) || \
       ( ( $SourceType == SNOW ) && ( $SRCSNOW == GRIB) ) || \
       ( ( $SourceType == SOIL ) && ( $SRCSOIL == GRIB) ) ) then

     printf "\n\nStarting GRIB processing for type %s\n\n" $SourceType

#
#  Go down to the "grib.misc" directory.
#
     echo "cd `pwd`/grib.misc"
     cd grib.misc
#
#  Remove whatever files may be leftover from a prior job.  Redirect
#  printout to supress warnings if there is nothing to remove.
#
     rm FILE:*              >&! /dev/null
     rm GRIBFILE*           >&! /dev/null
```

```
      rm -f Vtable
      rm -f pregrid.namelist
#
#  Build the Vtable:
#
      touch Vtable
      if ( $SourceType == 3D ) then
         foreach file ( $VT3D )
            cat ../$file >> Vtable
         end
      else if ( $SourceType == SST ) then
         foreach file ( $VTSST )
            cat ../$file >> Vtable
         end
      else if ( $SourceType == SNOW ) then
         foreach file ( $VTSNOW )
            cat ../$file >> Vtable
         end
      else if ( $SourceType == SOIL ) then
         foreach file ( $VTSOIL )
            cat ../$file >> Vtable
         end
      endif
#
#  Link the requested files to "GRIBFILE.AA", "GRIBFILE.AB", etc.
#
      set NUM = 0
      set num = 1

      if ( $SourceType == 3D ) then
         foreach file ( $InFiles )
            @ NUM ++
            if ( $NUM == 27 ) then
               set NUM = 1
               @ num ++
            endif
           printf "       ln -s   %s   %s\n" $file GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
            ln -s ${file} GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
         end
      else if ( $SourceType == SST ) then
         foreach file ( $InSST )
            @ NUM ++
            if ( $NUM == 27 ) then
               set NUM = 1
               @ num ++
            endif
           printf "       ln -s   %s   %s\n" $file GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
            ln -s ${file} GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
         end
      else if ( $SourceType == SNOW ) then
         foreach file ( $InSnow )
            @ NUM ++
            if ( $NUM == 27 ) then
               set NUM = 1
               @ num ++
            endif
           printf "       ln -s   %s   %s\n" $file GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
            ln -s ${file} GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
         end
      else if ( $SourceType == SOIL ) then
         foreach file ( $InSoil )
            @ NUM ++
            if ( $NUM == 27 ) then
               set NUM = 1
               @ num ++
            endif
           printf "       ln -s   %s   %s\n" $file GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
            ln -s ${file} GRIBFILE.${LETTERS[$num]}${LETTERS[$NUM]}
         end
      endif
#
```

```
# Link the pregrid.namelist file and run the program.
#
     ln -s ../pregrid.namelist pregrid.namelist
     ./pregrid_grib.exe
#
# Move the output files up to the "pregrid" directory.
#
     if ( $SourceType == 3D ) then
        mv FILE:* ..
     else
        foreach file ( FILE:* )
         printf "mv %s   %s\n" $file ../${SourceType}_${file}
          mv $file ../${SourceType}_${file}
        end
     endif
#
# Go back to the "pregrid" directory.
#
     echo "cd `pwd`/.."
     cd ..

     printf "\n\nDone with GRIB processing for type %s\n\n" $SourceType
   endif

#
# Print out five lines of # as a delimiter between ${SourceType}s
#
   repeat 5 printf \
"################################################################################\n"

end
printf "\n"

mv *FILE:${OYR}-${OMM_PROC}-* $DataDir/../${OLD_PROC}
mv *FILE* $DataDir/
```

C. Regridder 36-km sample namelist

```
&record1
 start_year              =  2002
 start_month             =  01
 start_day               =  01
 start_hour              =   00
 end_year                =  2002
 end_month               =  01
 end_day                 =  07
 end_hour                =   00
 interval                = 10800 /

&record2
 ptop_in_Pa              = 10000
 new_levels_in_Pa        = 95000 , 92500 , 90000 ,
                    80000 ,
                    75000 ,
                    65000 , 60000 ,
                    55000 ,
                    45000 ,
                    35000
 sst_to_ice_threshold    = -9999
 linear_interpolation    = .FALSE. /

&record3
 root                    = '../pregrid/FILE' '../pregrid/SOIL_FILE' '../pregrid/SST_FILE' '../pregrid/SNOW_FILE'
 terrain_file_name       = '../../TERRAIN/TERRAIN_DOMAIN1' /
 constants_full_name     = './ALMX_FILE' /

&record4
 print_echo              = .FALSE. ,
```

```
 print_debug                    = .FALSE. ,
 print_mask                     = .FALSE. ,
 print_interp                   = .FALSE. ,
 print_link_list_store          = .FALSE. ,
 print_array_store              = .FALSE. ,
 print_header                   = .FALSE. ,
 print_output                   = .FALSE. ,
 print_file                     = .FALSE. ,
 print_tc                       = .FALSE. ,
 print_f77_info                 = .TRUE. /

&record5
 insert_bogus_storm             = .FALSE.
 num_storm                      =      1
 latc_loc                       =     36.0
 lonc_loc                       =    -35.0
 vmax_meters_per_second         =     35.0
 rmax                           =   90000.0
 vmax_ratio                     =      0.75 /
```

D. FETCH (adp_sfc) sample namelist

```
&LATLON
 XLONE     =  -40
 XLONW     =  -140
 XLATS     =  15
 XLATN     =  60
/

 &DATE
 ISTARTYR   = 2002
 ISTARTMO   = 01
 ISTARTDY   = 01
 ISTARTHR   = 00
 IENDYR     = 2002
 IENDMO     = 01
 IENDDY     = 04
 IENDHR     = 00
/
```

E. FETCH (adp_upa) sample namelist

```
&LATLON
 XLONE     =  -50
 XLONW     =  -150
 XLATS     =  15
 XLATN     =  62
/

 &DATE
 ISTARTYR   = 2002
 ISTARTMO   = 01
 ISTARTDY   = 01
 ISTARTHR   = 00
 IENDYR     = 2002
 IENDMO     = 01
 IENDDY     = 15
 IENDHR     = 23
/
```

F. LITTLE_R sample 36-km namelist

```
&record1
```

```
 start_year              =  2002
 start_month             =    01
 start_day               =    01
 start_hour              =    00
 end_year                =  2002
 end_month               =    01
 end_day                 =    07
 end_hour                =    00
 interval                = 10800/

&record2
 fg_filename             = '../regridder/REGRID_DOMAIN1'
 obs_filename            = '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_00'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_03'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_06'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_09'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_12'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_15'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_18'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-01_21'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_00'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_03'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_06'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_09'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_12'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_15'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_18'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-02_21'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_00'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_03'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_06'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_09'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_12'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_15'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_18'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-03_21'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_00'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_03'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_06'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_09'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_12'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_15'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_18'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-04_21'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_00'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_03'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_06'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_09'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_12'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_15'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_18'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-05_21'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_00'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_03'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_06'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_09'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_12'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_15'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_18'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-06_21'
                           '../../FETCH/adp_upa/jan02/upper-air_obs_r:2002-01-07_00'
 sfc_obs_filename        = '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_00'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_03'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_06'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_09'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_12'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_15'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_18'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-01_21'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_00'
                           '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_03'
```

```
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_06'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_09'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_12'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_15'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_18'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-02_21'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_00'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_03'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_06'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_09'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_12'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_15'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_18'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-03_21'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_00'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_03'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_06'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_09'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_12'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_15'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_18'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-04_21'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_00'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_03'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_06'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_09'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_12'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_15'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_18'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-05_21'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_00'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_03'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_06'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_09'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_12'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_15'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_18'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-06_21'
                                   '../../FETCH/adp_sfc/jan02/surface_obs_r:2002-01-07_00' /
&record3
 max_number_of_obs            = 10000
 fatal_if_exceed_max_obs      = .TRUE./

&record4
 qc_test_error_max            = .TRUE.
 qc_test_buddy                = .TRUE.
 qc_test_vert_consistency     = .FALSE.
 qc_test_convective_adj       = .FALSE.
 max_error_t                  = 10
 max_error_uv                 = 13
 max_error_z                  = 8
 max_error_rh                 = 50
 max_error_p                  = 600
 max_buddy_t                  = 8
 max_buddy_uv                 = 8
 max_buddy_z                  = 8
 max_buddy_rh                 = 40
 max_buddy_p                  = 800
 buddy_weight                 = 1.0
 max_p_extend_t               = 1300
 max_p_extend_w               = 1300/

&record5
 print_obs_files              = .FALSE.
 print_found_obs              = .FALSE.
 print_header                 = .FALSE.
 print_analysis               = .FALSE.
 print_qc_vert                = .FALSE.
 print_qc_dry                 = .FALSE.
 print_error_max              = .FALSE.
 print_buddy                  = .FALSE.
```

```
 print_oa                     = .FALSE./

&record7
 use_first_guess              = .TRUE.
 f4d                          = .TRUE.
 intf4d                       =  10800
 lagtem                       = .FALSE. /

&record8
 smooth_type                  =  1
 smooth_sfc_wind              =  0
 smooth_sfc_temp              =  0
 smooth_sfc_rh                =  0
 smooth_sfc_slp               =  0
 smooth_upper_wind            =  0
 smooth_upper_temp            =  0
 smooth_upper_rh              =  0/

&record9
 oa_type                      = 'MQD'
 mqd_minimum_num_obs          = 30
 mqd_maximum_num_obs          = 1000
 radius_influence             = 5,4,3,2
 oa_min_switch                = .TRUE.
 oa_max_switch                = .TRUE./
```

G. INTERPF sample 36-km namelist

```
&record0
 input_file     = '../LITTLE_R/LITTLE_R_DOMAIN1' /   ! pressure-level data file name

&record1
 start_year    =  2002                  ! The starting and
 start_month    =   01                  ! ending dates to
 start_day      =   01                  ! process
 start_hour     =   00
 end_year       =  2002
 end_month      =   01
 end_day        =   07
 end_hour       =   00
 interval       = 10800                 ! time difference (s)
 less_than_24h  = .FALSE. /             ! if input is less than 24 h

&record2
 sigma_f_bu     = 1.000,0.995,0.990,0.985,0.980,0.970,0.960,     ! full sigma, bottom-up,
                  0.950,0.940,0.930,0.920,0.910,0.900,0.880,     ! end
                  0.860,0.840,0.820,0.800,0.770,0.740,0.700,     ! with 0.0
                  0.650,0.600,0.550,0.500,0.450,0.400,0.350,
                  0.300,0.250,0.200,0.150,0.100,0.050,0.000
 ptop           = 10000                 ! top pressure if need to be redefined
 isfc           = 0 /                   ! # sigma levels to spread
                                        ! surface information

&record3
 p0             = 1.e5                  ! base state sea-level pres (Pa)
 tlp            = 50.                   ! base state lapse rate d(T)/d(ln P)
 ts0            = 275.                  ! base state sea-level temp (K)
 tiso           = 0./                   ! base state isothermal stratospheric temp (K)

&record4
 removediv      = .TRUE.                ! T/F remove integrated mean divergence
 usesfc         = .TRUE.                ! T/F use surface data
 wrth2o         = .TRUE.                ! T/F specific humidity wrt H2O
 psfc_method    = 0 /                   ! T/F sfc temperature from diurnal avg

&record5
 ifdatim        = -1 /                  ! # of IC time periods to output
```

H. MM5 sample mmlif

```
&OPARAM
TIMAX  = 7920.,
TISTEP = 90.,
IFREST = .FALSE.,
   IXTIMR  = 0,
IFSAVE = .TRUE.,
   SVLAST = .TRUE.,
   SAVFRQ = 360.,
IFTAPE = 1,
   TAPFRQ = 60.,
 BUFFRQ = 1440.,
   INCTAP = 1,1,1,1,1,1,1,1,1,1,
IFSKIP = .FALSE.,
   CDATEST = '2002-10-28_00:00:00',
IFPRT = 0,
PRTFRQ = 720.,
MASCHK = 99999,
IFTSOUT = .FALSE.,
  TSLAT = 0.0,0.0,0.0,0.0,0.0,
  TSLON = 0.0,0.0,0.0,0.0,0.0,
&END
&LPARAM
RADFRQ    = 15.,
IMVDIF    = 1,
IVQADV    = 1,
IVTADV    = 1,
ITHADV    = 1,
ITPDIF    = 1,
ICOR3D    = 1,
IEXSI     = 0,
IFUPR     = 1,
IBOUDY = 3, 2, 2, 2, 2, 2, 2, 2, 2, 2,
IFDRY  = 0,
ISSTVAR= 1,
IMOIAV = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
IZ0TOPT= 0,
IFSNOW = 1, 1, 0, 0, 0, 0, 0, 0, 0, 0,
ISFFLX = 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
ITGFLG = 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
ISFPAR = 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
ICLOUD = 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
IEVAP  = 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
ISMRD  = 2,
NUDGE    =  1,
IFGROW   =  2,
RDMAXALB=.FALSE.
RDBRDALB=.FALSE.
IFRAD = 4,
ICUPA  = 8,8,8,8,8,8,8,8,8,8,
IMPHYS = 5,5,4,4,4,4,4,4,4,4      ,
IBLTYP = 7,7,7,7,7,7,7,7,7,7,
ISHALLO = 0,0,0,0,0,0,0,0,0,0,
IPOLAR = 0,
ISOIL = 3,
&END
&NPARAM
LEVIDN =   0,1,2,1,1,1,1,1,1,1,
NUMNC  =   1,1,2,1,1,1,1,1,1,1,
NESTIX = 129, 190,  31,  46,  46,  46,  46,  46,  46,  46,
NESTJX = 165, 181,  31,  61,  61,  61,  61,  61,  61,  61,
NESTI  =   1,  18,   8,   1,   1,   1,   1,   1,   1,   1,
NESTJ  =   1,  84,   9,   1,   1,   1,   1,   1,   1,   1,
XSTNES =   0.,  0.,900.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,
XENNES =7920.,7920.,1440.,720.,720.,720.,720.,720.,720.,720.
IOVERW =   1,   1,   0,   0,   0,   0,   0,   0,   0,   0,
IACTIV =   1,   1,   0,   0,   0,   0,   0,   0,   0,   0,
```

```
IMOVE  =   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
IMOVCO =   1,   1,   1,   1,   1,   1,   1,   1,   1,   1,
IMOVEI =   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
IMOVEJ =   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
IMOVET =   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
           0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
IFEED  =  0,
&END
&PPARAM
ZZLND  = 0.1,
ZZWTR  = 0.0001,
ALBLND = 0.15,
THINLD = 0.04,
XMAVA  = 0.3,
CONF   = 1.0,
&END
&FPARAM
FDASTA=0.,0.,0.,0.,0.,0.,0.,0.,0.,0.
FDAEND=7920.,7920.,0.,0.,0.,0.,0.,0.,0.,0.,
I4D= 1,1,0,0,0,0,0,0,0,0,
     1,1,0,0,0,0,0,0,0,0,
DIFTIM=180.,180.,0.,0.,0.,0.,0.,0.,0.,0.,
       180.,180.,0.,0.,0.,0.,0.,0.,0.,0.,
IWIND=1,1,0,0,0,0,0,0,0,0,
      1,1,0,0,0,0,0,0,0,0,
GV=2.5E-4,1.0E-4,0.,0.,0.,0.,0.,0.,0.,0.,
   2.5E-4,1.0E-4,0.,0.,0.,0.,0.,0.,0.,0.,
ITEMP=1,1,0,0,0,0,0,0,0,0,
      0,0,0,0,0,0,0,0,0,0,
GT=2.5E-4,1.0E-4,0.,0.,0.,0.,0.,0.,0.,0.,
   2.5E-4,1.0E-4,0.,0.,0.,0.,0.,0.,0.,0.,
IMOIS=1,1,0,0,0,0,0,0,0,0,
      0,0,0,0,0,0,0,0,0,0,
GQ=1.E-5,1.E-5,0.,0.,0.,0.,0.,0.,0.,0.,
   1.E-5,1.E-5,0.,0.,0.,0.,0.,0.,0.,0.,
IROT=0,0,0,0,0,0,0,0,0,0,
GR=5.E6,5.E6,0.,0.,0.,0.,0.,0.,0.,0.,
INONBL =0,0,0,0,0,0,0,0,0,0,
        0,0,0,0,0,0,0,0,0,0,
        1,1,1,1,1,1,1,1,1,1,
        1,1,1,1,1,1,1,1,1,1,
RINBLW=250.,
NPFG=50,
I4DI   =0,0,0,0,0,0,0,0,0,0,
ISWIND =1,0,0,0,0,0,0,0,0,0,
GIV  =4.E-4,4.E-4,0.,0.,0.,0.,0.,0.,0.,0.,
ISTEMP=1,0,0,0,0,0,0,0,0,0,
GIT  =4.E-4,4.E-4,0.,0.,0.,0.,0.,0.,0.,0.,
ISMOIS=1,0,0,0,0,0,0,0,0,0,
GIQ  =4.E-4,4.E-4,0.,0.,0.,0.,0.,0.,0.,0.,
RINXY=240.,
RINSIG=0.001,
TWINDO=40.0,
NPFI=20,
IONF=2,
IDYNIN=0,
DTRAMP=60.,
&END
```

Appendix J

Air Quality Model Performance Evaluation

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1. Overview

The discussion of model performance in this Appendix will focus on the comparison of observational data from the Federal Reference Monitor (FRM) and Speciated Trends Network (STN) monitoring sites and model output data from the 2002 VISTAS actual annual air quality modeling. The evaluation will primarily focus on the air quality model's performance with respect to individual components of fine particulate matter ($PM_{2.5}$), as good model performance of the component species will dictate good model performance of total or reconstituted fine particulate matter. Model performance of the total fine particulate matter will also be provided as a means to discuss the overall model performance for this Implementation Plan.

1.1 Monitoring Sites

The US EPA designated two areas as nonattainment for $PM_{2.5}$ in North Carolina. The Hickory Nonattainment area for $PM_{2.5}$ consists of Catawba County, while the Greensboro-Winston-Salem-High Point Nonattainment area (referred to as the Triad) consists of Davidson and Guilford counties. At the time of designations, Catawba County had both an FRM and STN monitor, and Davidson and Guilford counties each had an FRM monitor. The monitoring network has since been expanded to include STN monitors in Davidson and Guilford counties, as well as other additional monitoring sites around the state. The North Carolina $PM_{2.5}$ nonattainment areas and the current PM monitoring network are noted in Figure 1-1.

The model evaluation will focus on both the FRM and STN monitors across the state, due to the nature of the attainment test. Designations were based on FRM monitors, and calculations of future design values are calculated using current design value information from these sites. Since future attainment demonstrations hinge on the models representing the FRM sites well, it follow that model performance for these sites should be evaluated. STN data also needs to be evaluated as this data is used to speciate the FRM data so component based relative response factors can be calculated for each FRM monitoring site. More detailed information on the attainment test process is described in Appendix L.

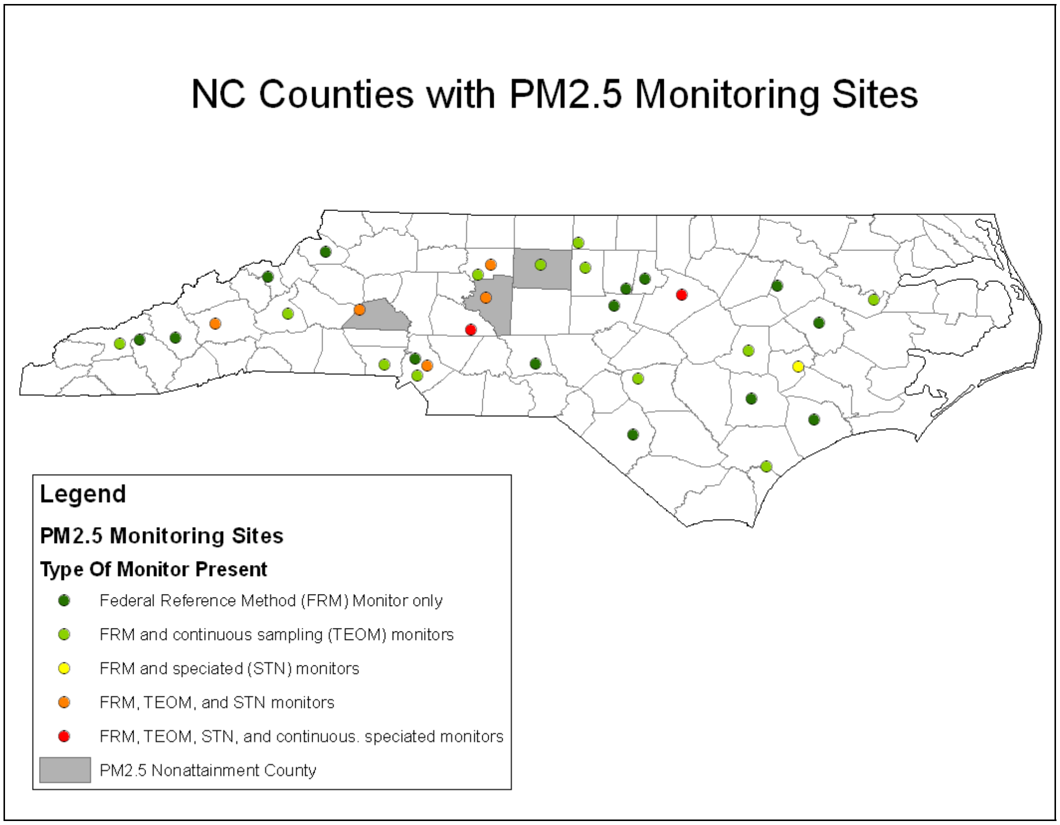


Figure 1-1: PM Nonattainment Areas and PM monitors in North Carolina.

1.2 Particulate Matter and Component Species

Particulate Matter can be liquid, solid, or can have a solid core surrounded by liquid. PM can include material produced by combustion, photochemical reactions, and can contain salt from sea spray and soil like particles. Particles are distinguished based on the method of formation. Primary particles are particles directly emitted into the atmosphere and retain the same chemical composition as when they were released. Secondary particles are those formed through chemical reactions involving atmospheric oxygen (O_2), water vapor (H_2O), hydroxyl radical (OH), nitrate (NO_3), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and organic gases from natural and anthropogenic sources. Fine particulate matter can therefore be composed of varying amount of different species, including:

- Sulfates
- Nitrates (usually found in the form of ammonium nitrate)
- Ammonium
- Hydrogen ion
- Particle bound water
- Elemental carbon
- Organic compounds
  - Primary organic species (from cooking and combustion)
  - Secondary organic compounds
- Crustal material (includes calcium, aluminum, silicon, magnesium, and iron)

- Sea salt (generally only found at coastal monitoring sites)
- Transitional metals
- Potassium (generally from wood burning or cooking)

For the purposes of model performance associated with this Implementation Plan, we will examine the species of particulate matter that are collected by the STN monitoring network. The components measured at STN include nitrate, sulfate, ammonia, and organic and elemental carbon. From these components we can also reconstruct a total $PM_{2.5}$ mass, which can be compared to a model total reconstructed fine mass. For this model performance evaluation, we will also examine the total $PM_{2.5}$ mass with respect to the total mass from the FRM monitoring sites.

2. Model Performance Statistics

To quantify model performance, several statistical measures were calculated and evaluated for all the STN and FRM monitors within the VISTAS 12km domain and individually for each STN and FRM monitor associated with North Carolina's $PM_{2.5}$ nonattainment areas. The statistical measures selected were based on the recommendations outlined in section 18.4.1 of the USEPA's Guidance On The Use Of Models And Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze ("*Attainment Guidance*").

In 2004 VISTAS established model performance goals and criteria for components of fine particle mass (Table 2.1) based on previous model performance for ozone and fine particles. EPA modeling guidance for fine particulate matter at the time noted that PM models might not be able to achieve the same level of performance as ozone models. VISTAS' evaluation considered several statistical performance measures and displays.

Table 2-1 Model performance goals and criteria for components of fine particle mass.

Fractional Bias	**Fractional Error**	**Comment**
$\leq$15%	$\leq$35%	Goal for PM model performance based on ozone model performance, considered excellent performance
$\leq$30%	$\leq$50%	Goal for PM model performance, considered good performance
$\leq$60%	$\leq$75%	Criteria for PM model performance, considered average performance. Exceeding this level of performance indicates fundamental concerns with the modeling system and triggers diagnostic evaluation.

The statistical measures were calculated for all of the component species of particulate matter responsible for light extinction, and for total light extinction. For convenience, these statistical measures or metrics, along with a variety of additional statistical measures, are summarized in Table 2-2.

Table 2-2 Statistical Metric Calculations

Statistical Measure	Shorthand Notation	Mathematical Expression	Notes
Accuracy of Paired Peak	A_p	$\frac{P - O_{peak}}{O_{peak}}$	
Coefficient of Determination	R^2	$\frac{\left[\sum_{i=1}^{N}\left(P_i - \overline{P}\right)\left(O_i - \overline{O}\right)\right]^2}{\sum_{i=1}^{N}(P_i - \overline{P})^2 \sum_{i=1}^{N}(O_i - \overline{O})^2}$	P_i= prediction at time and location i; O_i = observation at time and location i; $\overline{P}$ = arithmetic average of P_i, i = 1, 2, . . ., N; $\overline{O}$ = arithmetic average of O_i, i = 1, 2, . . ., N;
Normalized Mean Error	NME	$\frac{\sum_{i=1}^{N}\left\|P_i - O_i\right\|}{\sum_{i=1}^{N}O_i}$	Reported as %
Root Mean Square Error	RMSE	$\left[\frac{1}{N}\sum_{i=1}^{N}\left(P_i - O_i\right)^2\right]^{\frac{1}{2}}$	Reported as %
Mean Fractional Error	MFE	$\frac{2}{N}\sum_{i=1}^{N}\left\|\frac{P_i - O_i}{P_i + O_i}\right\|$	Reported as %
Mean Absolute Gross Error	MAGE	$\frac{1}{N}\sum_{i=1}^{N}\left\|P_i - O_i\right\|$	
Mean Normalized Gross Error	MNGE	$\frac{1}{N}\sum_{i=1}^{N}\frac{\left\|P_i - O_i\right\|}{O_i}$	Reported as %
Mean Biased	MB	$\frac{1}{N}\sum_{i=1}^{N}\left(P_i - O_i\right)$	Reported as concentration
Mean Normalized Bias	MNB	$\frac{1}{N}\sum_{i=1}^{N}\frac{\left(P_i - O_i\right)}{O_i}$	Reported as %
Mean Fractionalized Bias (Fractional Bias)	MFB	$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$	Reported as %
Normalized Mean Bias	NMB	$\frac{\sum_{i=1}^{N}\left(P_i - O_i\right)}{\sum_{i=1}^{N}O_i}$	Reported as %
Bias Factor	BF	$\frac{1}{N}\sum_{i=1}^{N}\left(\frac{P_i}{O_i}\right)$	Reported as BF:1 or 1:BF or in fractional notation (BF/1 or 1/BF)

2.1 Statistical Tables

The statistical metrics were calculated for the Hickory (Catawba County) and Hattie Avenue (Forsyth County) STN monitors to demonstrate model performance on for the components of $PM_{2.5}$ in and near the $PM_{2.5}$ nonattainment areas. Model performance statistics for the STN sites were calculated on a component and total $PM_{2.5}$ basis for the entire base year.

Model performance statistics have also been calculated for collectively for the FRM monitors within the VISTAS 12km domain, as well as individually for the 3 FRM monitors in the nonattainment areas (Hickory, Lexington, and Mendenhall) to demonstrate the model's ability to replicate total $PM_{2.5}$ mass at these sites. Summaries of the statistical tables are presented separately for the STN monitoring sites (Section 2.1.1) and FRM monitoring sites (Section 2.1.2).

2.1.1 Model Performance Statistics for STN Sites

Both the Hickory (Table 2-3) and Hattie Avenue (Table 2-4) STN sites show similar statistical trends for the components of $PM_{2.5}$. The mean fractional bias values presented in the tables suggest that all the components, except ammonia, are under predicted at each of the sites. This leads to an overall under-prediction of total $PM_{2.5}$ at both sites for the year. The mean fractional bias for ammonia indicates only a very slight over prediction at both sites; however the mean fractional error values suggest this number is the result of balance between over and under prediction across the year. Normalized bias and error produces more encouraging model performance statistics, as bias and error values decrease. We also see nitrates shift from being under predicted to being over predicted. Overall, model performance statistics, while not perfect, are reasonable for the components of $PM_{2.5}$.

2.1.2 Model Performance Statistics for the FRM Sites

The tables for the FRM model performance statistics are broken out by month, which show that there is a trend for total $PM_{2.5}$ to start off as slightly over predicted, then shift to slightly under predicted in the spring. Negative bias values peak in the summer months, before a trend back toward positive bias values by October. This trend is seen in both the mean fractional bias and the normalized mean fractional bias in the collective statistics for the all the FRM sites in the VISTAS domain, as well as the 3 FRM sites in the North Carolina $PM_{2.5}$ nonattainment areas. The model performance statistics tables can be found in Table 2-5 through Table 2-8 starting on page 44.

Table 2-3 Model Performance Statistics for the Hickory (Catawba County) STN Monitoring site (37-035-0004)

37-035-0004		Pollutant					
Statistical Measure	Abbrev.	SO4	NO3	OC	NH4	EC	PM25
Mean Fractionalized Bias (Fractional Bias)	MFB	-22.6710	-45.6240	-45.9420	0.0470	-38.6880	-24.0680
Mean Fractional Error	MFE	36.5230	95.2820	50.8140	33.8510	47.6100	36.2260
Accuracy of Paired Peak	A_p	-14.3780	3.6960	-32.9480	11.8600	-26.0520	-15.7440
Normalized Mean Bias	NMB	-14.3260	10.0740	-32.7020	-3.0160	-34.4990	-20.9890
Normalized Mean Error	NME	31.7830	72.3460	39.7650	32.3020	39.7050	30.4840
Mean Biased	MB	-14.3780	3.6960	-32.9480	11.8600	-26.0520	-15.7440
Mean Absolute Gross Error	MAGE	1.5430	0.8410	2.1080	0.5290	0.2870	4.9020
Root Mean Square Error	RMSE	2.1480	1.1900	2.5920	0.7480	0.3870	6.4110
Coefficient of Determination	R^2	0.6570	0.3660	0.3890	0.4180	0.4300	0.4610
Number of Points used	n	50	50	50	50	50	49

Table 2-4 Model Performance Statistics for the Hattie Avenue (Forsyth County) STN Monitoring site (37-067-0022)

37-067-0022		Pollutant					
Statistical Measure	Abbrev.	SO4	NO3	OC	NH4	EC	PM25
Mean Fractionalized Bias (Fractional Bias)	MFB	-14.1840	-35.3550	-48.2610	0.6820	-3.8770	-19.2570
Mean Fractional Error	MFE	31.7940	76.7290	53.0330	29.6960	30.4620	26.5040
Accuracy of Paired Peak	A_p	-6.9750	-1.8550	-34.4750	10.0430	7.1710	-14.1970
Normalized Mean Bias	NMB	-10.8610	15.6900	-32.5150	-4.8180	-2.1740	-17.7670
Normalized Mean Error	NME	25.7980	66.8970	38.3890	29.3730	30.6660	24.2430
Mean Normalized Bias	MNB						
Mean Biased	MB	-6.9750	-1.8550	-34.4750	10.0430	7.1710	-14.1970
Mean Absolute Gross Error	MAGE	1.3160	0.6870	1.9260	0.5020	0.1660	3.8390
Root Mean Square Error	RMSE	1.7440	1.0030	2.1940	0.7330	0.2550	5.4080
Coefficient of Determination	R^2	0.7450	0.5130	0.5840	0.4730	0.3000	0.6080
Number of Points used	n	54	54	54	54	54	54

Table 2-5 Model Performance Statistics for the FRM Monitoring Sites within the VISTAS 12km Domain.

All VISTAS FRM Sites		January	February	March	April	May	June	July	August	September	October	November	December
Statistical Measure	Abbrev.	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25
Mean Fractionalized Bias (Fractional Bias)	MFB	3.87179	-5.00249	-11.5124	-18.60138	-32.29198	-34.01488	-37.5508	-17.17965	-17.81556	12.57825	9.42611	-1.15629
Mean Fractional Error	MFE	32.51936	29.65687	32.76715	30.39688	38.81785	38.97467	45.33094	32.1642	35.16821	32.31407	32.17262	36.62851
Accuracy of Paired Peak	A_p	-0.25745	0.16006	-0.13917	-0.10491	0.87539	-0.22932	-0.4327	-0.06662	-0.20342	0.01004	-0.11037	-0.41067
Normalized Mean Bias	NMB	7.79789	-3.21695	-5.75633	-13.48394	-24.85635	-26.42513	-29.84115	-15.11038	-10.97409	19.69164	16.98349	0.68683
Normalized Mean Error	NME	33.0415	28.14266	29.60649	26.23081	30.89238	30.72728	36.10852	26.68481	26.80111	35.01287	34.78851	34.8323
Mean Normalized Bias	MNB	16.9901	4.42162	4.39775	-10.90071	-20.80268	-24.63417	-21.6425	-9.69121	-7.93415	25.43418	19.19293	10.52794
Mean Normalized Gross Error	MNGE	39.72529	31.85955	38.45982	28.23872	33.76054	31.89422	40.49355	29.04517	31.4553	41.14046	37.26213	39.56016
Mean Biased	MB	0.91415	-0.36289	-0.63763	-1.48697	-3.24962	-3.87066	-5.48763	-2.34163	-1.56093	2.24939	1.90059	0.07785
Mean Absolute Gross Error	MAGE	3.87349	3.17467	3.2795	2.89266	4.03875	4.50082	6.64017	4.13531	3.81213	3.99954	3.89312	3.94814
Root Mean Square Error	RMSE	5.21913	4.38938	4.45683	3.74948	5.49243	6.04268	8.86405	5.606	5.25377	5.47428	5.32453	5.26488
Coefficient of Determination	R^2	0.33012	0.45595	0.42787	0.43043	0.45697	0.67614	0.50262	0.65574	0.6596	0.54024	0.45193	0.41422
Bias Factor	BF	1.16947	1.04422	1.04398	0.89099	0.79169	0.75366	0.78358	0.90275	0.92032	1.25434	1.19193	1.10528
Number of Points used	n	2740	2707	2789	2778	2758	2710	2925	2709	2685	2788	2699	2661

Table 2-6 Model Performance Statistics for the Hickory (Catawba County) FRM Monitoring site (37-035-0004)

FRM: 37-035-0004		January	February	March	April	May	June	July	August	September	October	November	December
Statistical Measure	Abbrev.	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25
Mean Fractionalized Bias (Fractional Bias)	MFB	10.28557	-24.51066	-25.30801	-15.82477	-17.78711	-34.29187	-45.3679	-15.78621	-17.24198	25.14946	-10.92016	3.08583
Mean Fractional Error	MFE	19.10233	25.95861	32.14226	20.70477	19.45451	34.29187	45.3679	26.17538	31.9897	27.45942	24.03837	25.17245
Accuracy of Paired Peak	A_p	0.04317	-0.09879	-0.1763	-0.00499	-0.19553	-0.42383	-0.36958	-0.14559	-0.01765	0.27824	-0.04994	-0.09921
Normalized Mean Bias	NMB	5.40073	-18.72328	-23.38787	-13.18737	-16.96025	-32.53042	-38.38965	-17.807	-16.67013	27.92665	-9.00896	3.654
Normalized Mean Error	NME	15.72311	19.9611	28.46699	18.91983	18.18236	32.53042	38.38965	22.99225	25.84471	30.13704	19.00118	20.12219
Mean Normalized Bias	MNB	14.27531	-20.74026	-18.62383	-13.1912	-15.13653	-28.18097	-35.00442	-11.03096	-10.96486	33.69843	-6.76357	9.81511
Mean Normalized Gross Error	MNGE	22.16478	22.23697	25.8631	18.57948	16.84285	28.18097	35.00442	25.06525	28.3495	35.92392	21.56552	27.7277
Mean Biased	MB	0.74868	-2.3092	-3.17607	-1.43479	-2.73399	-5.24824	-9.32171	-3.6629	-3.03063	3.21715	-1.09279	0.4721
Mean Absolute Gross Error	MAGE	2.17962	2.46187	3.86582	2.05848	2.931	5.24824	9.32171	4.72951	4.69857	3.47179	2.30484	2.59979
Root Mean Square Error	RMSE	2.72987	2.65671	5.5412	2.44399	4.07019	7.01467	10.84356	5.52071	5.84947	4.46585	2.82757	3.69954
Coefficient of Determination	R^2	0.78737	0.92657	0.44631	0.71435	0.6854	0.80312	0.30351	0.83091	0.41104	0.72664	0.69705	0.79278
Bias Factor	BF	1.14275	0.7926	0.81376	0.86809	0.84863	0.71819	0.64996	0.88969	0.89035	1.33698	0.93236	1.09815
Number of Points used	n	8	9	10	10	10	9	11	10	10	10	10	10

Table 2-7 Model Performance Statistics for the Lexington (Davidson County) FRM Monitoring Site (37-057-0002)

FRM: 37-057-0002		January	February	March	April	May	June	July	August	September	October	November	December
Statistical Measure	Abbrev.	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25
Mean Fractionalized Bias (Fractional Bias)	MFB	4.63564	-18.0252	-9.9917	-9.35937	-26.63161	-42.23228	-40.24946	-29.80245	-10.85414	12.6755	-12.31272	-19.06711
Mean Fractional Error	MFE	20.83672	21.63888	55.88976	14.2902	29.48054	42.23228	41.83626	29.80245	27.62713	19.98572	30.13473	45.82583
Accuracy of Paired Peak	A_p	0.17986	-0.11705	0.15716	0.02694	-0.03313	-0.2793	-0.35558	-0.24467	-0.0794	0.21105	0.23135	-0.32285
Normalized Mean Bias	NMB	8.43928	-14.79351	-18.88724	-7.37745	-20.72336	-35.10524	-35.79996	-26.31458	-13.34432	14.89208	-0.13561	-18.53893
Normalized Mean Error	NME	20.27853	17.44602	35.13404	13.43276	23.21198	35.10524	36.51237	26.31458	24.45658	19.64973	23.4158	37.13708
Mean Normalized Bias	MNB	8.04976	-14.5975	292.0322	-7.82412	-21.11925	-33.73975	-31.93295	-24.98397	-6.21985	16.7945	-4.45061	-3.56587
Mean Normalized Gross Error	MNGE	21.48891	18.37526	337.8194	13.02814	24.18666	33.73975	33.58529	24.98397	26.12053	23.59218	24.17365	45.82681
Mean Biased	MB	1.27602	-2.10068	-2.61693	-0.82381	-3.37169	-5.62386	-8.13733	-5.03924	-2.01666	1.96129	-0.01946	-2.76045
Mean Absolute Gross Error	MAGE	3.06611	2.47733	4.86802	1.49999	3.77659	5.62386	8.29926	5.03924	3.696	2.58787	3.36017	5.52971
Root Mean Square Error	RMSE	3.81138	2.96724	6.62947	1.98443	4.78826	6.79069	9.37234	6.2034	4.26848	2.98761	4.32064	6.82838
Coefficient of Determination	R^2	0.7756	0.78917	0.40266	0.66008	0.71797	0.78242	0.61825	0.83332	0.38543	0.92932	0.81825	0.66368
Bias Factor	BF	1.0805	0.85402	3.92032	0.92176	0.78881	0.6626	0.68067	0.75016	0.9378	1.16795	0.95549	0.96434
Number of Points used	n	10	9	9	6	10	10	10	10	8	10	8	10

Table 2-8 Model Performance Statistics for the Mendenhall (Guilford County) FRM Monitoring Site (37-081-0013)

FRM: 37-081-0013		January	February	March	April	May	June	July	August	September	October	November	December
Statistical Measure	Abbrev.	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25	PM25
Mean Fractionalized Bias (Fractional Bias)	MFB	19.1454	-1.12418	-7.666	-24.20169	-24.93979	-32.97002	-36.445	-21.66835	-4.68628	16.90341	5.42927	4.05433
Mean Fractional Error	MFE	36.67853	18.49358	28.45474	28.04378	30.58534	33.73738	42.21012	29.33581	30.1668	28.51508	27.07489	35.1864
Accuracy of Paired Peak	A_p	0.09011	0.12577	0.14355	-0.09023	-0.17322	-0.24689	-0.20378	-0.39376	-0.18011	0.36109	0.49883	-0.48266
Normalized Mean Bias	NMB	25.46292	0.66019	-0.45107	-19.24879	-17.68747	-29.28373	-34.12104	-25.16558	-7.95848	26.58833	15.66082	-2.36134
Normalized Mean Error	NME	40.13498	18.97885	26.0331	23.6201	23.88124	29.87053	36.78232	28.89808	25.28658	34.81678	30.02136	36.26746
Mean Normalized Bias	MNB	31.81679	1.53086	-1.45199	-18.83038	-18.81816	-27.13435	-27.45204	-16.63162	3.12702	24.03073	10.56236	13.36104
Mean Normalized Gross Error	MNGE	45.70157	18.22748	27.00923	22.93126	25.16462	27.92454	34.14149	25.61538	32.50039	33.82903	28.2018	38.90338
Mean Biased	MB	3.04737	0.07394	-0.05381	-2.1033	-2.26072	-4.50481	-7.70365	-4.36443	-1.14101	3.0182	1.81091	-0.27164
Mean Absolute Gross Error	MAGE	4.8033	2.12563	3.1055	2.58095	3.05238	4.59508	8.3045	5.01175	3.62535	3.95227	3.47147	4.17215
Root Mean Square Error	RMSE	5.96173	2.90943	4.00003	3.35457	3.81557	5.55912	10.02389	6.91199	4.19206	5.2867	4.5967	6.08506
Coefficient of Determination	R^2	0.30967	0.65173	0.62773	0.34213	0.56949	0.7936	0.60927	0.72854	0.59994	0.80392	0.83195	0.50524
Bias Factor	BF	1.31817	1.01531	0.98548	0.8117	0.81182	0.72866	0.72548	0.83368	1.03127	1.24031	1.10562	1.13361
Number of Points used	n	28	28	31	26	27	30	31	28	27	31	30	26

2.2 Statistical Plots

An additional way to evaluate model performance statistics is to visualize performance via "soccer plots" and "bugle plots". The soccer plot is so named because the dotted lines resemble a soccer goal. The soccer plot is useful as both bias and error are shown on a single plot. As bias and error approach zero, the points are plotted closer to or within the "goal", represented here by the dashed boxes.

The "bugle plot", named for the shape formed by the criteria and goal lines. The bugle plots are shaped as such because the goal and criteria lines are adjusted based on the average concentration of the observed species. As the average concentration becomes smaller, the criteria and goal lines become larger to adjust for the model's poor ability to predict at low concentrations.

The analysis of "bugle plots" demonstrated that greater emphasis should be placed on performance of those components with the greatest contribution to $PM_{2.5}$ mass (e.g. sulfate and organic carbon) and that greater bias and error could be accepted for components with smaller contributions to total $PM_{2.5}$ mass (e.g. elemental carbon, nitrate, and soil). The "soccer plots" and "bugle plots" have been included as model performance evaluation displays in EPA's modeling guidance for Ozone, $PM_{2.5}$, and Regional Haze. (2006).

The soccer and bugle plots for the North Carolina STN and FRM monitors follow. Plots have been developed for the average monthly concentrations of $PM_{2.5}$ and its component species at the STN sites for the all the sites within the VISTAS 12km, for all North Carolina STN sites, and individually for the Hickory and Hattie Avenue STN sites (Figures 2-1 through 2-16). FRM based soccer and bugle plots have been constructed for the monthly average total $PM_{2.5}$ for the all the VISTAS FRM sites collectively, for all North Carolina FRM sites collectively, and individually for the 3 FRM sites within the nonattainment areas (Figures 2-17 through 2-32).

From the STN plots plot one can see the general tendency for the model to have some difficulty in predicting nitrates, as the monthly average values tend to fall outside the criteria goals for performance in the soccer plots. Because nitrates are generally found in low concentration across the southeast, the bugle plots are more encouraging with nitrates largely falling within criteria is not goals levels of model performance. There is some variation of individual model performance at the individual STN sites within North Carolina (e.g. elemental carbon performance at Hickory), however model performance is still generally with in acceptable or criteria levels. This is further supported by the FRM soccer and scatter plots, which generally show total $PM_{2.5}$ model performance largely falls within the "goal" modeling performance range. A more detailed summary of model performance for each site level is presented prior to the presented soccer and bugle plots in the following sections

2.2.1 STN Statistical Plots

2.2.1.1 All VISTAS STN Monitoring Sites

The soccer plots for monthly average component performance for all the VISTAS sites shows generally good model performance for most species of $PM_{2.5}$ and total $PM_{2.5}$. The exception is the prediction of nitrate values, which most values fall outside the criteria goal (Figure 2-1).

There are a few months that fall on the criteria level goal, which is better seen in the zoomed view presented in Figure 2-2. However, when the very low concentration of nitrates is taken into consideration, as presented in the bugle plots (Figures 2-3 and 2-4), nitrate performance largely falls within the criteria and goal model performance lines. One can still note a general tendency for under prediction in nitrates, and other species in Figure 2-3, which leads to a slight under prediction in total reconstructed $PM_{2.5}$.

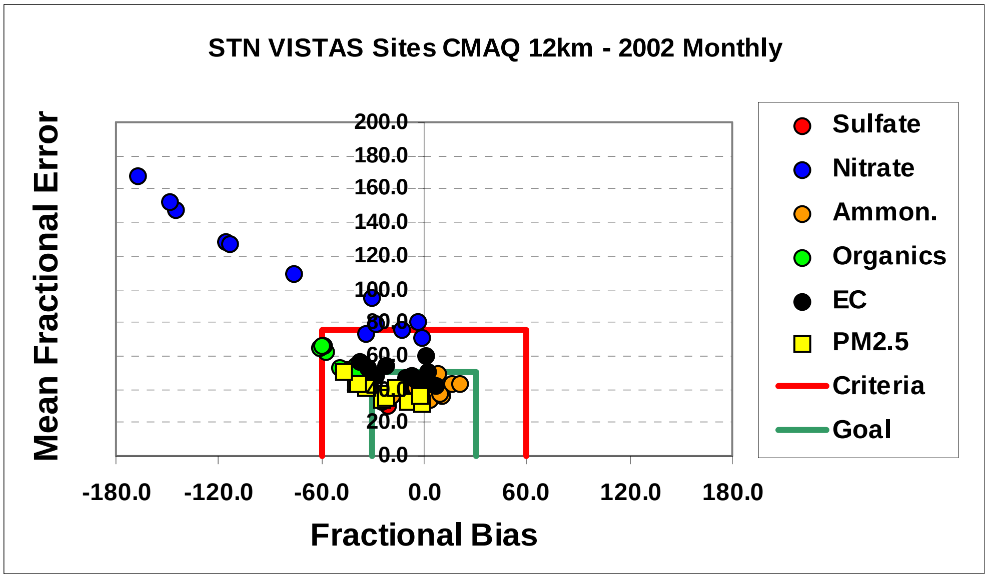


Figure 2-1: Soccer plot depicting both the mean fractional error and fractional bias for component concentration for all VISTAS STN monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

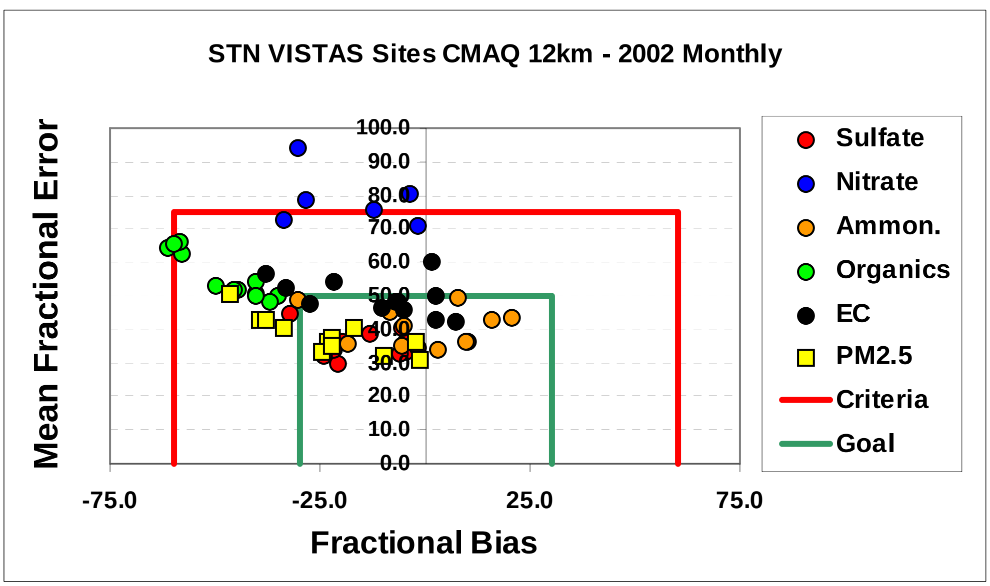


Figure 2-2: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for all VISTAS STN monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

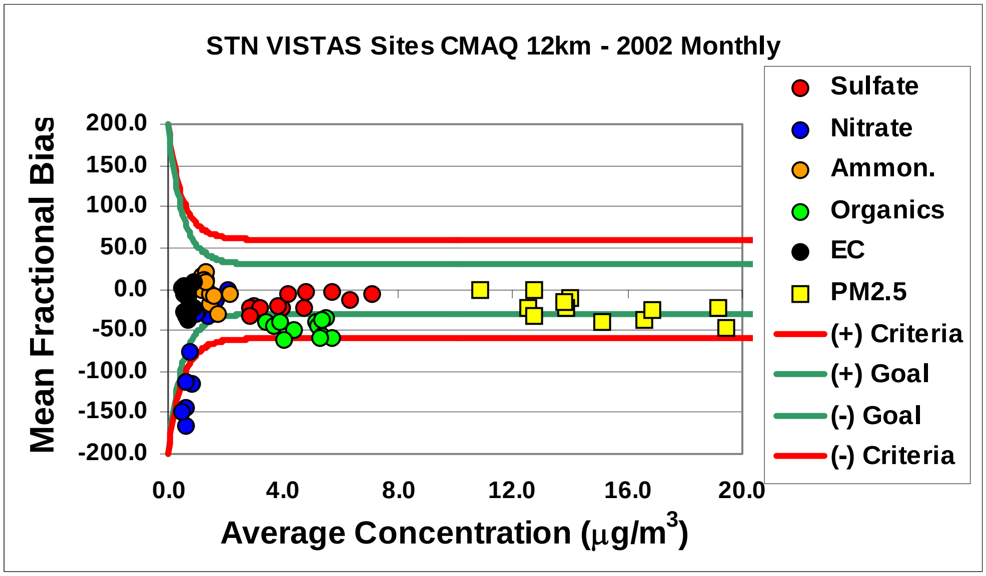


Figure 2-3: Bugle plot of the mean fraction bias for particulate matter and its component concentrations for all VISTAS STN monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

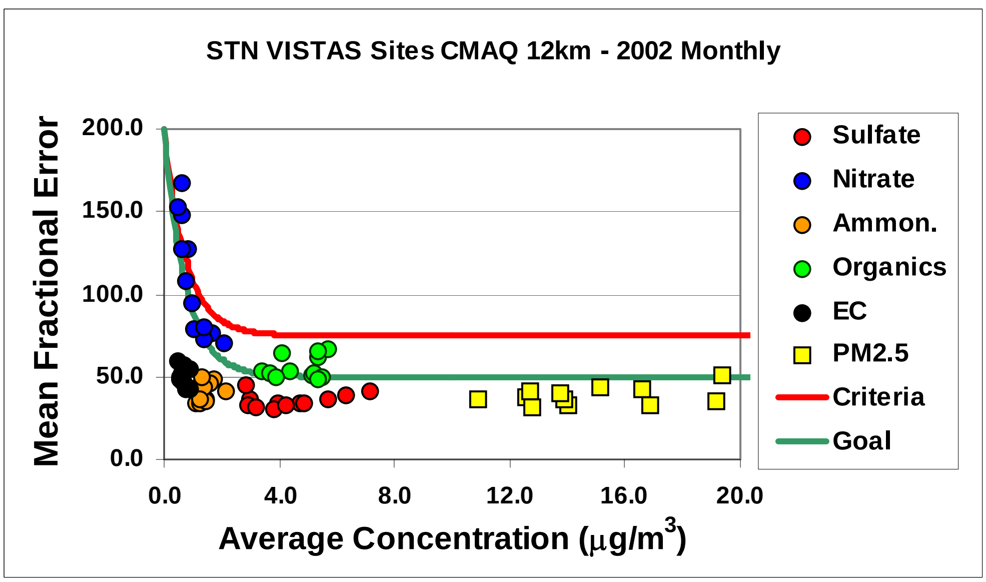


Figure 2-4: Bugle plot of mean fraction error for particulate matter and its component species for all VISTAS STN monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.1.2 All North Carolina STN Monitoring Sites

The North Carolina STN sites correlate well to what was seen collectively across the VISTAS STN sites, as nitrate prediction under performs as seen in the soccer plots (Figure 2-5). However, wee see again that when performance is weighted by concentration, as in the bugle plots, nitrate performance again falls within criteria modeling performance goals. A slight deviation from the

VISTAS level figures is a slight under prediction in organic carbon values. Four months fall just outside criteria level model performance goals in the soccer plots, and continue to just fall outside criteria goals for mean fractional bias when concentration is considered (Figure 2-7). It is not surprising that model performance does not improve for organic carbon when concentration is taken into consideration, as organic carbon is generally a larger portion of total $PM_{2.5}$ mass in North Carolina. Otherwise, the model performs well in for STN sites in North Carolina.

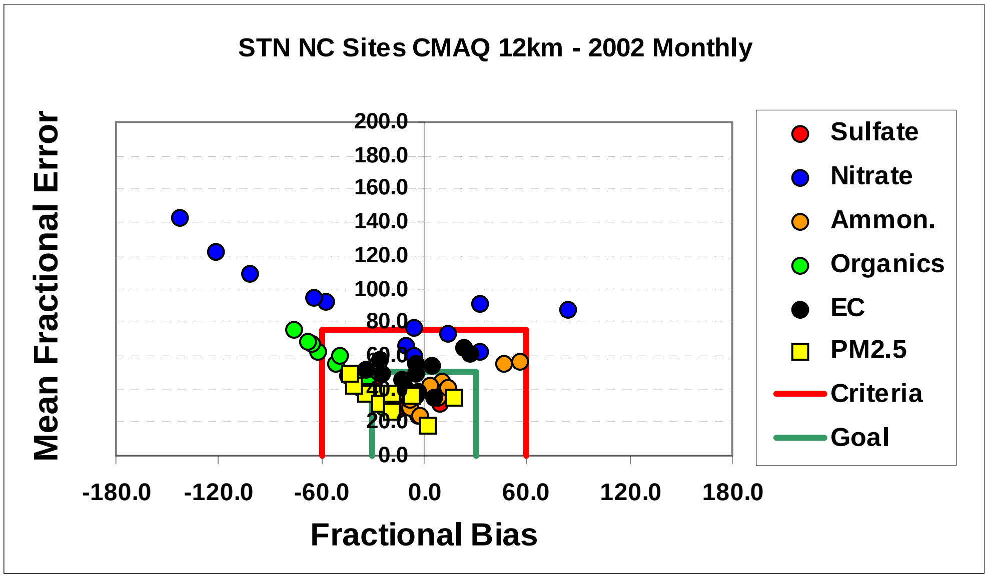


Figure 2-5: Soccer plot depicting both the mean fractional error and fractional bias for component concentration for all North Carolina STN monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

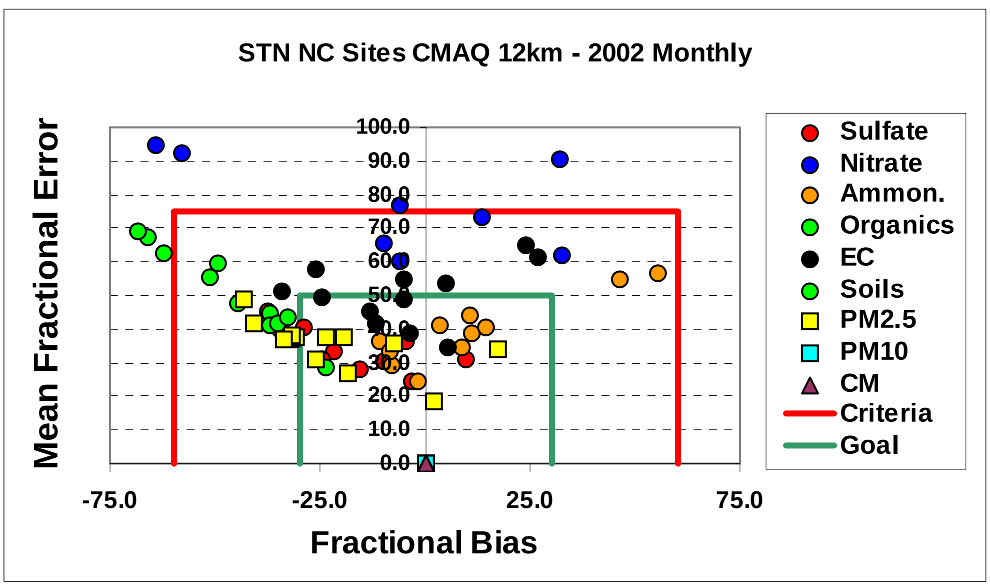


Figure 2-6: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for all North Carolina STN monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

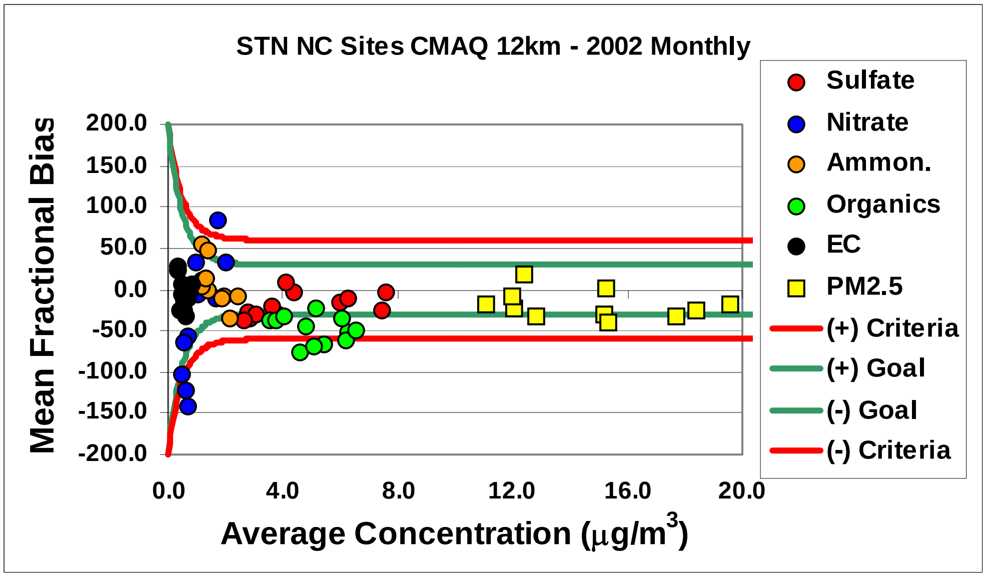


Figure 2-7: Bugle plot of the mean fraction bias for particulate matter and its component concentrations for all North Carolina STN monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

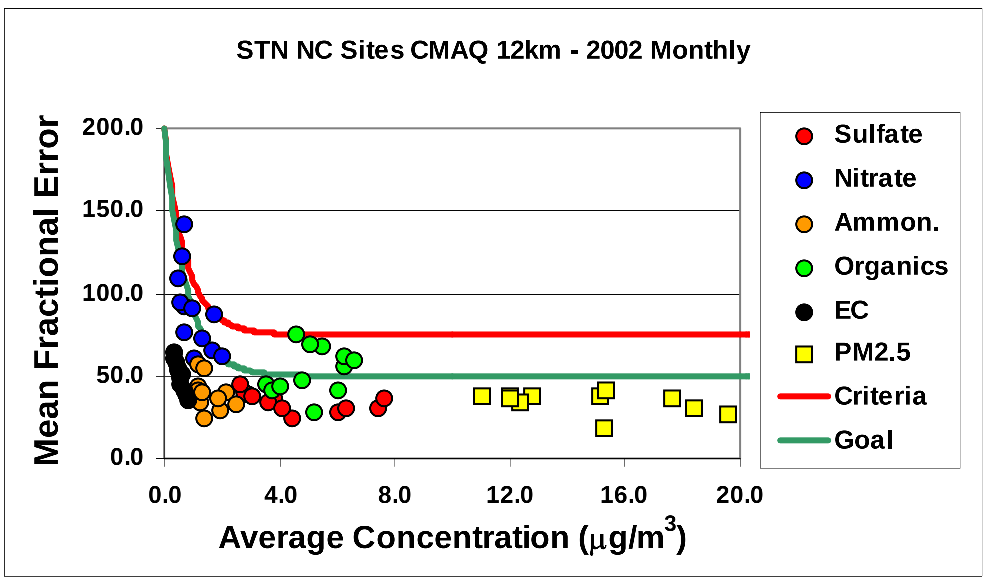


Figure 2-8: Bugle plot of mean fraction error for particulate matter and its component species for all North Carolina STN monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.1.3 Hickory STN Monitoring Site (37-035-004)

The soccer plots of monthly concentrations for the Hickory STN site again show that values for, nitrate generally fall outside of criteria performance thresholds. For Hickory, we also see some month for elemental carbon fall outside of criteria performance thresholds, as well as a couple of months of organic carbon values. Other pollutants generally fall within criteria thresholds, with a portion of months within goal thresholds. When concentration is factored into performance criteria, nitrate performance improves with respect to mean fractional bias and error. We do see organic carbon fall outside of criteria goals for mean fractional bias, just as with the North Carolina total STN plots.

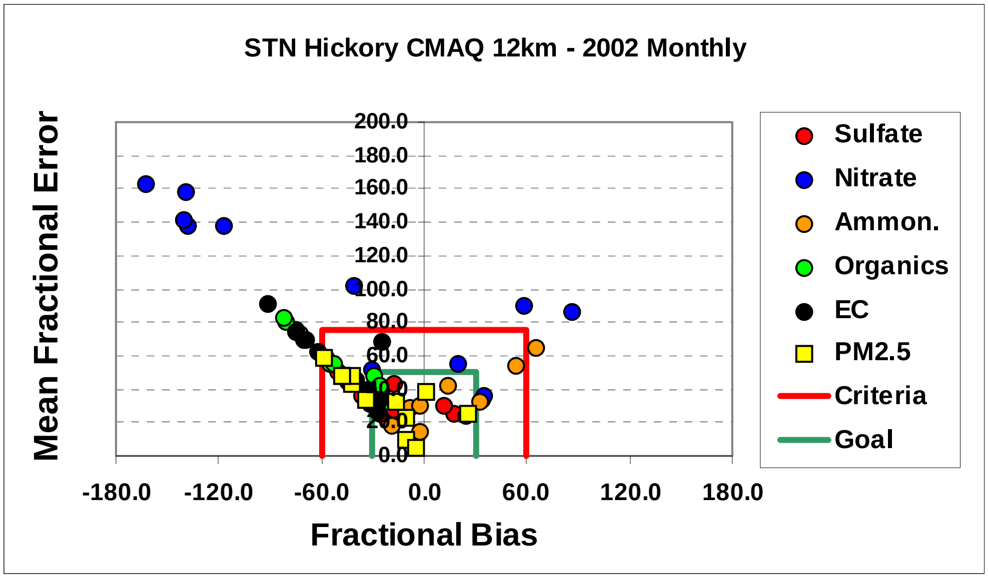


Figure 2-9: Soccer plot depicting both the mean fractional error and fractional bias for component concentration for the Hickory (37-035-0004) STN monitoring site. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

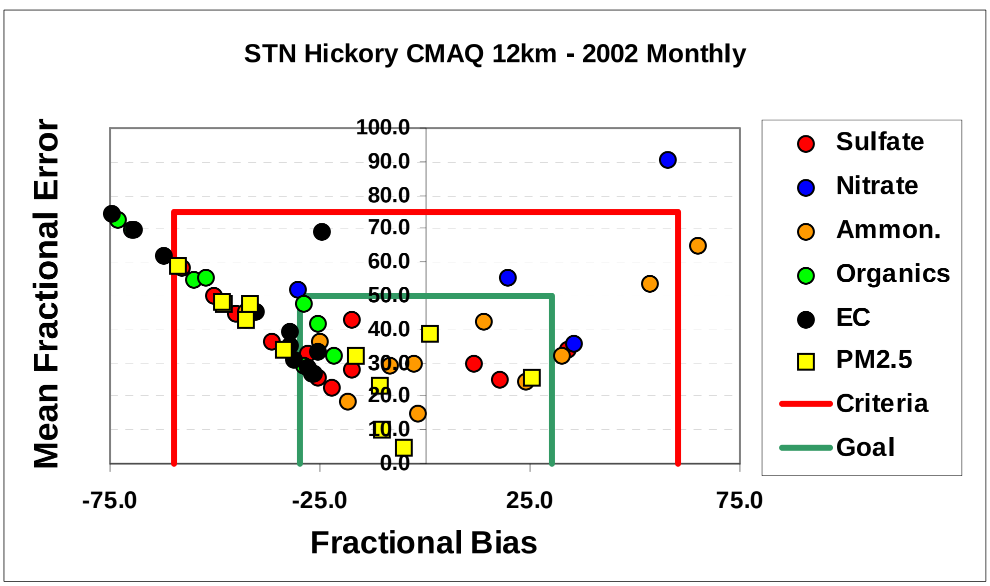


Figure 2-10: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for the Hickory (37-035-0004) STN monitoring site. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

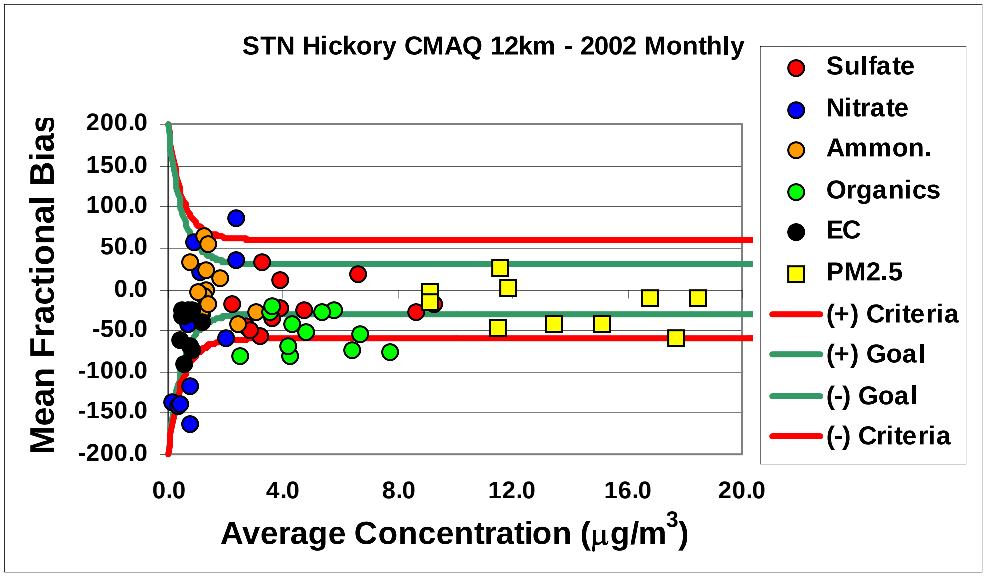


Figure 2-11: Bugle plot of the mean fraction bias for particulate matter and its component species concentrations for the Hickory (37-035-0004) STN monitoring site. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

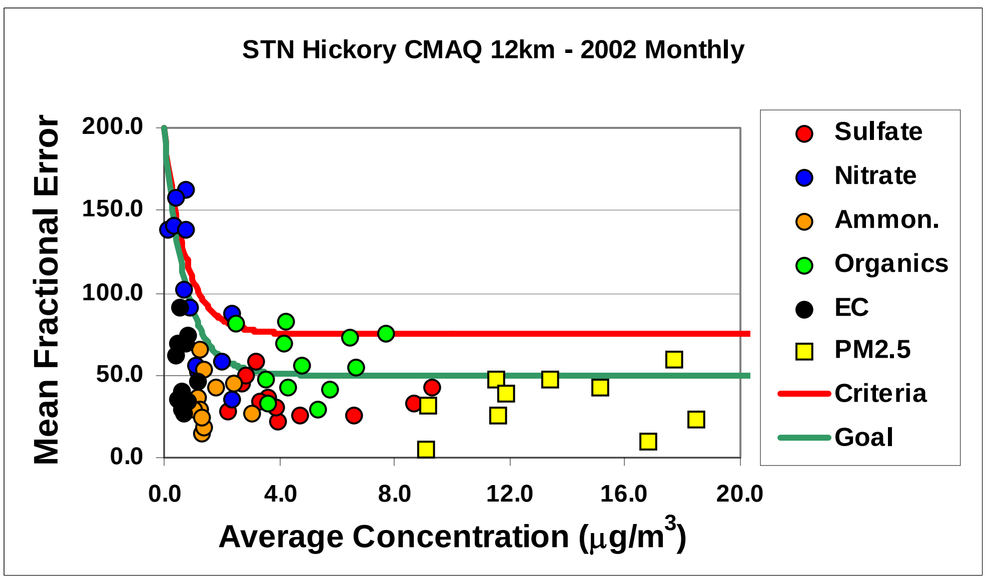


Figure 2-12: Bugle plot of mean fraction error for particulate matter and its component species for the Hickory (37-035-0004) STN monitoring site. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.1.4 Hattie Avenue STN Monitoring Site (37-07-000)

Monthly average component concentration performance is similar to the Hickory STN site. Nitrate generally falls outside of suggested criteria model performance goals. The main difference is seen with organic and elemental carbon performance. More monthly values of organic carbon fall outside of criteria levels at Hattie Avenue than at Hickory, with more monthly values of elemental carbon falling within criteria values. When concentration is taken into consideration, all elemental carbon and nitrate values fall with in criteria goals (Figure 2-15 and 2-16). Under prediction of organic carbon values still persist, but this is in line with the overall model performance seen across North Carolina, and overall $PM_{2.5}$ performance is within criteria level, if not within the goal level thresholds.

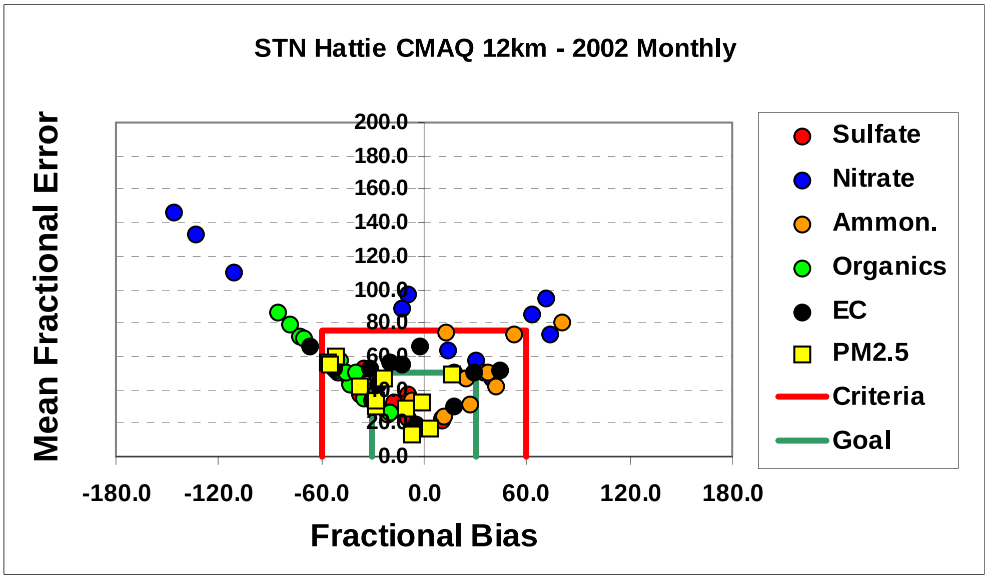


Figure 2-13: Soccer plot depicting both the mean fractional error and fractional bias for component concentration for the Hattie Avenue (37-037-0022) STN monitoring site. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

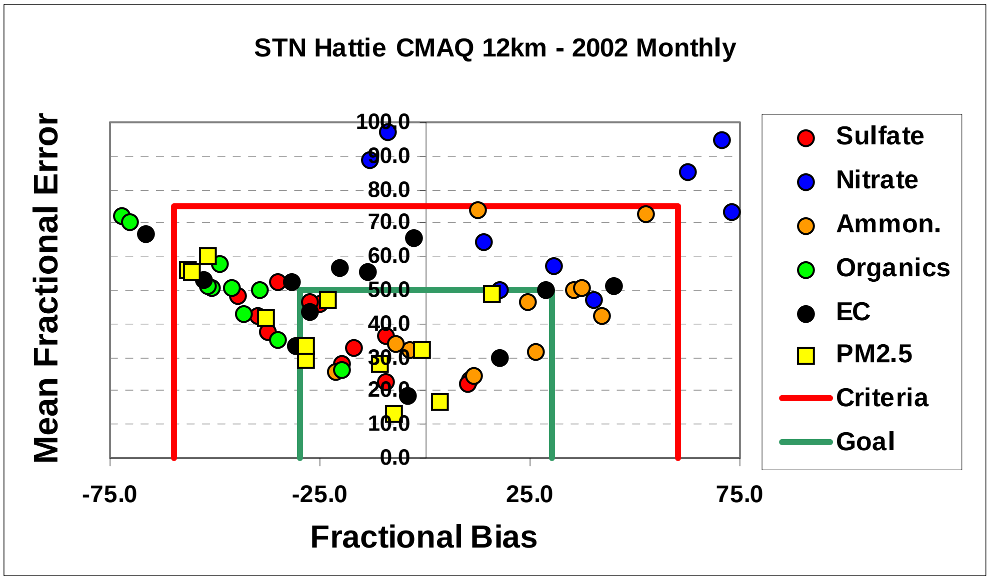


Figure 2-14: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for the Hattie Avenue (37-037-0022) STN monitoring site. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

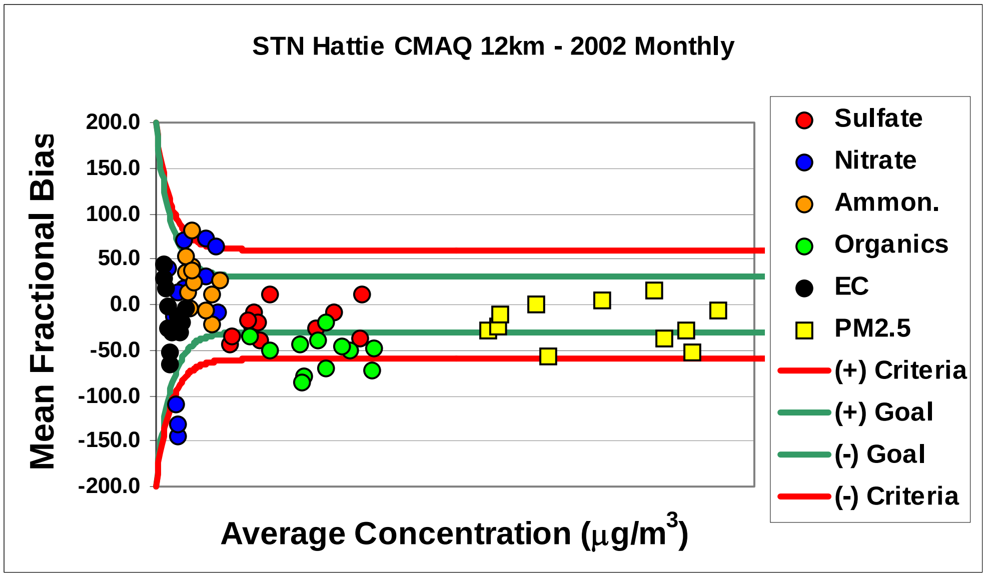


Figure 2-15: Bugle plot of the mean fraction bias for particulate matter and its component species concentrations for the Hattie Avenue (37-037-0022) STN monitoring site. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

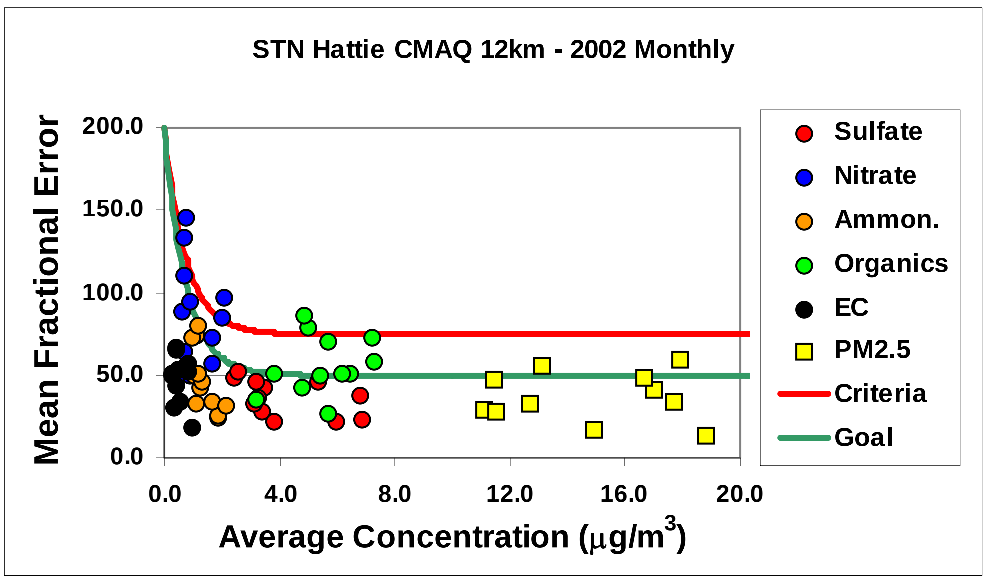


Figure 2-16: Bugle plot of mean fraction error for particulate matter and its component species for the Hattie Avenue (37-037-0022) STN monitoring site. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.2 FRM Monitoring Sites

2.2.2.1 All VISTAS FRM Monitoring Sites

Monthly total $PM_{2.5}$ concentration performance at All the VISTAS FRM monitors largely falls within goal level thresholds, with only two months falling just outside goal level performance.

Figure 2-19 suggests a negative bias in $PM_{2.5}$ prediction for most of the year. However, Figure 2-20 shows mean fractional error values remain within goal levels across the year.

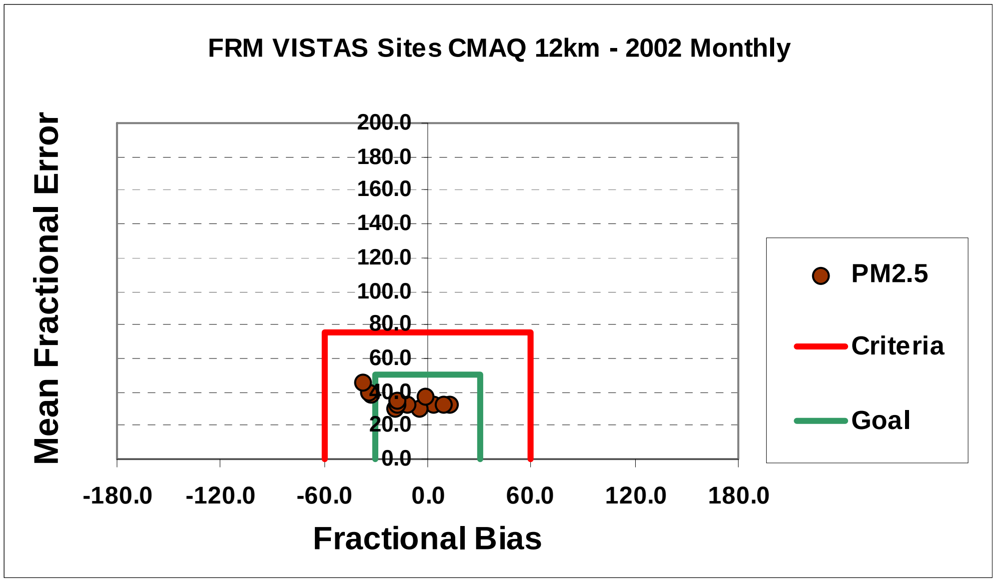


Figure 2-17: Soccer plot depicting both the mean fractional error and fractional bias for component concentration for all the VISTAS FRM Monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

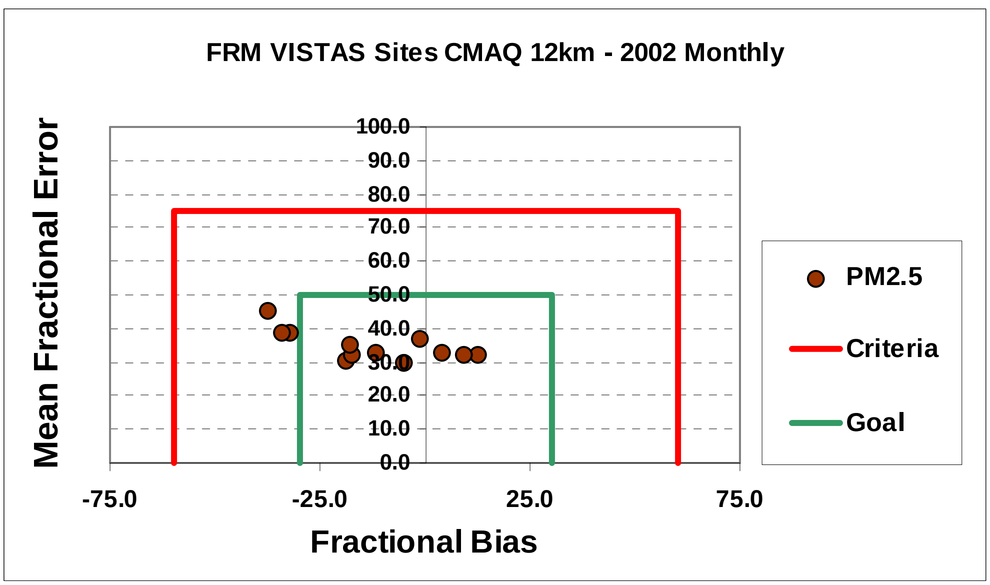


Figure 2-18: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for all the VISTAS FRM Monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

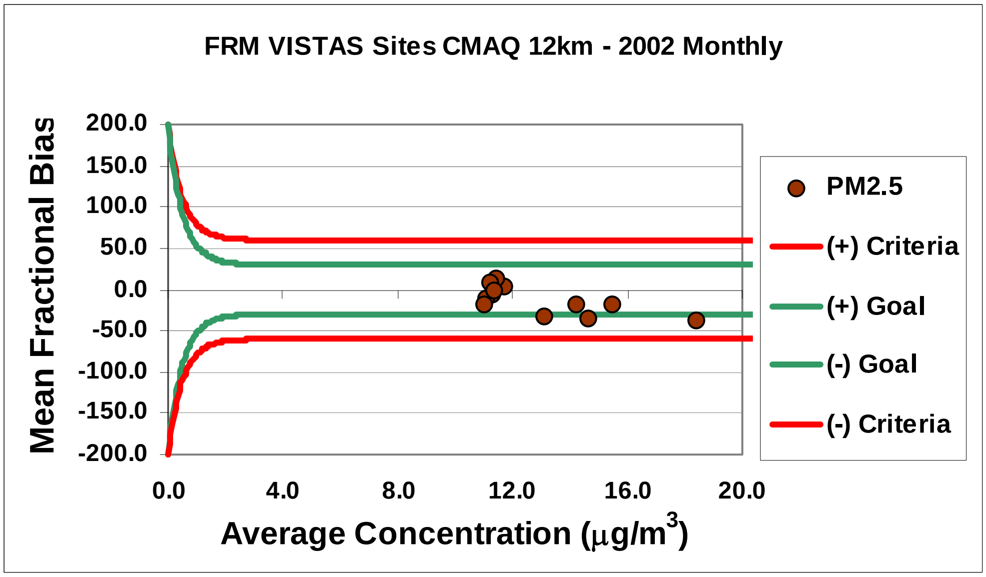


Figure 2-19: Bugle plot of the mean fraction bias for particulate matter and its component species concentrations for all the VISTAS FRM Monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

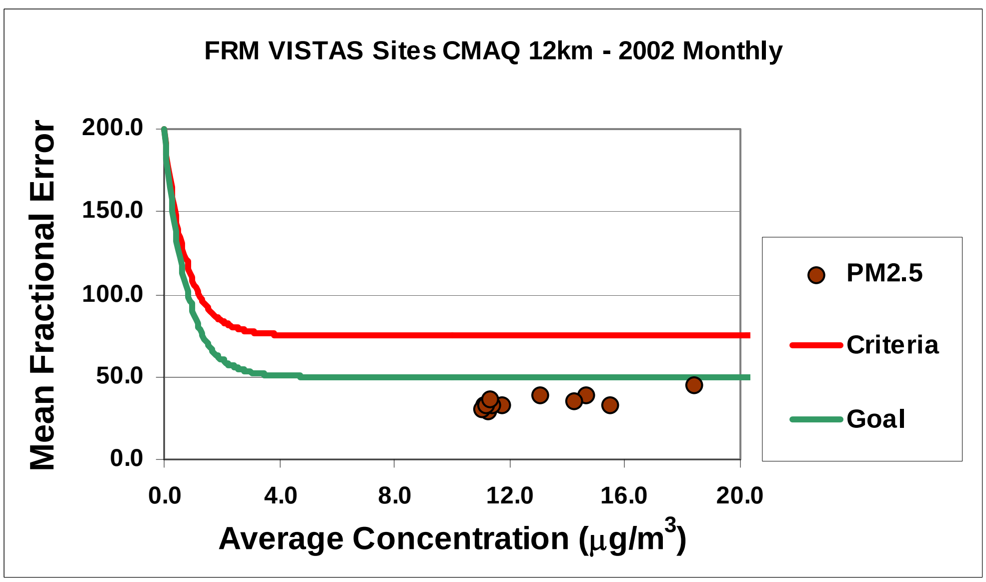


Figure 2-20: Bugle plot of mean fraction error for particulate matter and its component species for all the VISTAS FRM Monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.2.2 All North Carolina FRM Monitoring Sites

Model performance for North Carolina FRM sites is very similar to that for the VISTAS sites collectively. Most months fall within the goal threshold, with only two month falling just outside due to a larger negative fractional bias. The under prediction, or large negative bias is reiterated in the mean fractional bias bugle plot (Figure 2-22). Again, mean fractional error remains well within goal model performance levels.

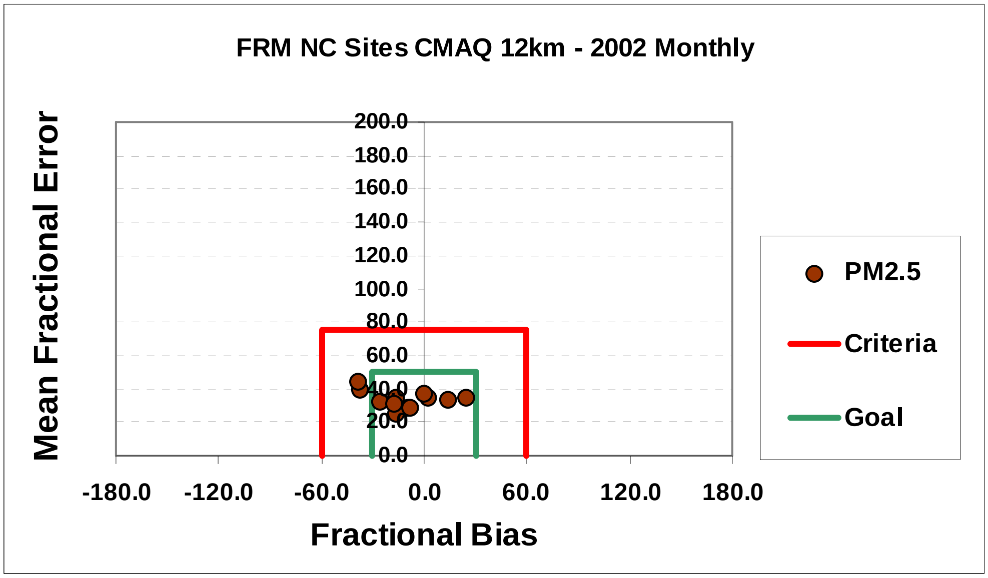


Figure 2-21: Soccer plot depicting both error and bias for the light extinction due to particulate matter and its component species for all the North Carolina FRM Monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red box) and modeling performance goals (green box).

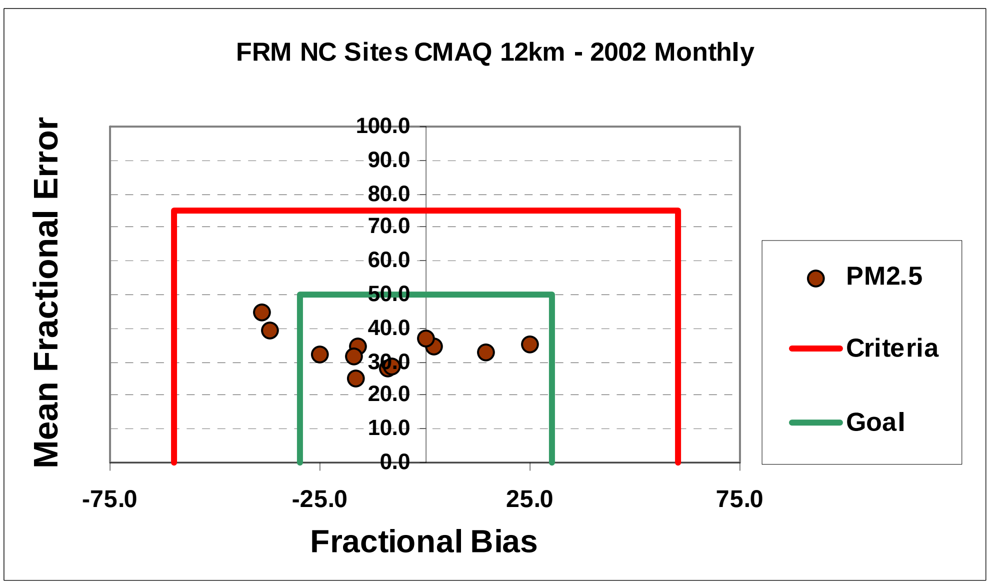


Figure 2-22: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for all the North Carolina FRM Monitoring sites. Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

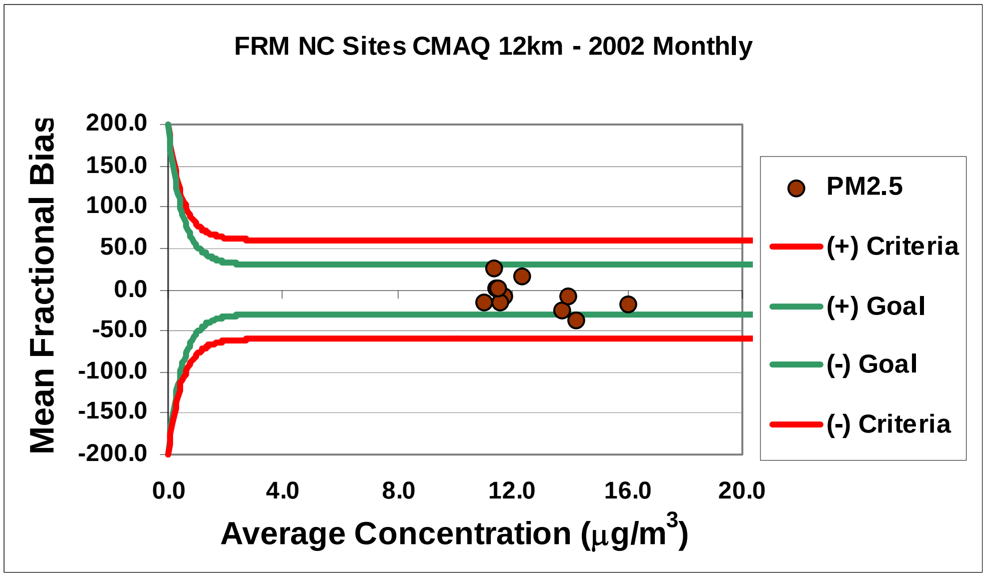


Figure 2-23: Bugle plot depicting the mean fractional bias for the light extinction due to particulate matter and its component species for all the North Carolina FRM Monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

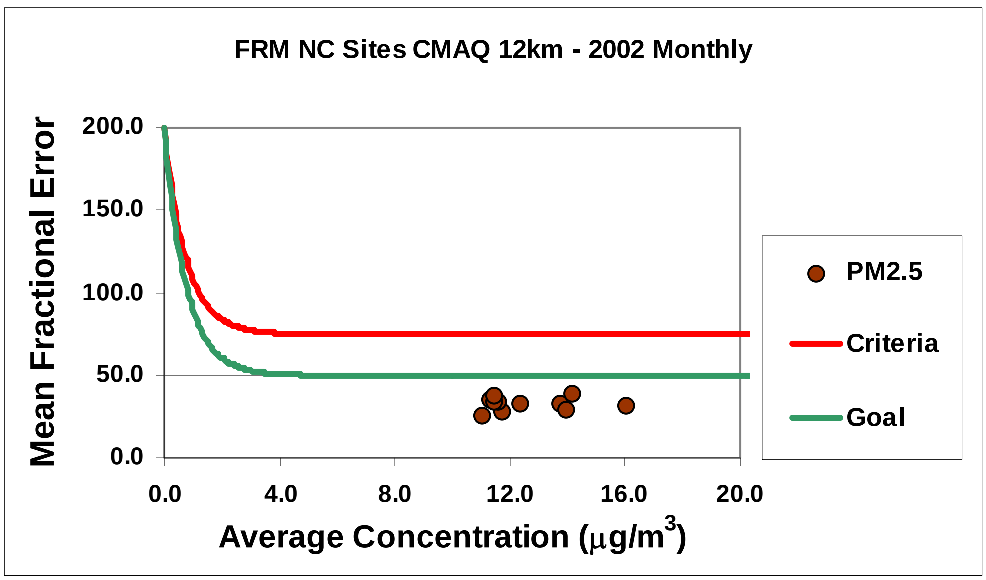


Figure 2-24: Bugle plot depicting the mean fractional error for the light extinction due to particulate matter and its component species for all the North Carolina FRM Monitoring sites. Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.2.3 Hickory FRM Monitoring Site (37-035-004)

Overall model performance at the Hickory FRM site follows model performance seen on average at all North Carolina sites. However, we see a slightly more pronounce negative bias trend than in the bugle plot (Figure 2-25) than seen across all North Carolina sites. Figure 2-26 shows a month with a higher mean fractional error level than seen previously, though it remained within goal performance levels.

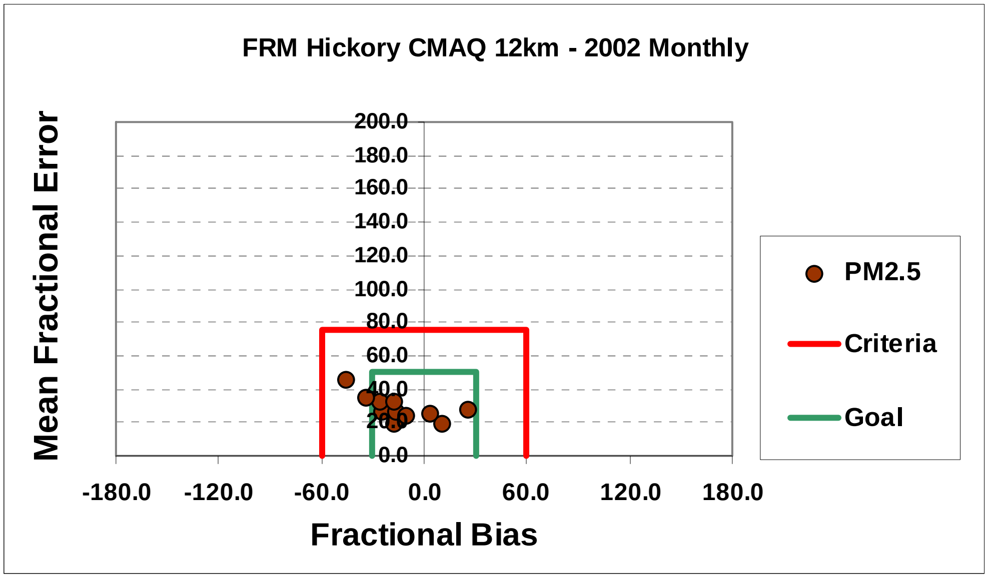


Figure 2-25: Soccer plot depicting both error and bias for the light extinction due to particulate matter and its component species for the Hickory FRM monitoring site (37-035-0004). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red box) and modeling performance goals (green box).

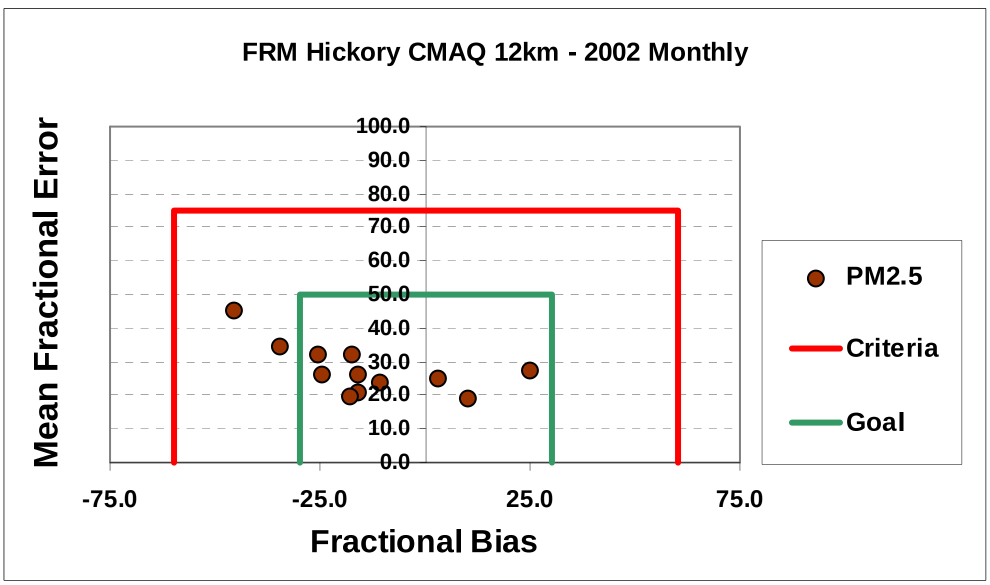


Figure 2-26: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for Hickory FRM monitoring site (37-035-0004). . Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

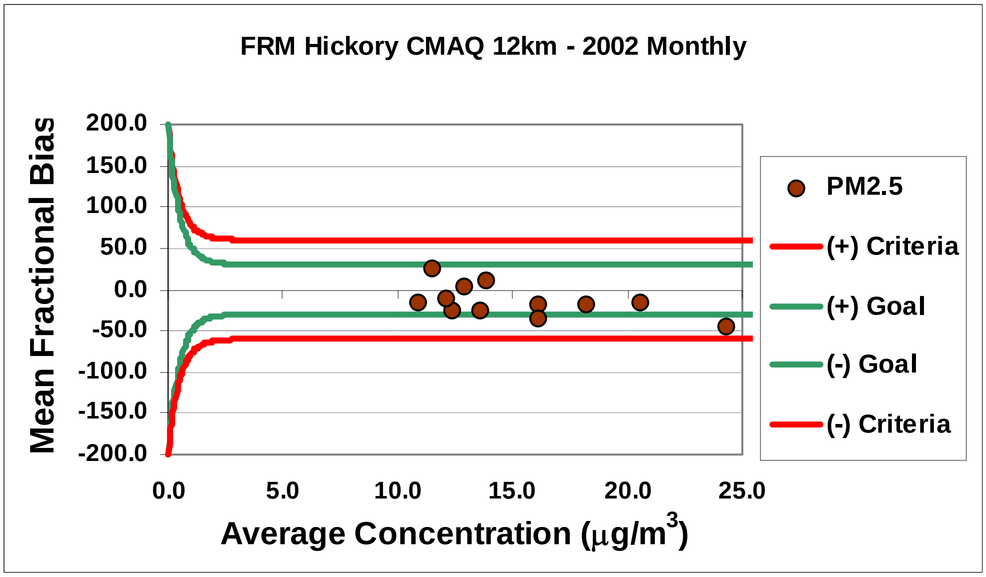


Figure 2-27: Bugle plot depicting the mean fractional bias for the light extinction due to particulate matter and its component species for the Hickory FRM monitoring site (37-035-0004). . Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

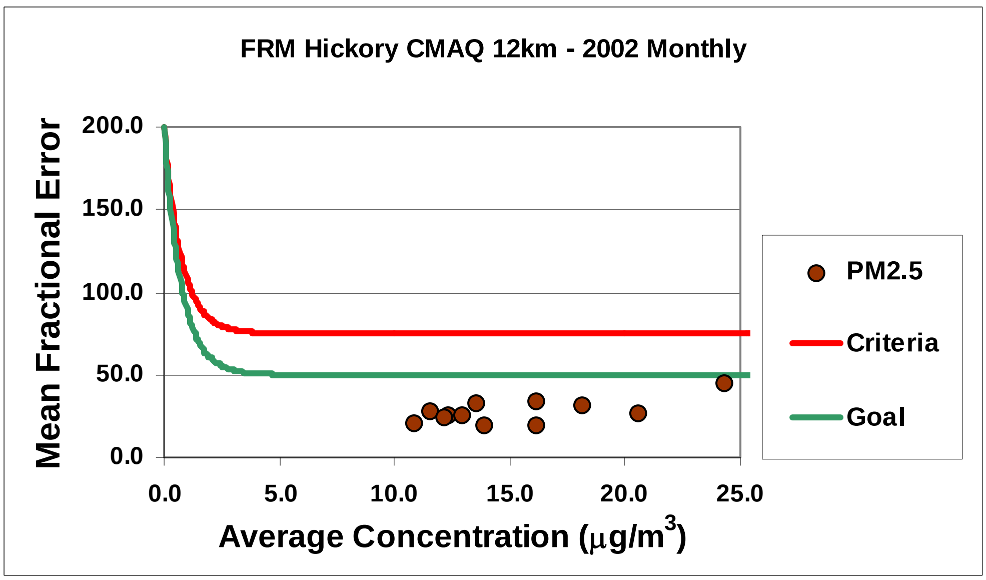


Figure 2-28: Bugle plot depicting the mean fraction error for the light extinction due to particulate matter and its component species for the Hickory FRM monitoring site (37-035-0004). . Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.2.4 Lexington FRM Monitoring Site (37-057-0002)

FRM model performance at Lexington is similar to Hickory. We again see a slightly more pronounce negative bias trend than in the bugle plot (Figure 2-28) than seen across all North Carolina sites. Figure 2-29 shows that a few months showed a higher mean fractional error level than seen with even the Hickory FRM site. Figure 2-29 also shows a month (March) slipping just outside goal performance levels.

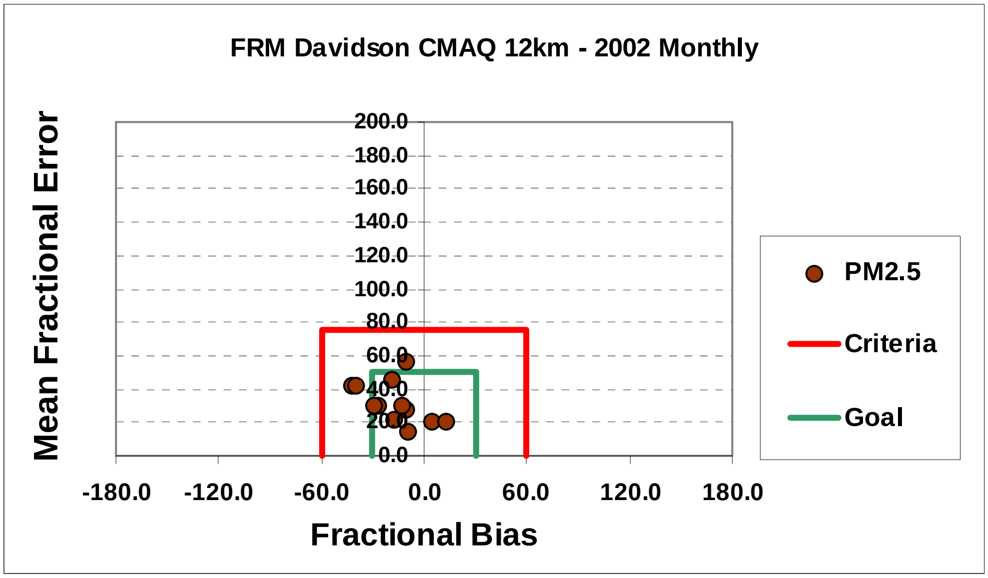


Figure 2-29: Soccer plot depicting both error and bias for the light extinction due to particulate matter and its component species for the Lexington FRM Monitoring site (37-057-0002). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red box) and modeling performance goals (green box).

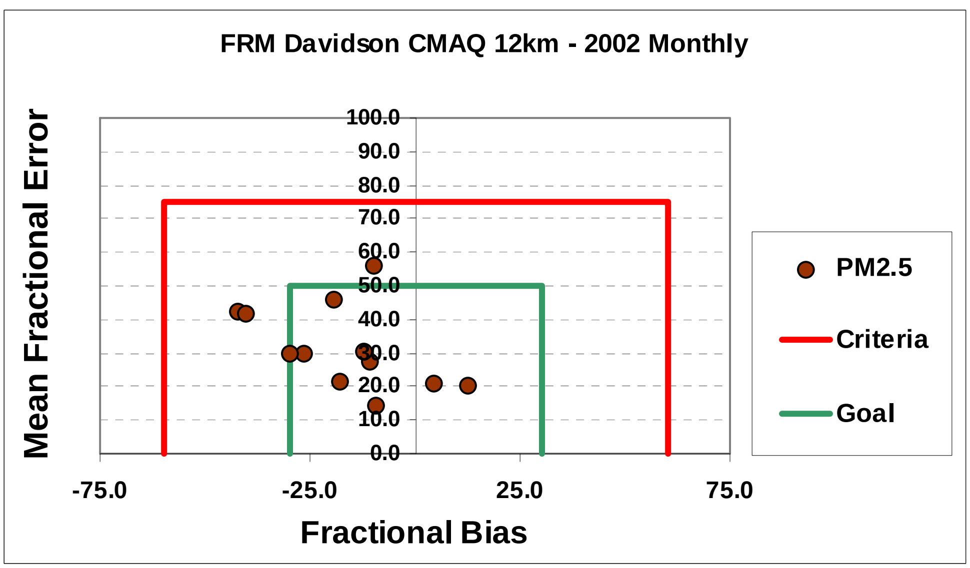


Figure 2-30: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for the Lexington FRM Monitoring site (37-057-0002). . Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

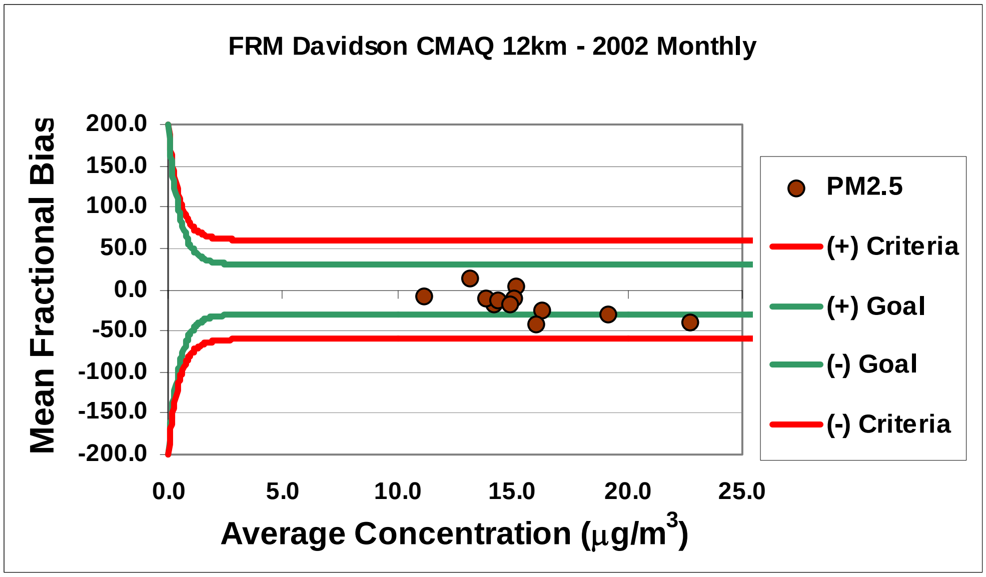


Figure 2-31: Bugle plot depicting the mean fractional bias for the light extinction due to particulate matter and its component species for the Lexington FRM Monitoring site (37-057-0002). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

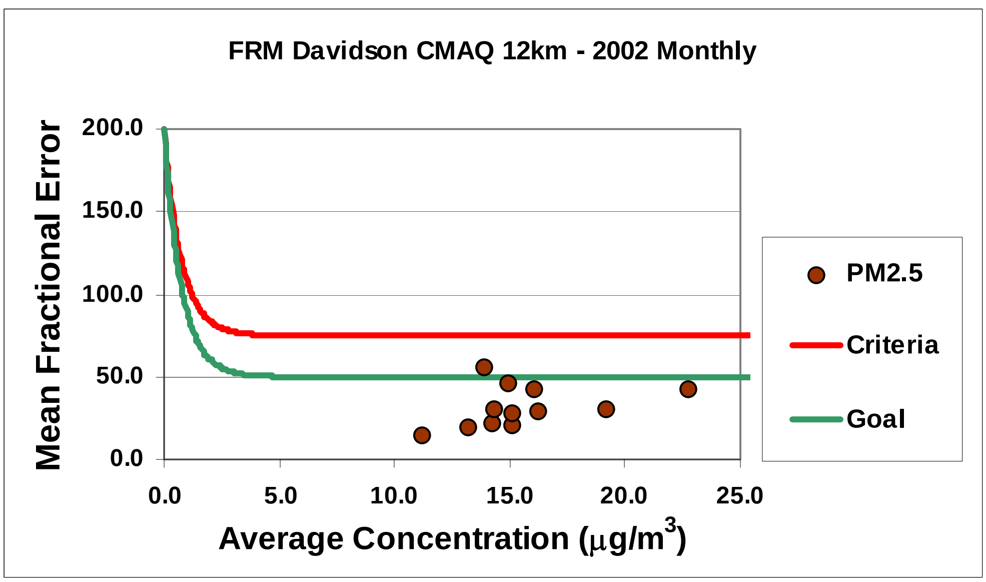


Figure 2-32: Bugle plot depicting the mean fraction error for the light extinction due to particulate matter and its component species for the Lexington FRM Monitoring site (37-057-0002). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

2.2.2.5 Mendenhall FRM Monitoring Site (37-081-0013)

Model performance at the Mendenhall FRM site again is similar to Hickory, more so than Lexington. We again see a slightly more pronounce negative bias trend than in the bugle plot (Figure 2-31) than seen across all North Carolina sites. Figure 2-32 shows that a few months showed a higher mean fractional error level than seen with even the Hickory FRM site, but still fall within goal performance levels.

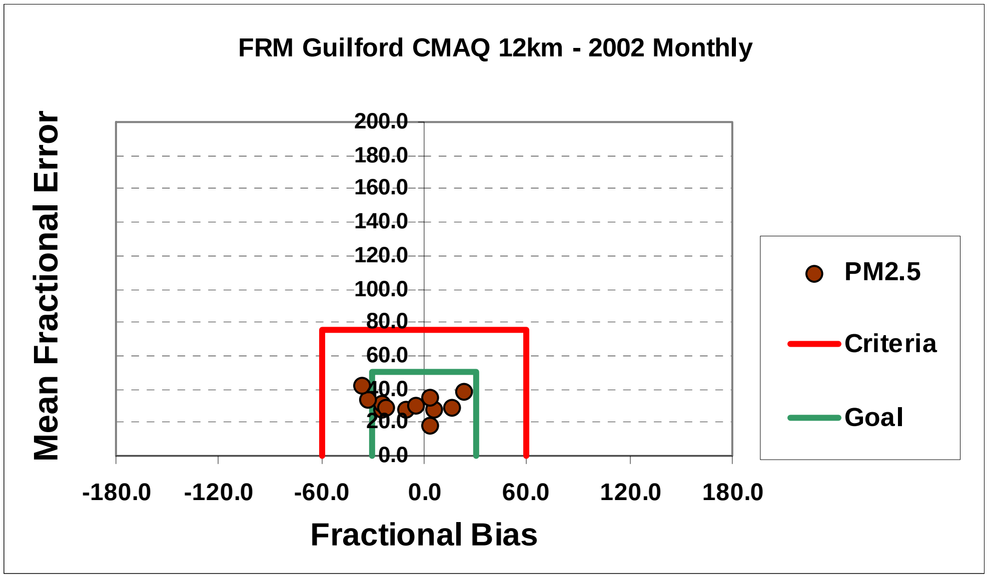


Figure 2-33: Soccer plot depicting both error and bias for the light extinction due to particulate matter and its component species for the Mendenhall FRM Monitoring site (37-081-0013). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red box) and modeling performance goals (green box).

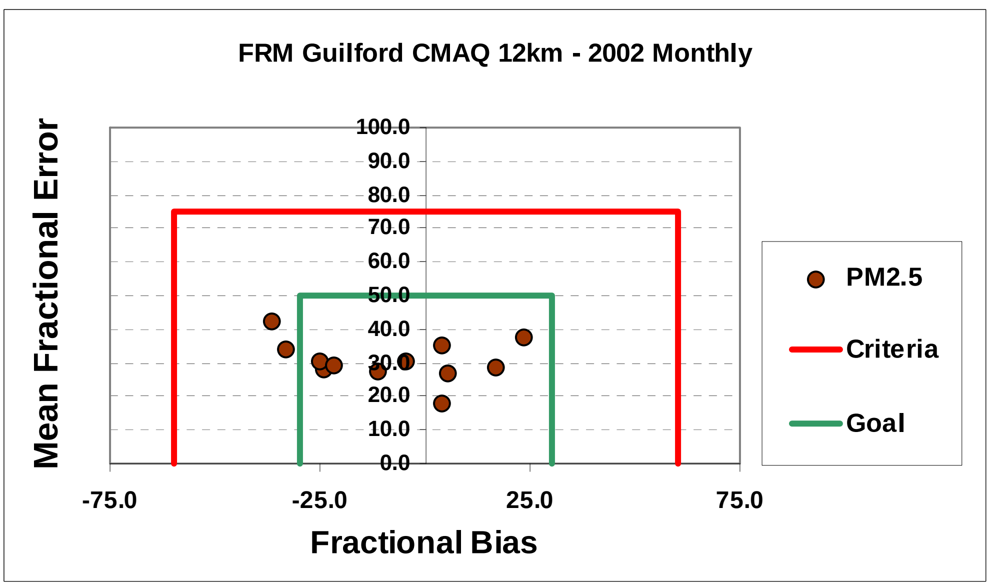


Figure 2-34: A zoomed view of the soccer plot depicting both the mean fractional error and fractional bias for component concentration for the Mendenhall FRM Monitoring site (37-081-0013). Each point represents a monthly value as compared to the model performance criteria (red box) and modeling performance goals (green box).

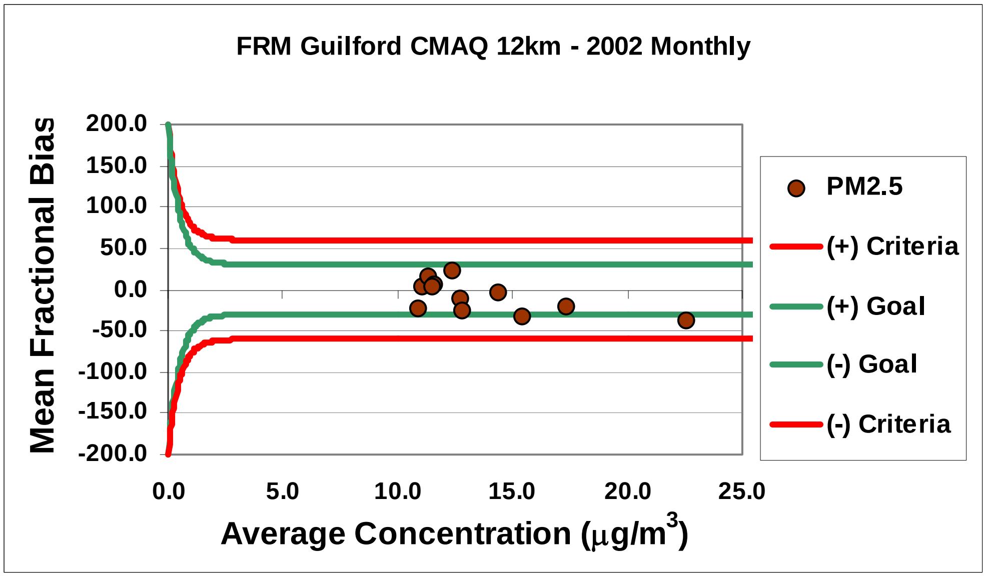


Figure 2-35: Bugle plot depicting the mean fractional bias for the light extinction due to particulate matter and its component species for the Mendenhall FRM Monitoring site (37-081-0013). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

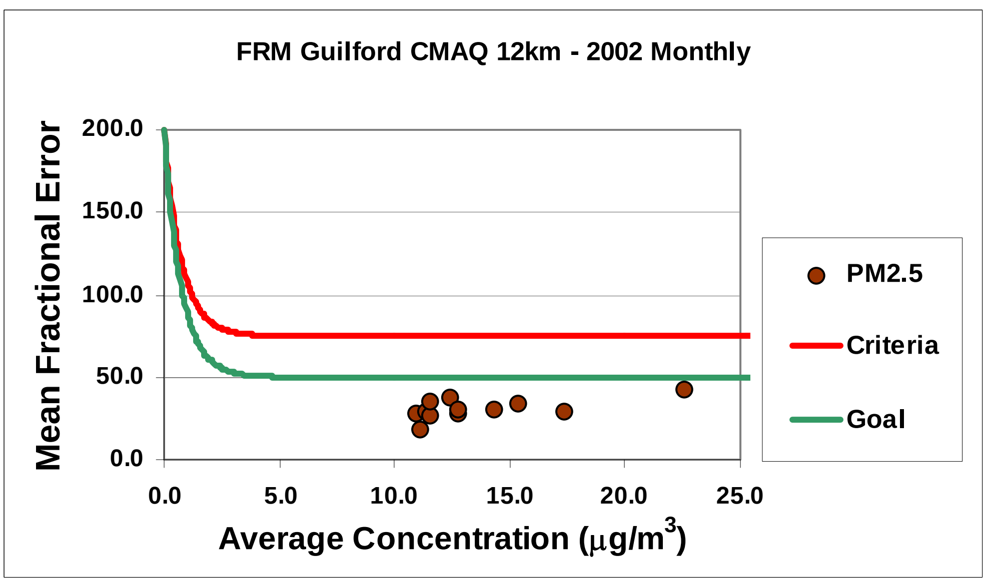


Figure 2-36: Bugle plot depicting the mean fraction error for the light extinction due to particulate matter and its component species for the Mendenhall FRM Monitoring site (37-081-0013). Each point represents a monthly mean fraction bias value as compared to the model performance criteria (red lines) and modeling performance goals (green lines).

3. Spatial Plots

The 12km domain spatial plots of model-simulated daily concentration of the constituents of particle pollution most responsible for light extinction for 2002, with the actual observed concentrations overlaid are presented in this section. These plots are presented for the entire 12km domain.

A subset of days from 2002 is presented in this appendix, though all days from 2002 are used in developing the relative reduction factor (RRF) and subsequently the future design value (DVF). For model performance evaluation, the USEPA's Attainment Guidance suggests looking at days with a daily average $PM_{2.5}$ concentration greater than 65 micrograms per meter cubed (μg/m^3). However, neither the Hickory nor the Triad $PM_{2.5}$ nonattainment area has any observed values greater than or equal to 65 μg/m^3. This lead the North Carolina Division of Air Quality chose to use a cut off of 30 μg/m^3 at any of the monitoring sites in either nonattainment area, as an initial method to select days for examination in the model performance evaluation and in the results section.

To ensure at least four days from each quarter were presented, daily $PM_{2.5}$ values form each quarter were ranked, and the four days with the highest average daily values in each quarter were also chosen. This selection process identified 28 days for presentation in this appendix, and examination in the model results section (Appendix K). The selected days are presented in Table 3-1 below.

There are two pages of overlays for each identified date. The first page for each date contains the daily average spatial plots for sulfate (SO4), nitrate (NO3), ammonium (NH4), and organic carbon (OC) overlaid with STN data. The second page in the series contains two plots: one with STN elemental carbon (EC) observations overlaid on modeled EC levels, and the other with FRM data overlaid on daily average total $PM_{2.5}$. Note that because of the varying polling frequencies at the monitors, the number of observation available for plots between the days varies.

A table immediately precedes the plots, which details the actual observed daily average total $PM_{2.5}$ values for the STN and FRM sites within the North Carolina $PM_{2.5}$ nonattainment areas. The color scale for all the plots moves from lower concentrations in shade of blue to warmer colors for higher concentrations.

Overall, the spatial plots correspond to results seen in the statistical metrics and plots. Nitrate has a tendency to be slightly under predicted across the domain for the year. The modeled nitrates tend to be more representative on higher concentration days. However, the model also tends to spread areas of high nitrate concentrations further than the observations suggest, especially in the first quarter. The model has some instances of under prediction of organic and elemental carbon from day to day. However, the general spatial pattern is generally well represented through out the year.

Sulfates were generally well represented, especially on high concentrations days. There was some under prediction of peaks, especially isolated peaks. Ammonium was actually fair well represented in the model. Peaks were generally captured fairly well, and the model identified a peak in eastern North Carolina associated with livestock activities, despite limited observations.

The spatial patter of total $PM_{2.5}$ compared to the FRM mass is actually well represented across the year. August 3rd stands out, as the model captured the gradient of $PM_{2.5}$ concentration across North Carolina particularly well. However, we do see some performance issues along the Great lakes area, which are likely due to under prediction of nitrates and occasionally sulfates in that area.

Table 3-1: Days selected for model evaluation and the observed value at each of the monitoring sites in the Hickory and Triad PM Nonattainment areas. Gray cells indicate no monitoring data was available for that day either due to the sampling frequency or the site being off line

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
01/05/02	5	Q1		22.3	28.5	25.5
01/06/02	6	Q1				23.9
02/25/02	56	Q1	24.5	21.4	20.3	18.8
03/06/02	65	Q1		24.8	22.8	15.6
05/26/02	146	Q2		22.6	25.3	
06/04/02	155	Q2		29.0	26.4	26.0
06/10/02	161	Q2		27.5	22.4	23.5
06/13/02	164	Q2		23.1	26.9	25.8
07/01/02	182	Q3	36.9	33.5	31.1	32.9
07/02/02	183	Q3				37.7
07/03/02	184	Q3				30.8
07/08/02	189	Q3				31.1
07/09/02	190	Q3				34.9
07/16/02	197	Q3		33.5	33.1	34.8
07/17/02	198	Q3				41.8
07/18/02	199	Q3				41.8
08/02/02	214	Q3				31.4
08/03/02	215	Q3		30.0	19.5	17.4
08/11/02	223	Q3				33.4
08/12/02	224	Q3	33.3	40.7	36.9	
08/22/02	234	Q3				31.1
08/23/02	235	Q3				33.2
09/17/02	260	Q3	30.6	27.6		21.2
09/18/02	261	Q3				30.5
11/21/02	325	Q4				26.6
11/25/02	329	Q4		19.3	25.9	19.9
12/07/02	341	Q4		29.2	43.7	49.2
12/31/02	365	Q4		28.9	18.9	20.5

3.1 January 5, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
01/05/02	5	Q1		22.3	28.5	25.5

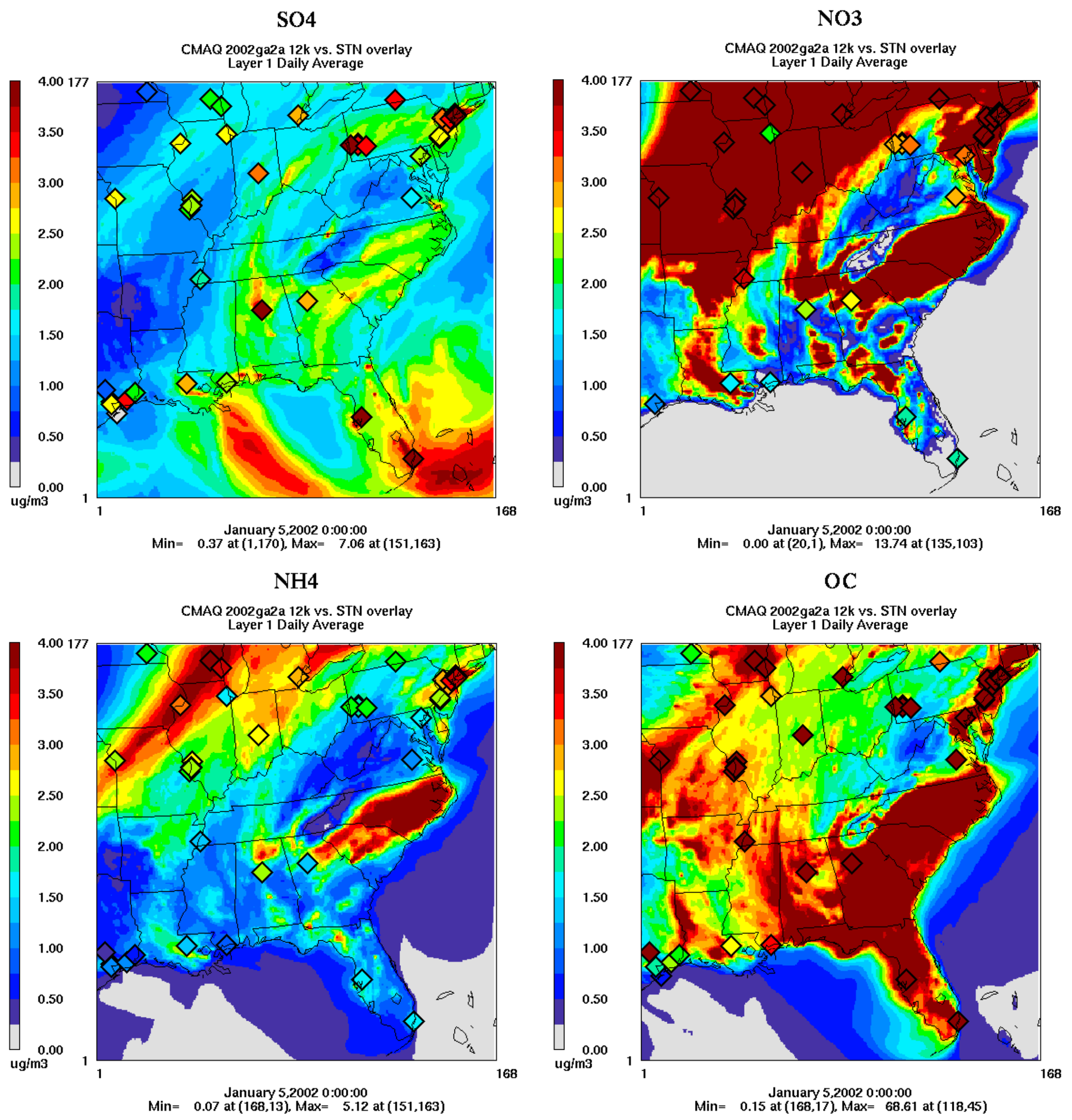
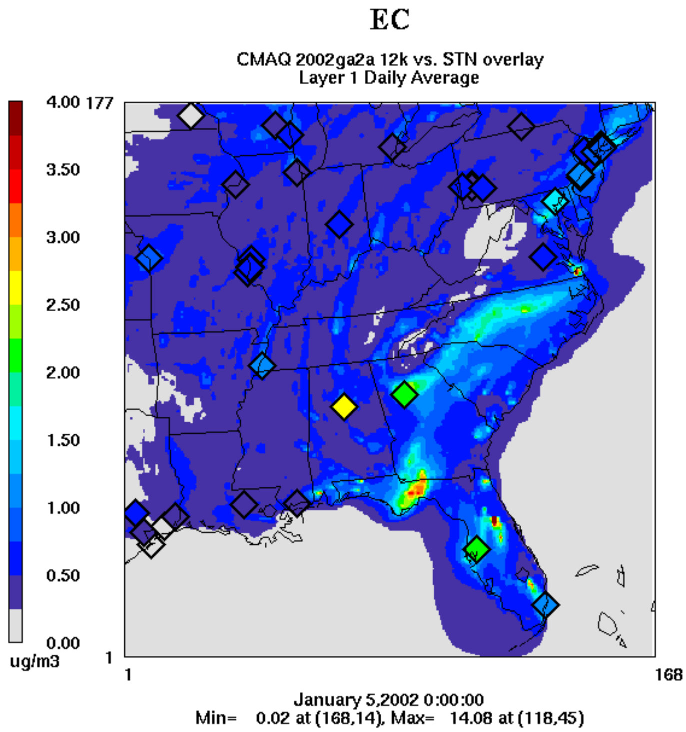


Figure 3-1: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For January 5, 2002



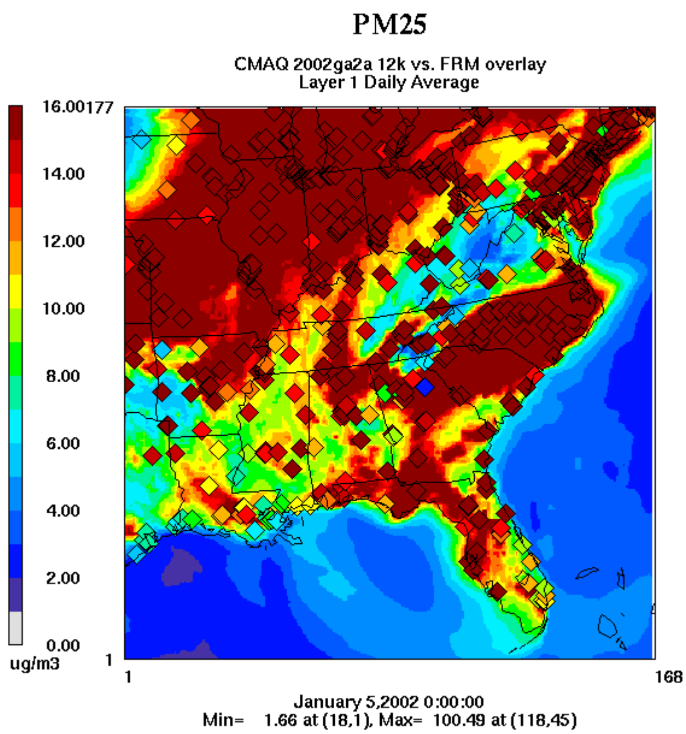


Figure 3-2: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For January 5, 2002

3.2 January 6, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
01/06/02	6	Q1				23.9

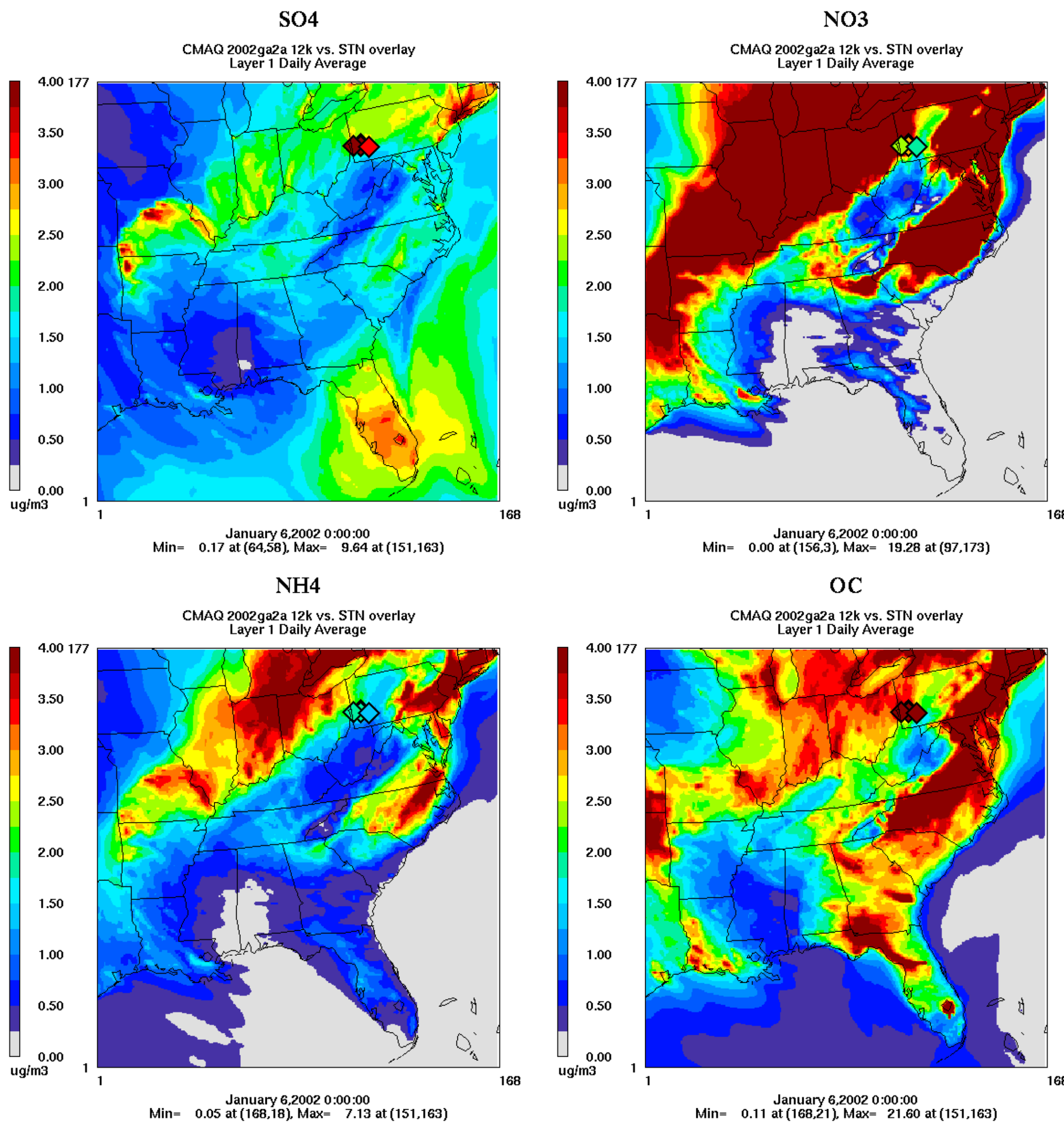
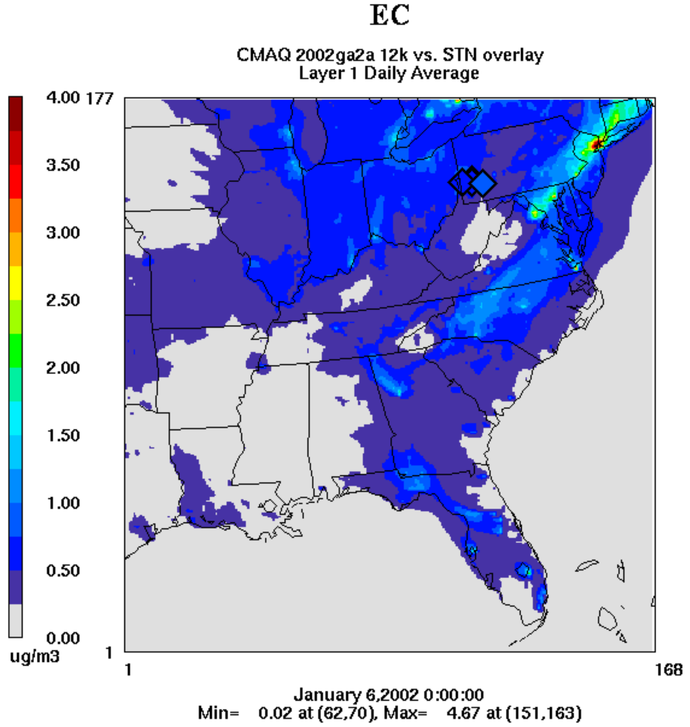


Figure 3-3: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For January 6, 2002



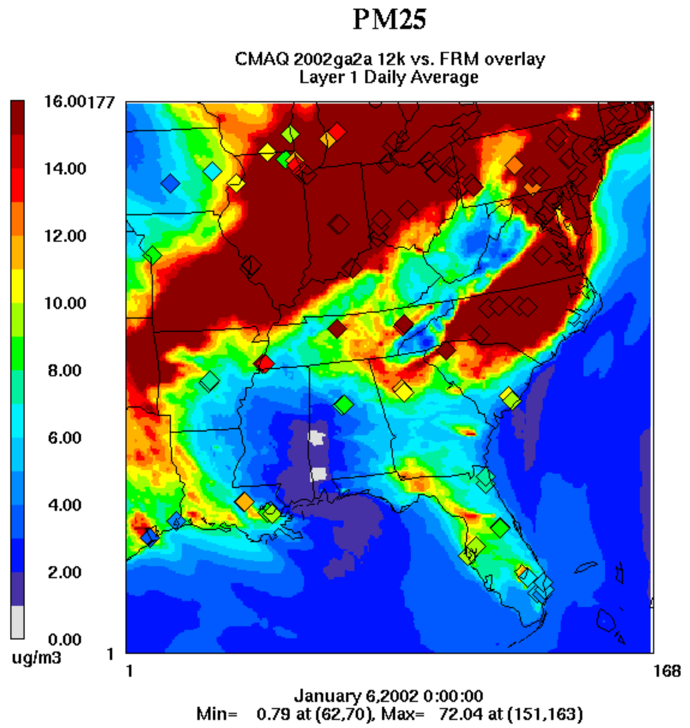


Figure 3-4: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For January 6, 2002

3.3 February 25, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
02/25/02	56	Q1	24.5	21.4	20.3	18.8

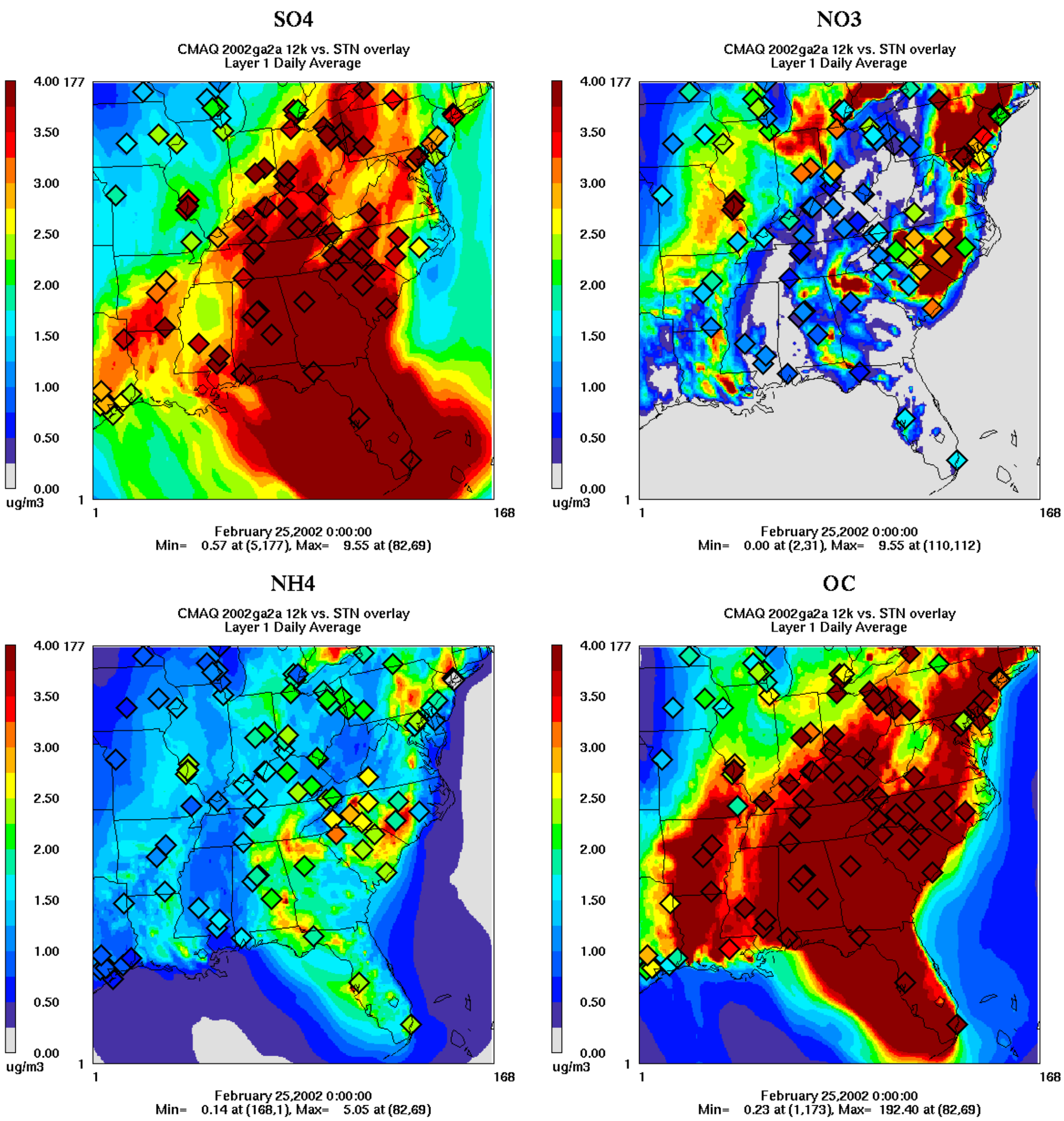
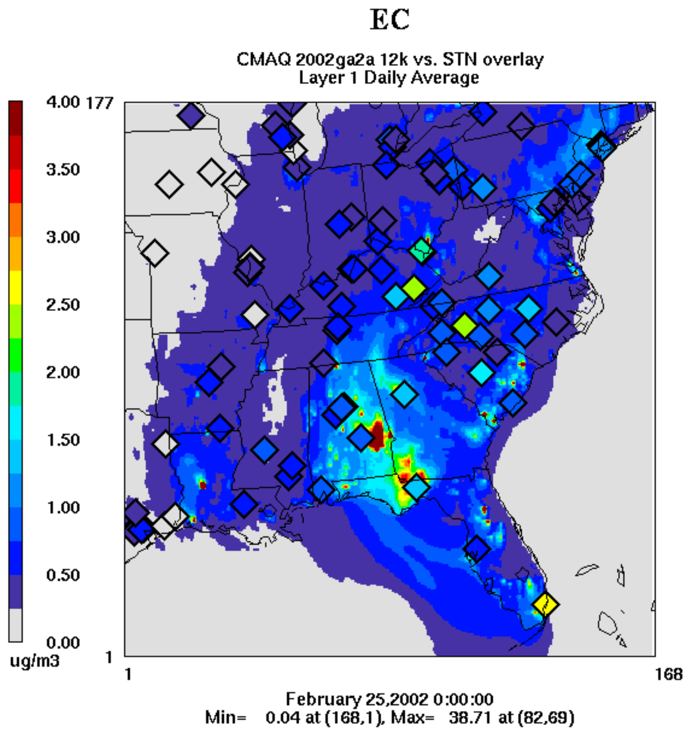


Figure 3-5: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For February 25, 2002



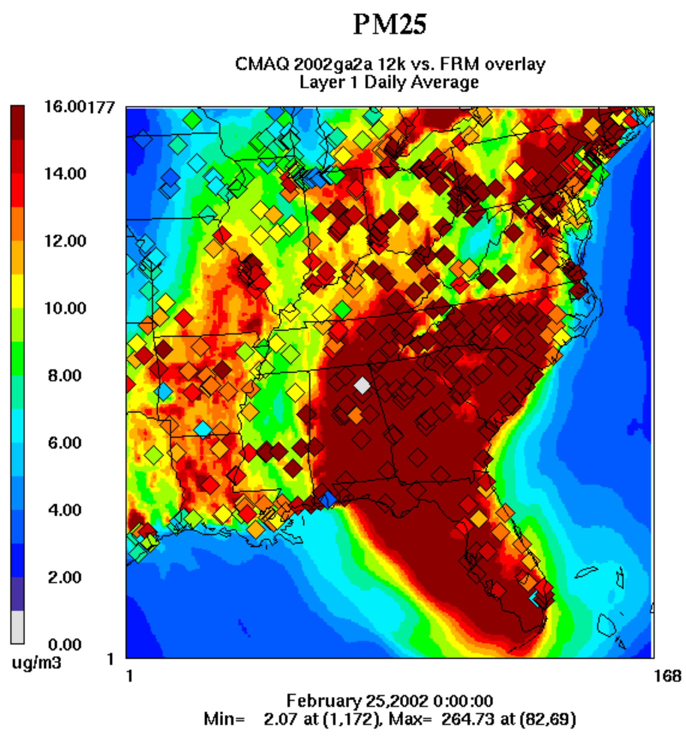


Figure 3-6: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For February 25, 2002

3.4 March 3, 2006

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
03/06/02	65	Q1		24.8	22.8	15.6

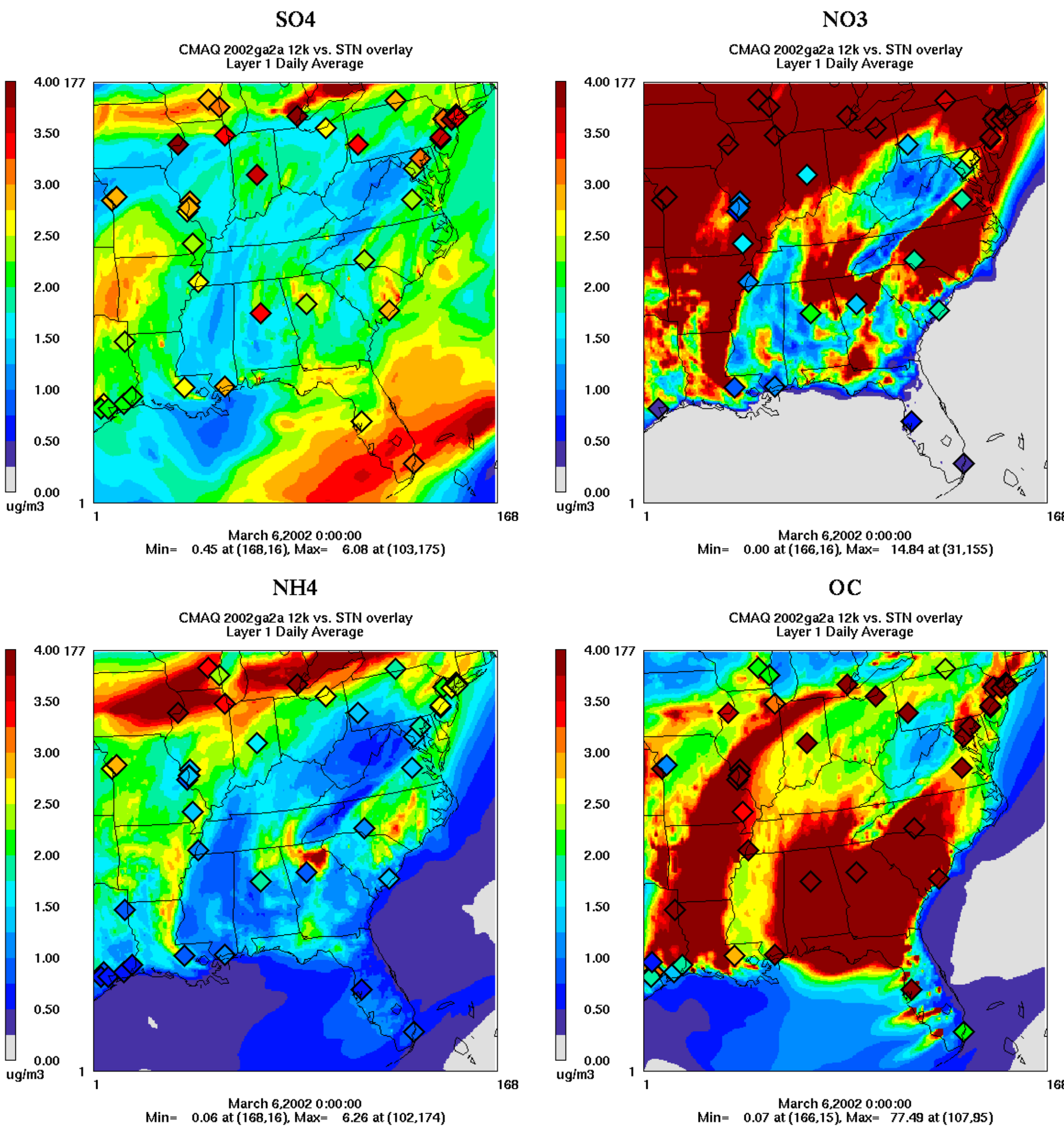
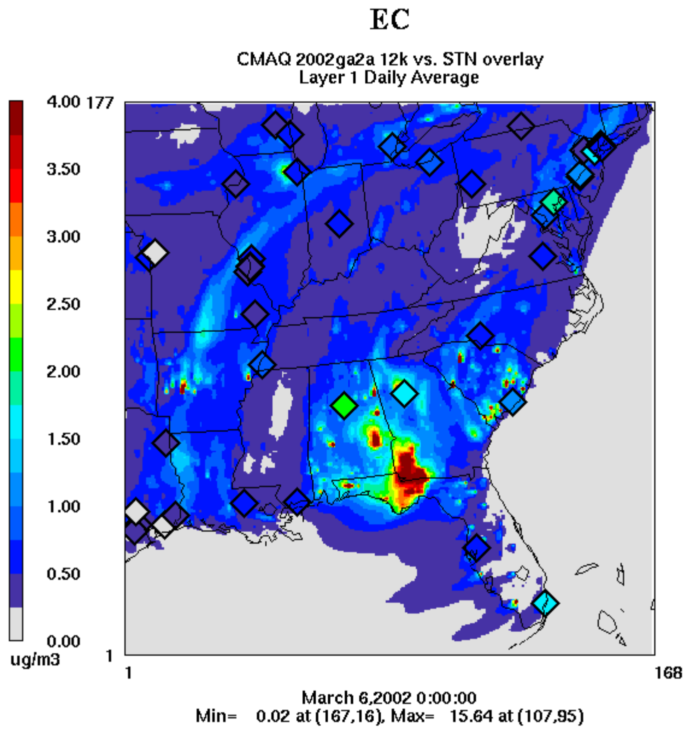


Figure 3-7: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For March 3, 2002



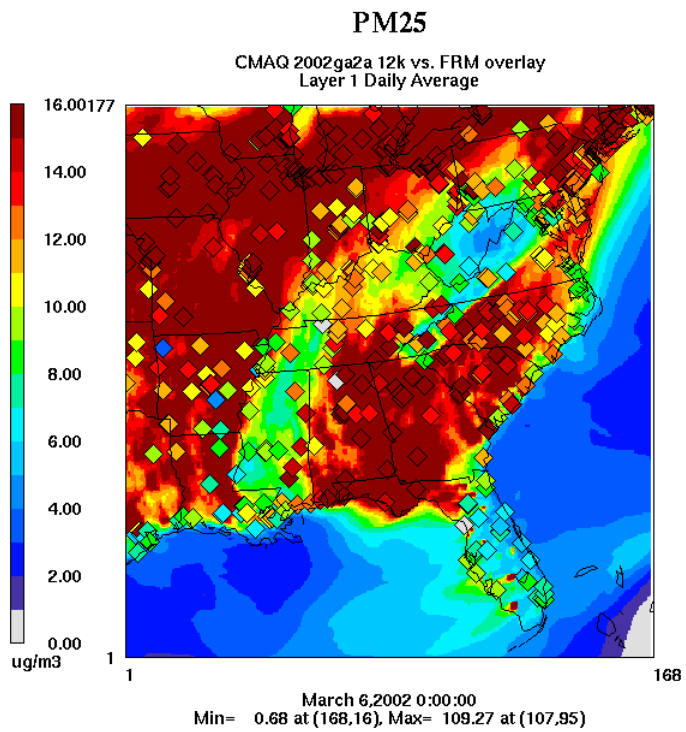


Figure 3-8: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For March 3, 2002

3.5 May26, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
05/26/02	146	Q2		22.6	25.3	

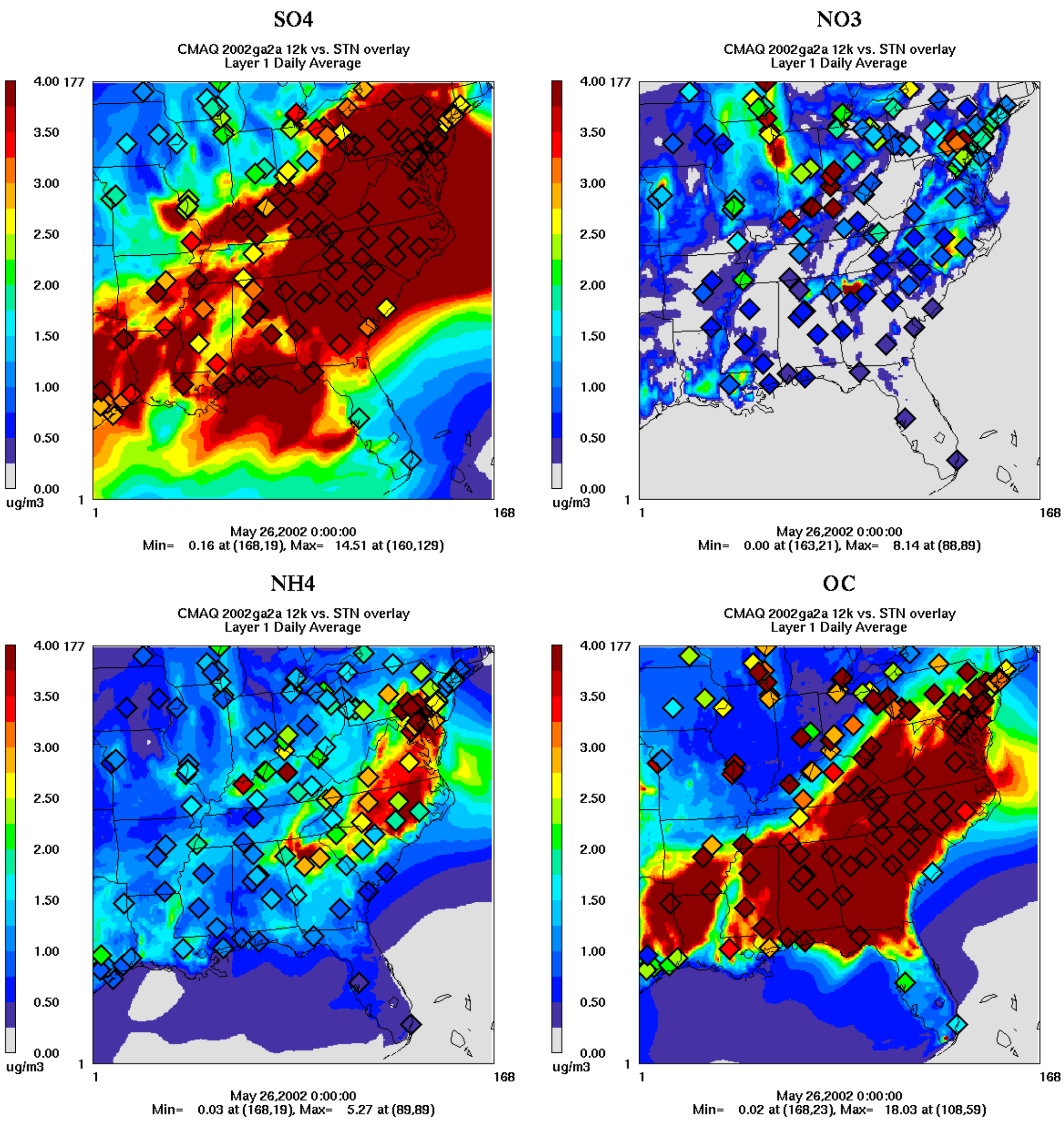


Figure 3-9: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For May 26, 2002

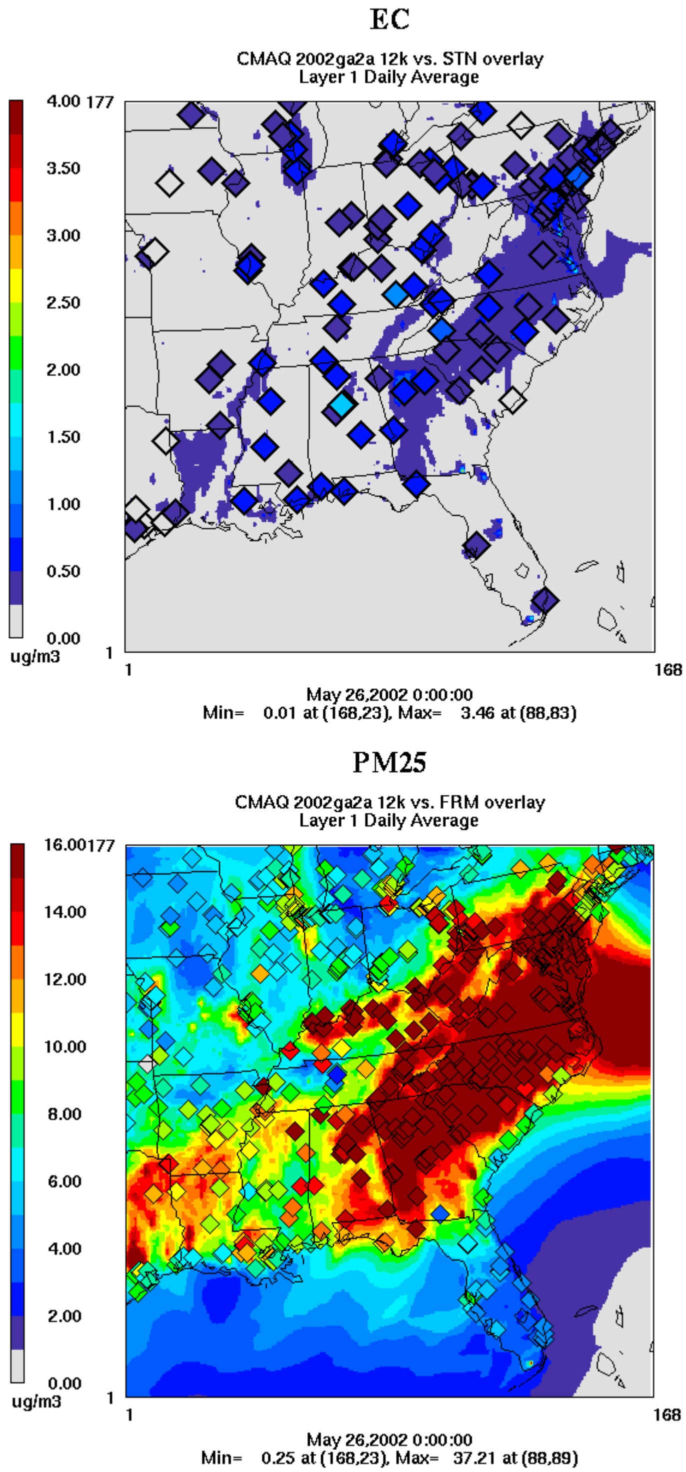


Figure 3-10: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For May 26, 2002

3.6 June 4, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
06/04/02	155	Q2		29.0	26.4	26.0

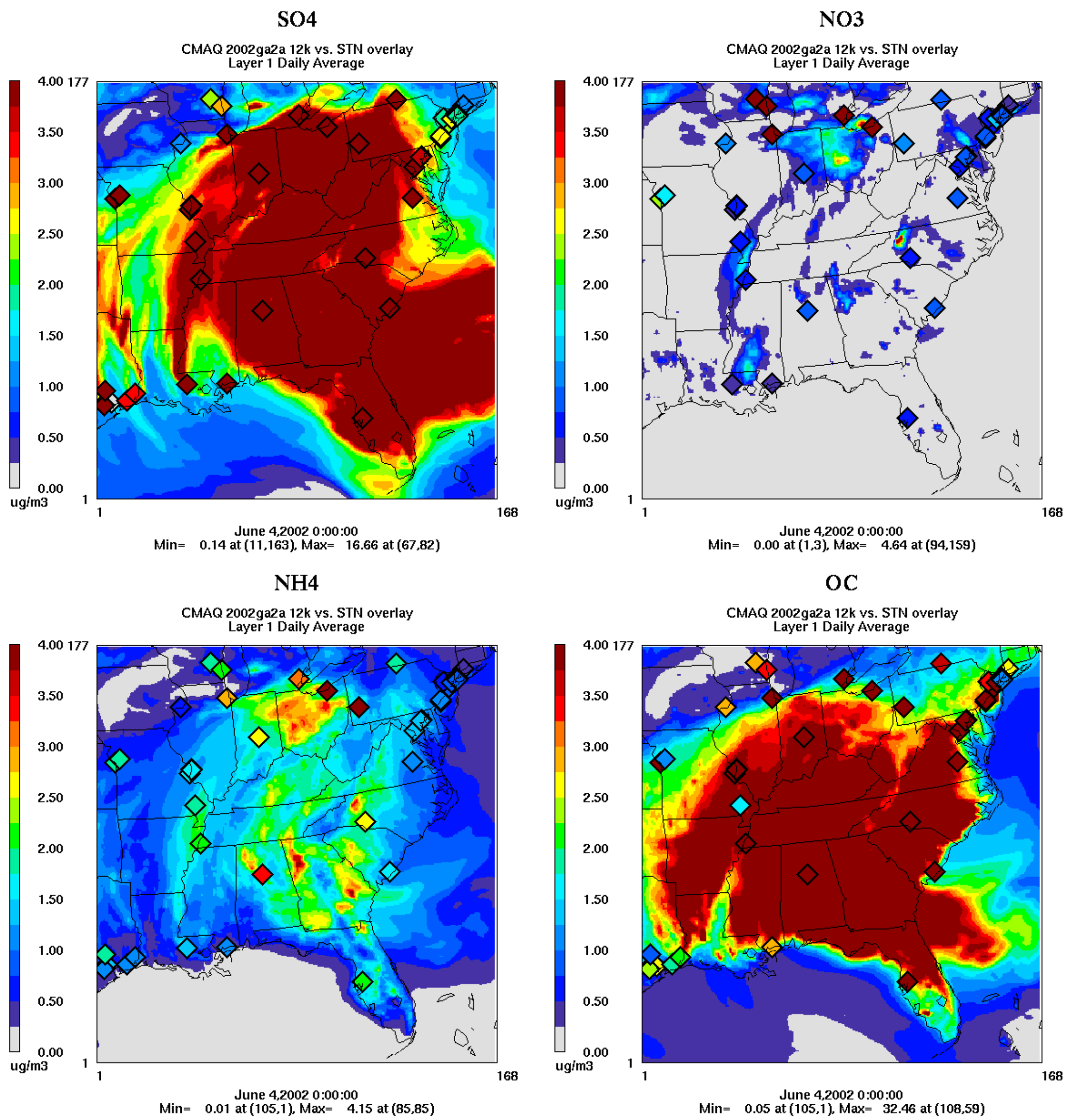


Figure 3-11: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For June 4, 2002

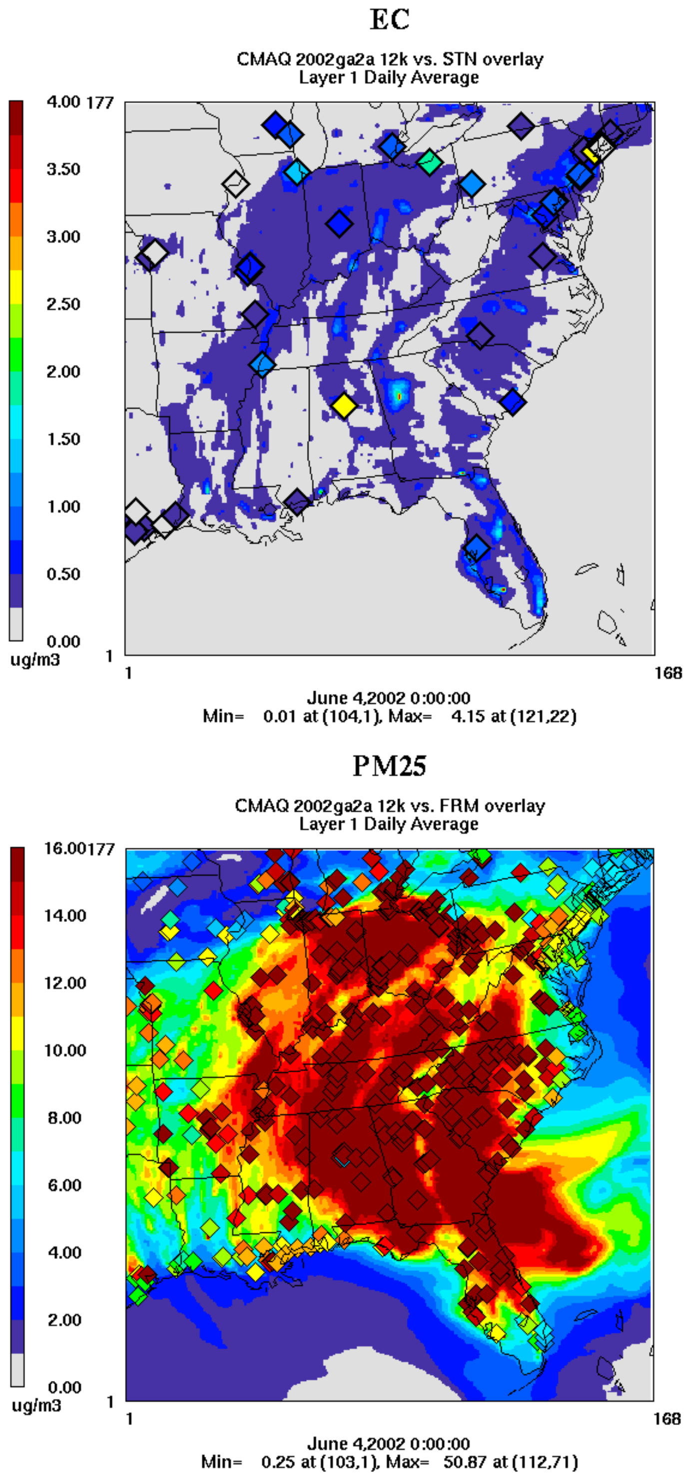


Figure 3-12: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For June 4, 2002

3.7 June 10, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
06/10/02	161	Q2		27.5	22.4	23.5

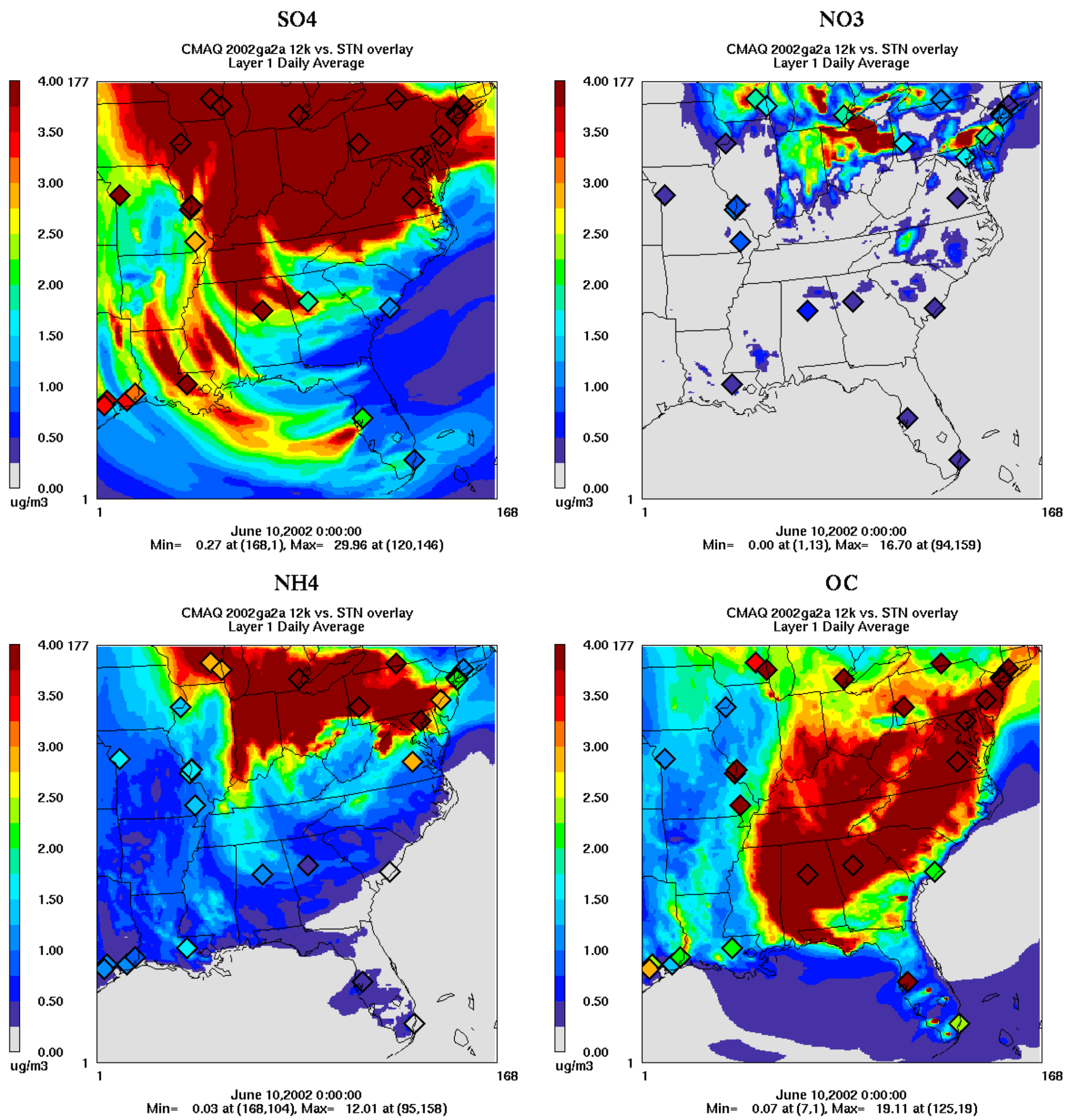
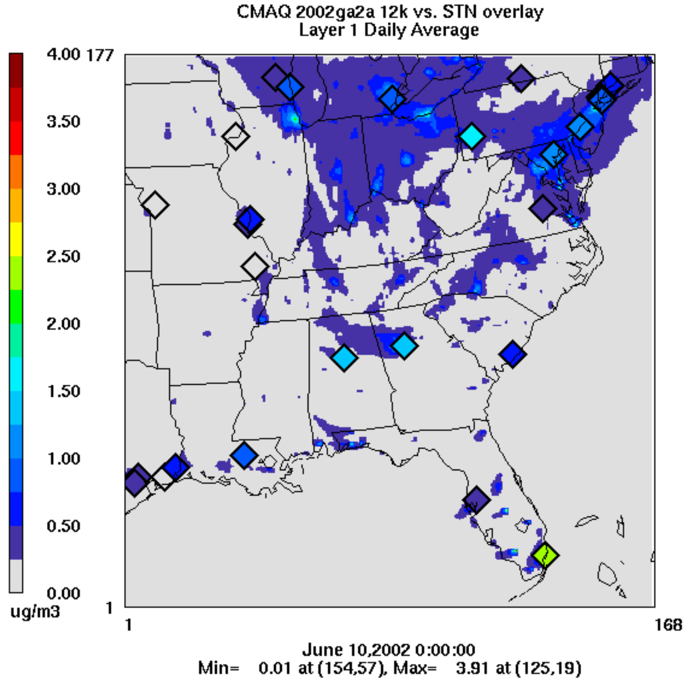


Figure 3-13 Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For June 10, 2002

EC



PM25

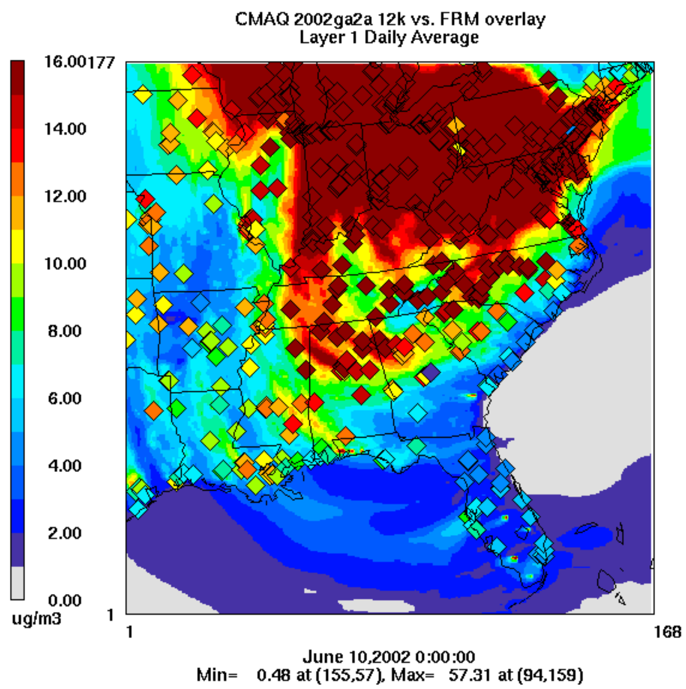


Figure 3-14: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For June 10, 2002

3.8 June 13, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
06/13/02	164	Q2		23.1	26.9	25.8

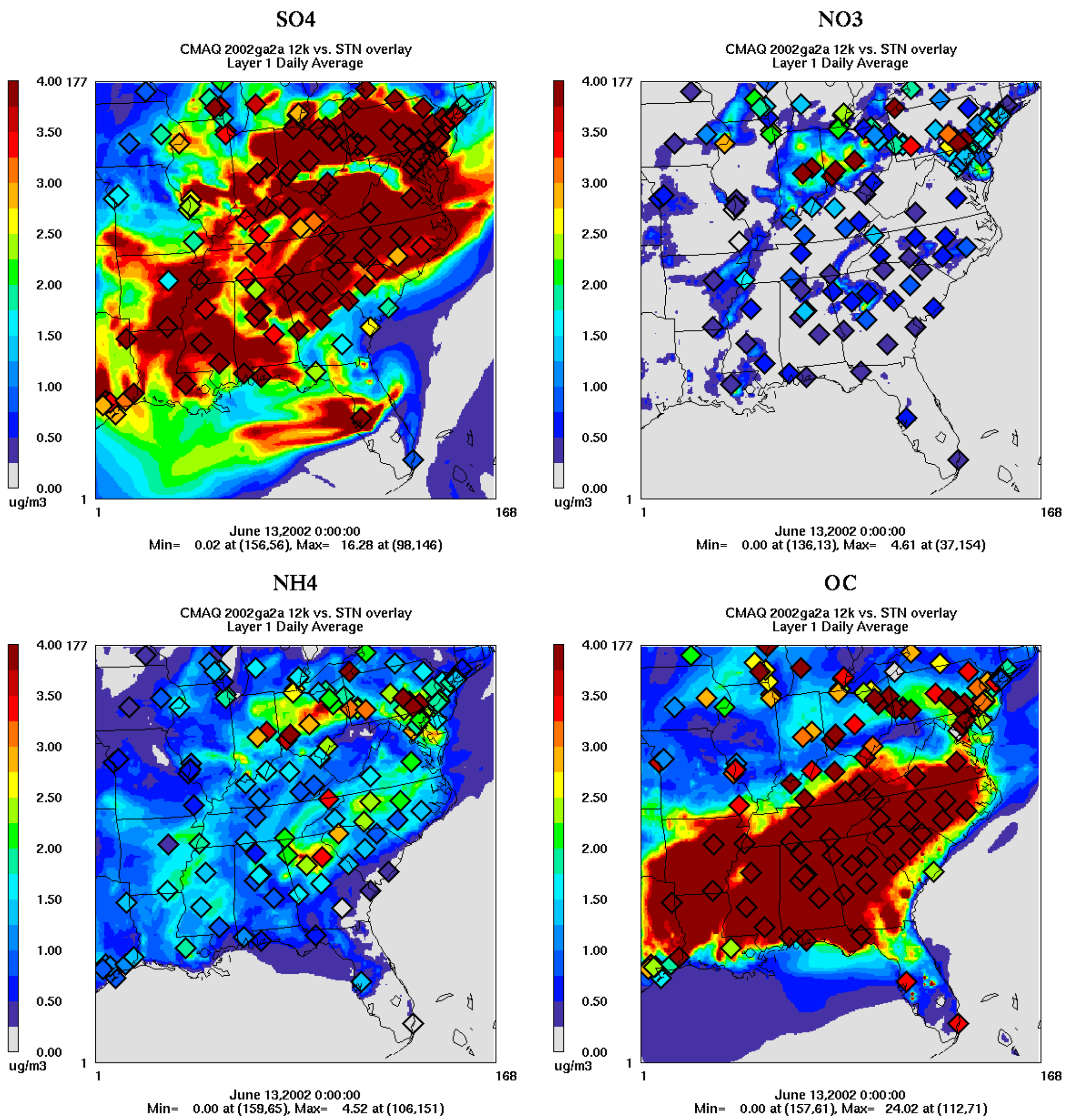


Figure 3-15: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For June 13, 2002

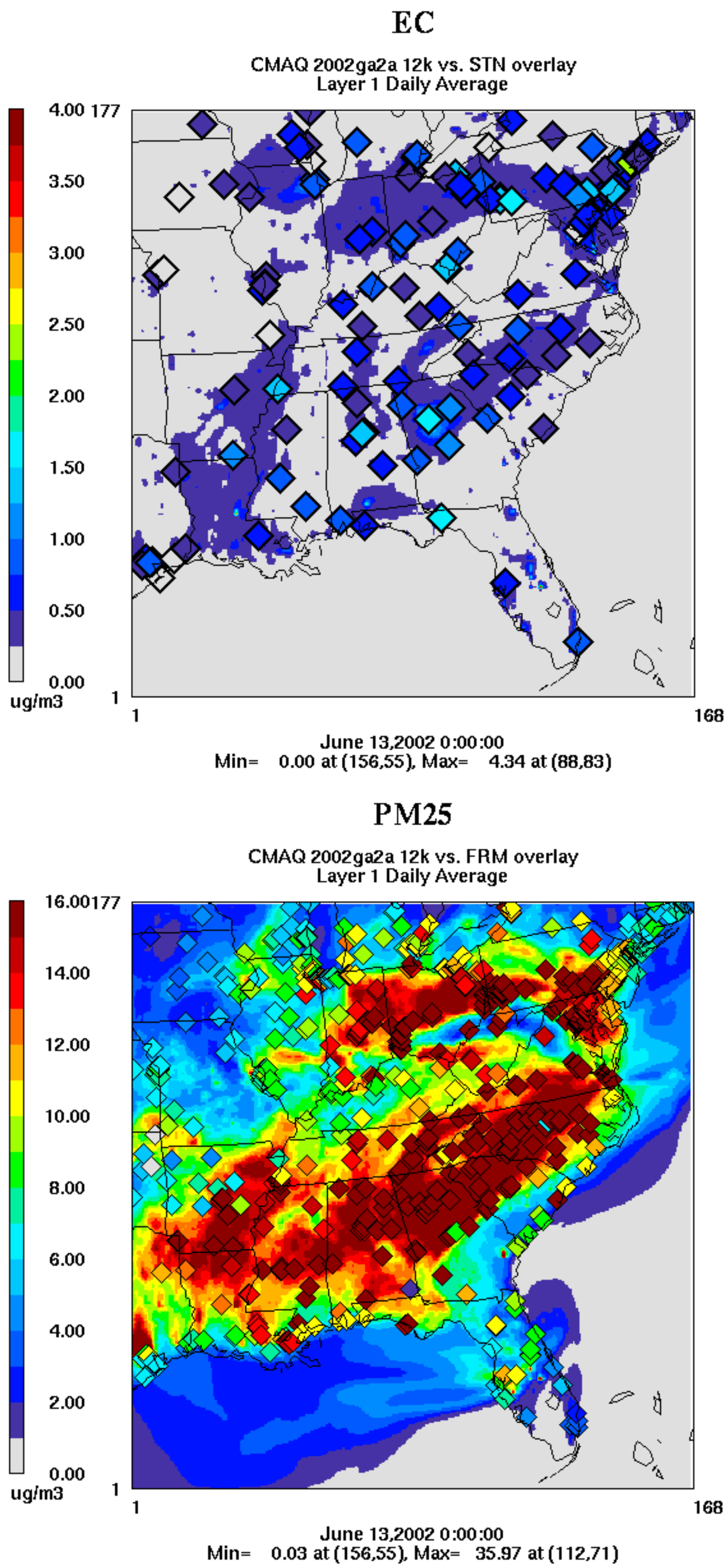


Figure 3-16: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For June 13, 2002

3.9 July 1, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/01/02	182	Q3	36.9	33.5	31.1	32.9

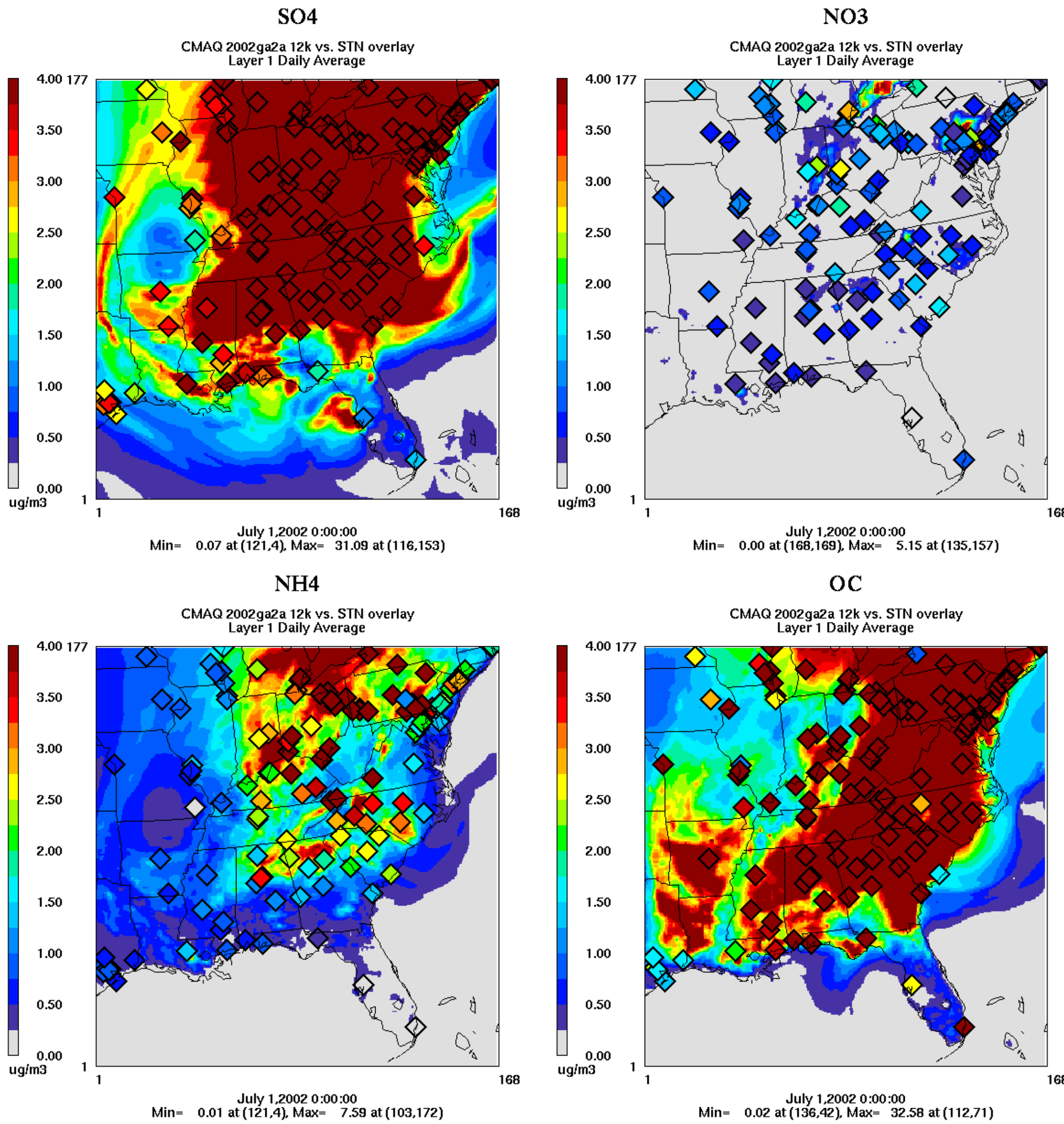
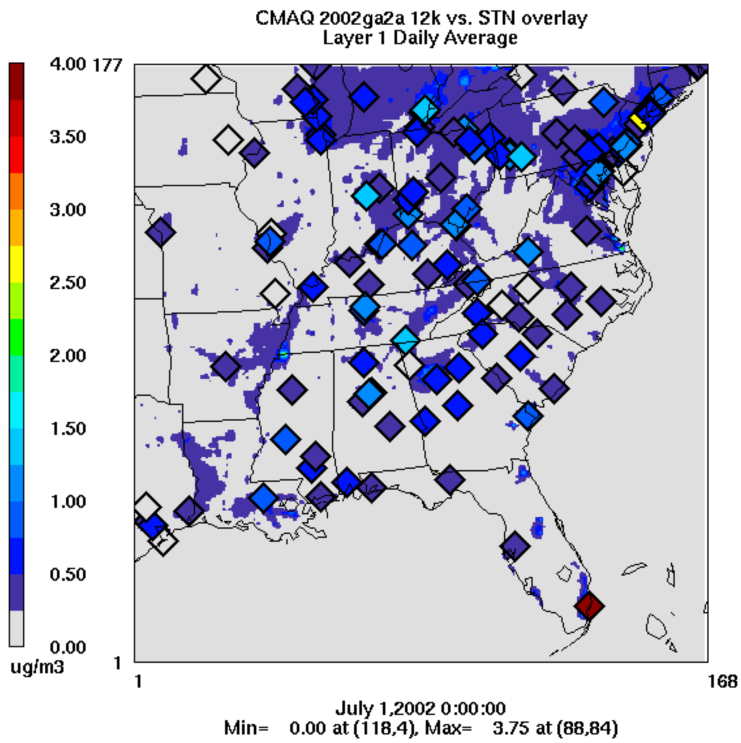


Figure 3-17: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 1, 2002

EC



PM25

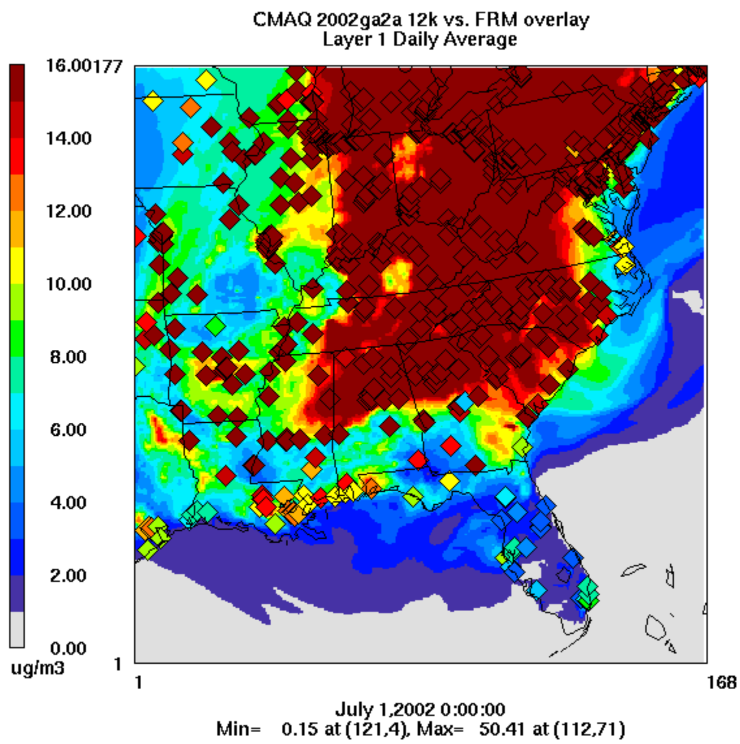


Figure 3-18: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 1, 2002

3.10 July 2, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/02/02	183	Q3				37.7

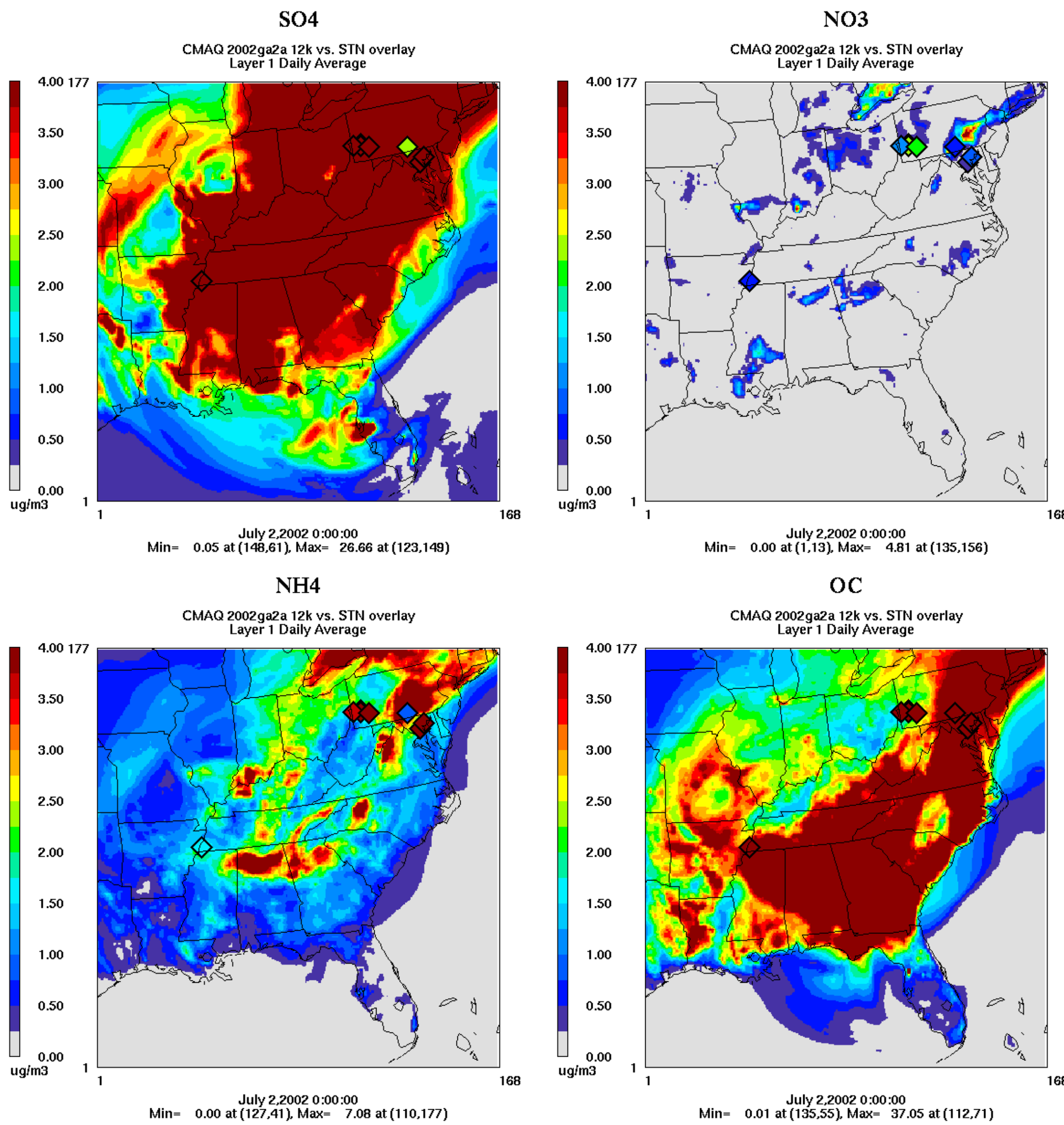


Figure 3-19: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 2, 2002

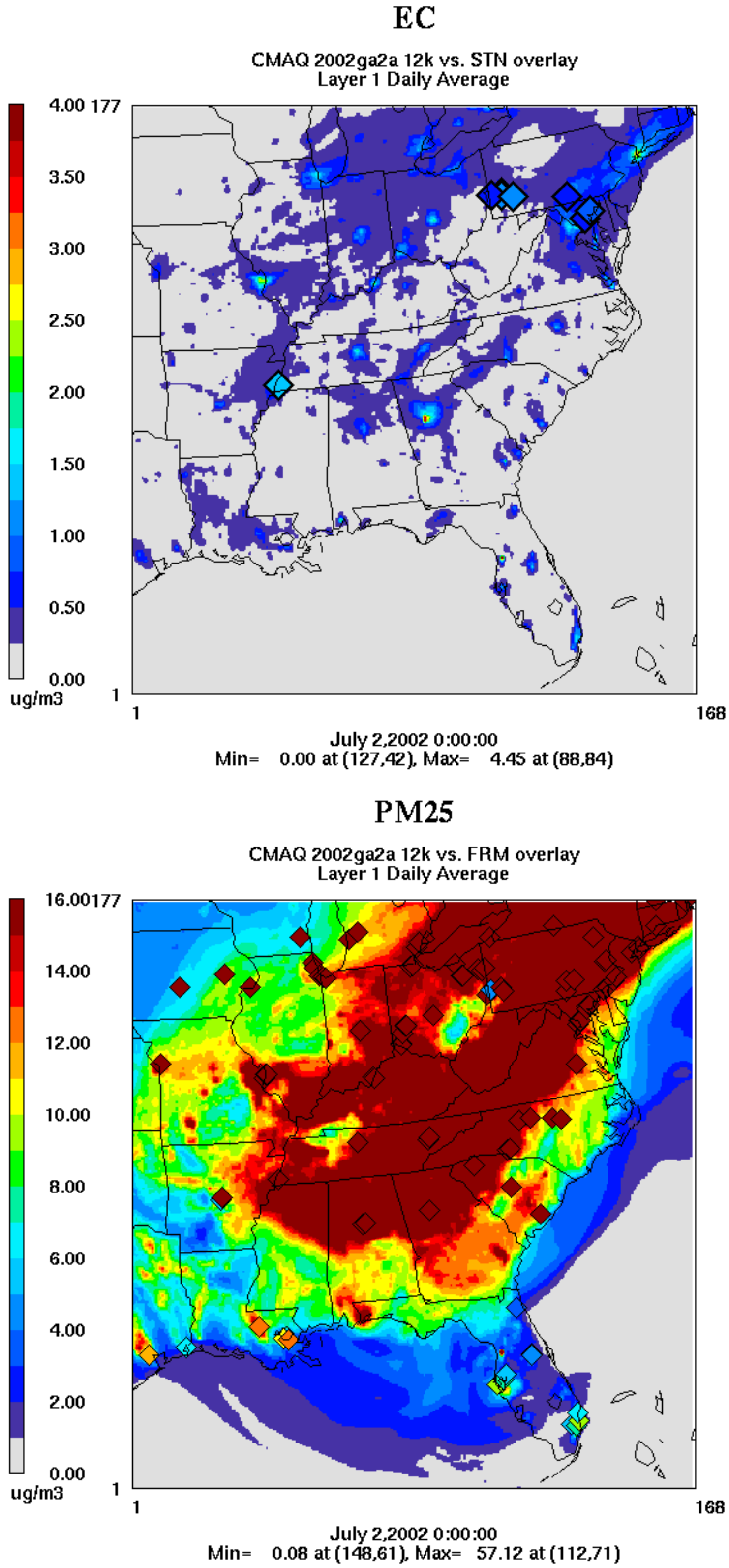


Figure 3-20: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 2, 2002

3.11 July 3, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/03/02	184	Q3				30.8

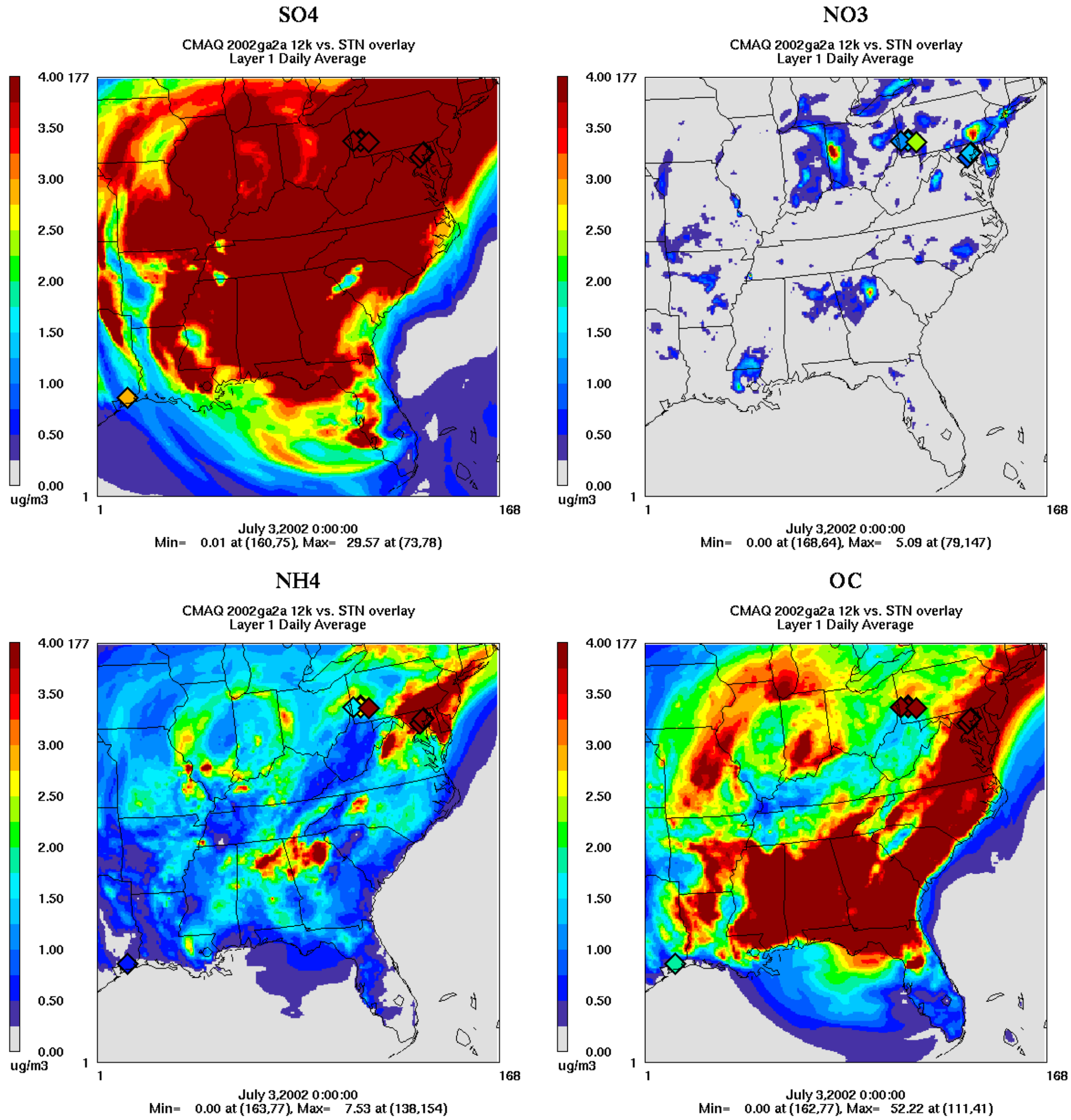
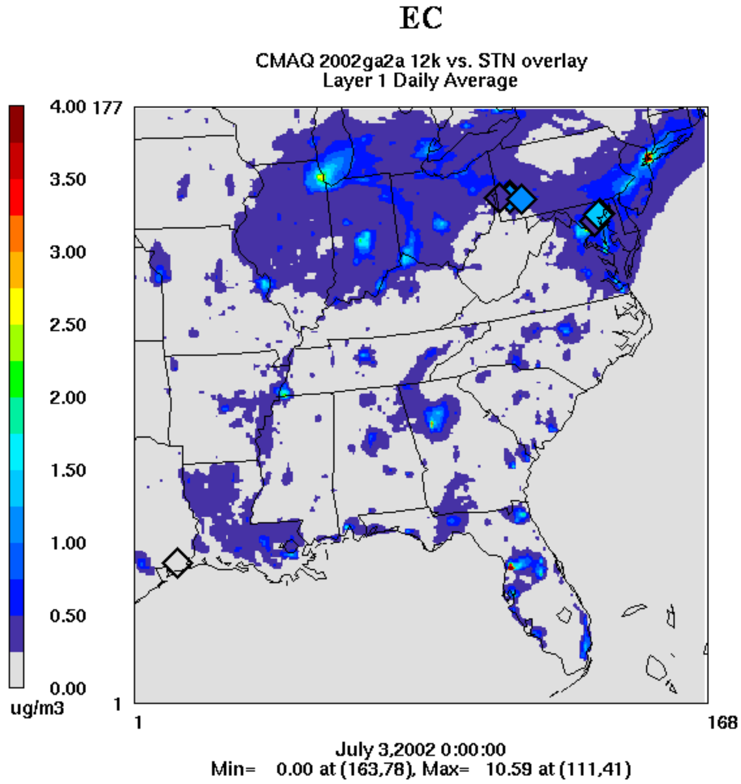


Figure 3-21: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 3, 2002



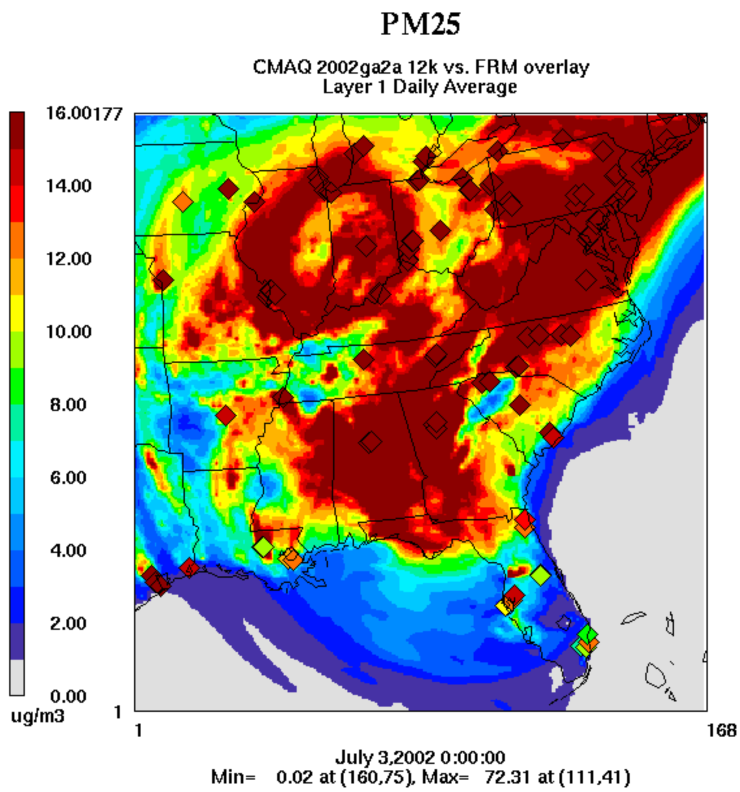


Figure 3-22: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 3, 2002

3.12 July 8, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/08/02	189	Q3				31.1

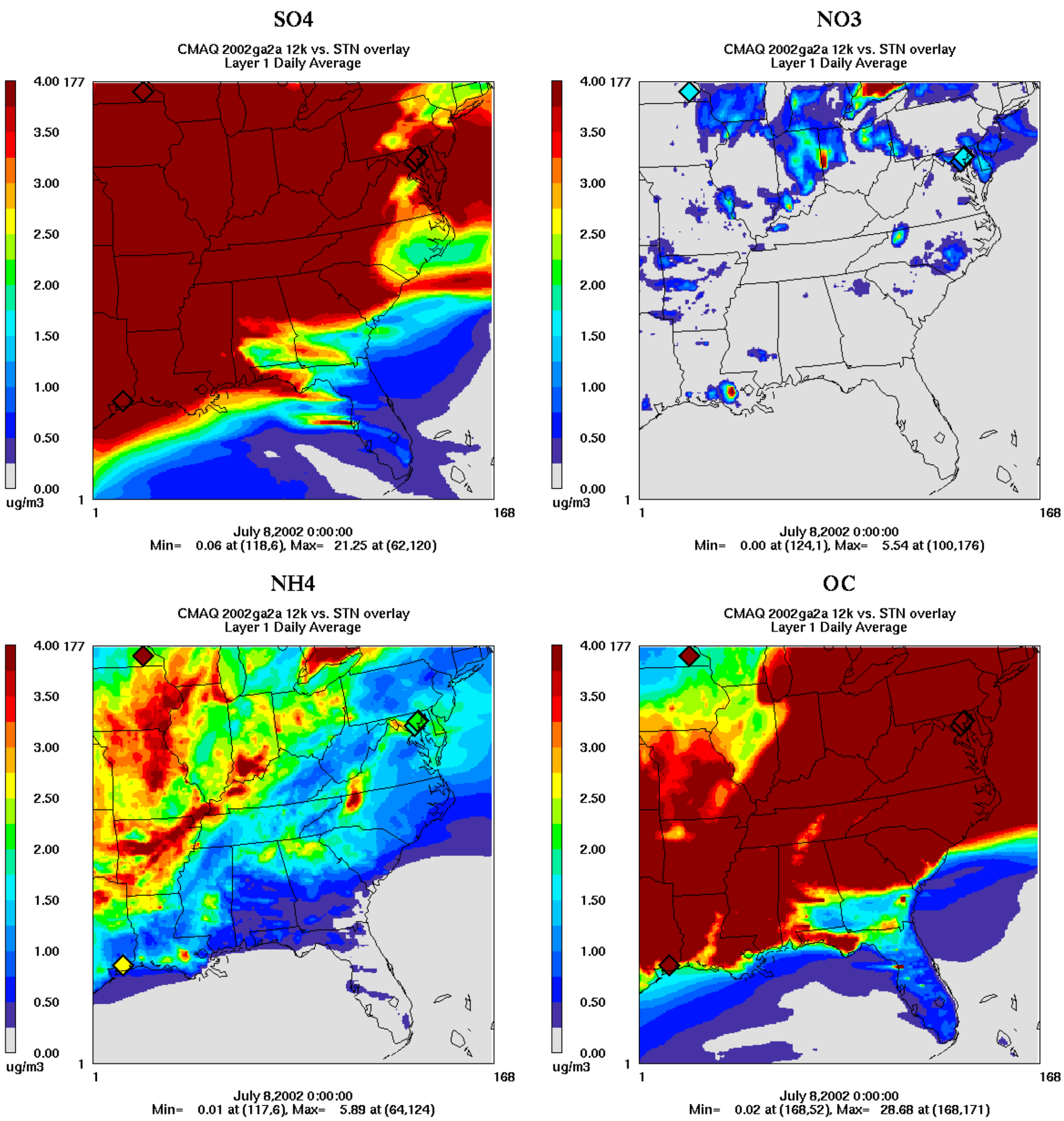
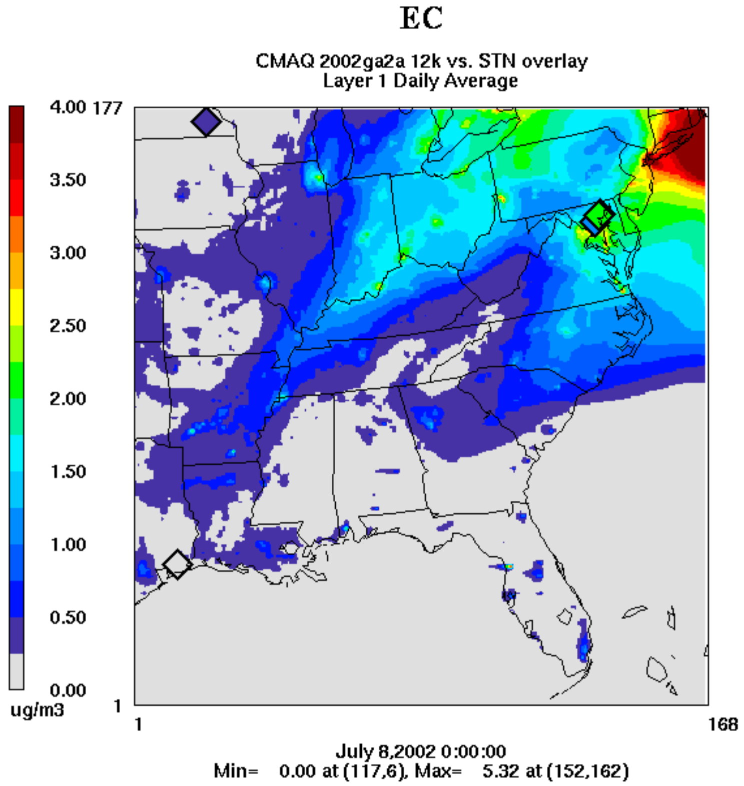


Figure 3-23: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 8, 2002



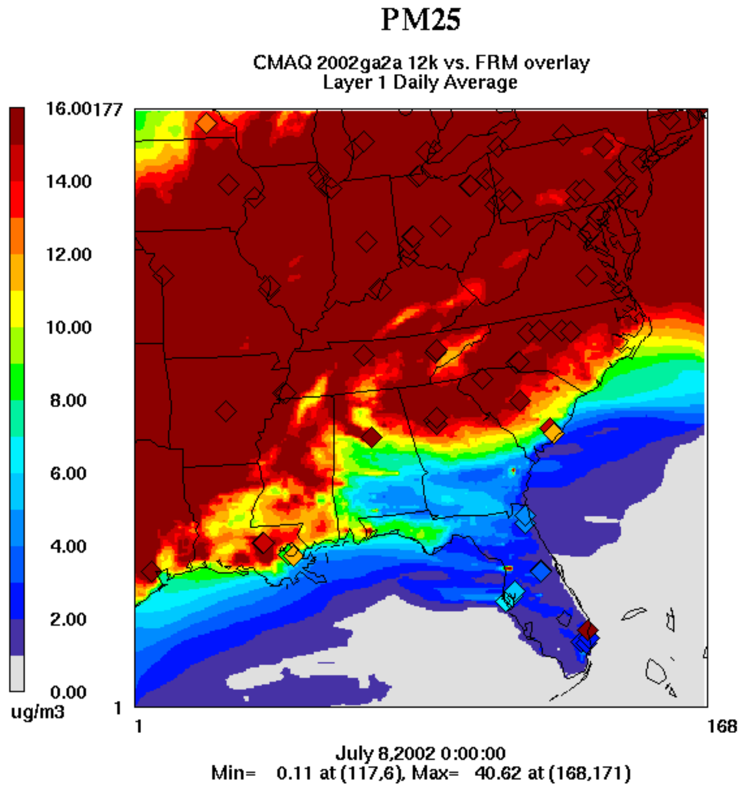


Figure 3-24: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 8, 2002

3.13 July 9, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/09/02	190	Q3				34.9

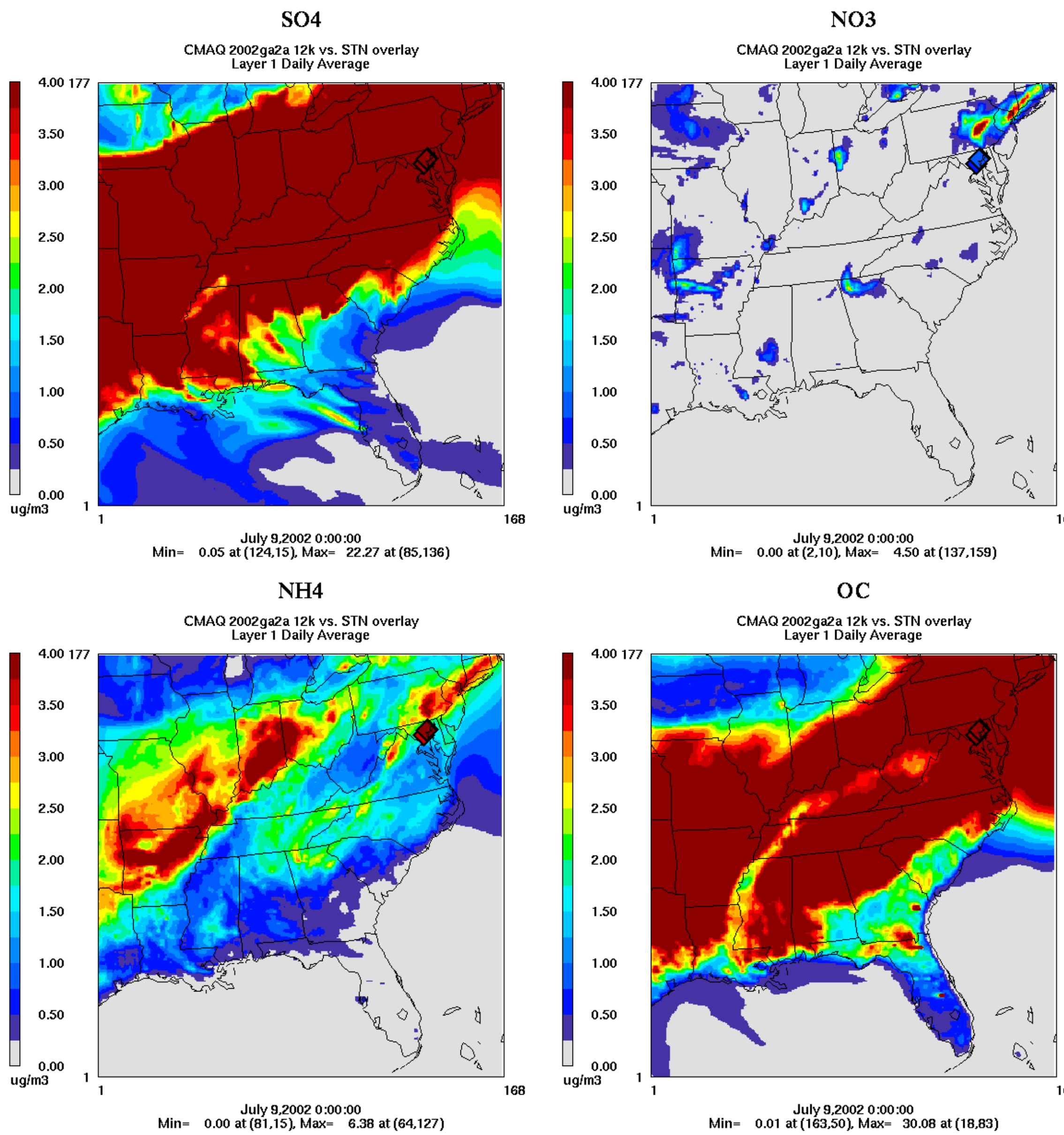
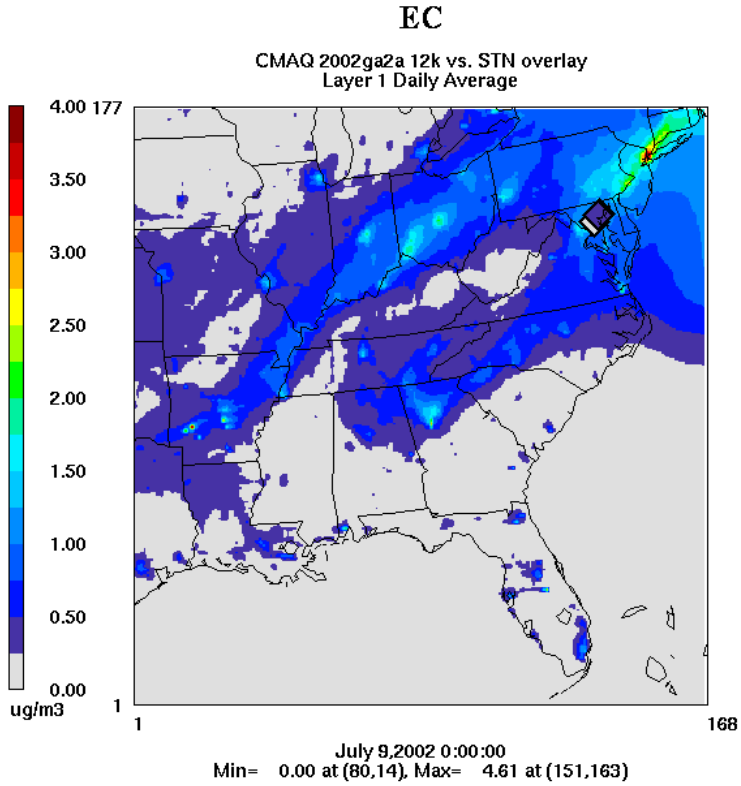


Figure 3-25: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 9, 2002



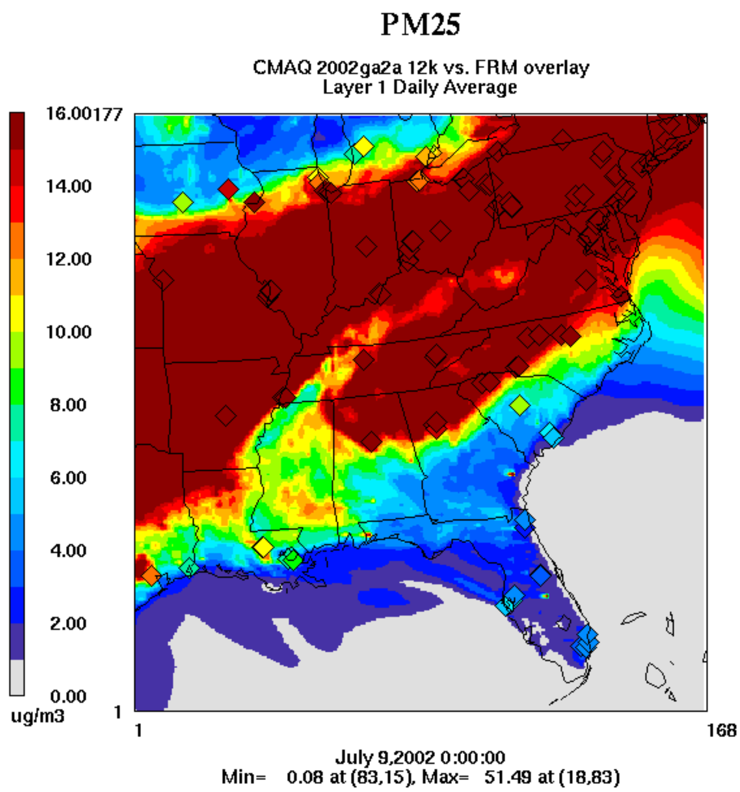


Figure 3-26: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 9, 2002

3.14 July 16, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/16/02	197	Q3		33.5	33.1	34.8

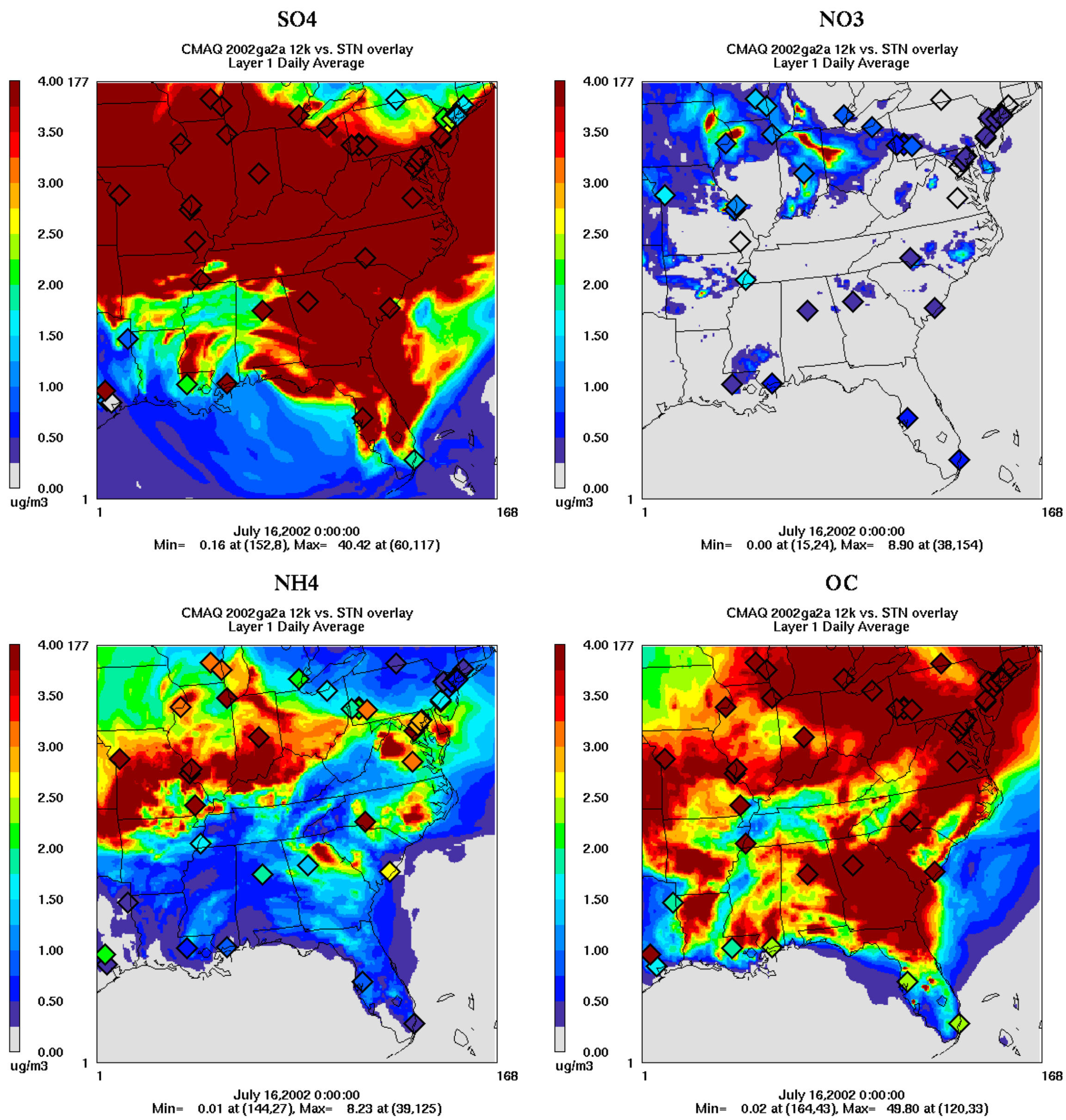
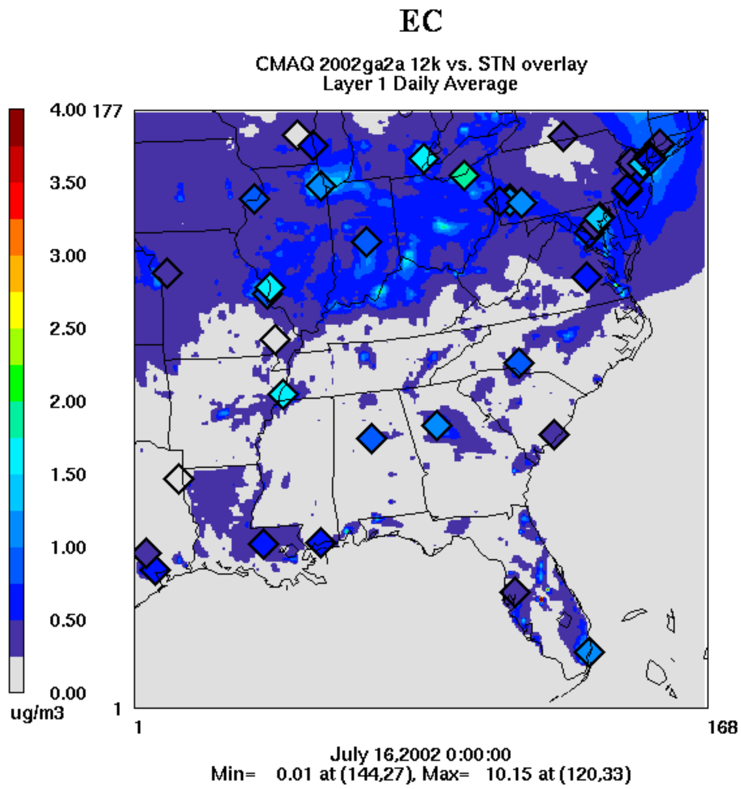


Figure 3-27: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 16, 2002



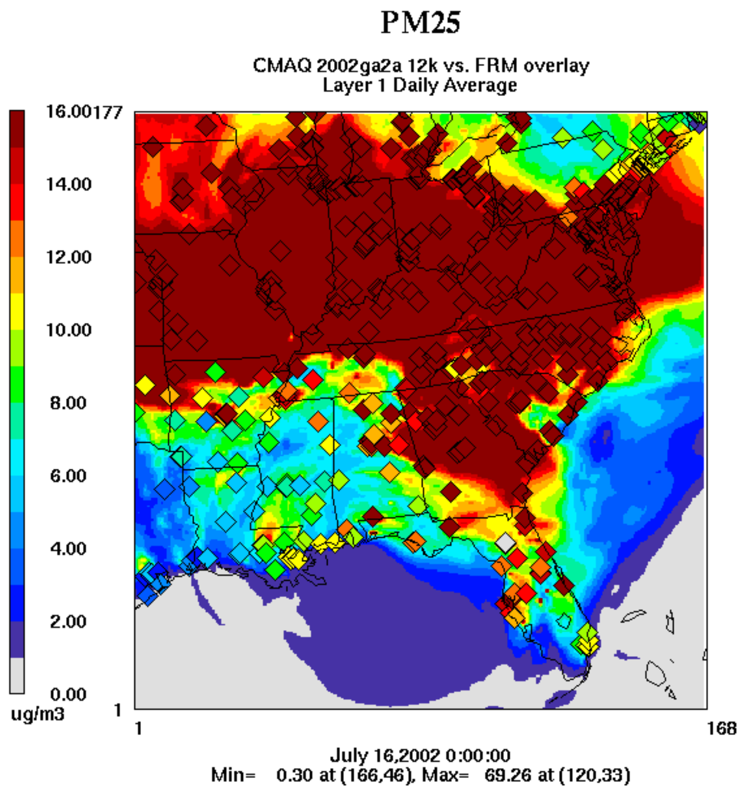


Figure 3-28: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 16, 2002

3.15 July 17, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/17/02	198	Q3				41.8

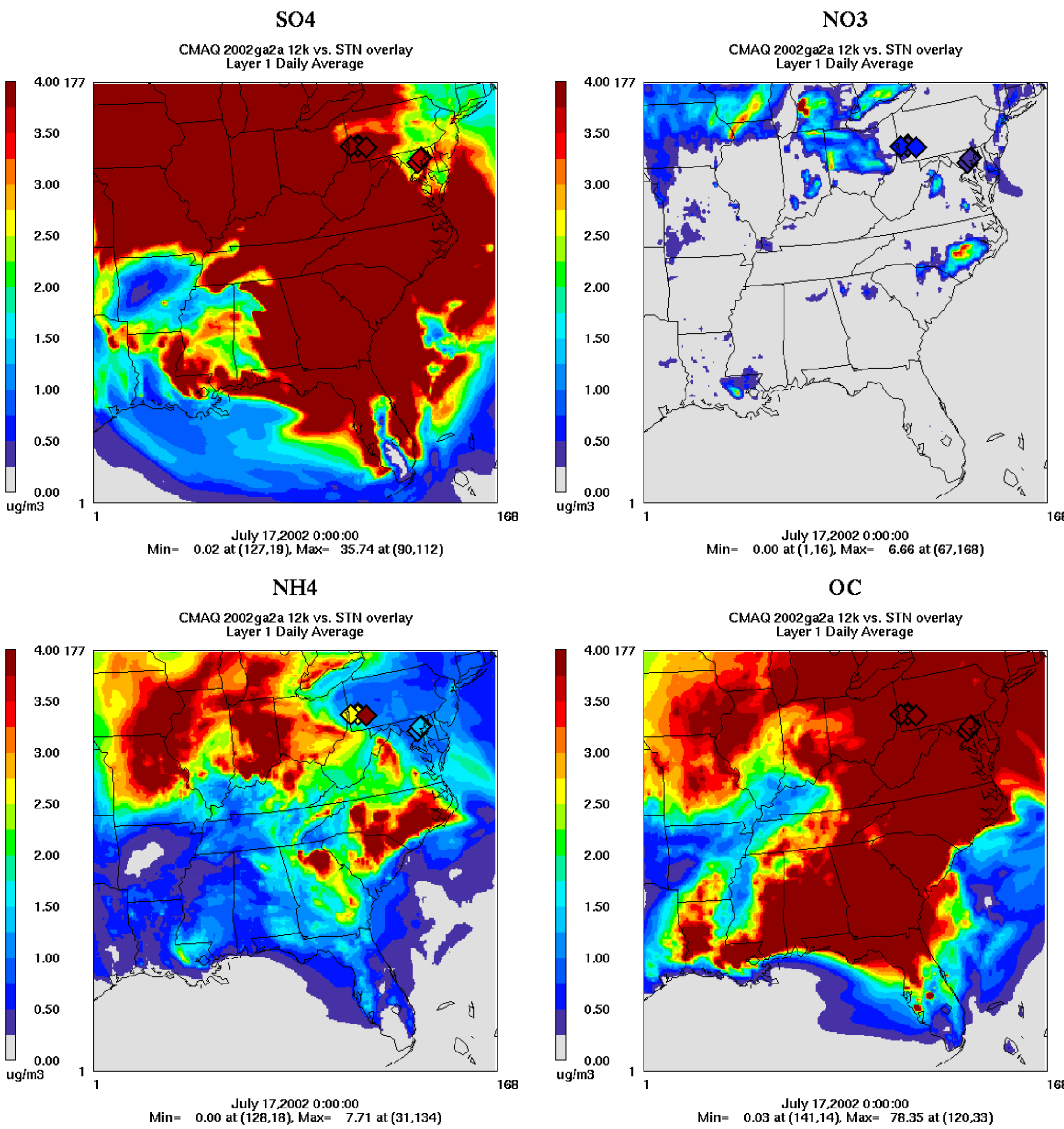


Figure 3-29: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 17, 2002

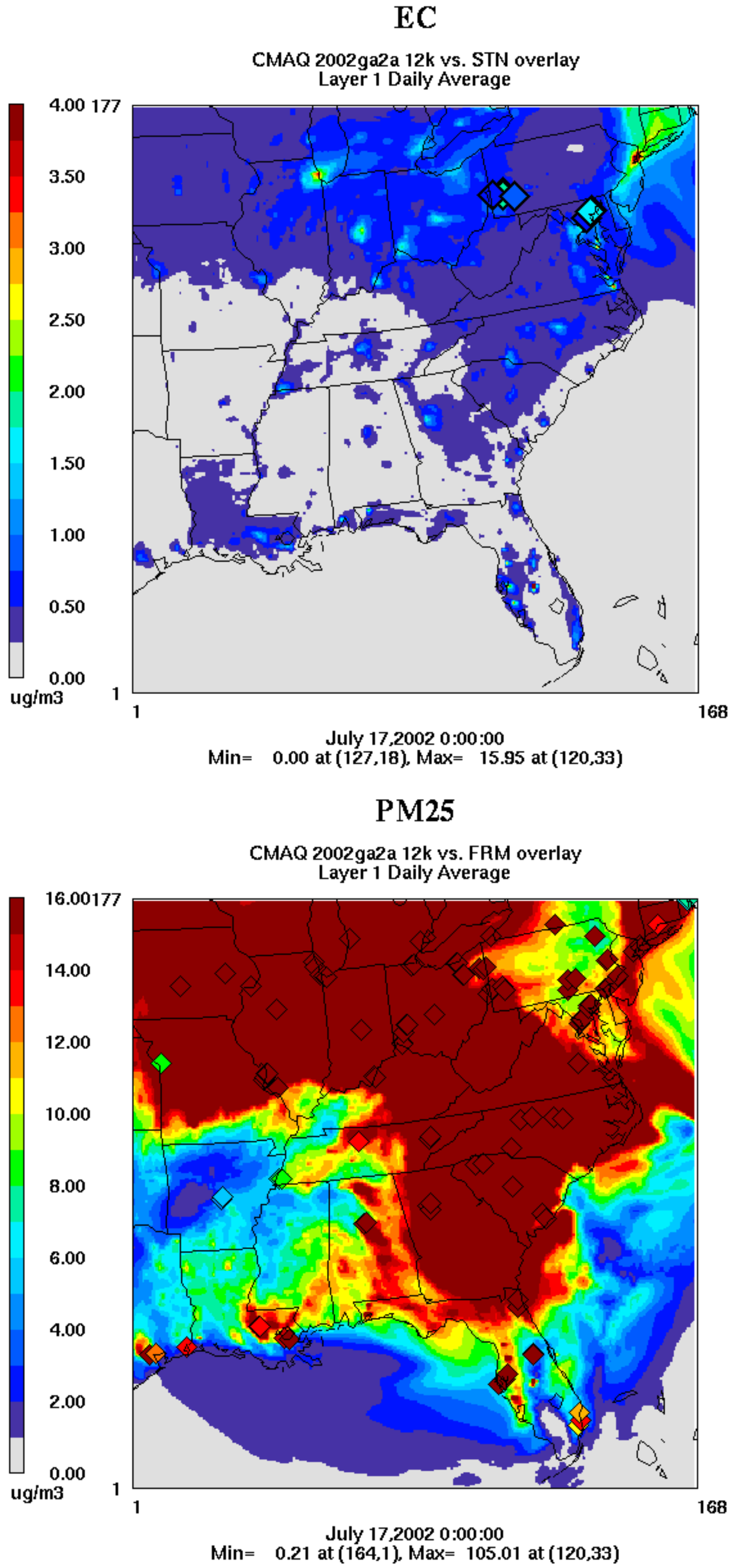


Figure 3-30: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 17, 2002

3.16 July 18, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/18/02	199	Q3				41.8

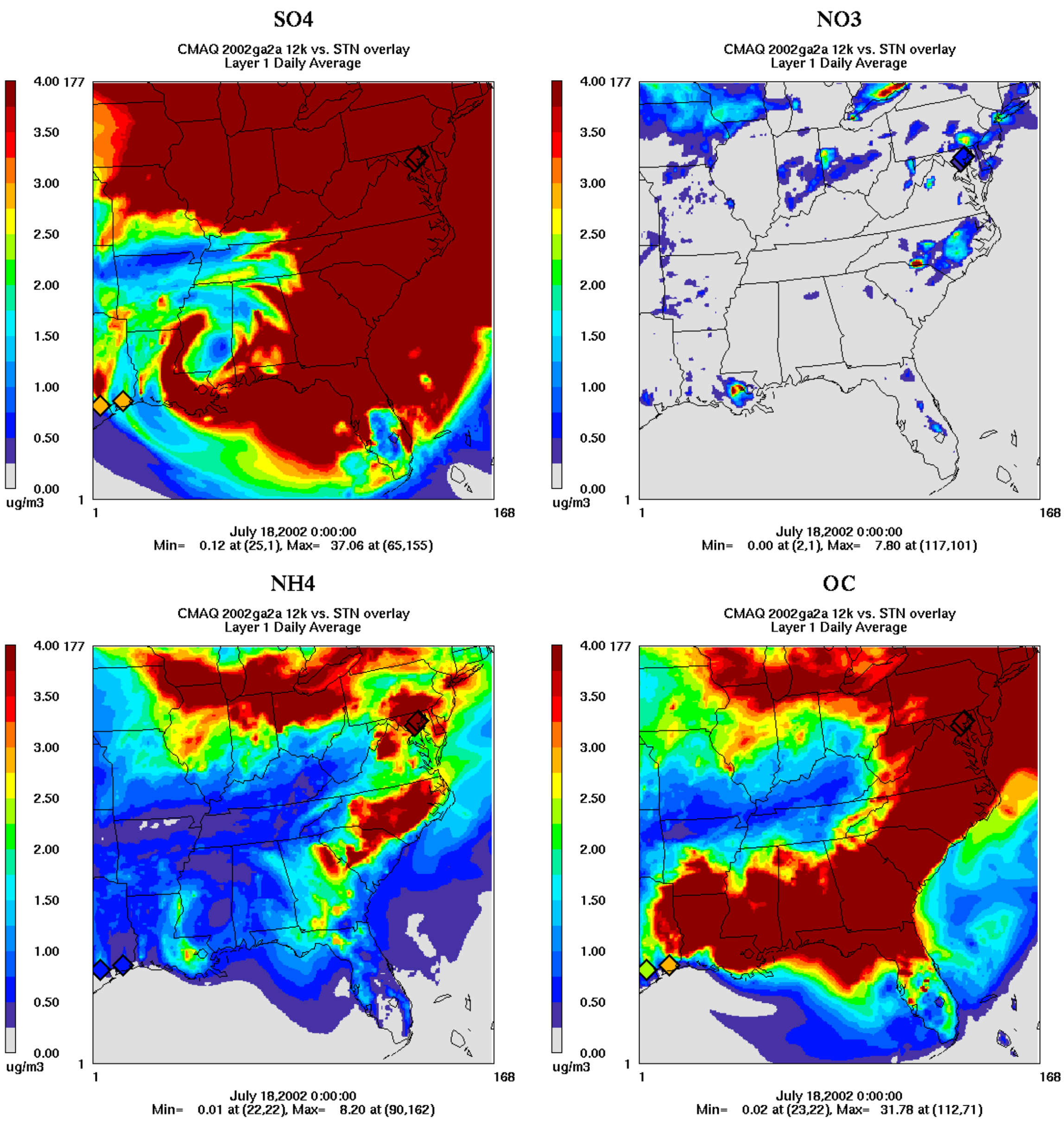
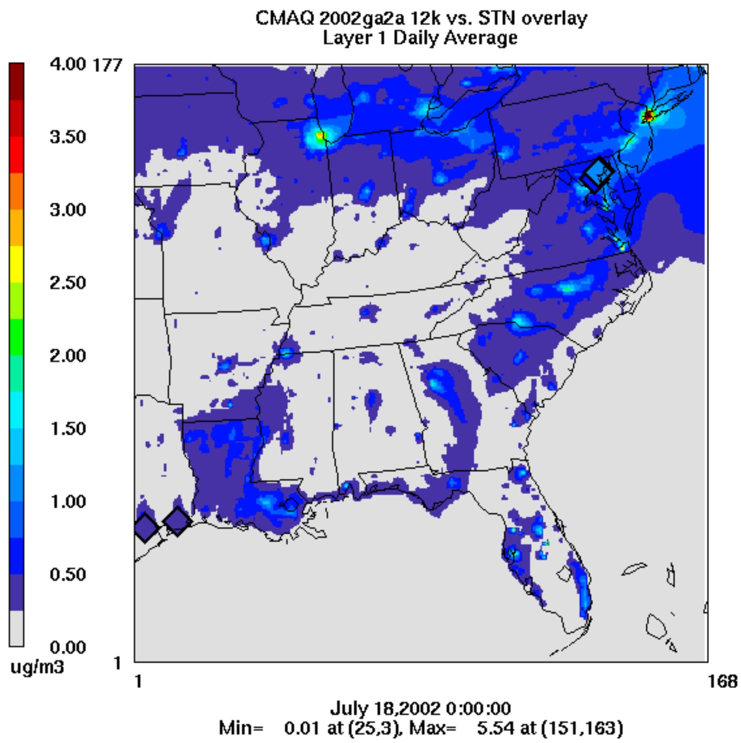


Figure 3-31: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For July 18, 2002

EC



PM25

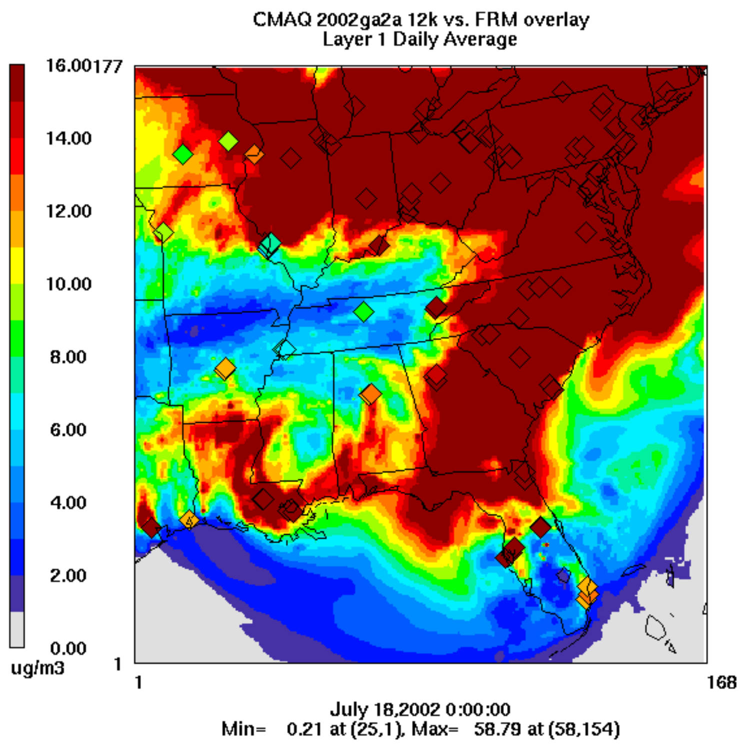


Figure 3-32: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For July 18, 2002

3.17 August 2, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/02/02	214	Q3				31.4

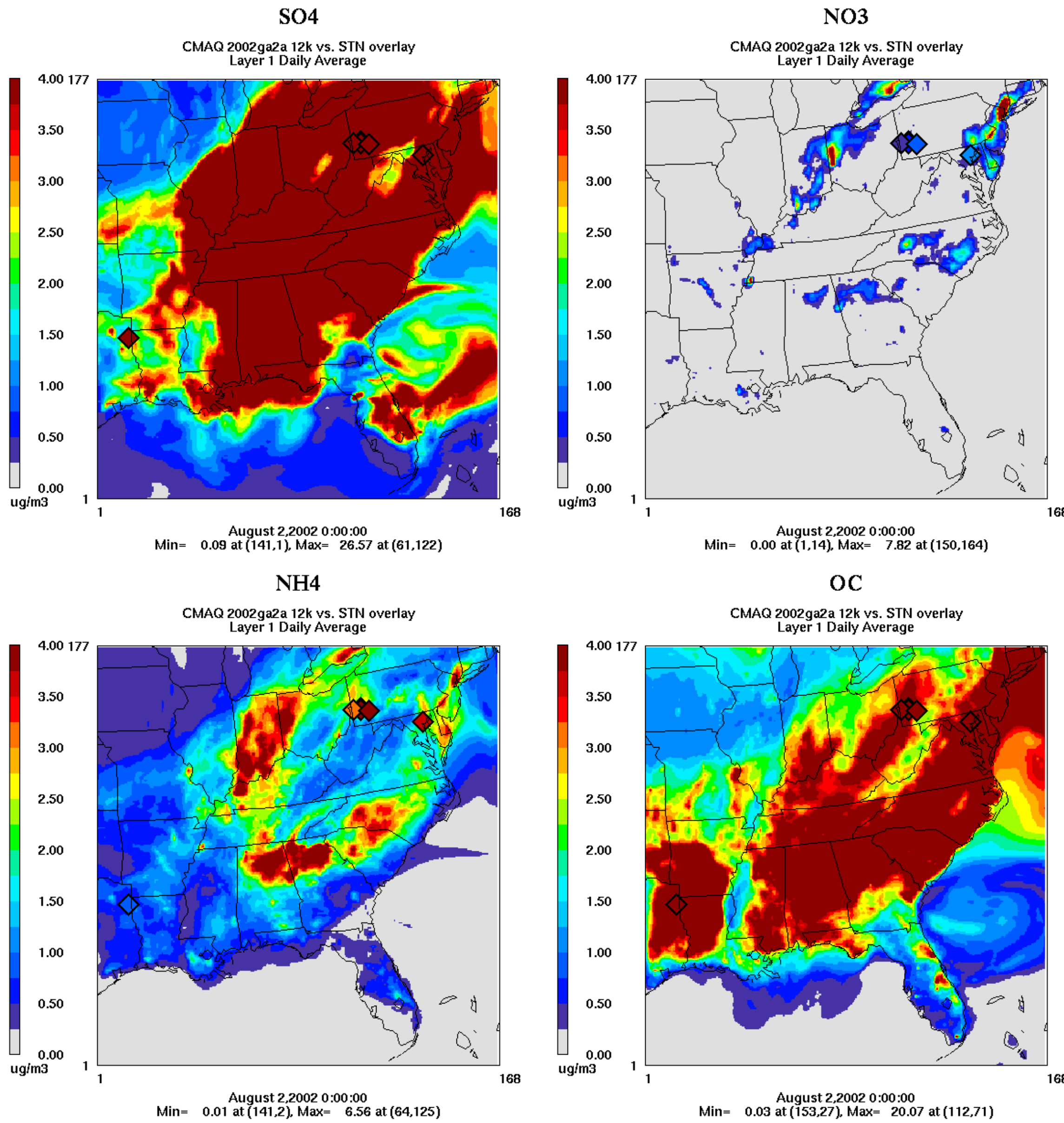
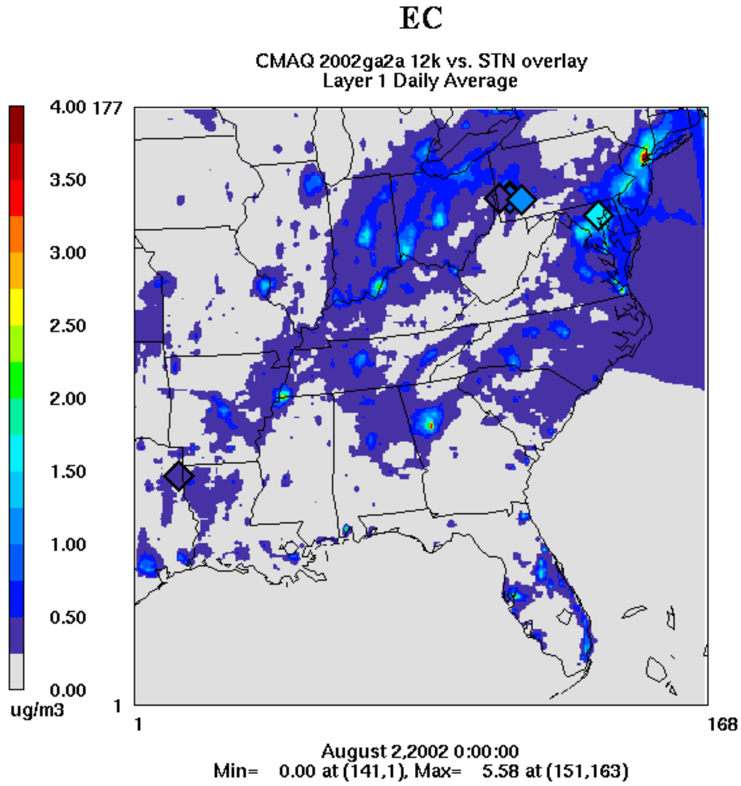


Figure 3-33: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For August 2, 2002



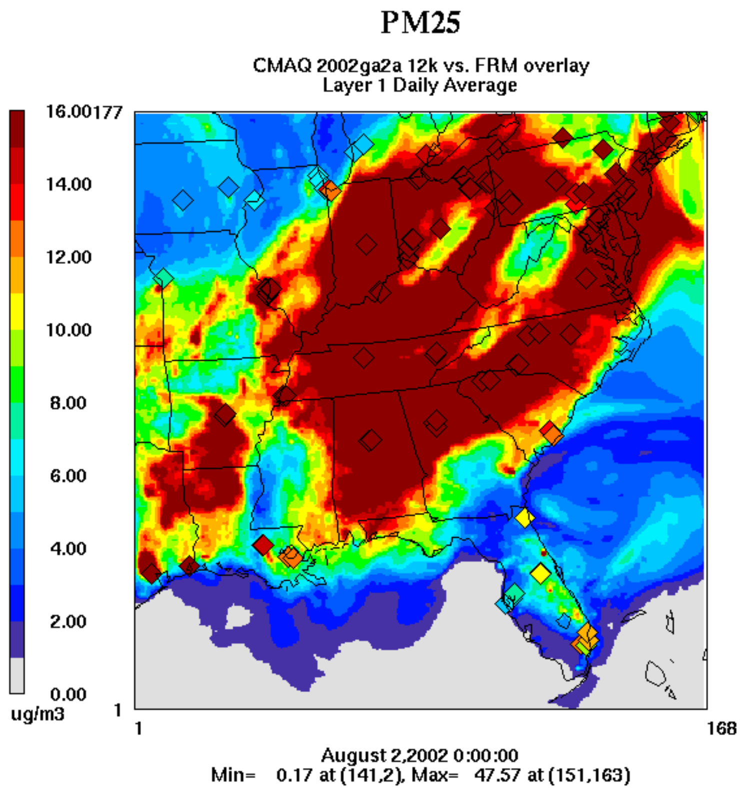


Figure 3-34: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For August 2, 2002

3.18 August 3, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/03/02	215	Q3		30.0	19.5	17.4

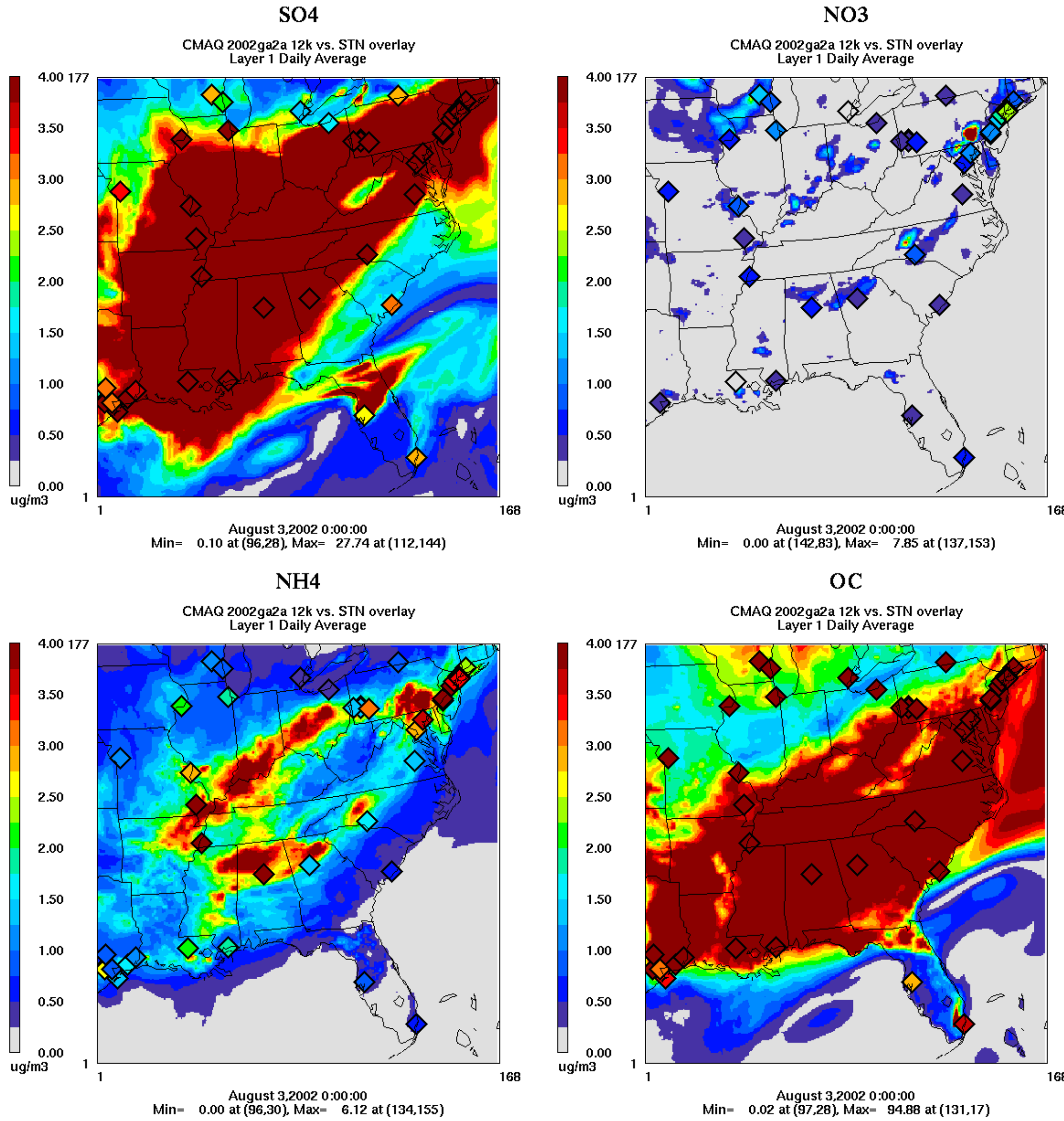
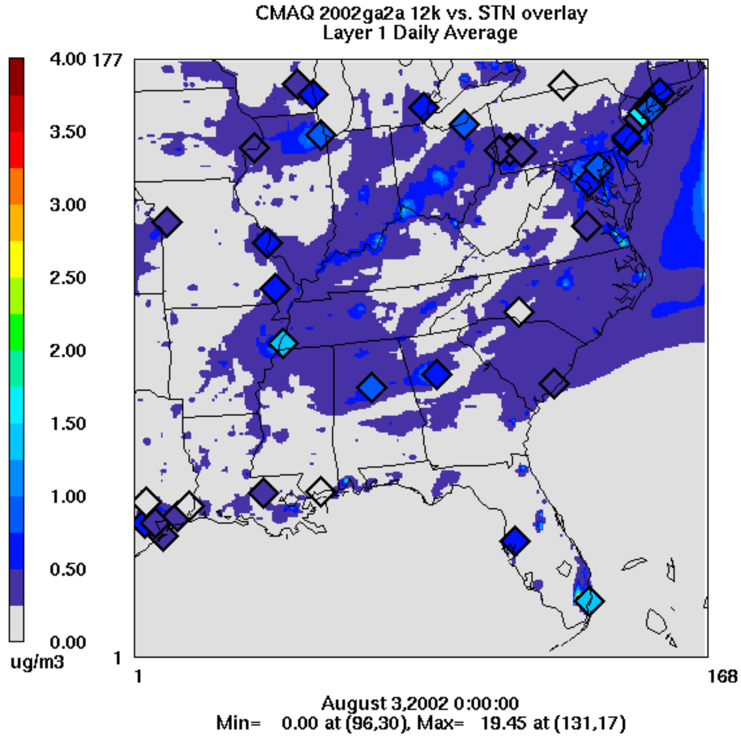


Figure 3-35: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For August 3, 2002

EC



PM25

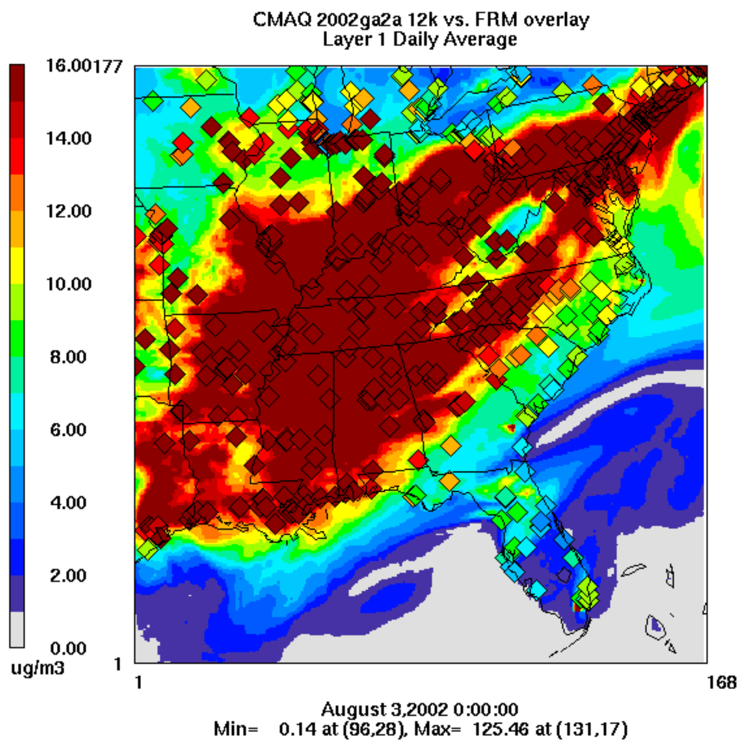


Figure 3-36: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For August 3, 2002

3.19 August 11, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/11/02	223	Q3				33.4

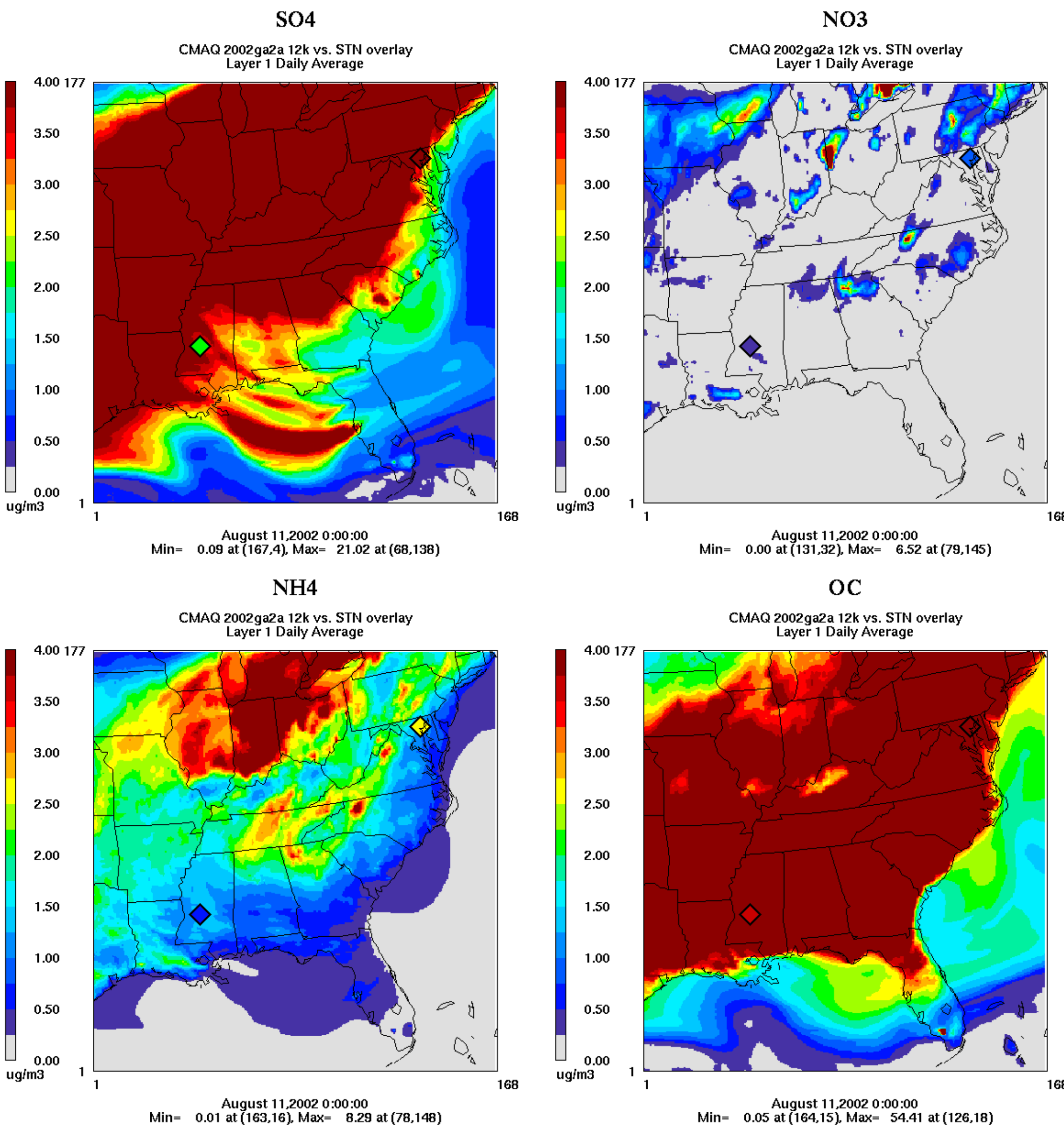
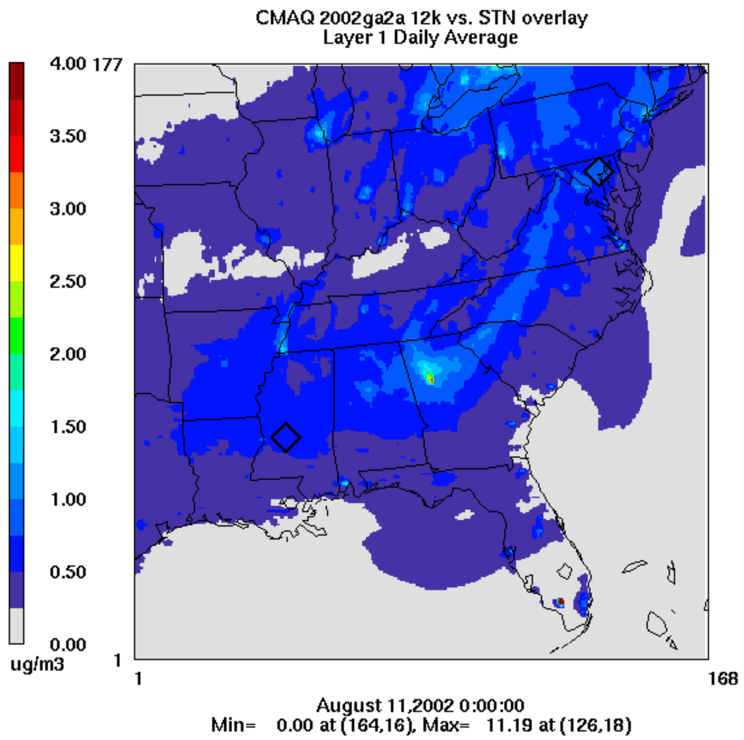


Figure 3-37: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For August 11, 2002

EC



PM25

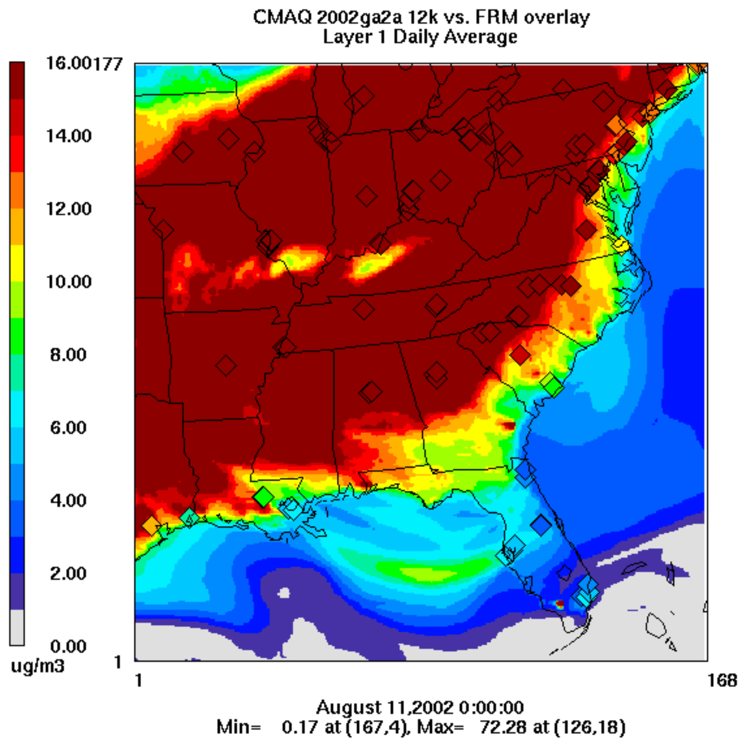


Figure 3-38: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For August 11, 2002

3.20 August 12, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/12/02	224	Q3	33.3	40.7	36.9	

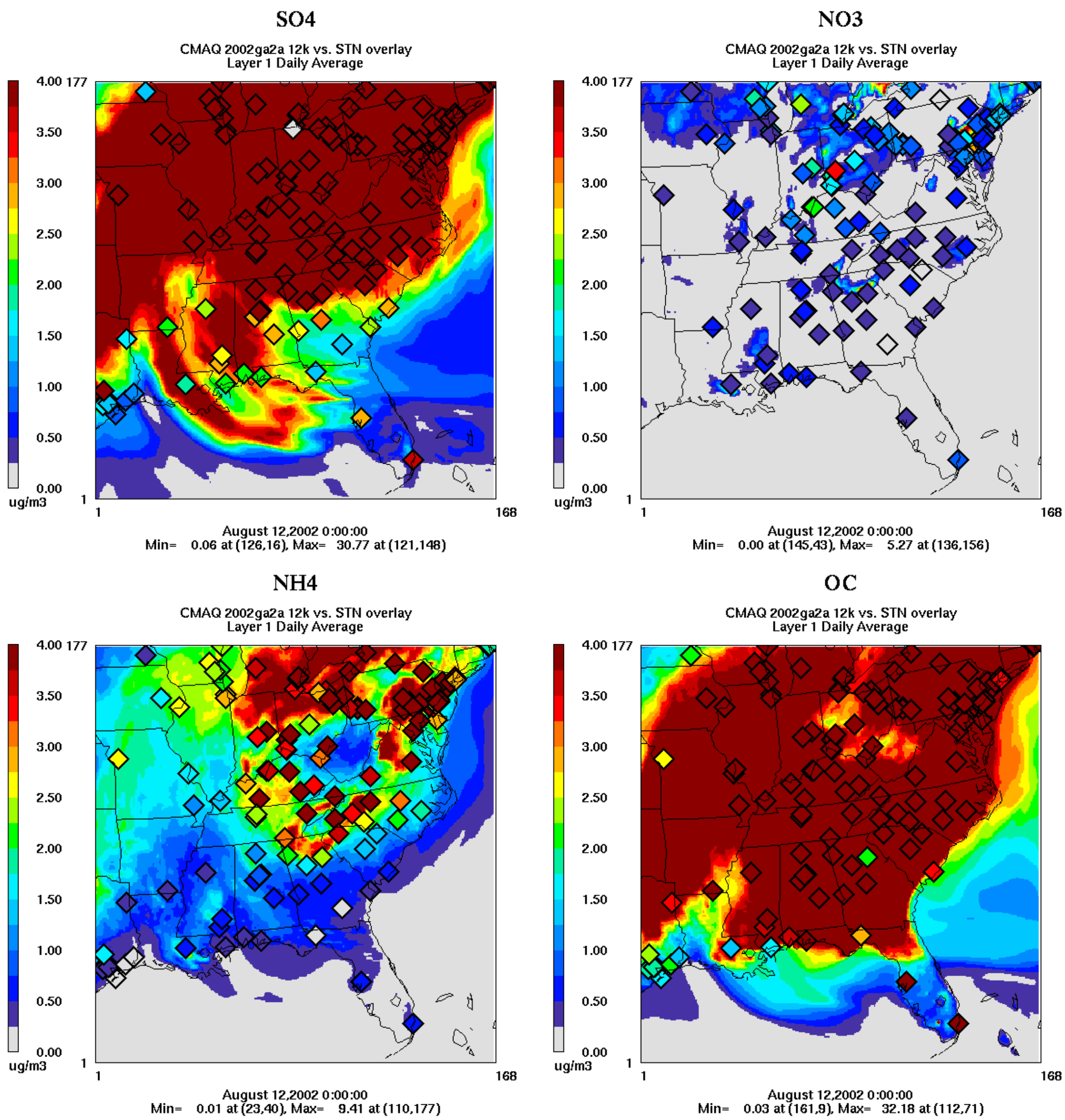
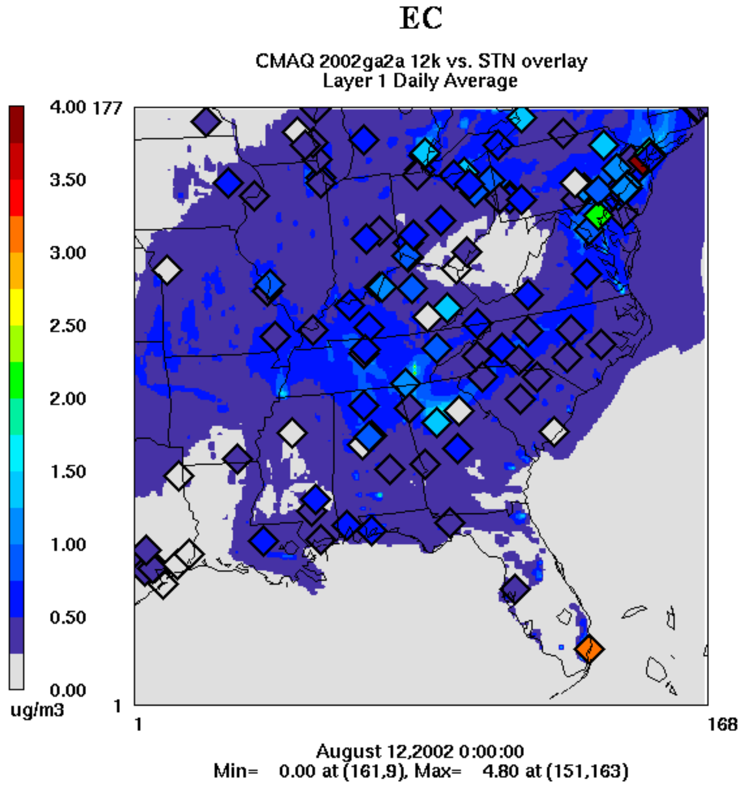


Figure 3-39: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For August 12, 2002



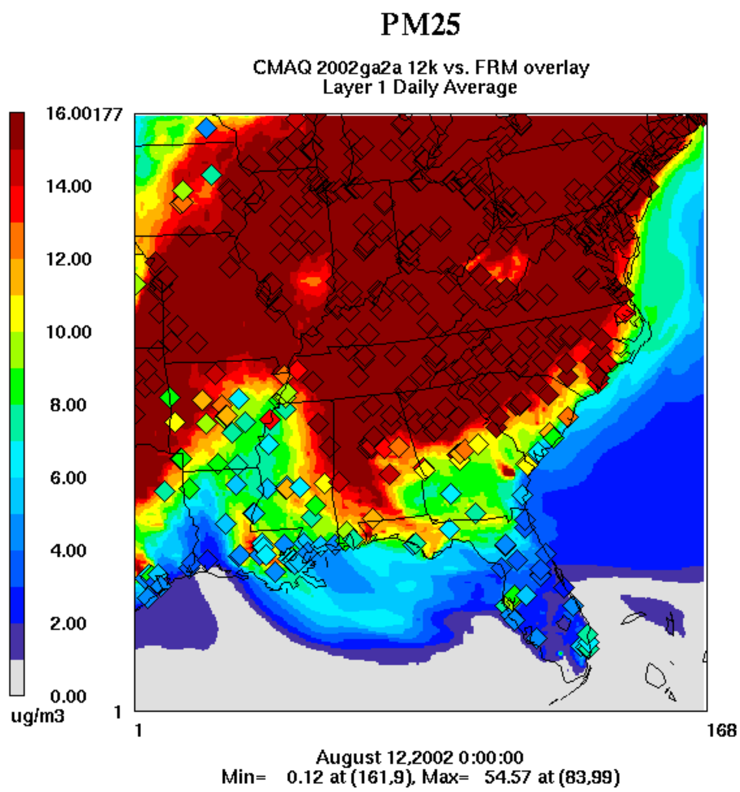


Figure 3-40: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For August 12, 2002

3.21 August 22, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/22/02	234	Q3				31.1

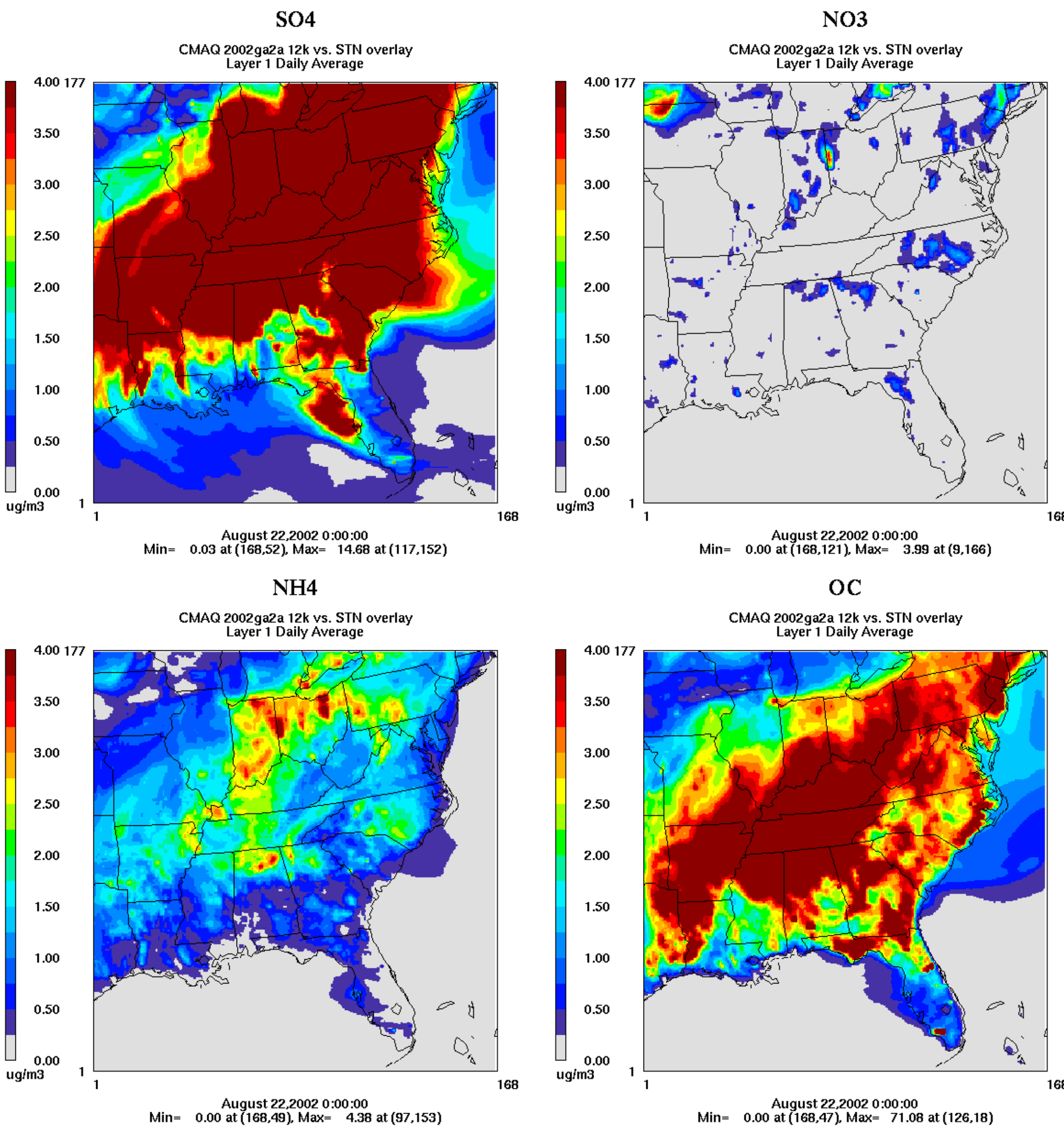
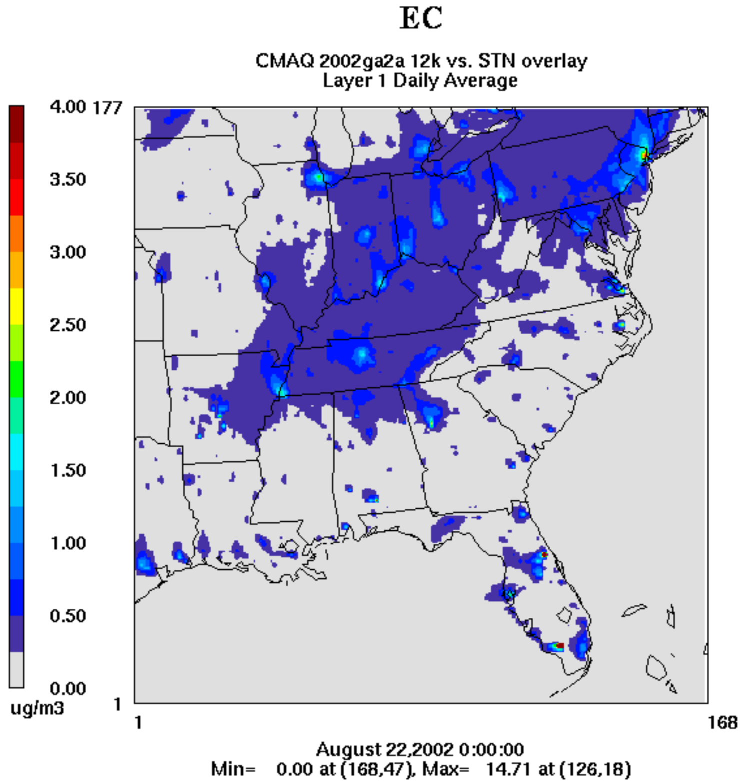


Figure 3-41: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For August 22, 2002



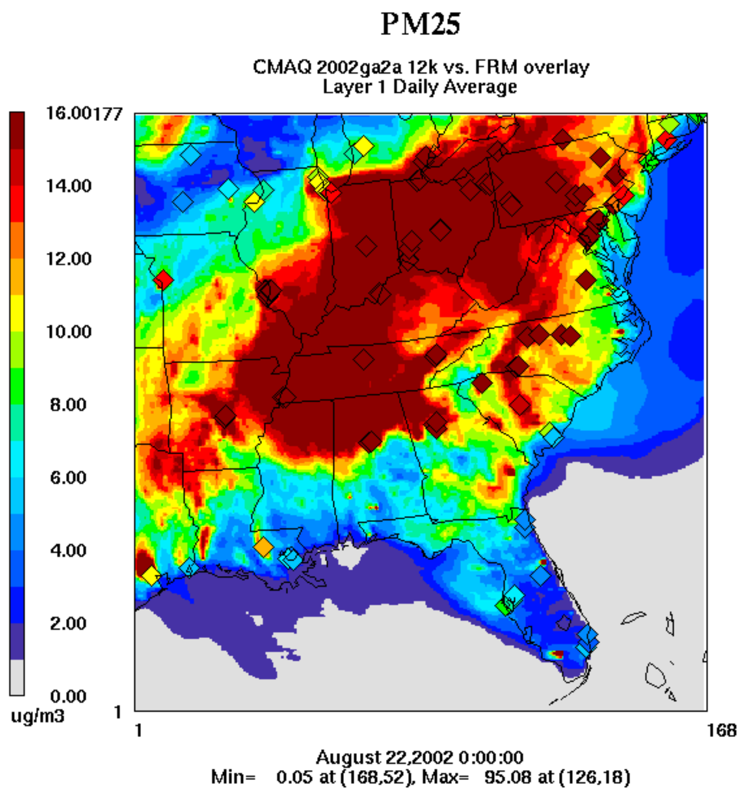


Figure 3-42: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For August 22, 2002

3.22 August 23, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/23/02	235	Q3				33.2

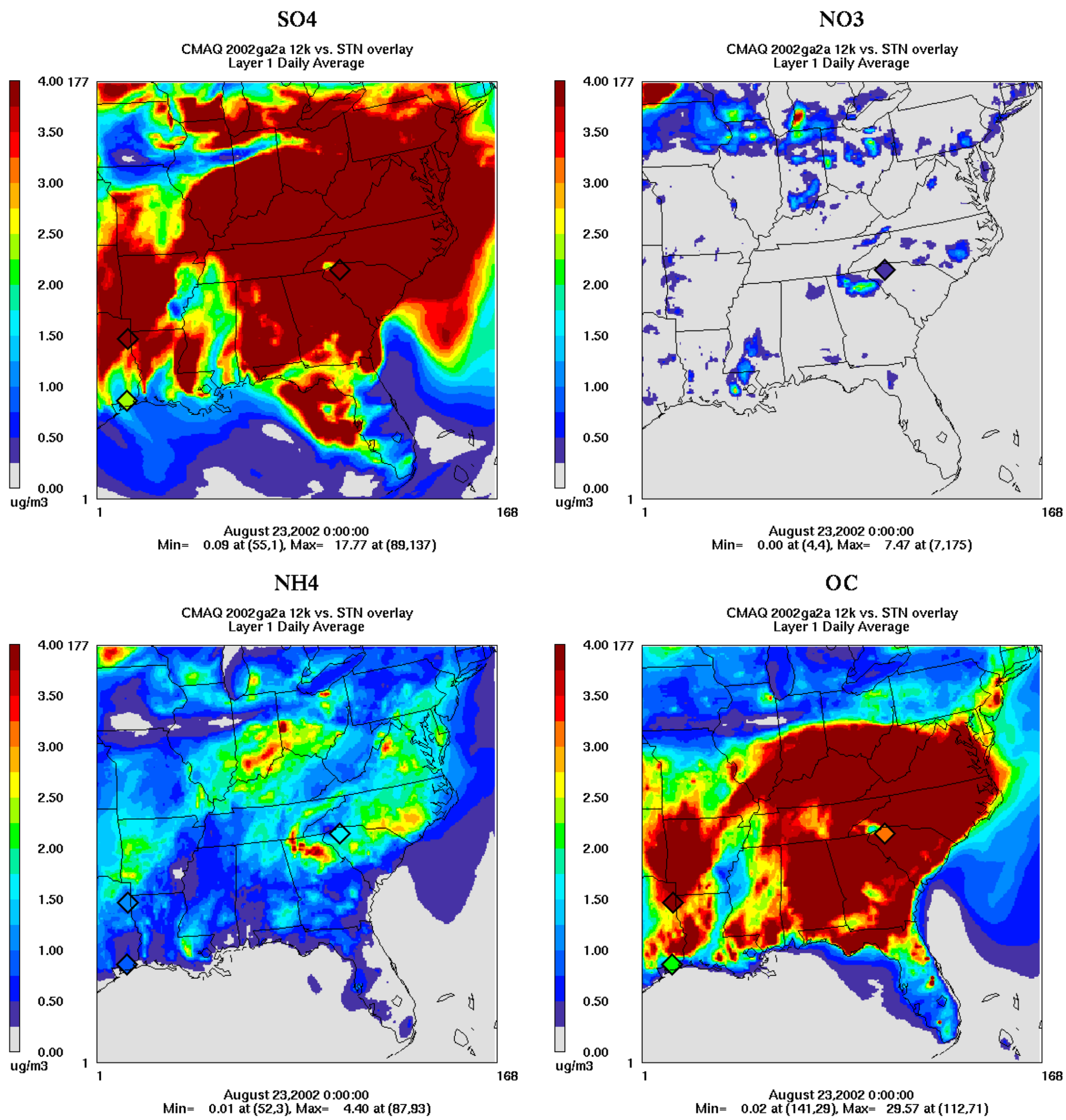
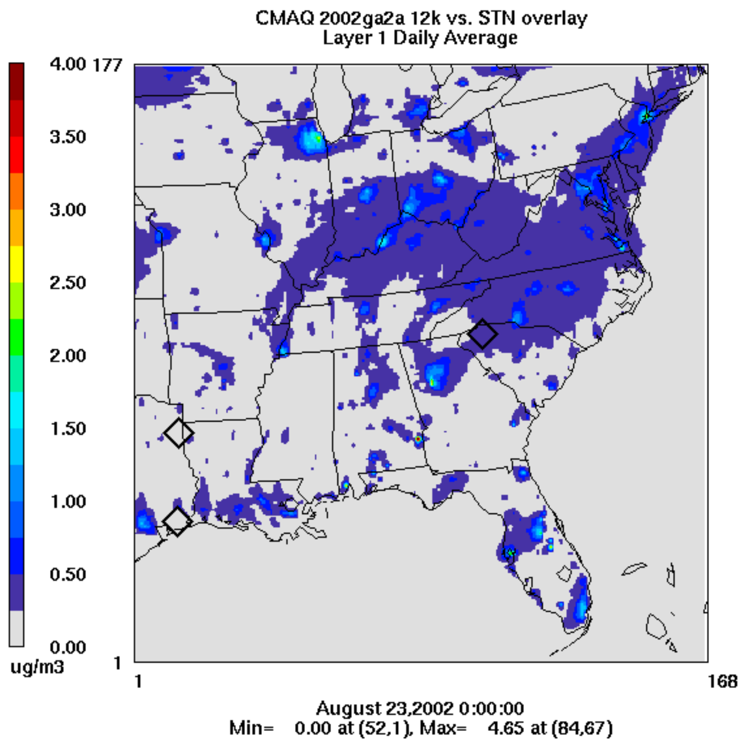


Figure 3-43: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For August 23, 2002

EC



PM25

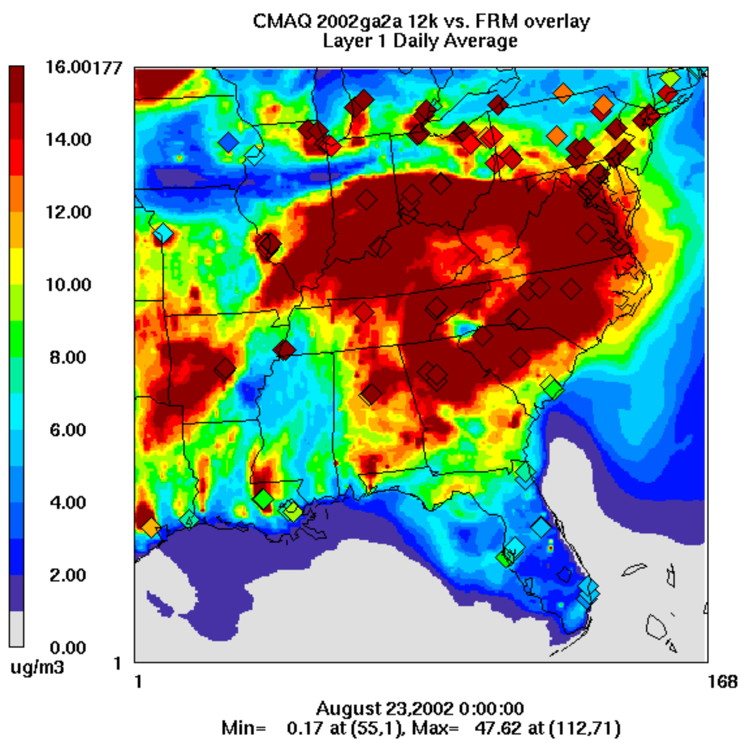


Figure 3-44: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For August 23, 2002

3.23 September 17, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
09/17/02	260	Q3	30.6	27.6		21.2

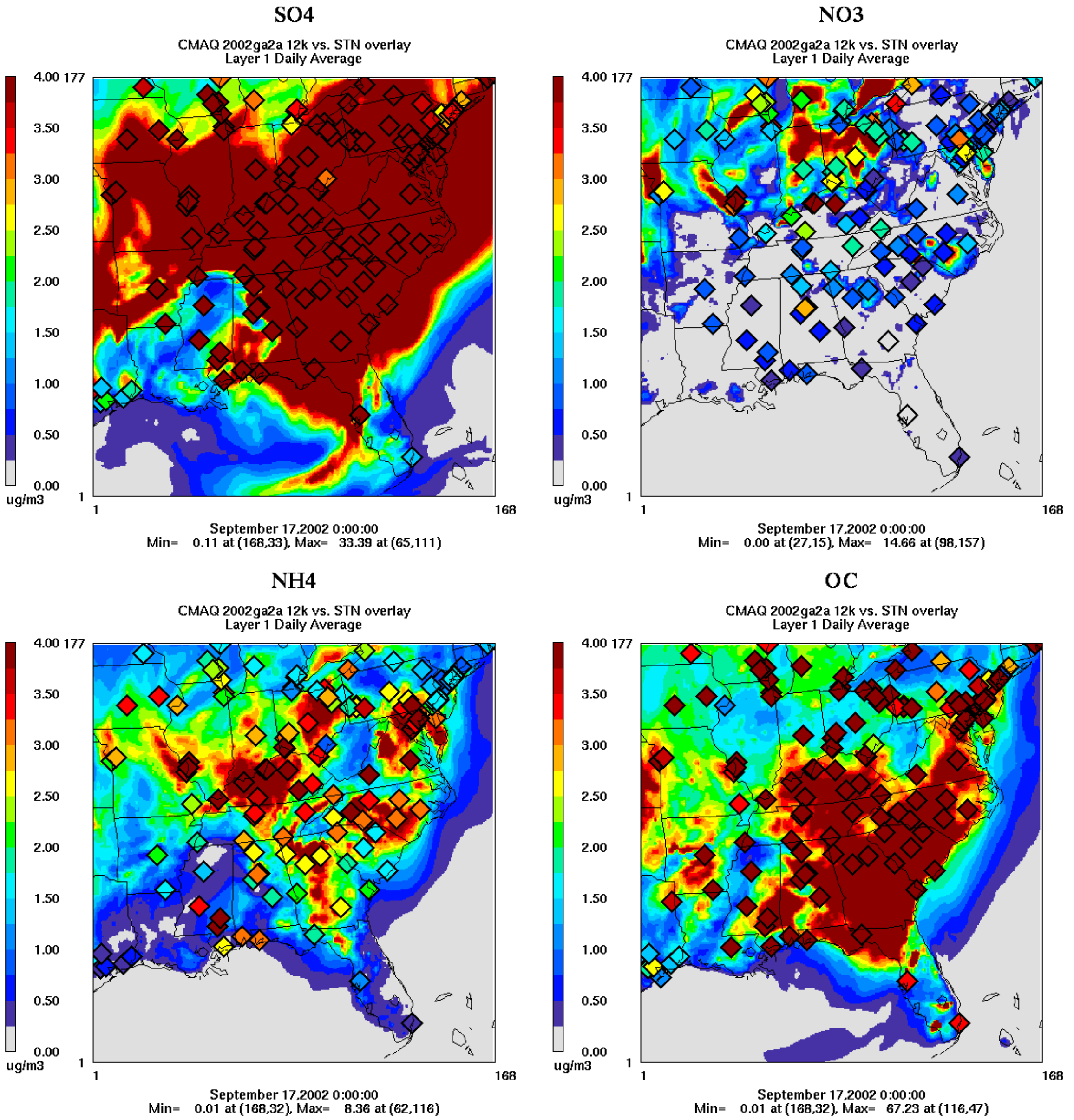
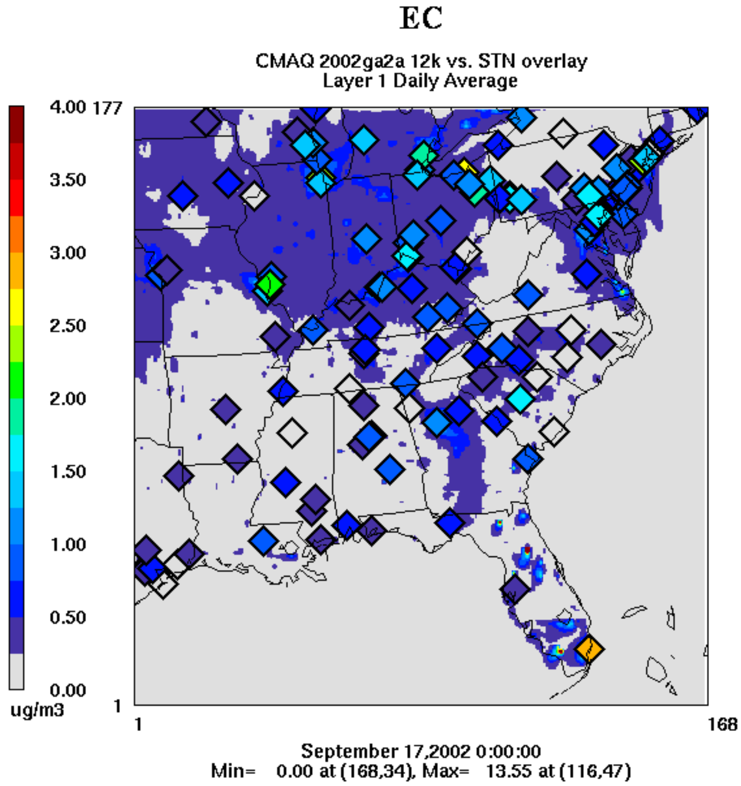


Figure 3-45: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For September 17, 2002



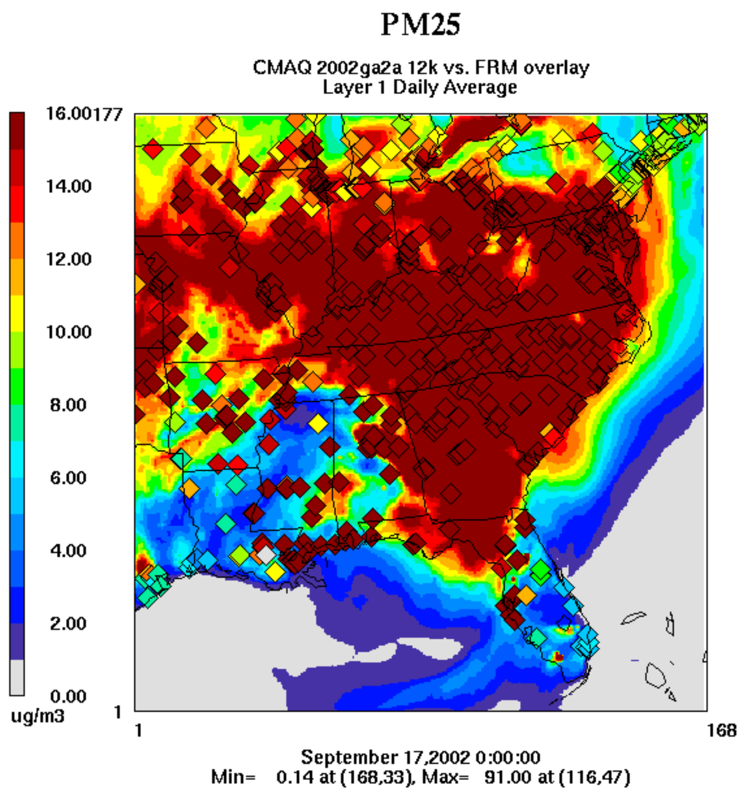


Figure 3-46: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For September 17, 2002

3.24 September 18, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
09/18/02	261	Q3				30.5

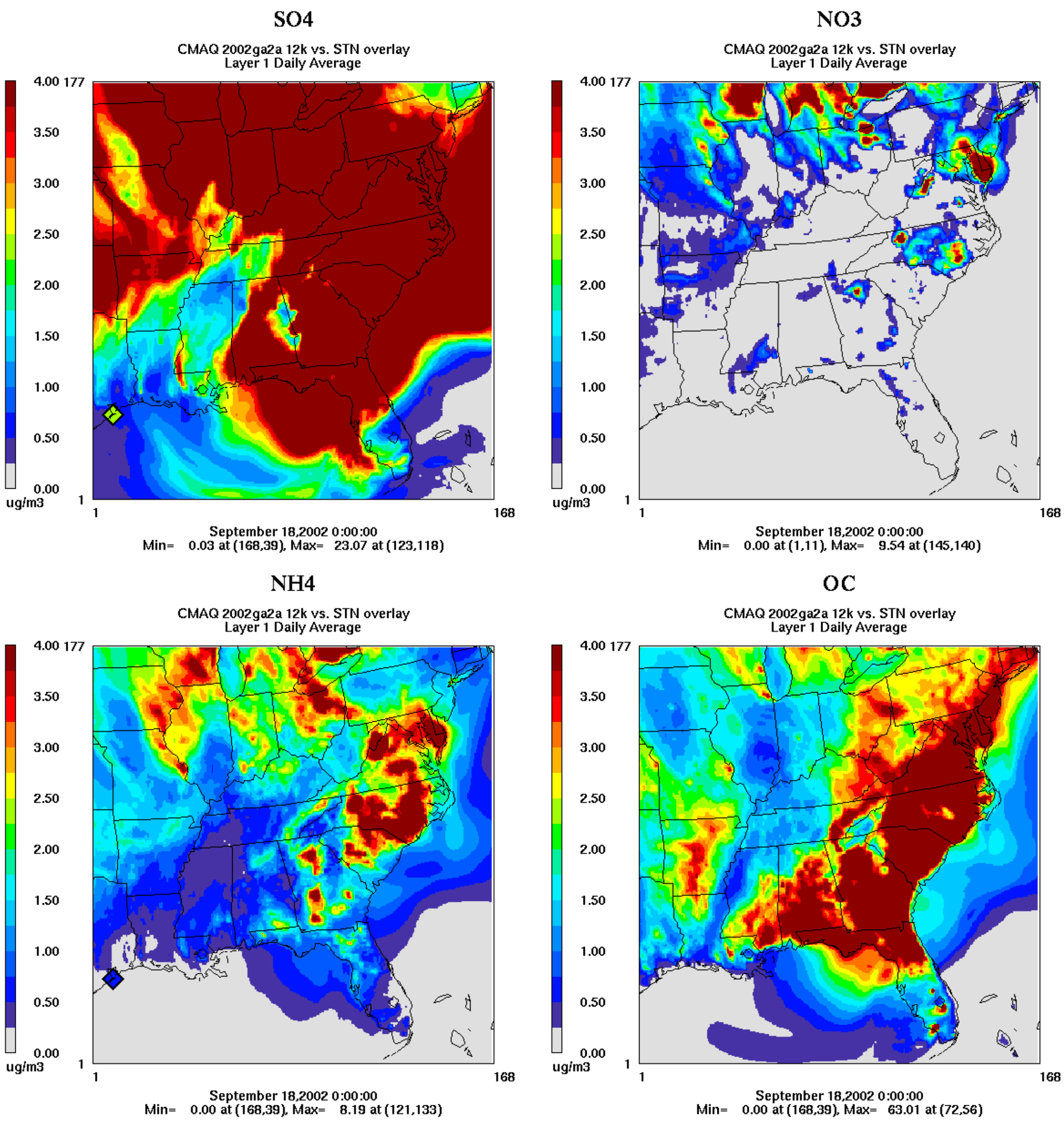
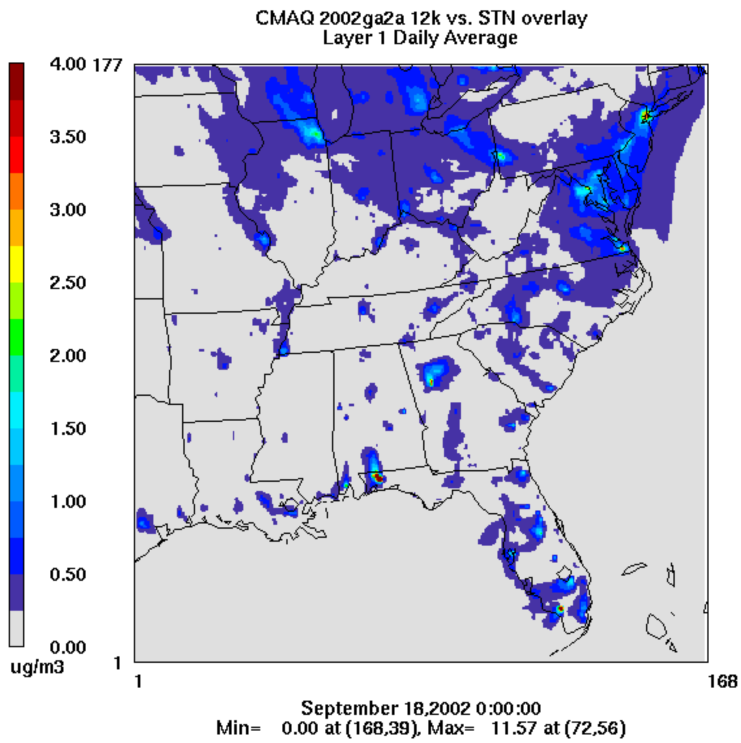


Figure 3-47: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For September 18, 2002

EC



PM25

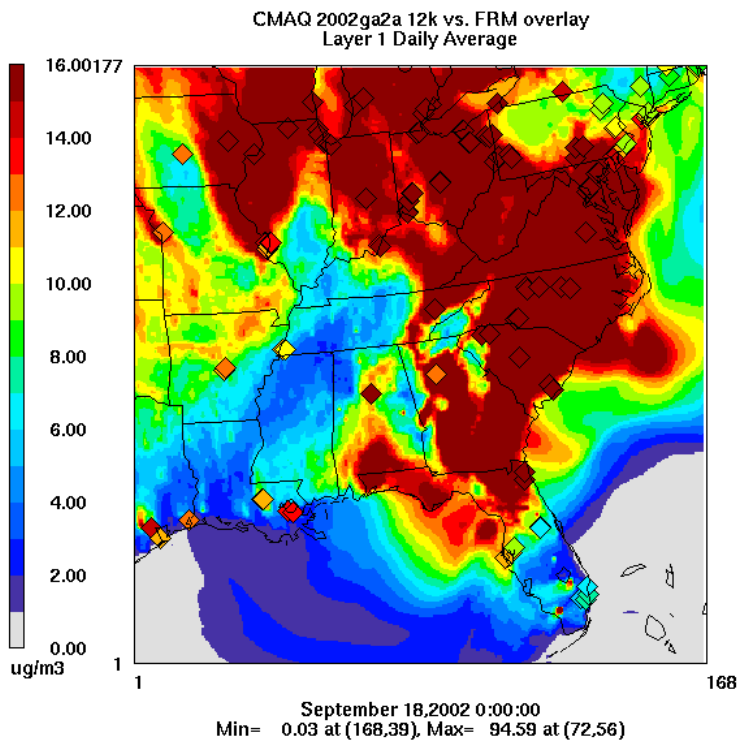


Figure 3-48: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For September 18, 2002

3.25 November 21, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
11/21/02	325	Q4				26.6

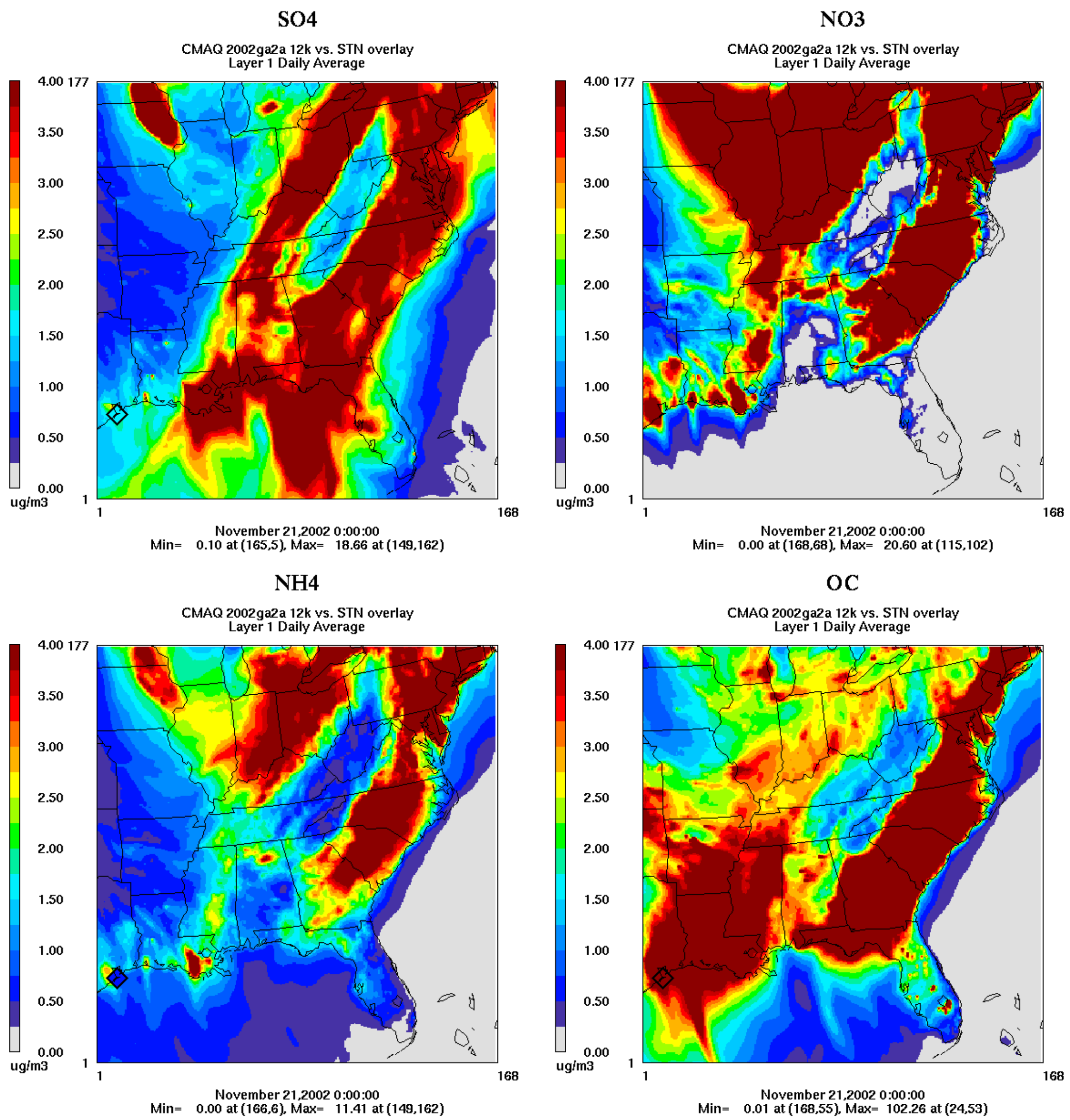
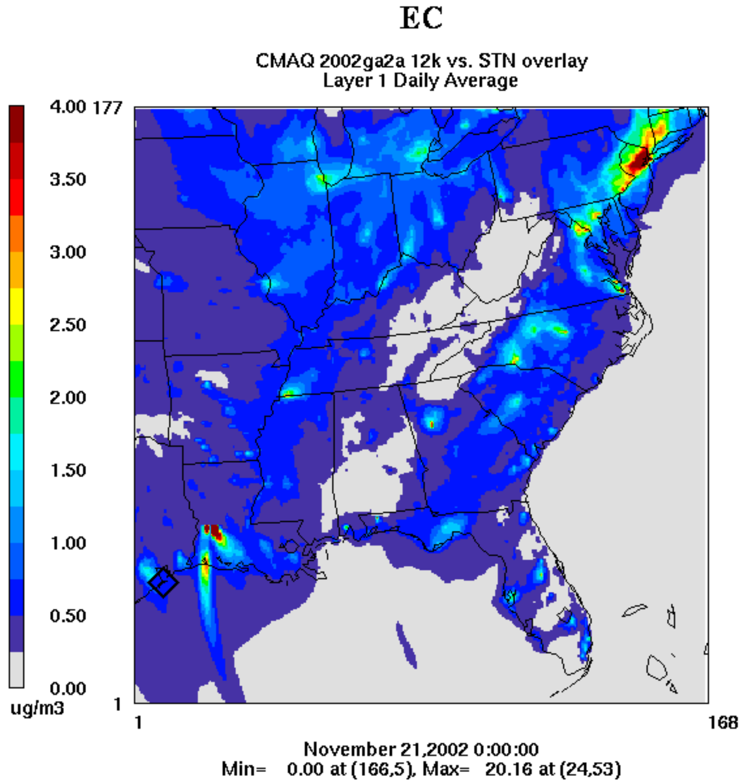


Figure 3-49: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For November 21, 2002



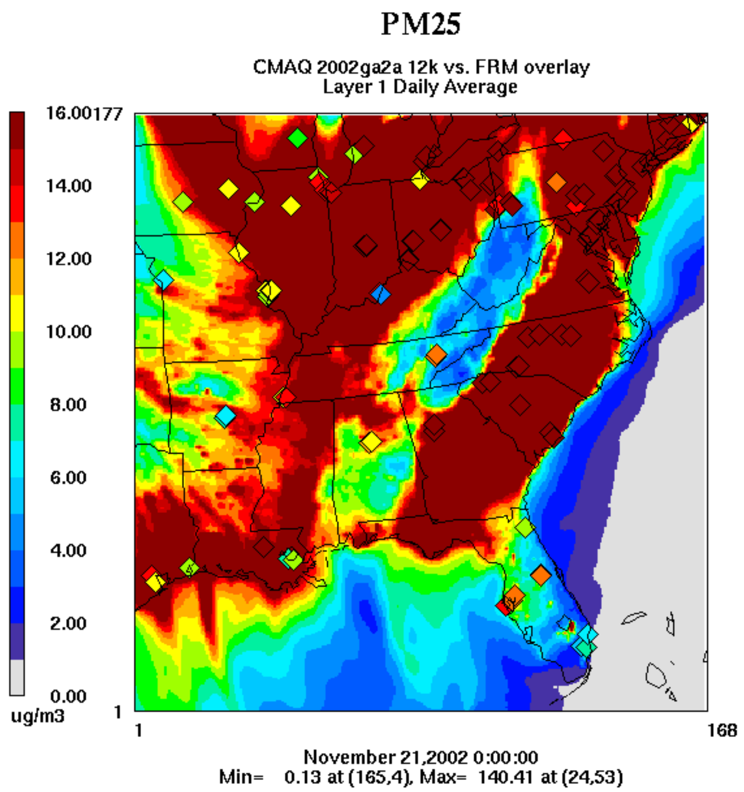


Figure 3-50: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For November 21, 2002

3.26 November 25, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
11/25/02	329	Q4		19.3	25.9	19.9

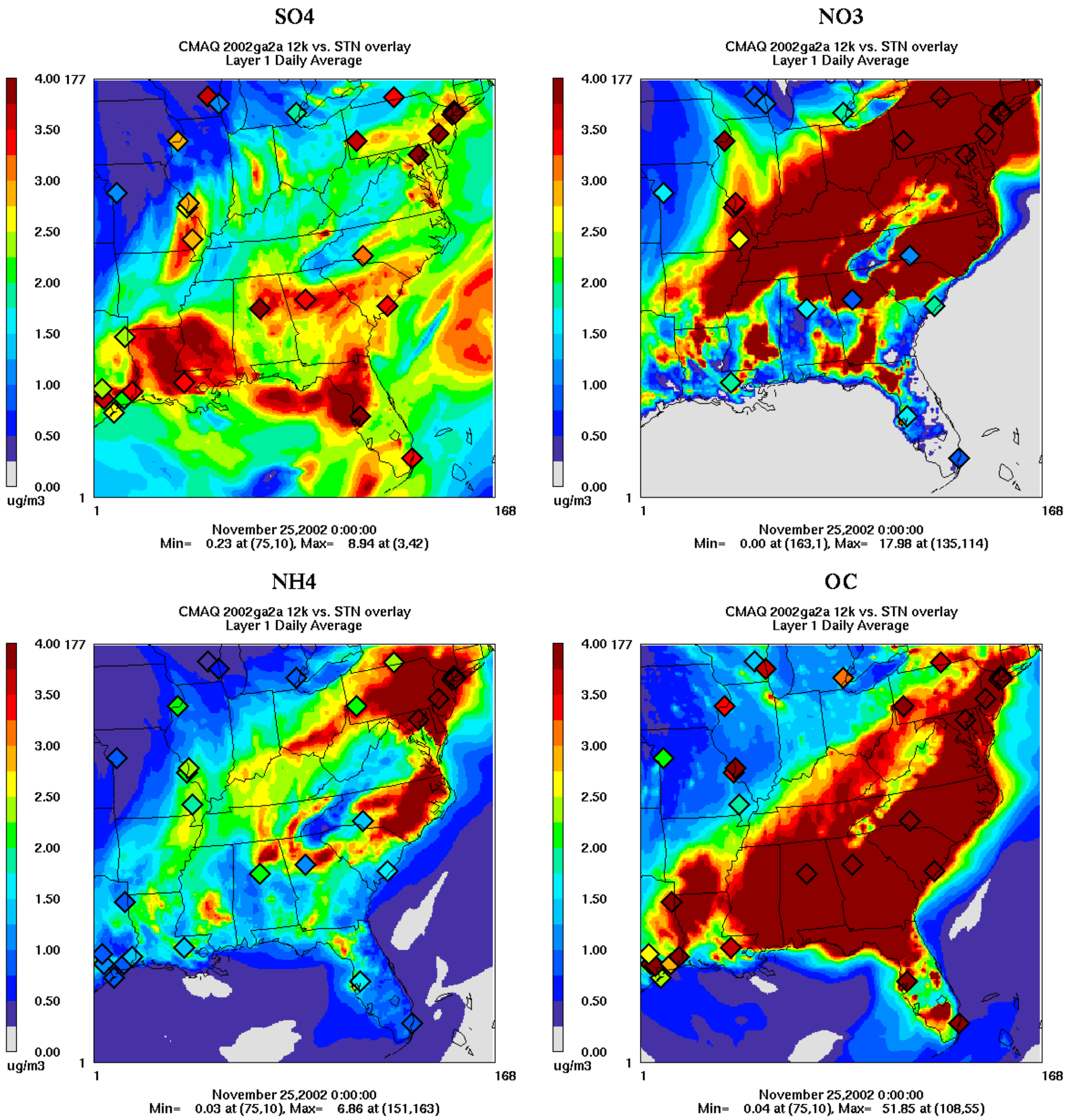


Figure 3-51: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For November 25, 2002

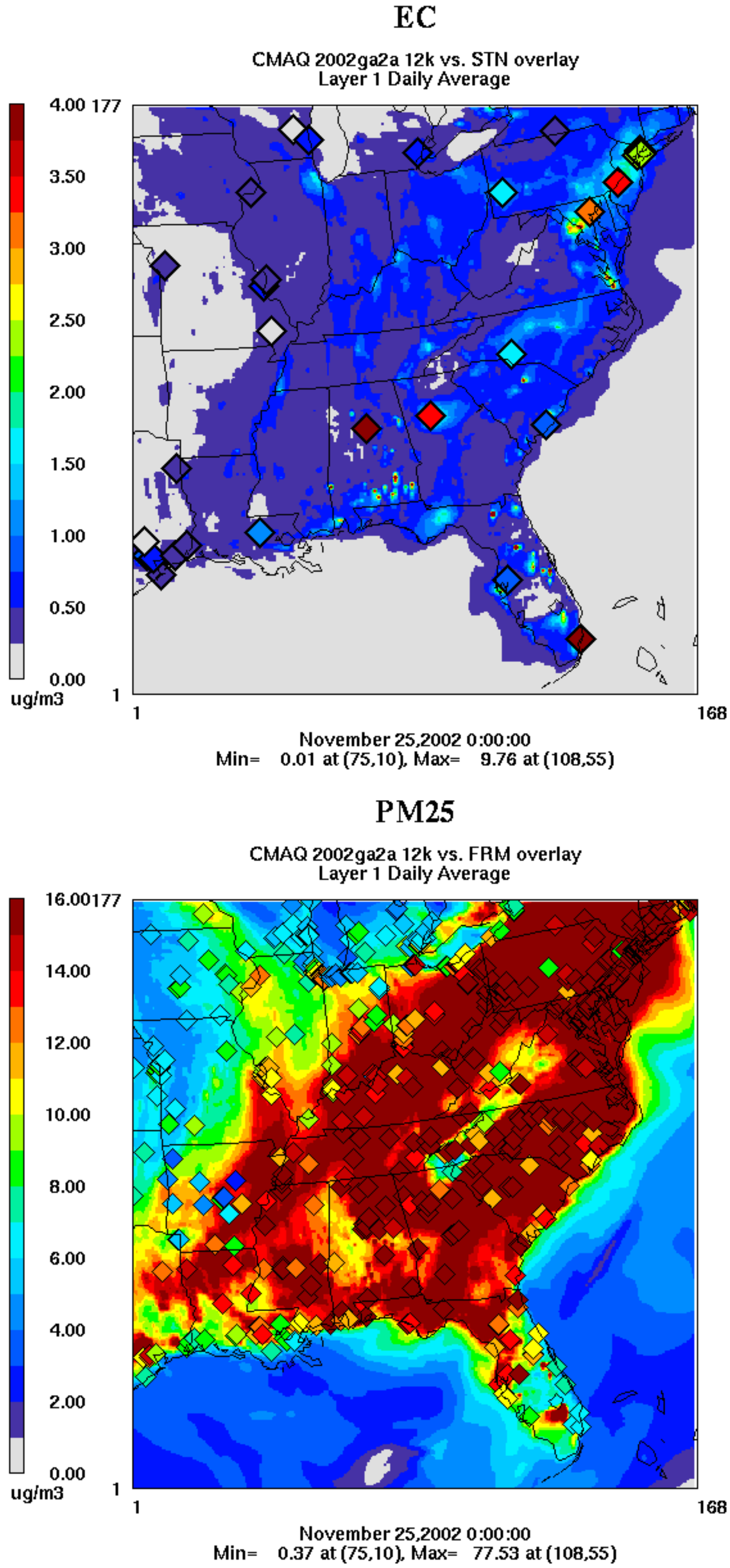


Figure 3-52: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For November 25, 2002

3.27 December 7, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
12/07/02	341	Q4		29.2	43.7	49.2

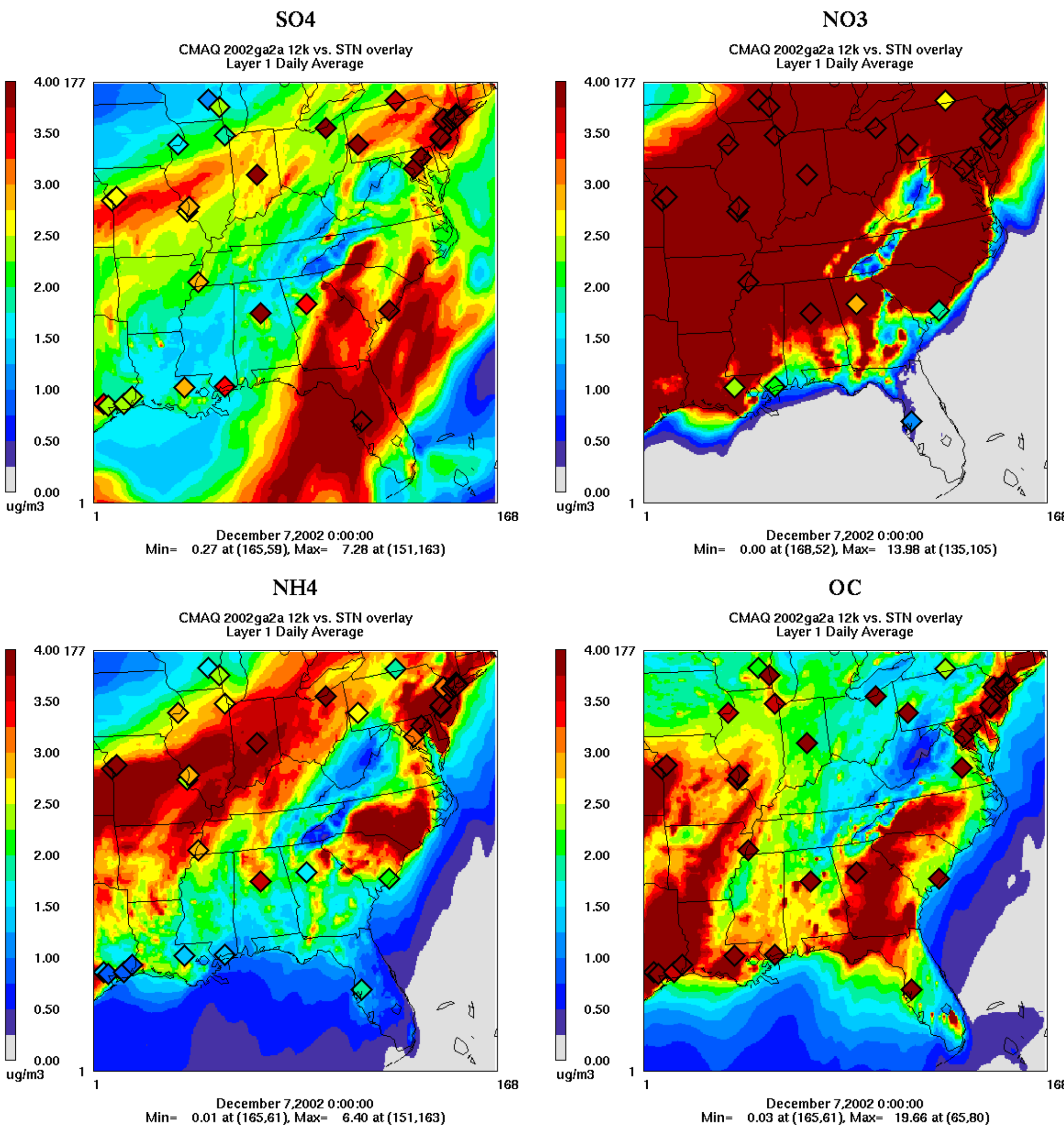


Figure 3-53: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For December 7, 2002

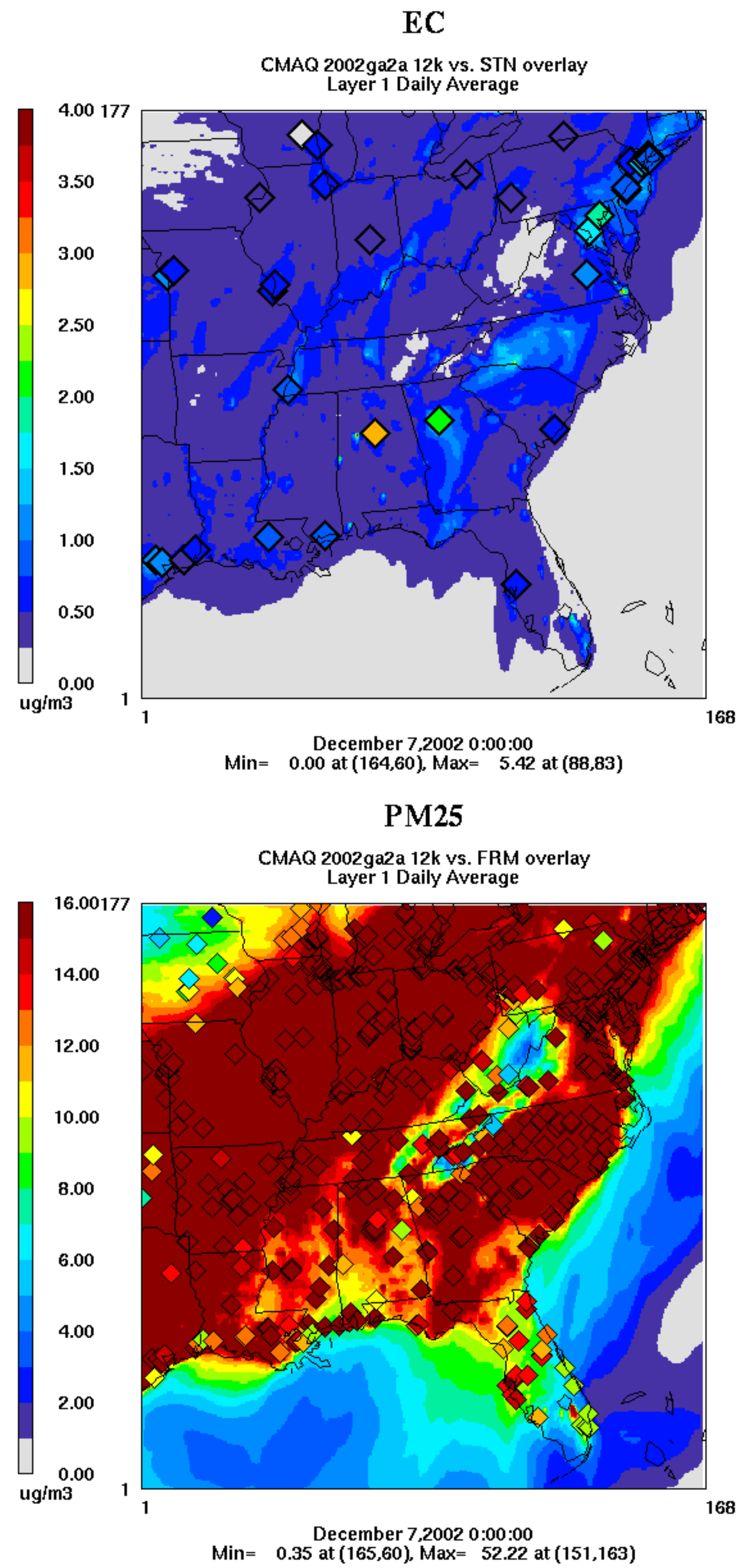


Figure 3-54: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For December 7, 2002

2.28 December 31, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
12/31/02	365	Q4		28.9	18.9	20.5

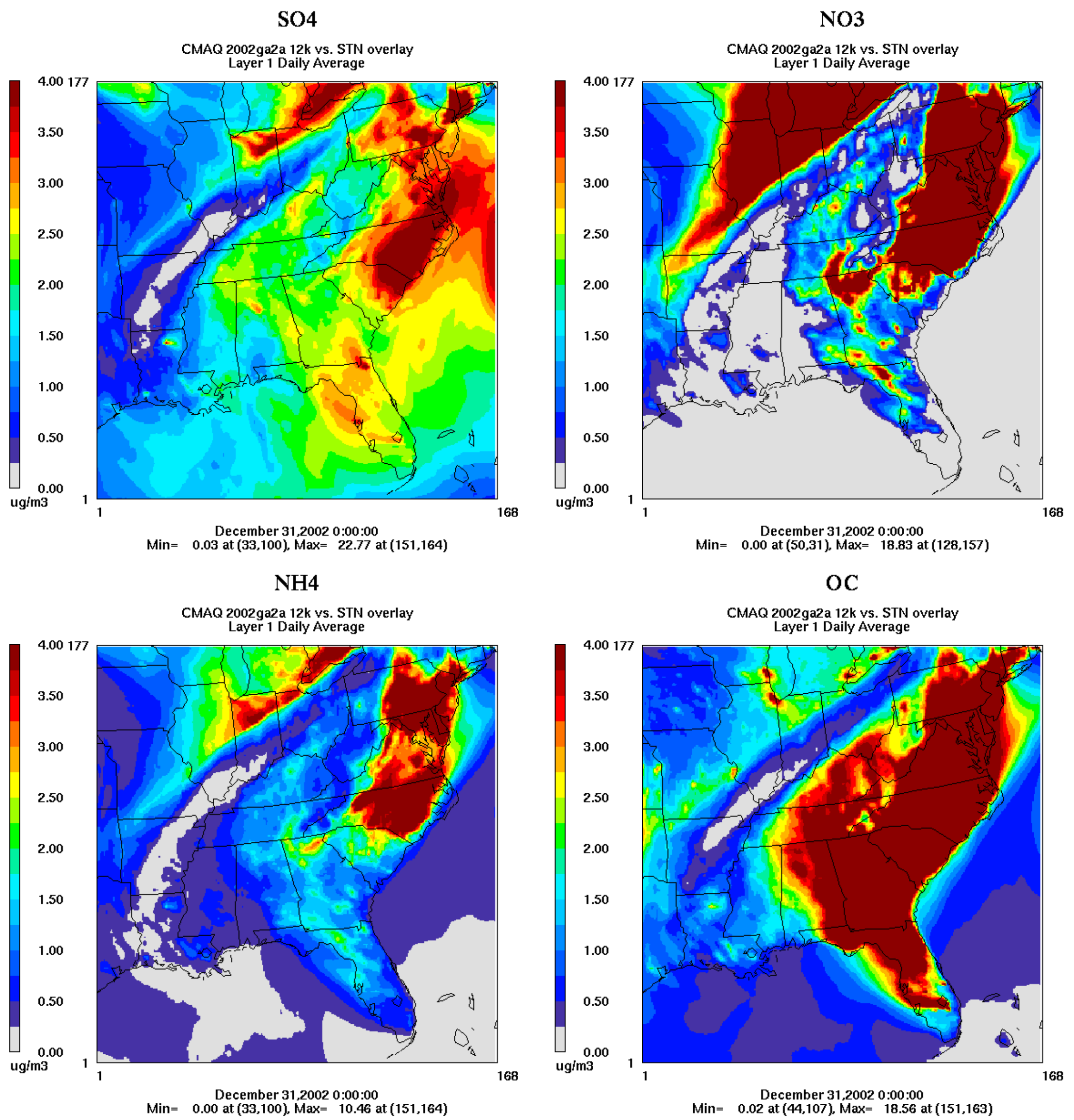
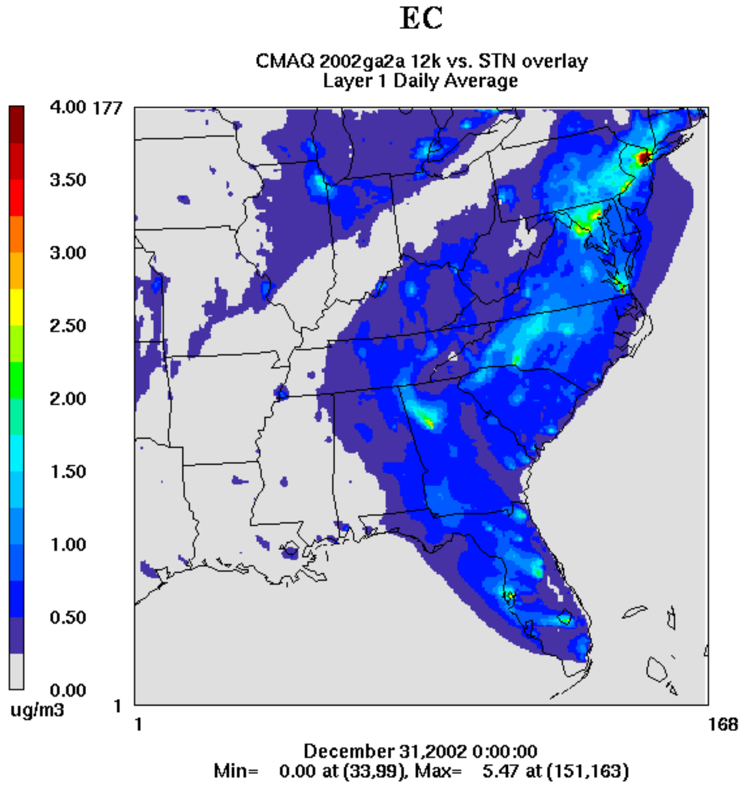


Figure 3-55: Modeled Predicted And Observed Daily Average Sulfate (SO4) Component Concentrations (top left), Daily Average Nitrate (NO3) Component Concentrations (top right), Daily Average Ammonium (NH4) Component Concentrations, And Daily Average Organic Carbon (OC) Component Concentrations Spatial Plots For December 31, 2002



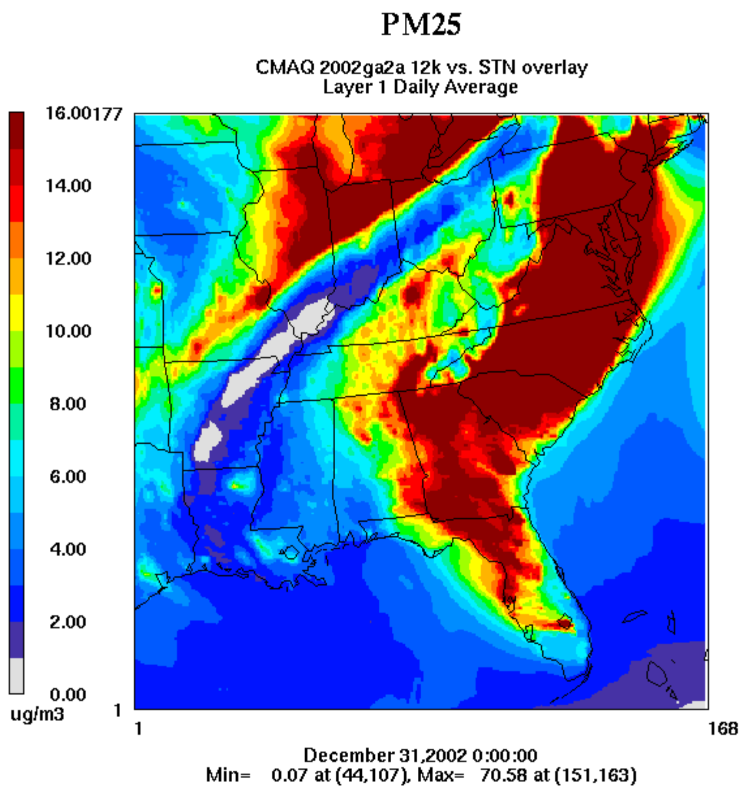


Figure 3-56: Modeled Predicted And Observed Daily Average Elemental Carbon (EC) Component Concentrations (top), FRM Total Fine Particulate Matter ($PM_{2.5}$) Concentration (bottom) Spatial Plots For December 31, 2002

4. Scatter Plots

Monthly scatter plots of the model-simulated mass of the components of $PM_{2.5}$ versus the observed mass of each of the components of $PM_{2.5}$ are presented in this section. As with previous model performance statistics and plots, scatter plots were produced for all the STN sites in the VISTAS 12km domain (38 monitors), for all the STN monitors in North Carolina (8 monitors), and individually for the Hickory and Hattie Avenue STN monitors. These scatter plots are presented in Section 4.1, by species, by month.

Section 4.2 has the monthly scatter plots of the model-simulated $PM_{2.5}$ mass versus the observed $PM_{2.5}$ mass at FRM monitors. Scatter plots have been produced for all the FRM sites in the VISATAS domain (226 monitors), for all the FRM monitors within North Carolina (36 monitors), and individually for the 3 FRM monitors in the $PM_{2.5}$ nonattainment areas (Hickory, Lexington, and Mendenhall).

The green line on the scatter plots represents the 1:1 line, with points falling on the line suggesting accurate model prediction and points falling above (below) indicating over (under) prediction by the model. The equation for the best fit line, the correlation coefficient, fractional bias, and fraction gross error for the data presented in the scatter plot appear in the top of the graph area for reference. The scatter plots contain information on both the 12km domain (blue x's) and the 36km domain (red +'s) modeling results. Though both are presented in this appendix, the model performance evaluation focuses on the 12km results, as the attainment test calculations are based on the 12km modeling.

The sulfate spatial plots (Figures 4-1 through 4-12) show a good spread across the 1:1 line for the VISTAS sites collectively, though a slight negative bias remains. The negative bias does decrease during the summer months through fall (June through October). The negative bias is more pronounced when looking at the North Carolina STN sites collectively. However, North Carolina STN sites do show a positive bias for the month of October. Looking and the Hickory and Hattie Avenue sites separately, the negative bias trend is seen across the year, with each site has a couple months of positive bias during the period of June to October. Additionally, Hattie Avenue has a slightly less biased than the Hickory site for sulfates.
Nitrate performance (Figure 4-13 through 4-24) is similar to other statistics presented previously. For the VISTAS sites on the whole, we see good scatter across the 1:1 line, with a slight negative bias, especially during the April to September timeframe. Overall VISTAS performance does become better in November and December, though there is still a negative bias. Model performance for the North Carolina STN sites as a whole, and for both the Hickory and Hattie Avenue sites individually, differ from the VISTAS level performance in that nitrates are actually over predicted for January and the winter months (October through December). In addition, the North Carolina sites on the whole and Hattie Avenue show better that VISTAS model performance for the February to April timeframe.

Ammonium performance (Figures 4-25 though 4-36) was more of a mixed bag across sites. The modeled tended to over predict in the spring and winter and under predict in summer and fall. Data was generally spread across the 1:1 line, with many values on either side of the line. With a balance of over prediction and under prediction for most months, bias values are low, with high error values.

Organic Carbon is consistently under predicted across all level of the STN sites. The scatter plots show a majority of points falling below the 1:1 line consistently for all months (Figure 4-37 through 4-48). The magnitude of the under prediction is fairly consistent between VISTAS STN sites, North Carolina STN sites and the individual STN sites in the nonattainment areas, suggesting the under prediction is a model wide shortcoming.

As with Ammonium, elemental carbon values were well spread across the 1:1 line resulting in low bias vales for much of the year (Figure 4-49 through 4-60). The general trend across sites was to start the year slightly over predicting for January, and then trend toward slightly under predicting through the spring. Values returned to over predicting for July and August before settling back to a slight under prediction trend. Hickory did deviate from the pattern set at all VISTAS and North Carolina STN sites and the Hattie Avenue site, by consistently under predicting across the entire year. As with sulfate, model performance at Hattie Avenue appeared slightly less biased than at the Hickory STN site.

Overall the negative bias seen in the scatter plots for the components of $PM_{2.5}$ lead to a general negative bias in the reconstructed $PM_{2.5}$ mass for the STN sites (Figures 4-61 through 4-72). The negative bias is not as pronounced in January and the October through December timeframe, probably in part due to the over prediction of nitrates seen during the same period. A similar trend is seen in the FRM total $PM_{2.5}$ mass scatter plots (Figure 4-73 though 4-96), though the under prediction is not as pronounced as with the STN sites.

4.1 Monthly STN Scatter Plots

4.1.1 Sulfates

4.1.1.1 January

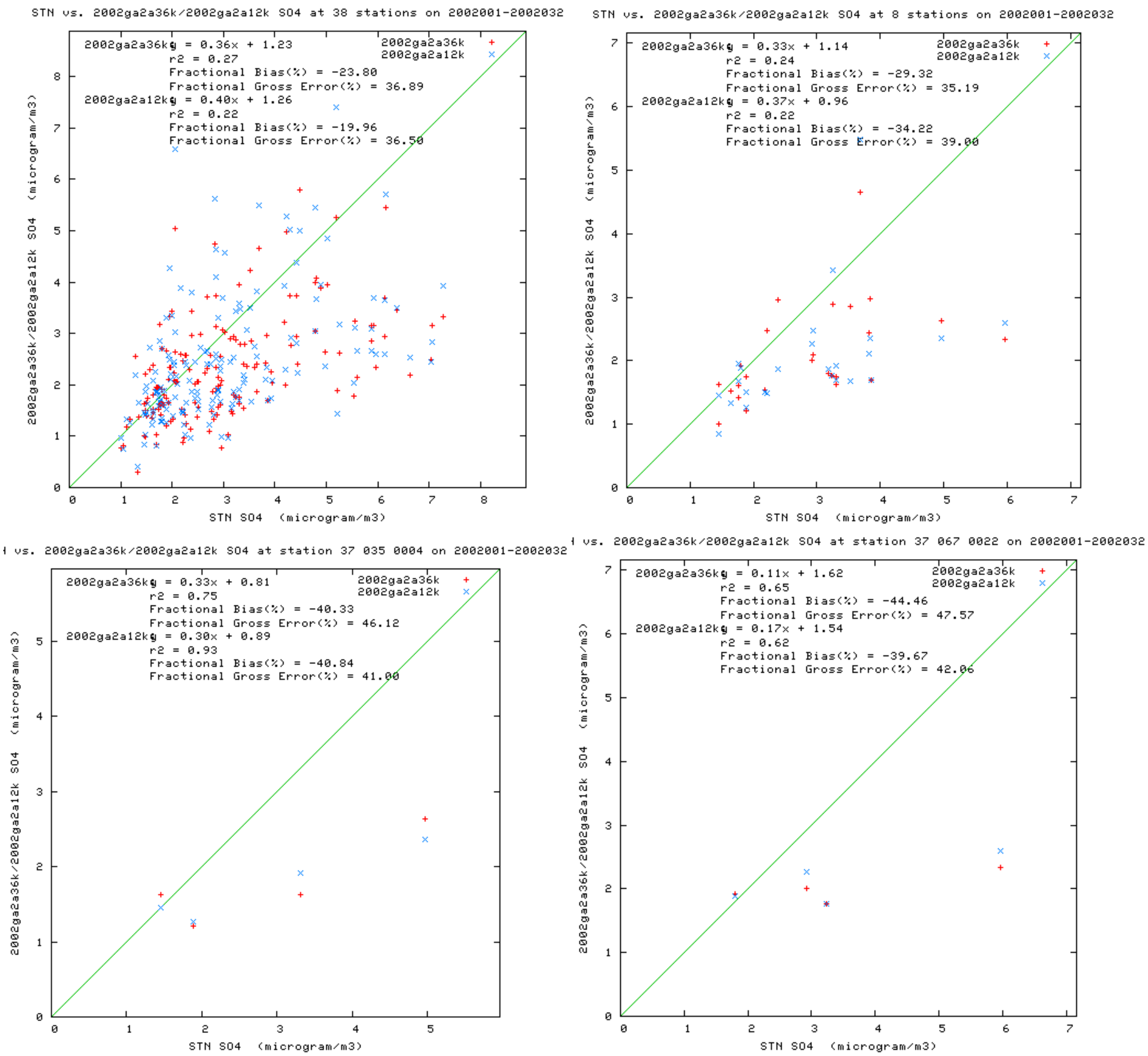


Figure 4-1: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of January.

4.1.1.2 February

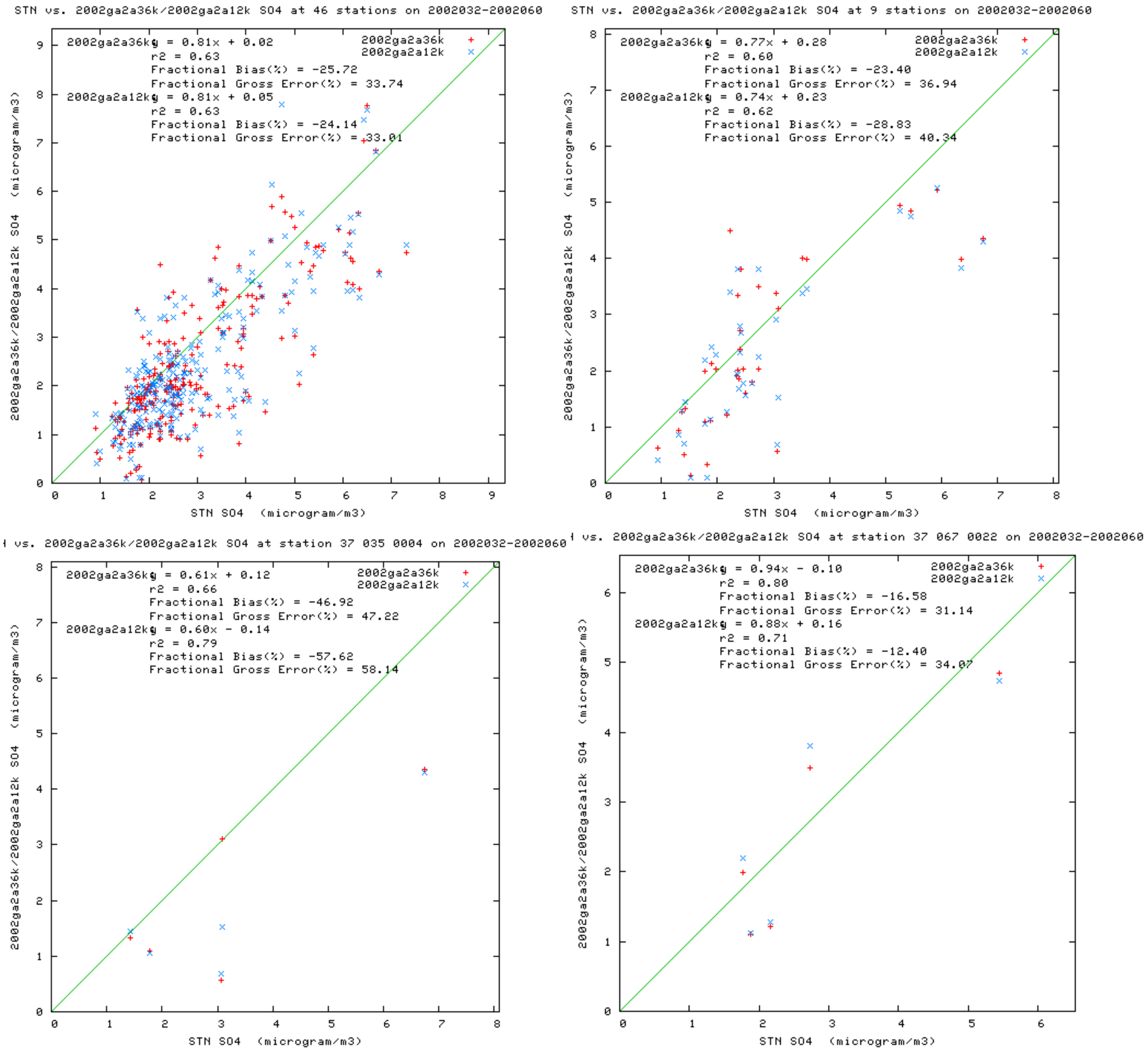


Figure 4-2: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of February.

4.1.1.3 March

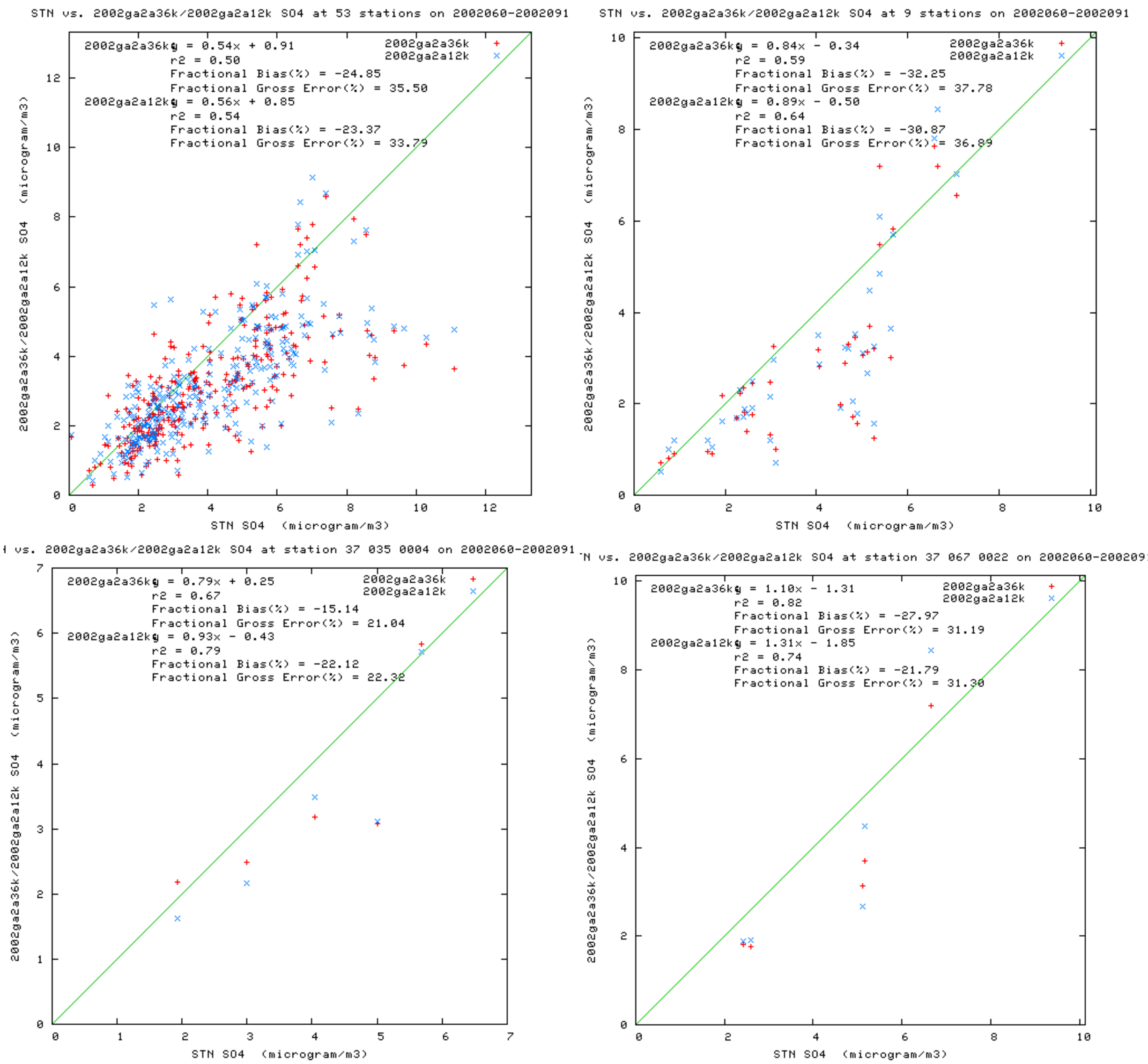


Figure 4-3: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of March.

4.1.1.4 April

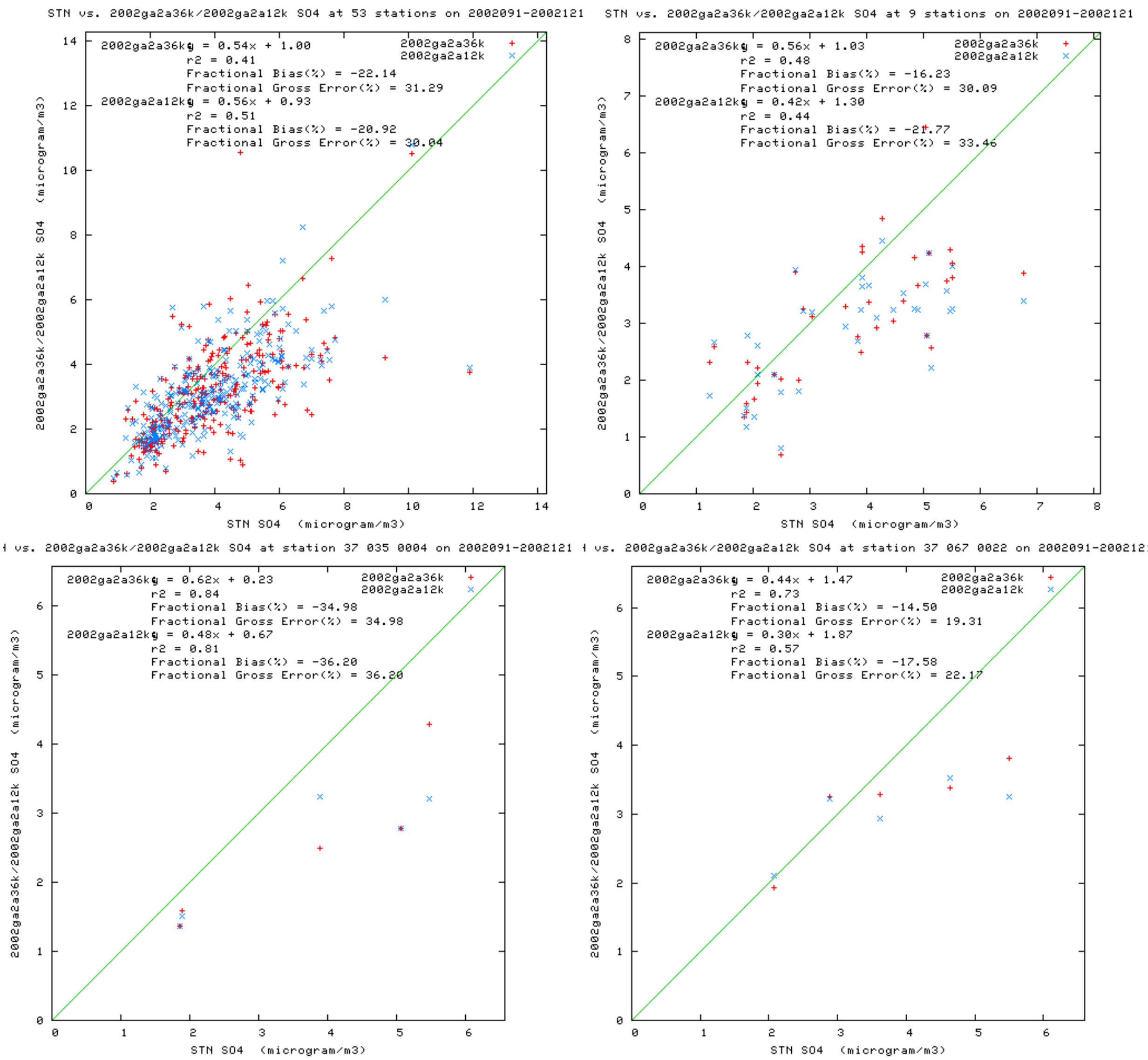


Figure 4-4: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of April.

4.1.1.5 May

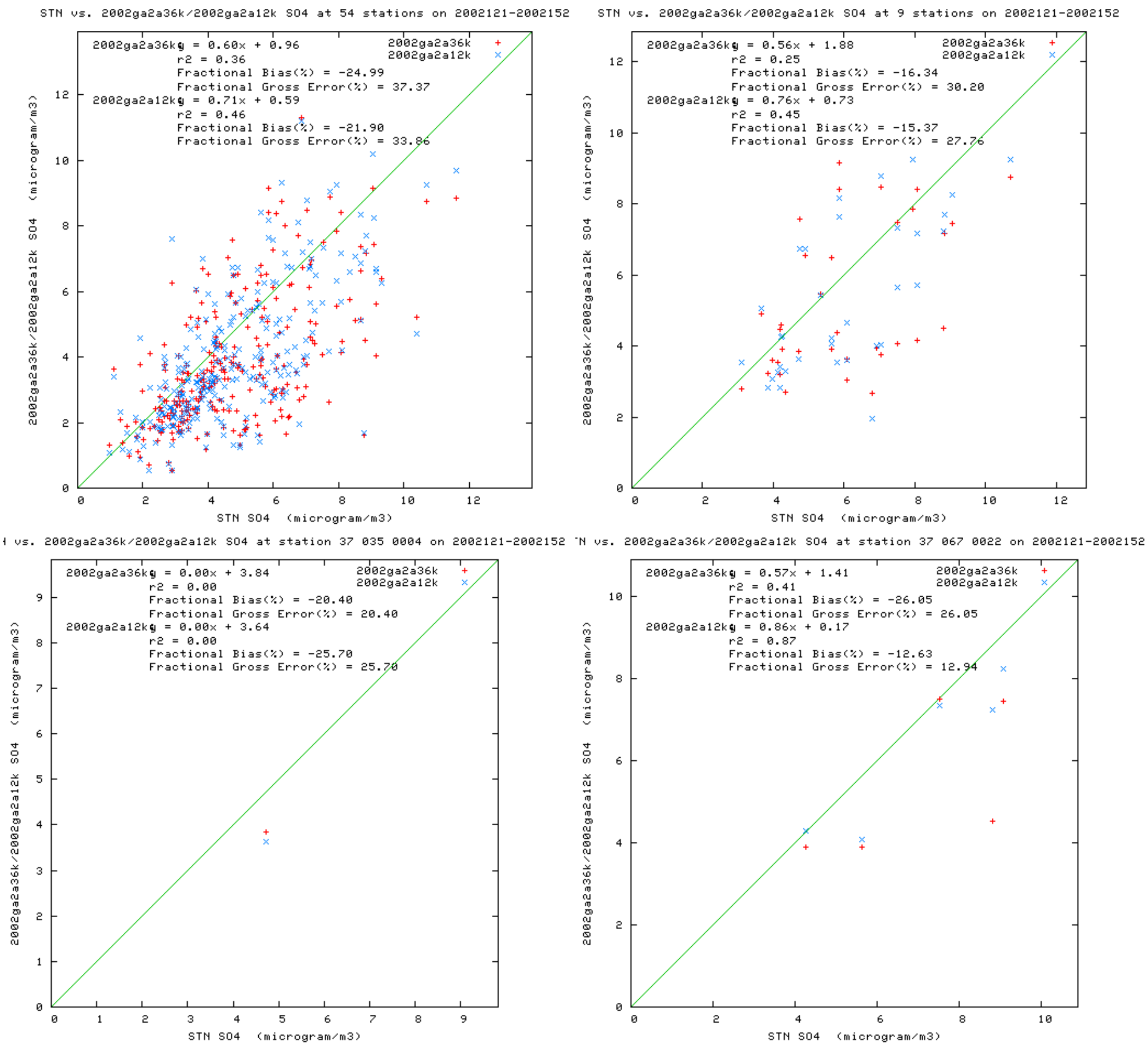


Figure 4-5: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of May.

4.1.1.6 June

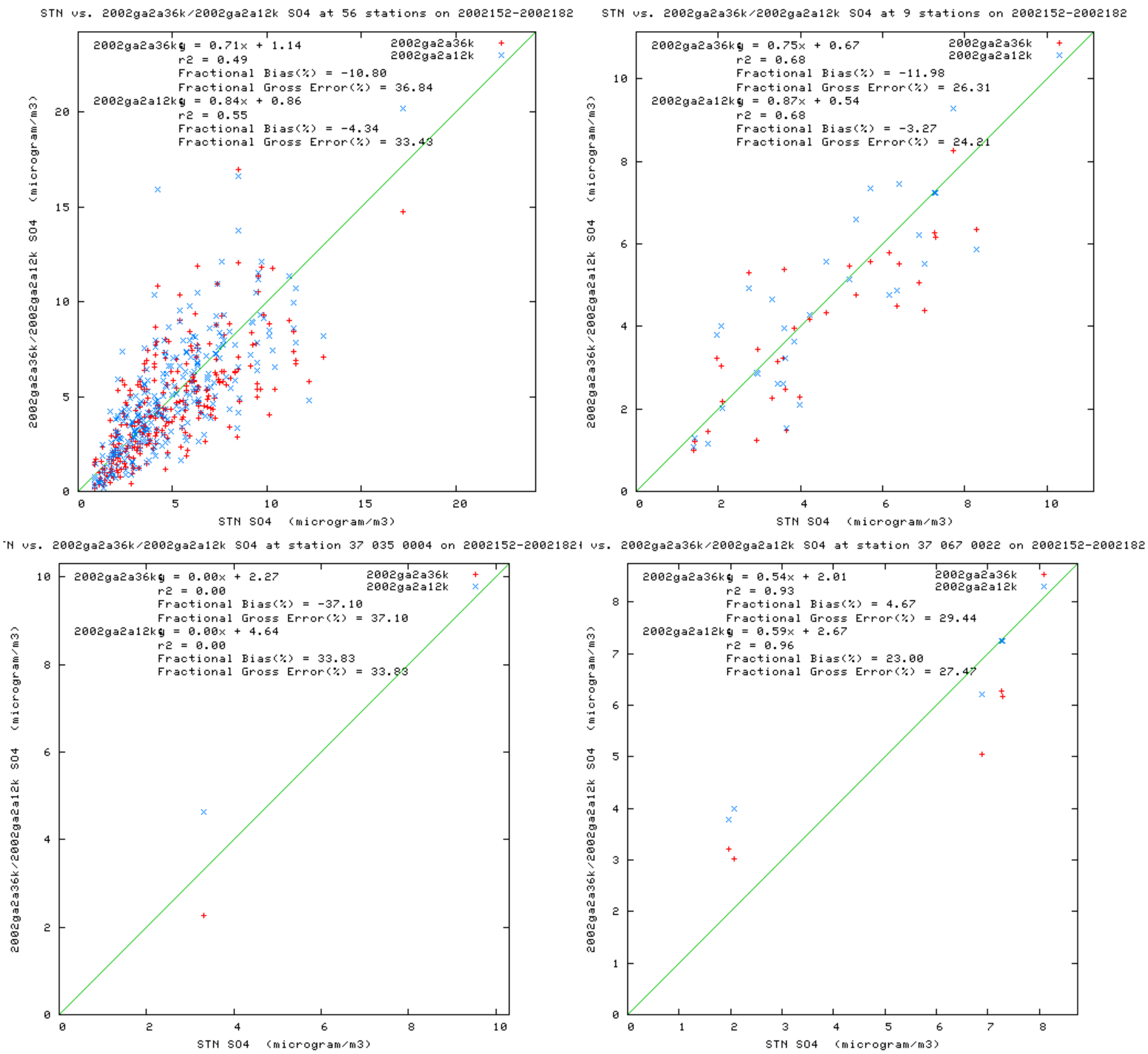


Figure 4-6: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of June.

4.1.1.7 July

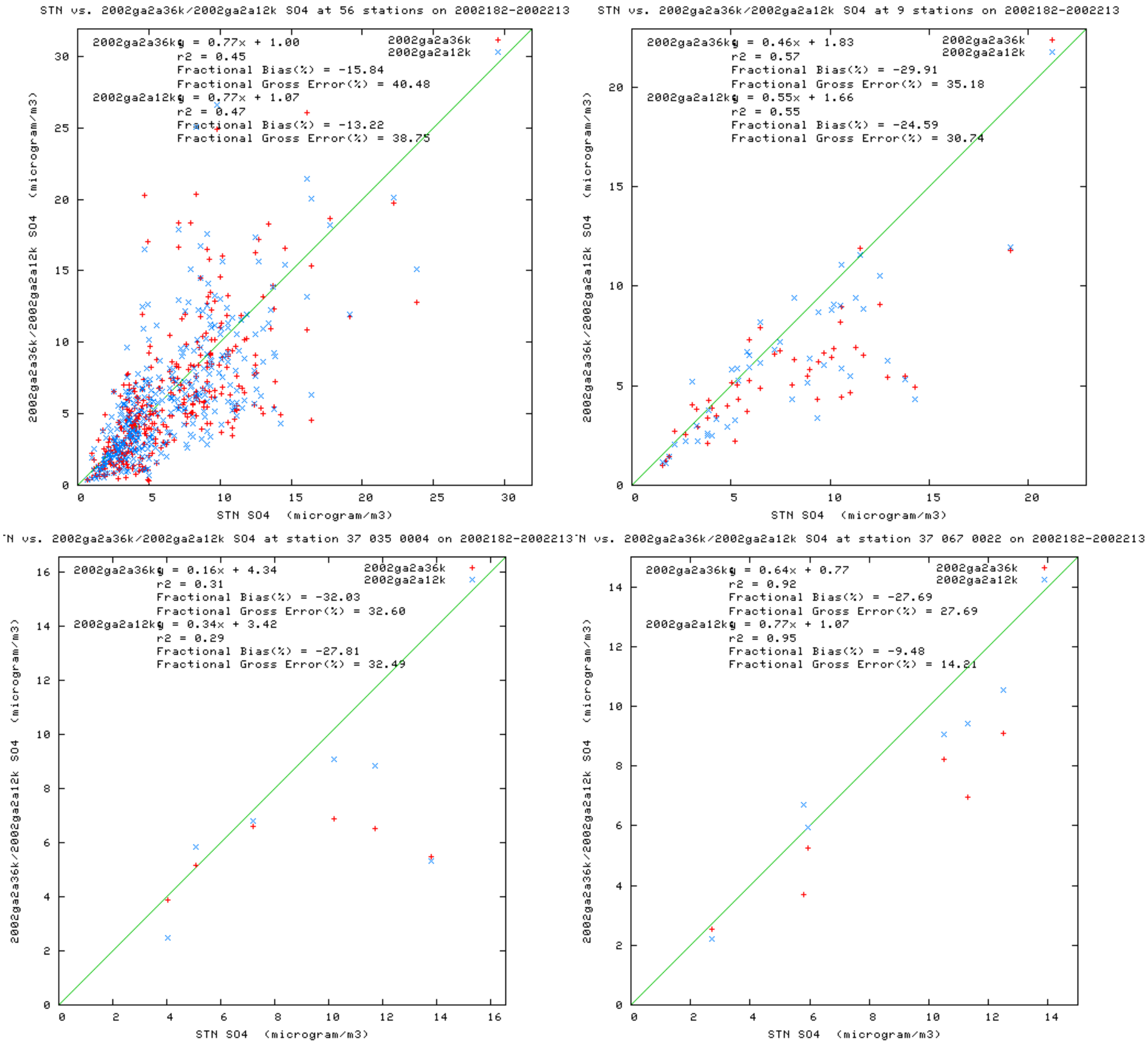


Figure 4-7: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of July.

4.1.1.8 August

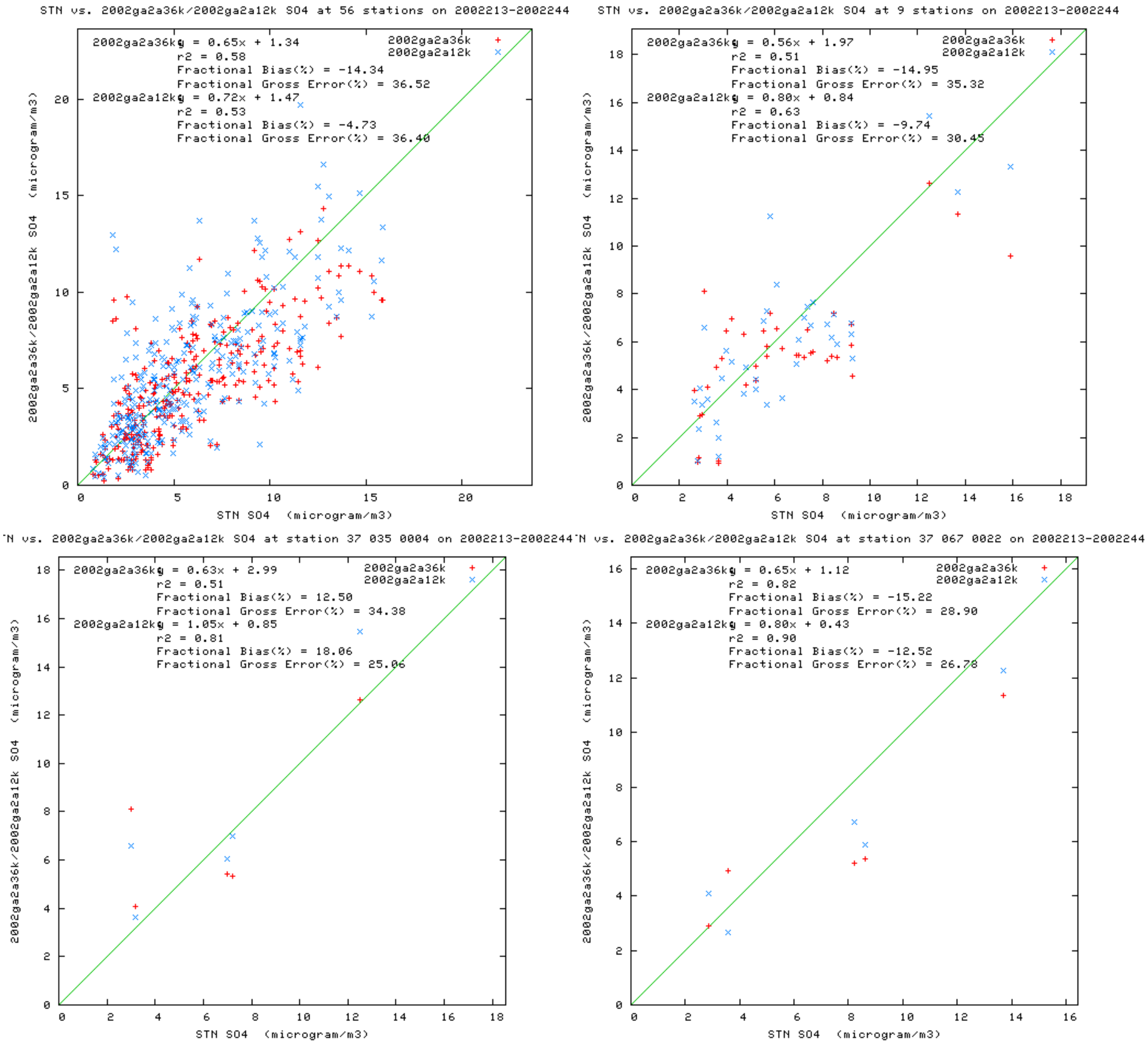


Figure 4-8: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of August.

4.1.1.9 September

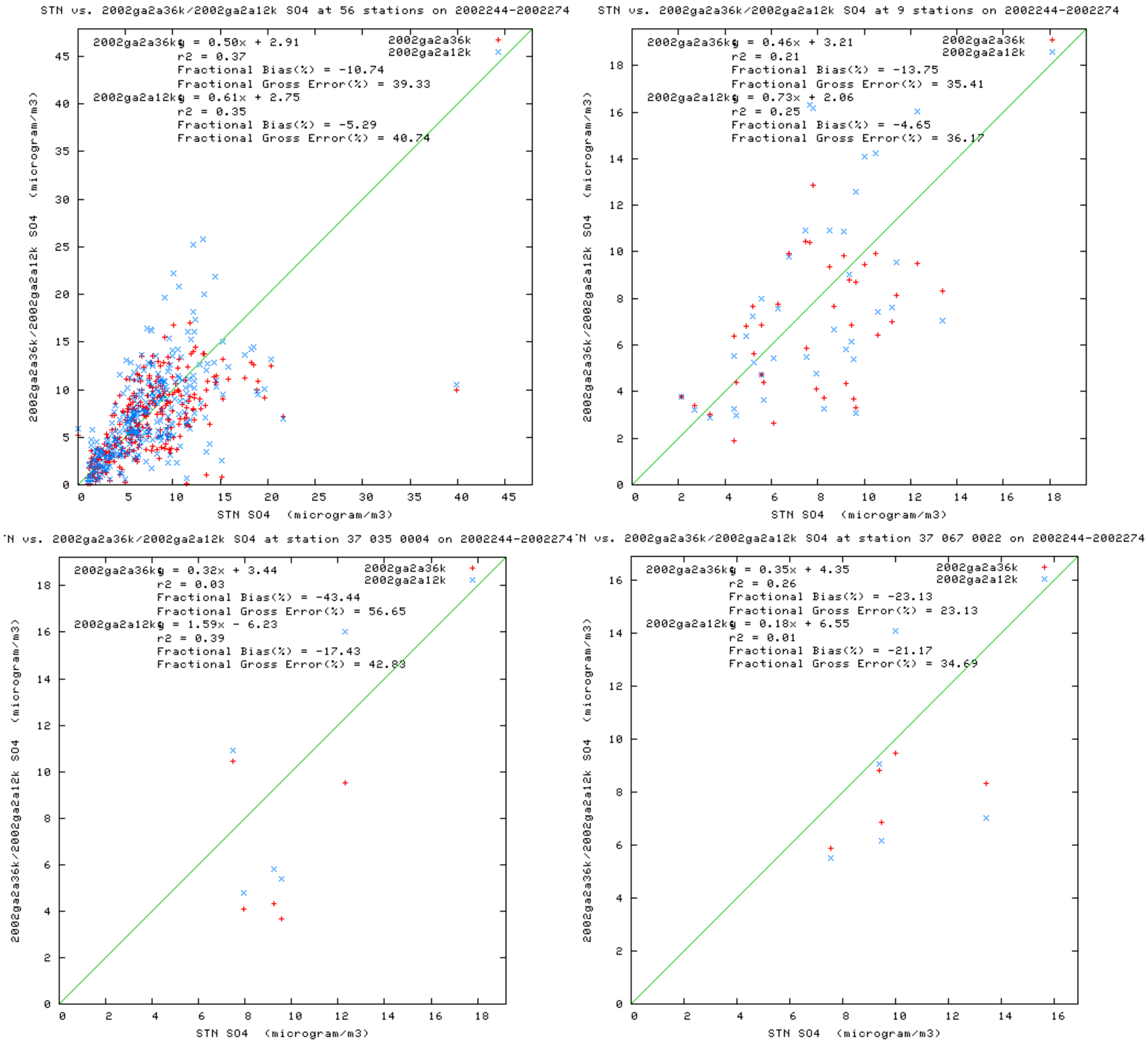


Figure 4-9: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of September.

4.1.1.10 October

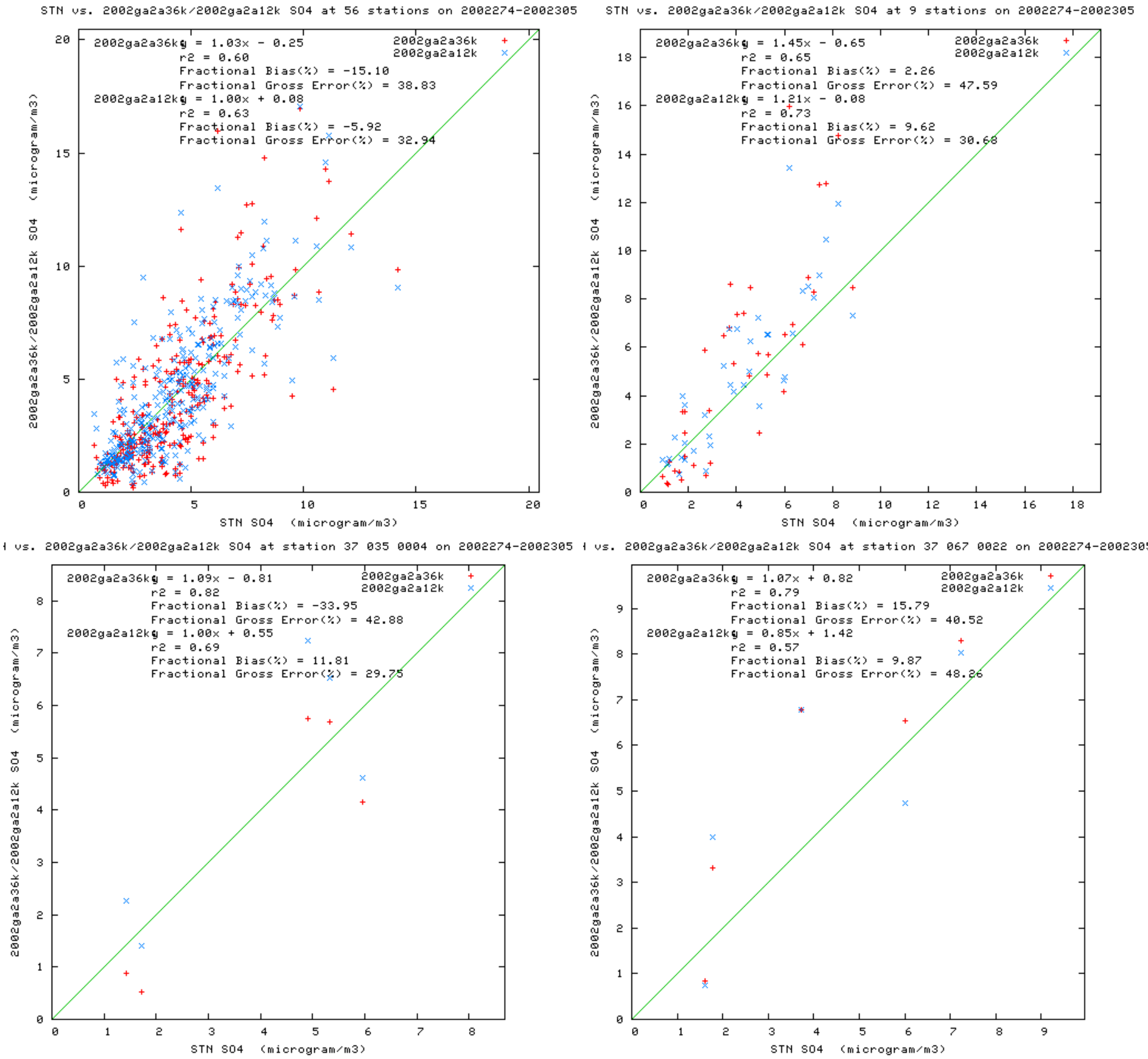


Figure 4-10: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of October.

4.1.1.11 November

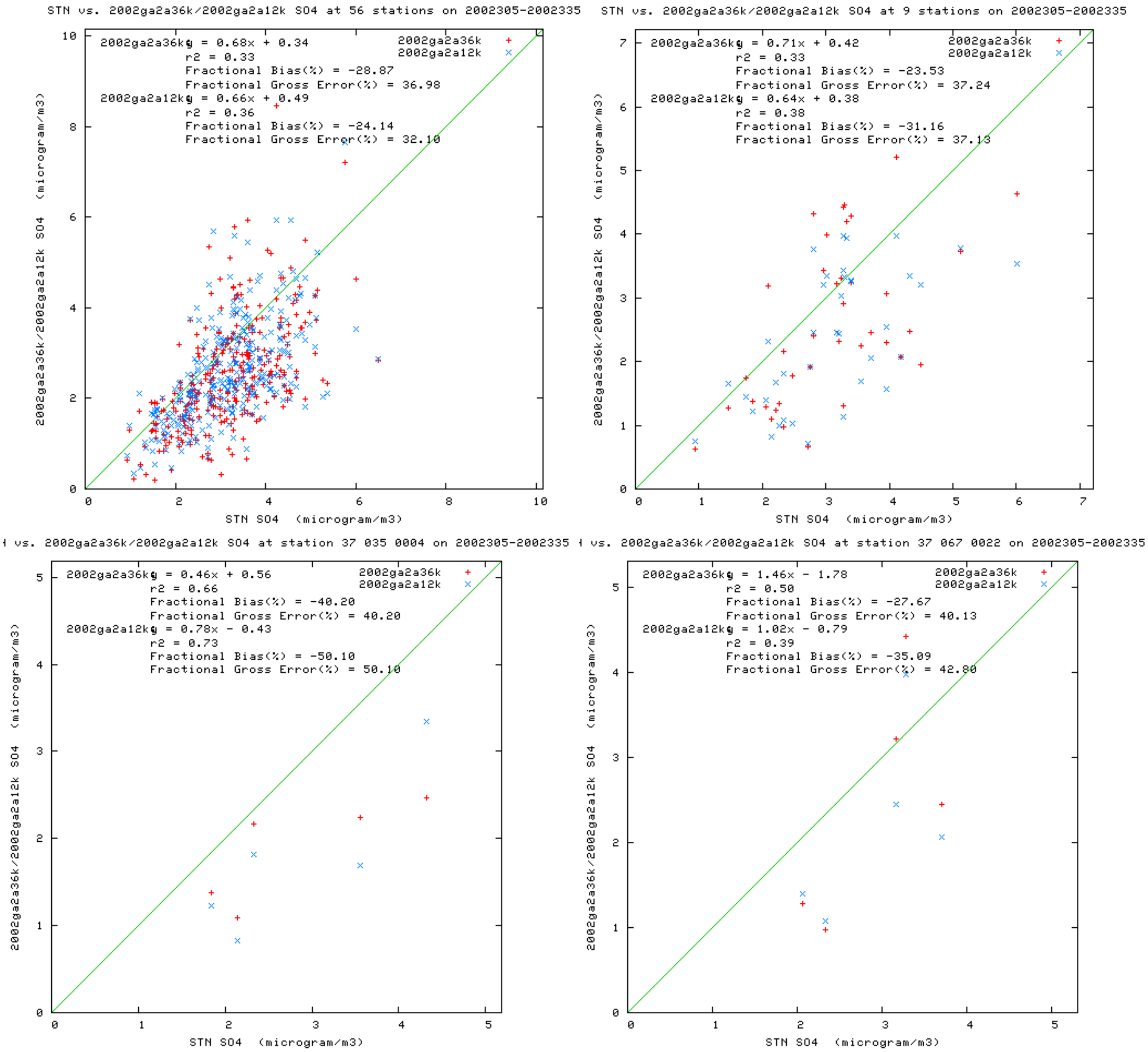


Figure 4-11: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of November.

4.1.1.12 December

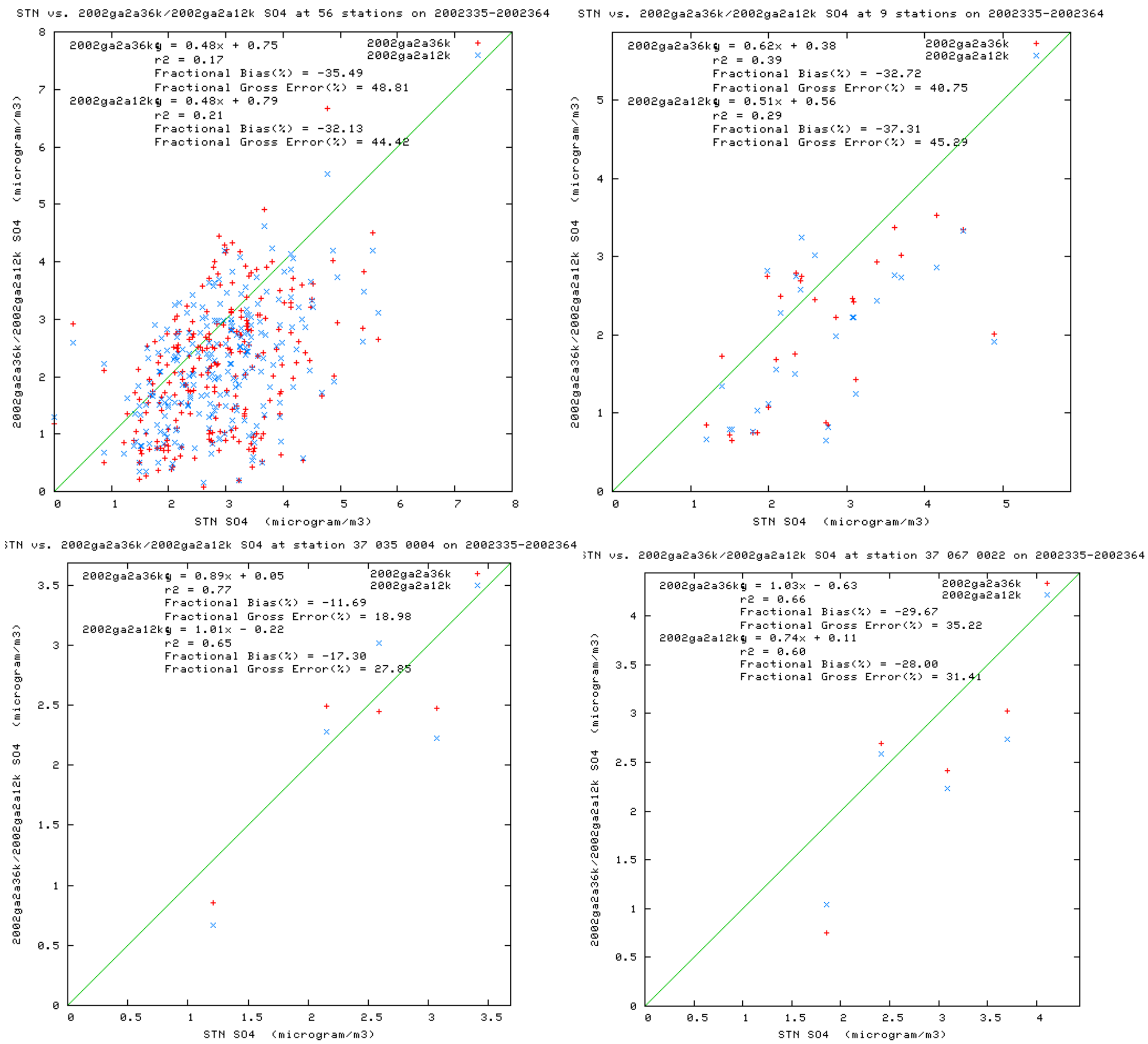


Figure 4-12: Scatter Plot of Observed Sulfate from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of December.

4.1.2 Nitrates

4.1.2.1 January

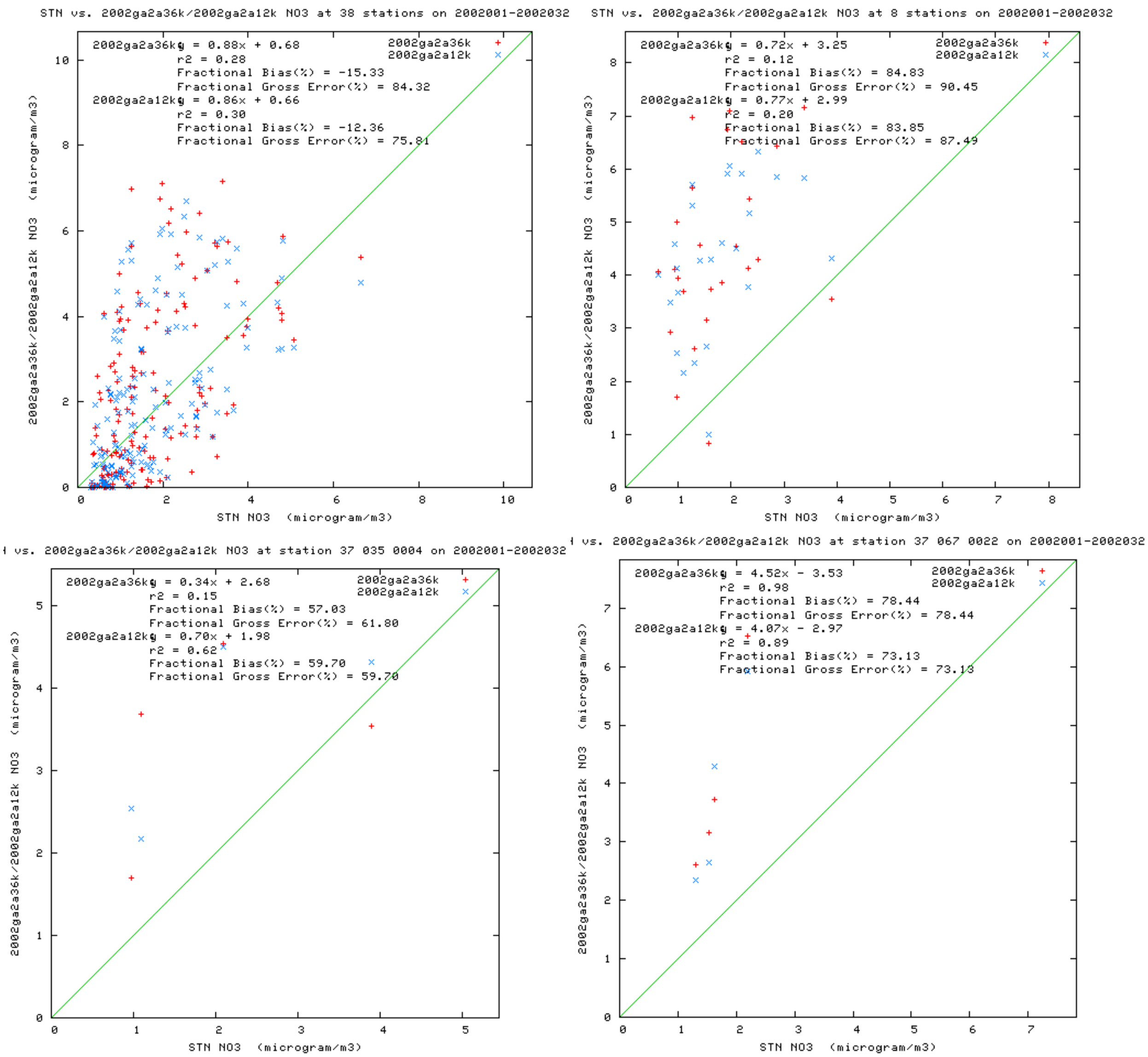


Figure 4-13: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of January.

4.1.2.2 February

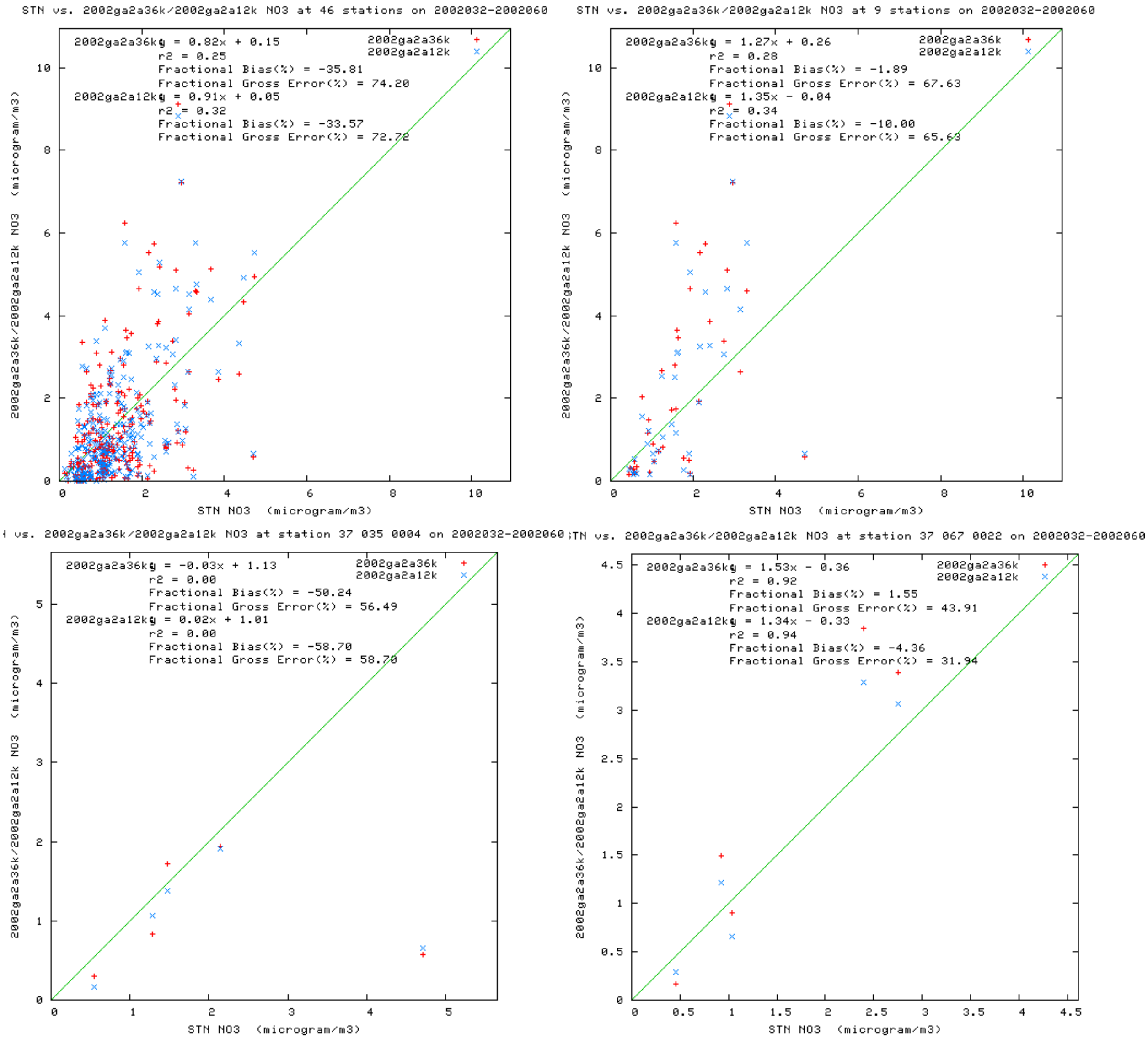


Figure 4-14: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of February.

4.1.2.3 March

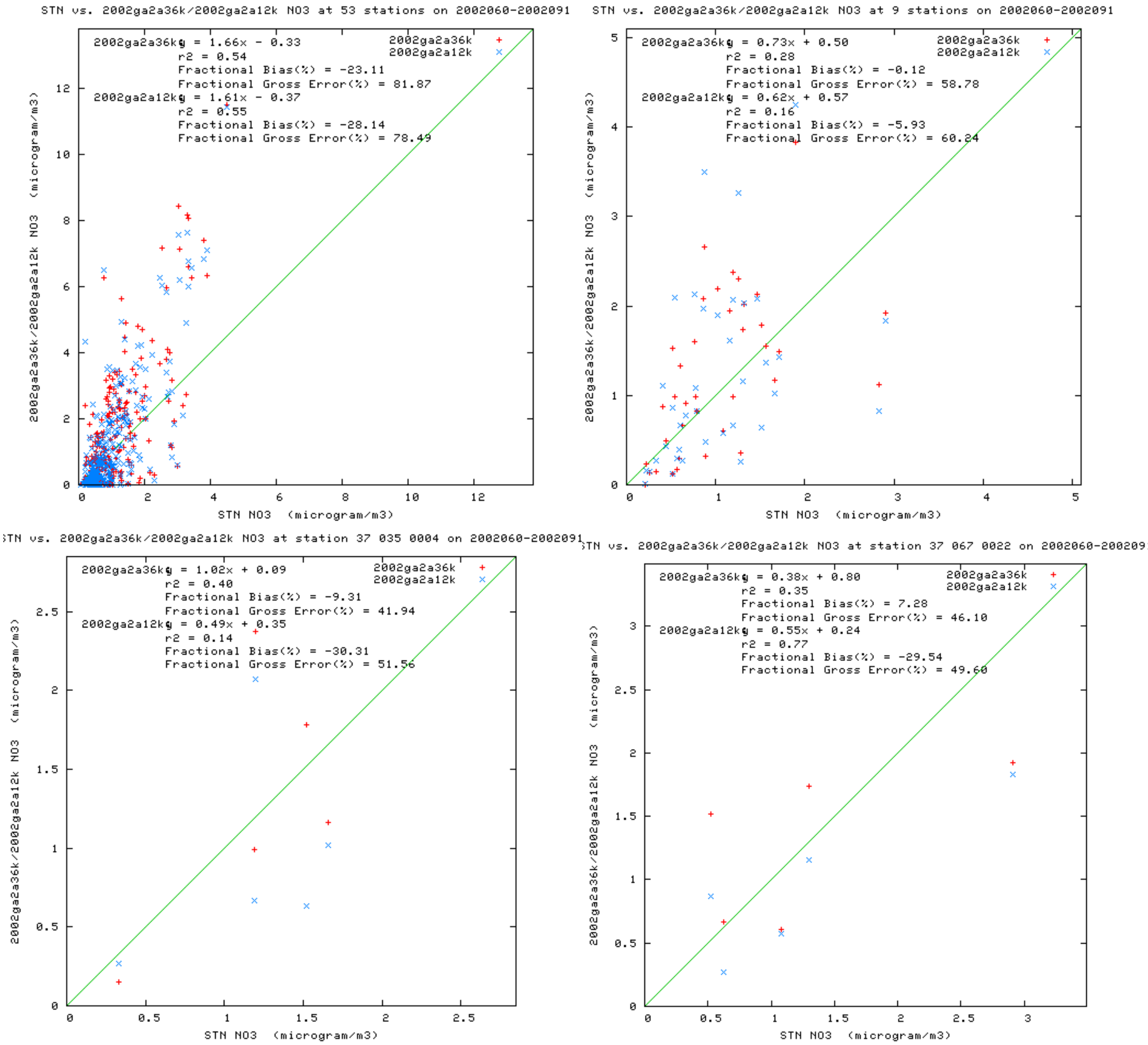


Figure 4-15: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of March.

4.1.2.4 April

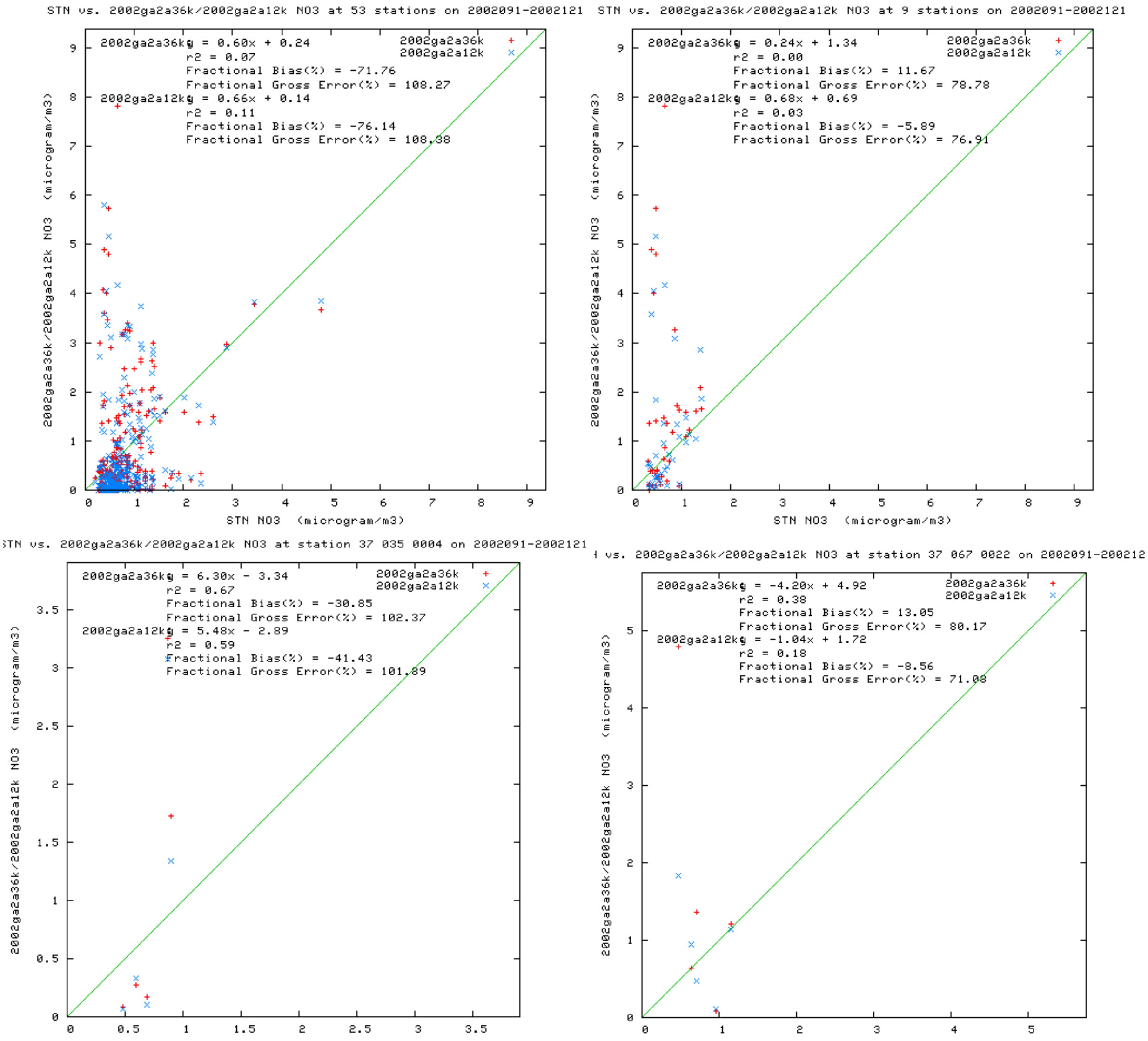


Figure 4-16: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of April.

4.1.2.5 May

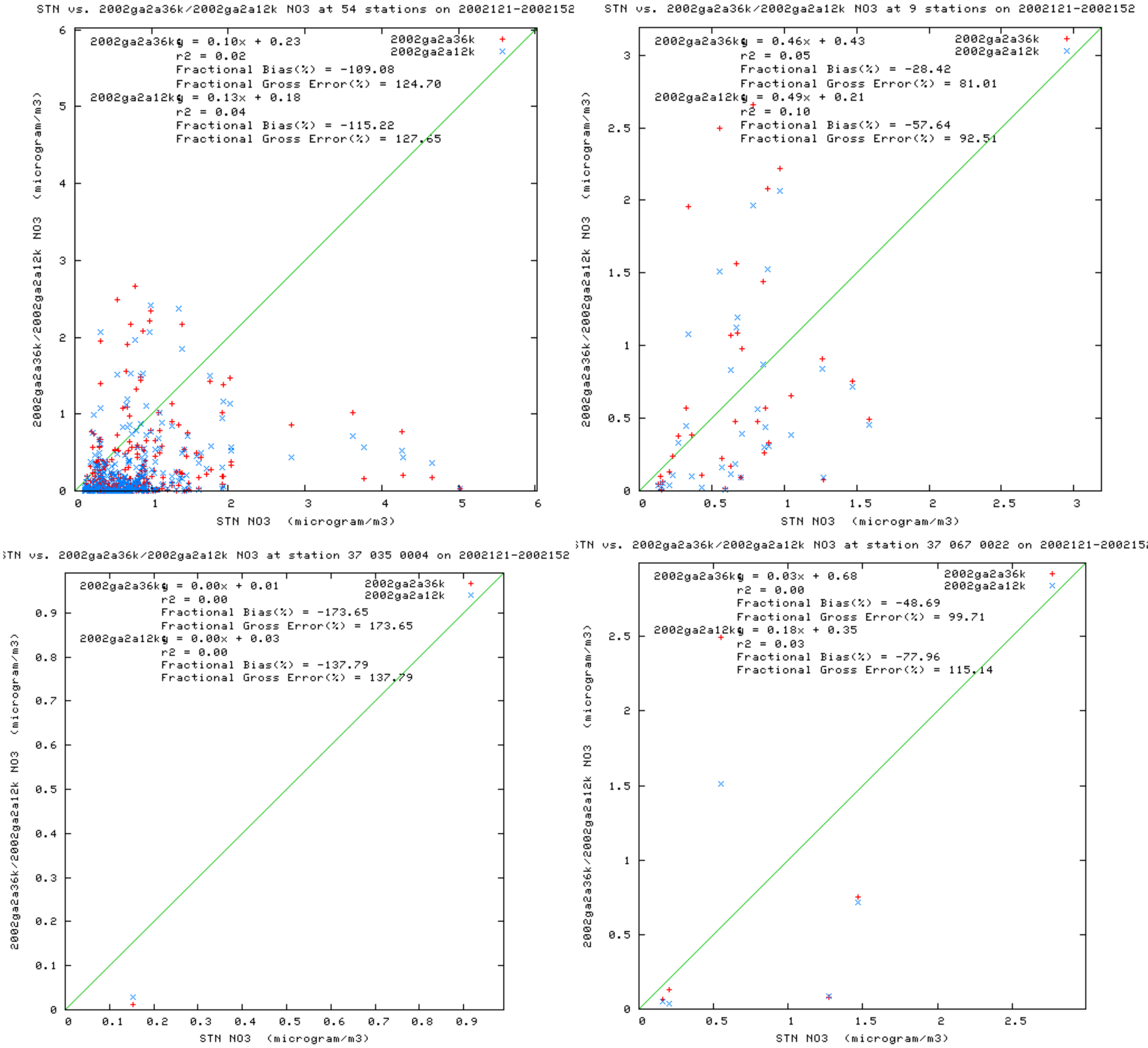


Figure 4-17: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of May.

4.1.2.6 June

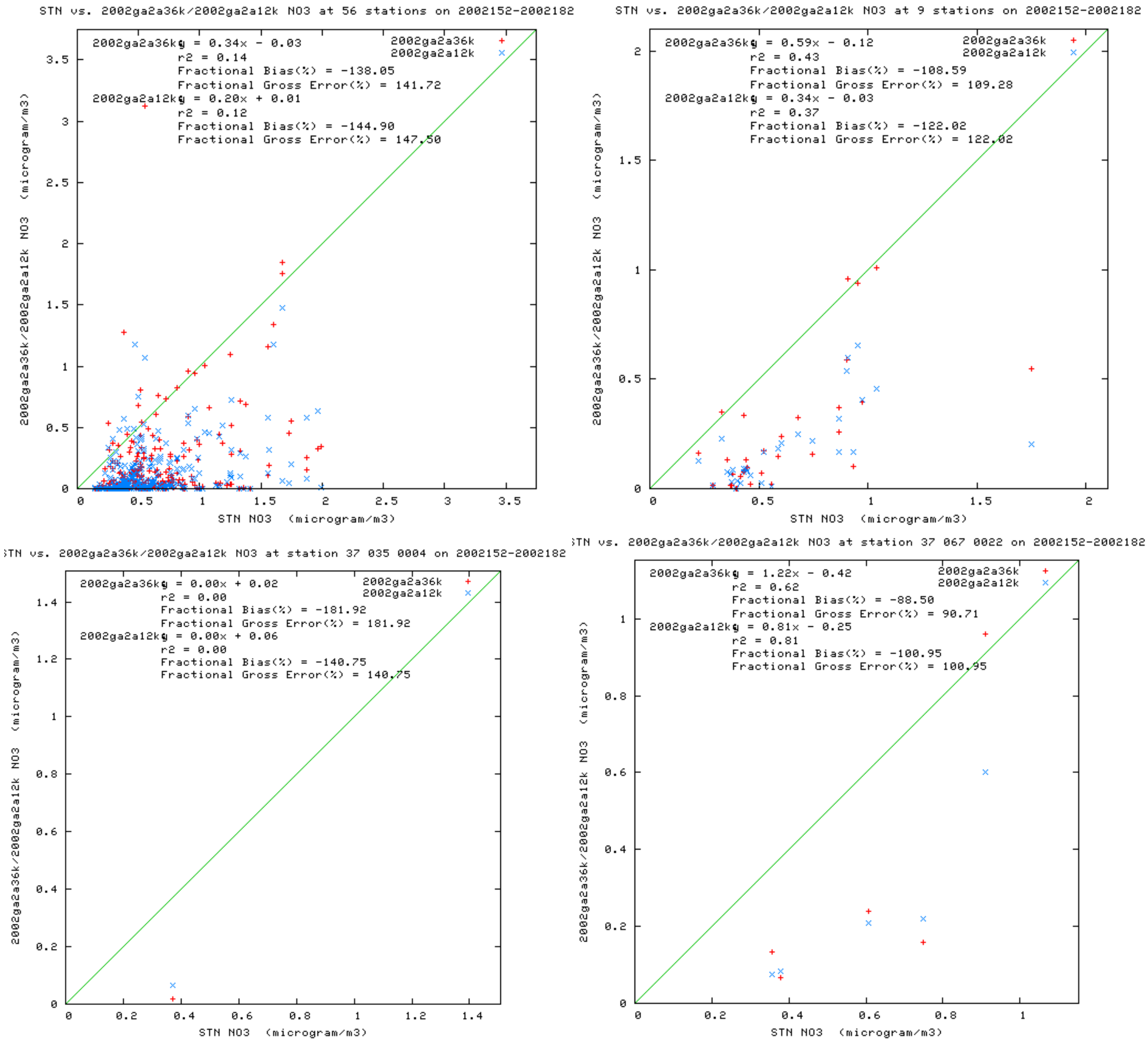


Figure 4-18: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of June.

4.1.2.7 July

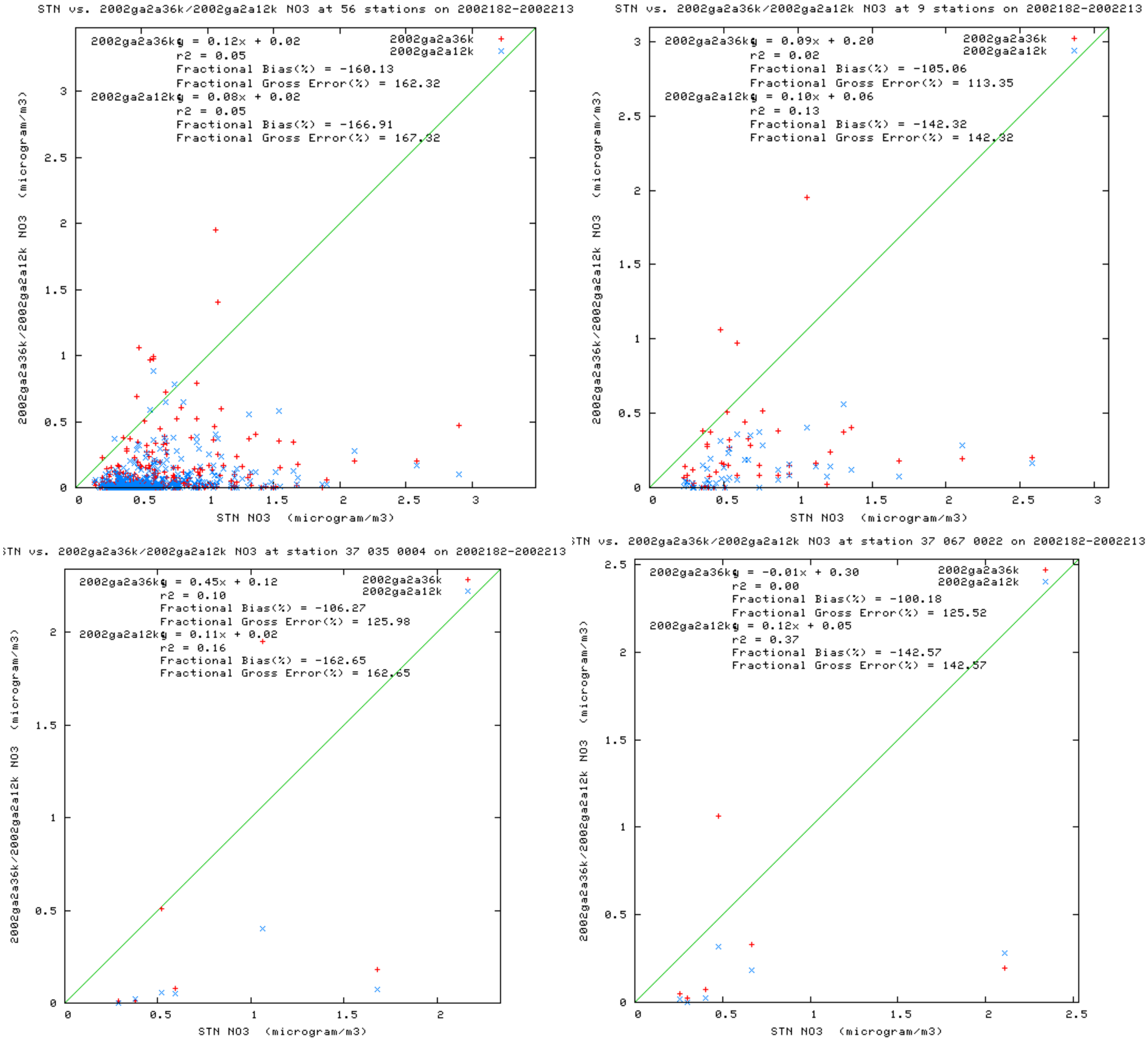


Figure 4-19: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of July.

4.1.2.8 August

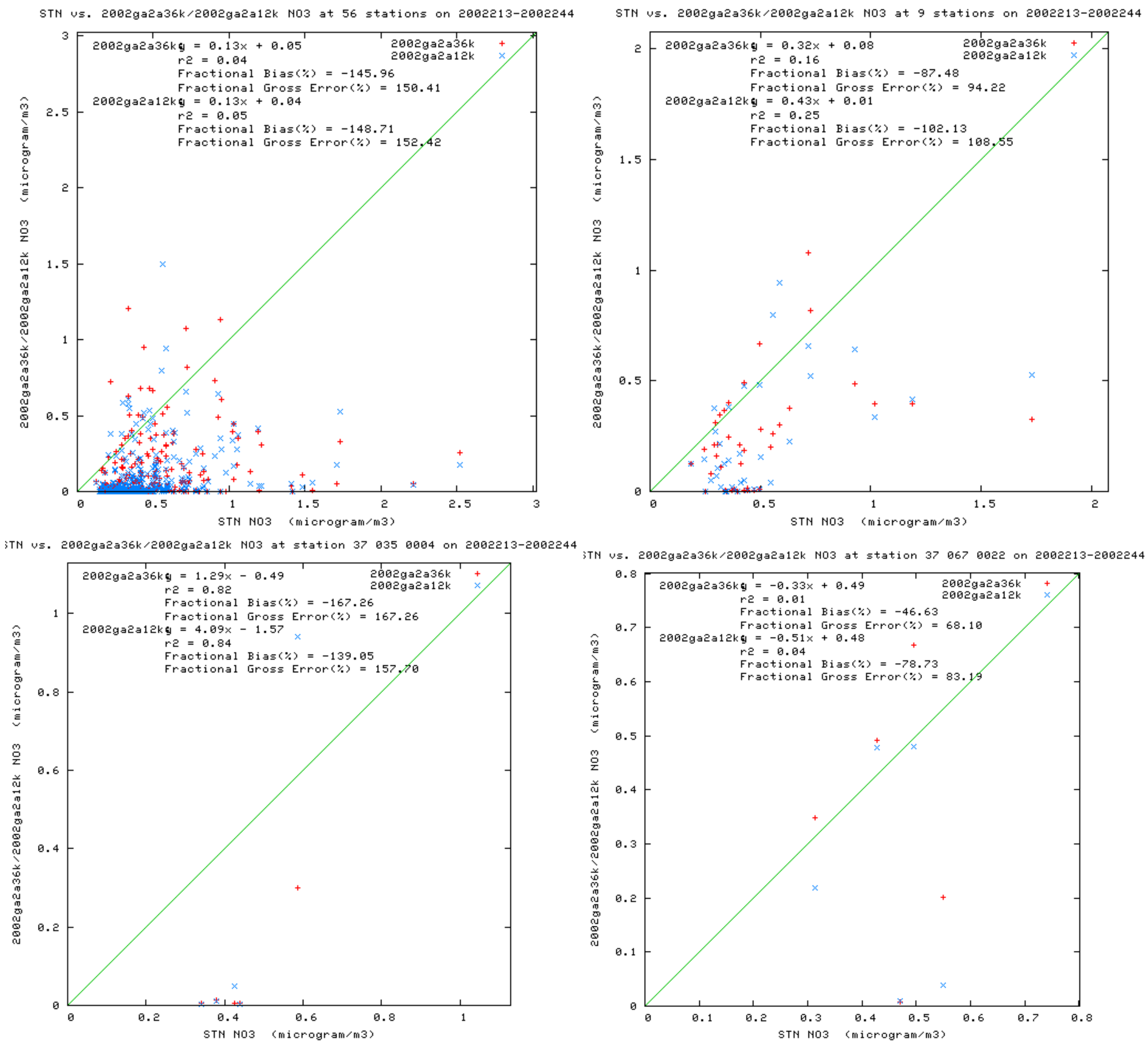


Figure 4-20: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of August.

4.1.2.9 September

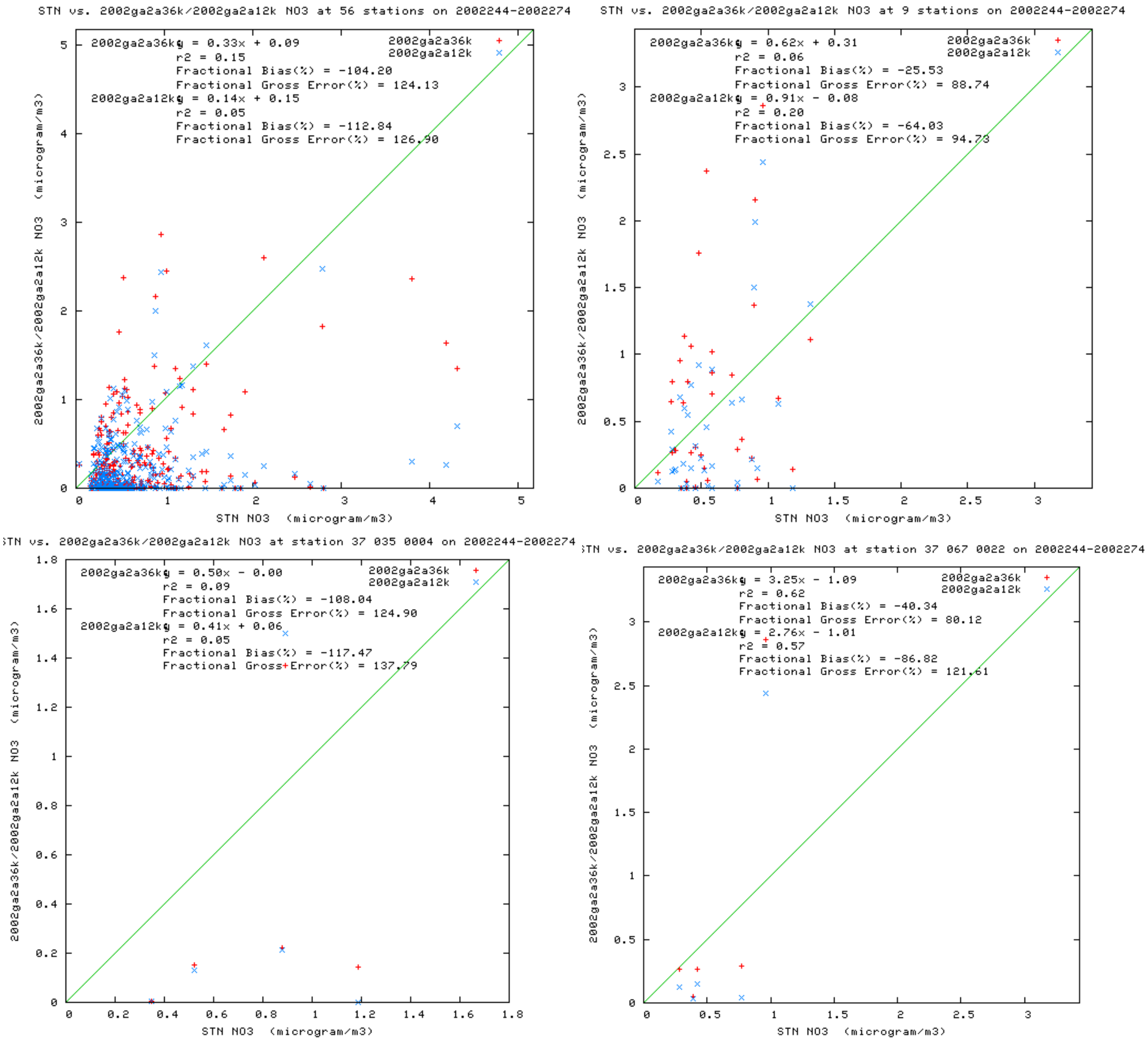


Figure 4-21: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of September.

4.1.2.10 October

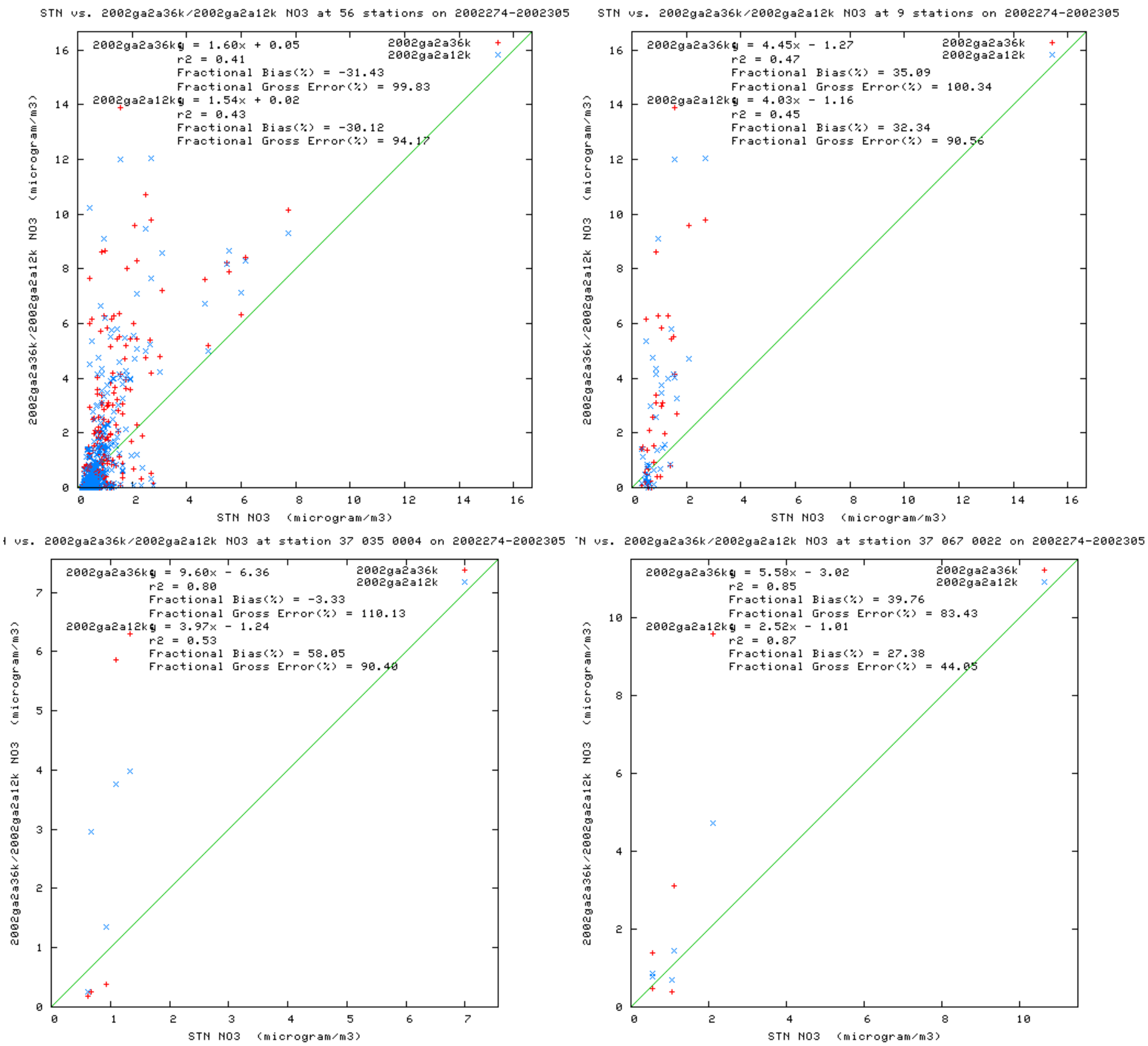


Figure 4-22: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of October.

4.1.2.11 November

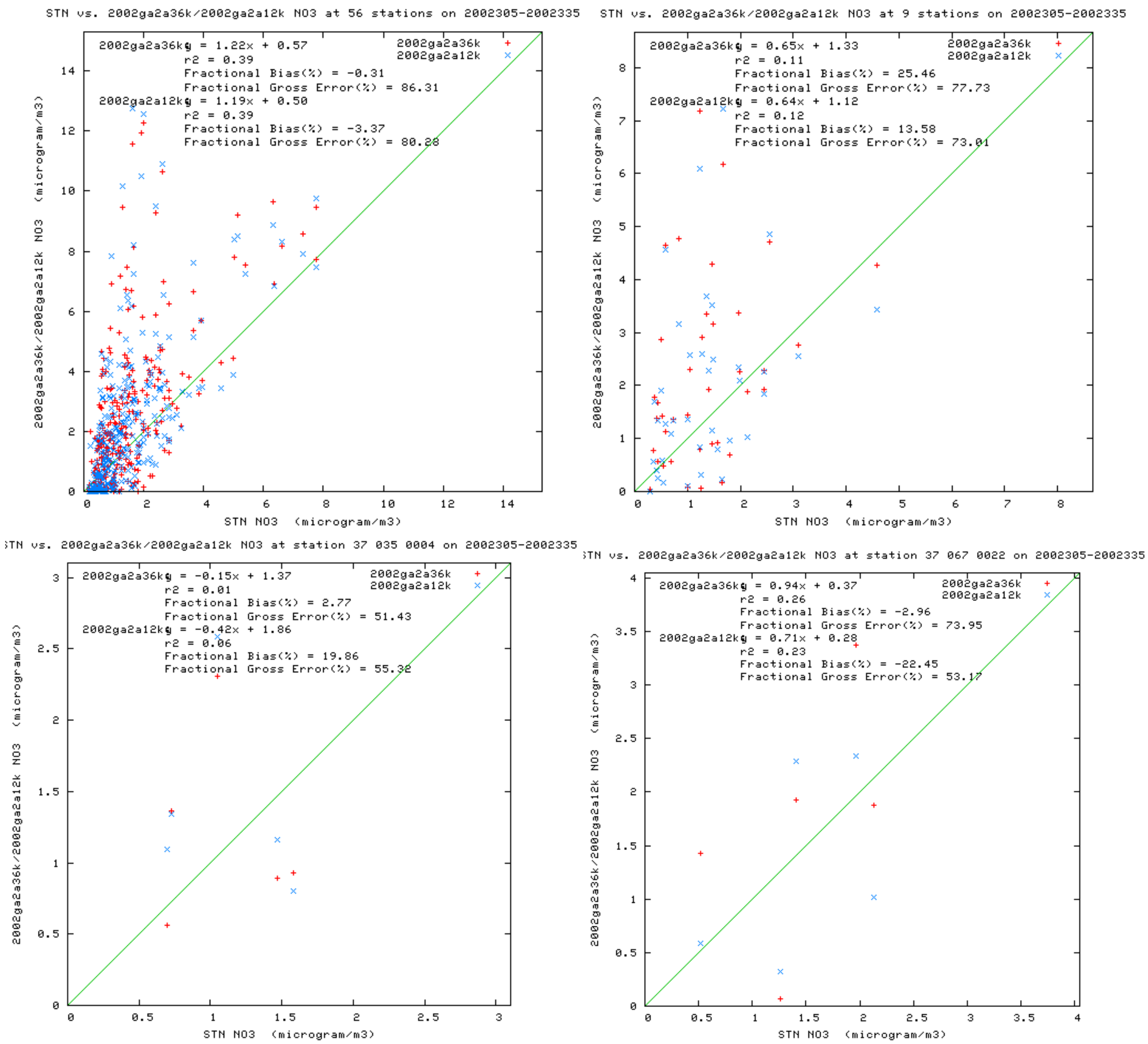


Figure 4-23: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of November.

4.1.2.12 December

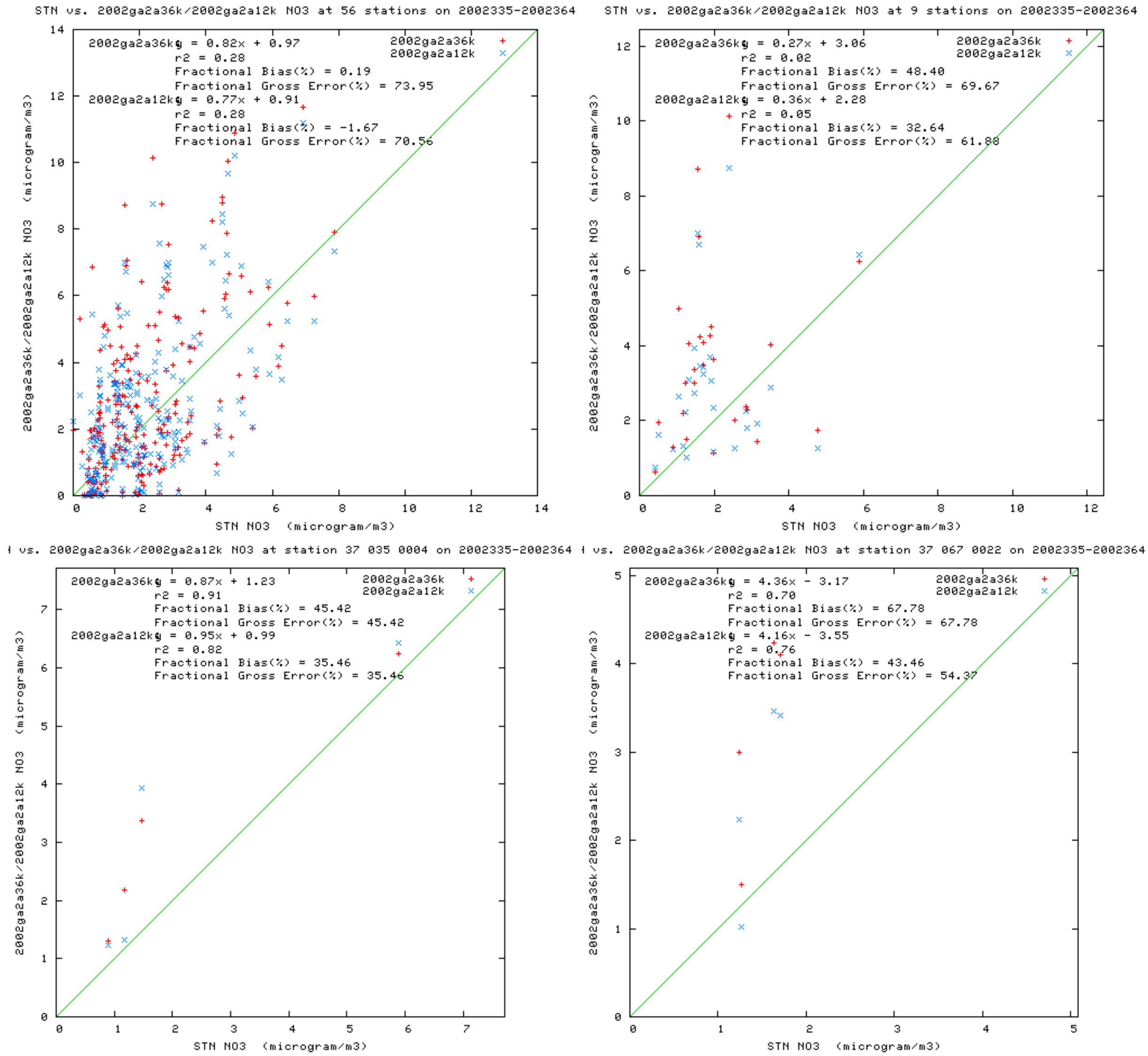


Figure 4-24: Scatter Plot of Observed Nitrates from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of December.

4.1.3 Ammonium

4.1.3.1 January

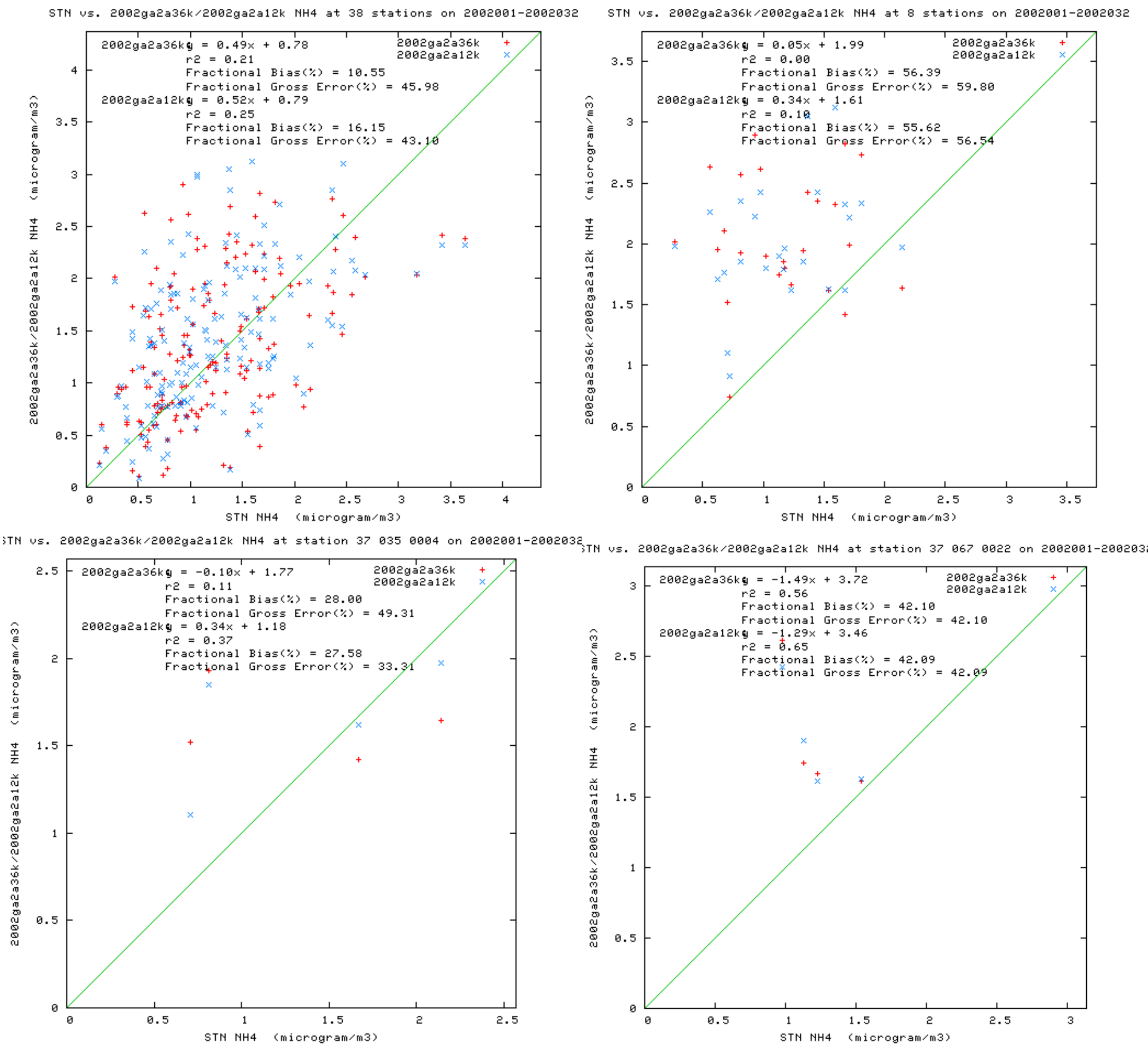


Figure 4-25: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of January.

4.1.3.2 February

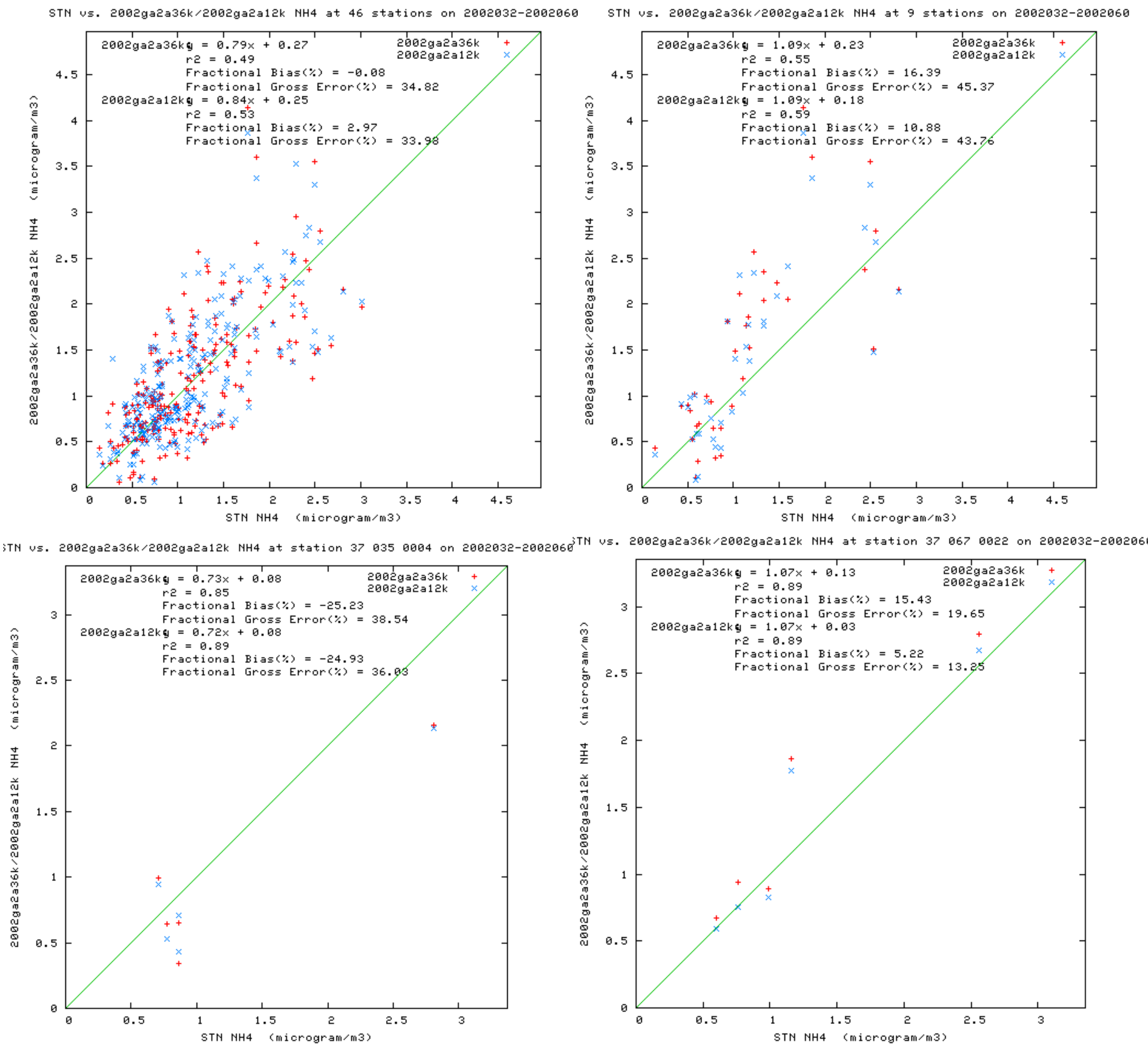


Figure 4-26: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of February.

4.1.3.3 March

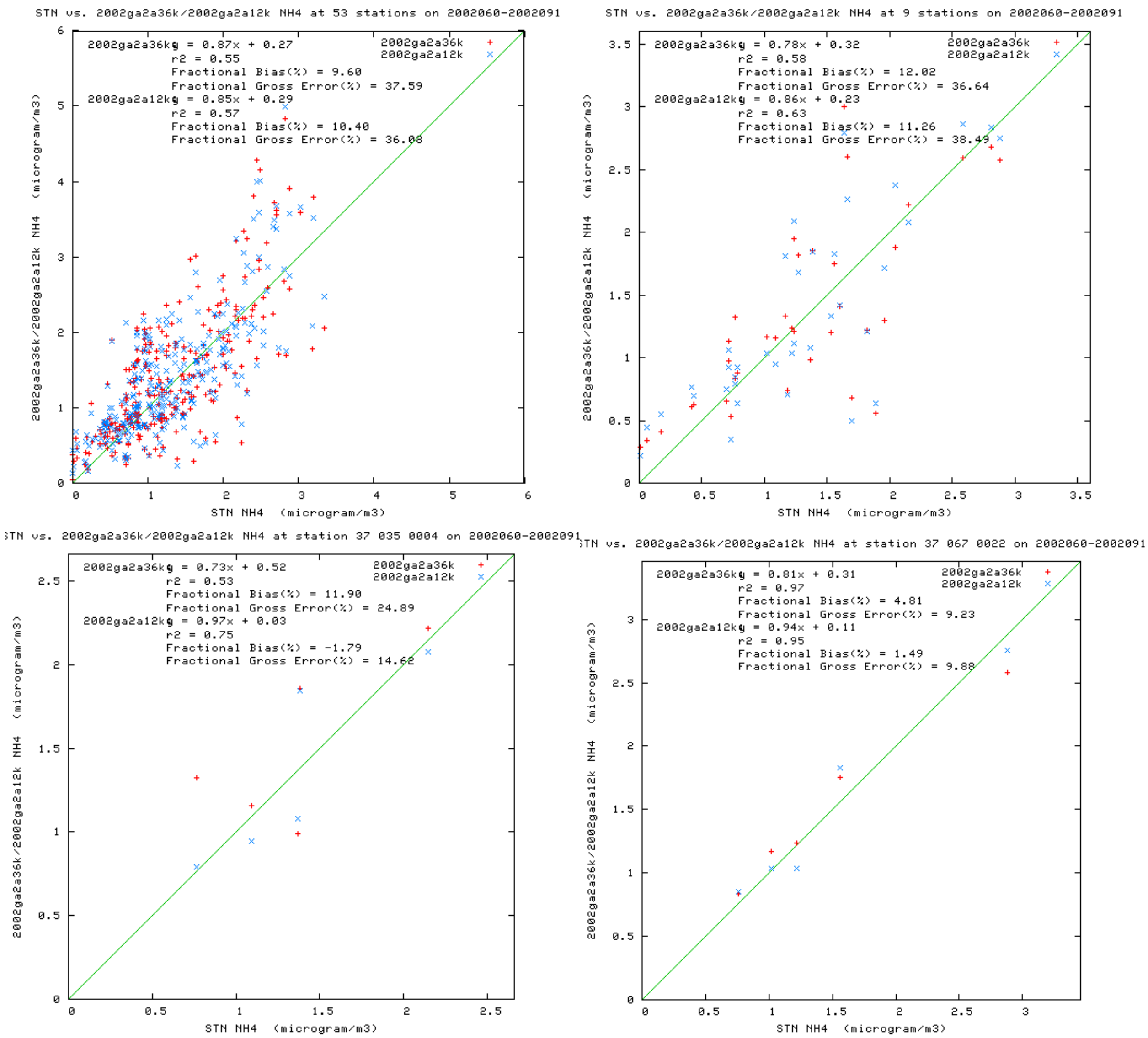


Figure 4-27: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of March.

4.1.3.4 April

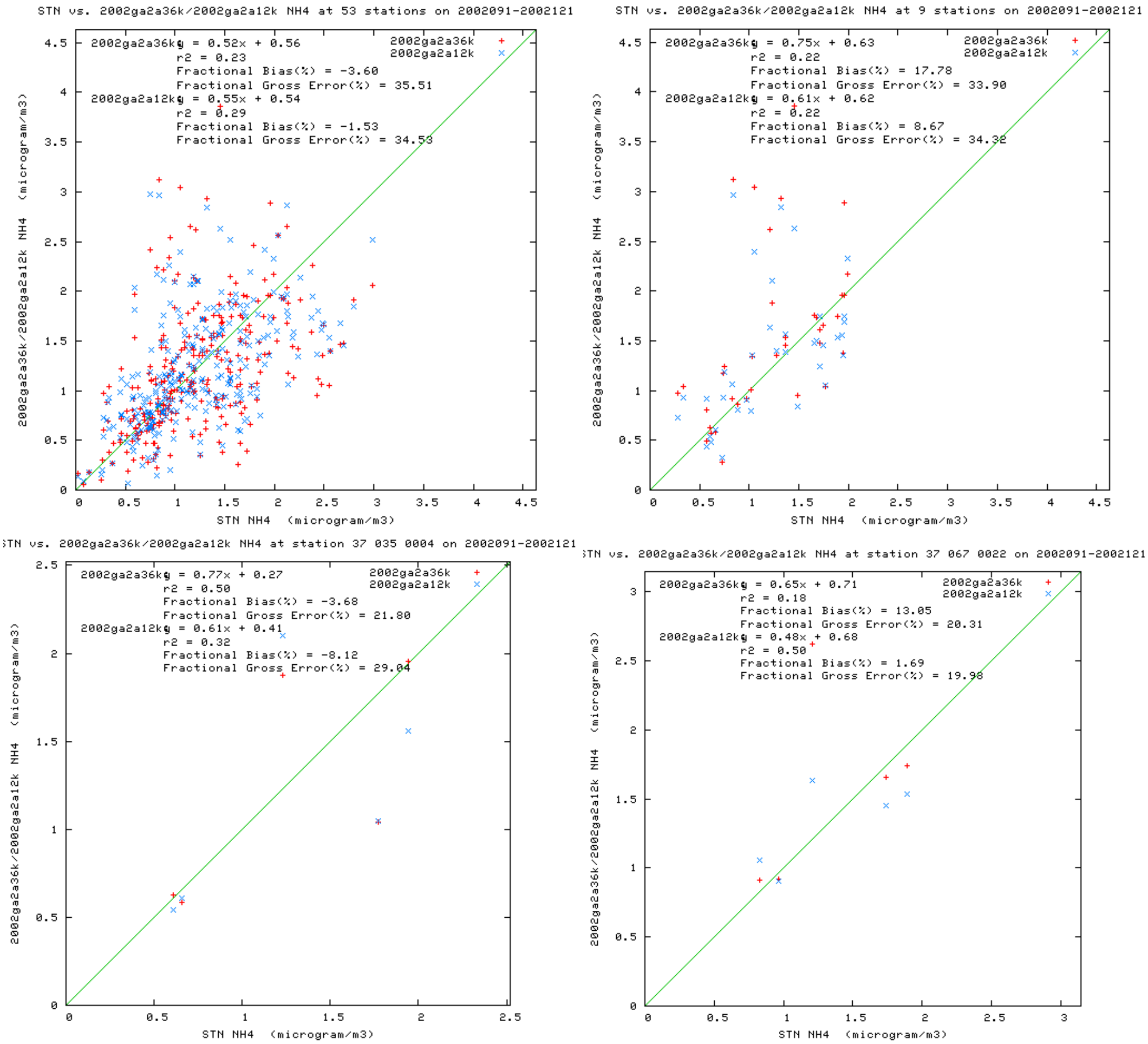


Figure 4-28: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of April.

4.1.3.5 May

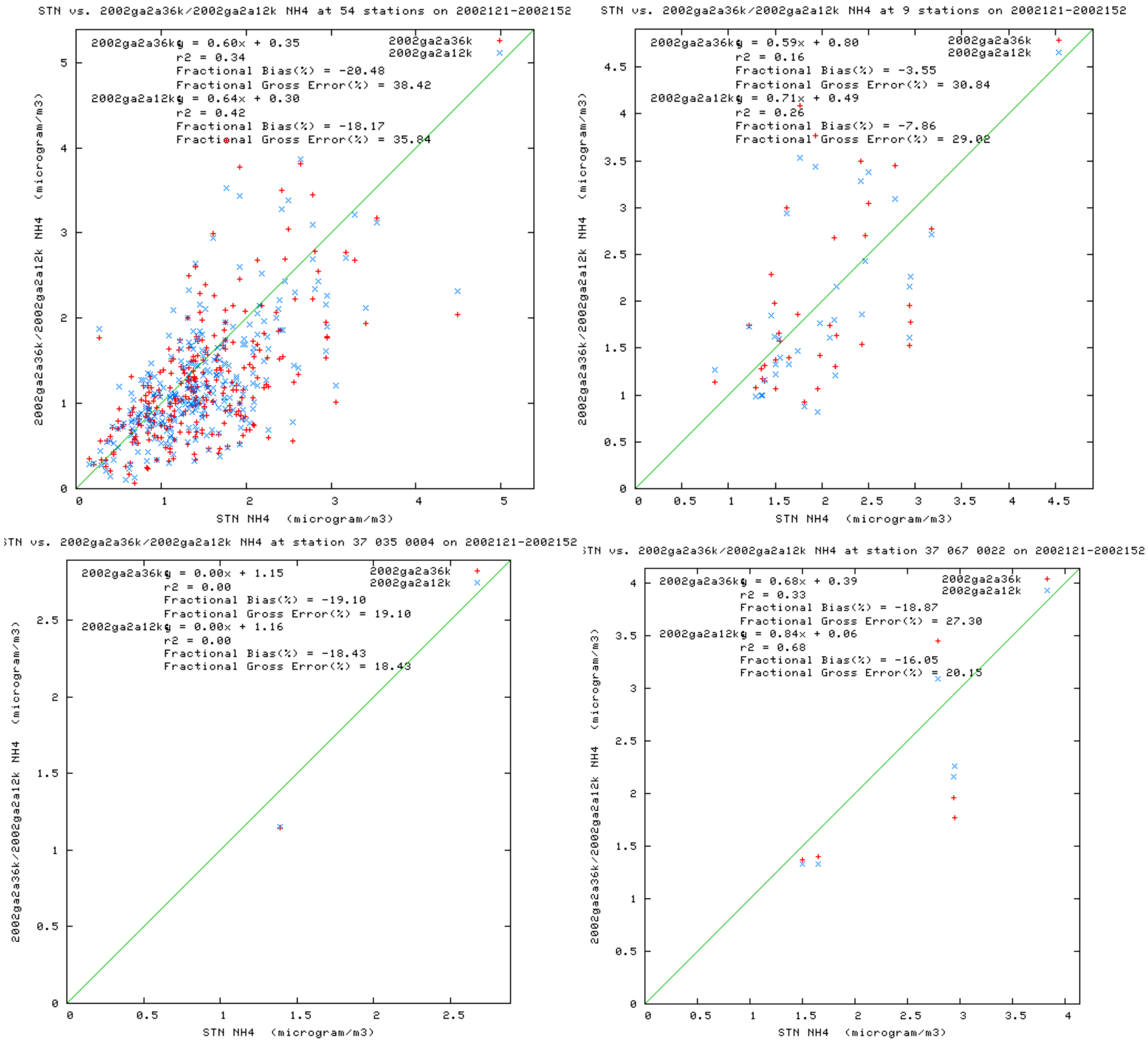


Figure 4-29: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of May.

4.1.3.6 June

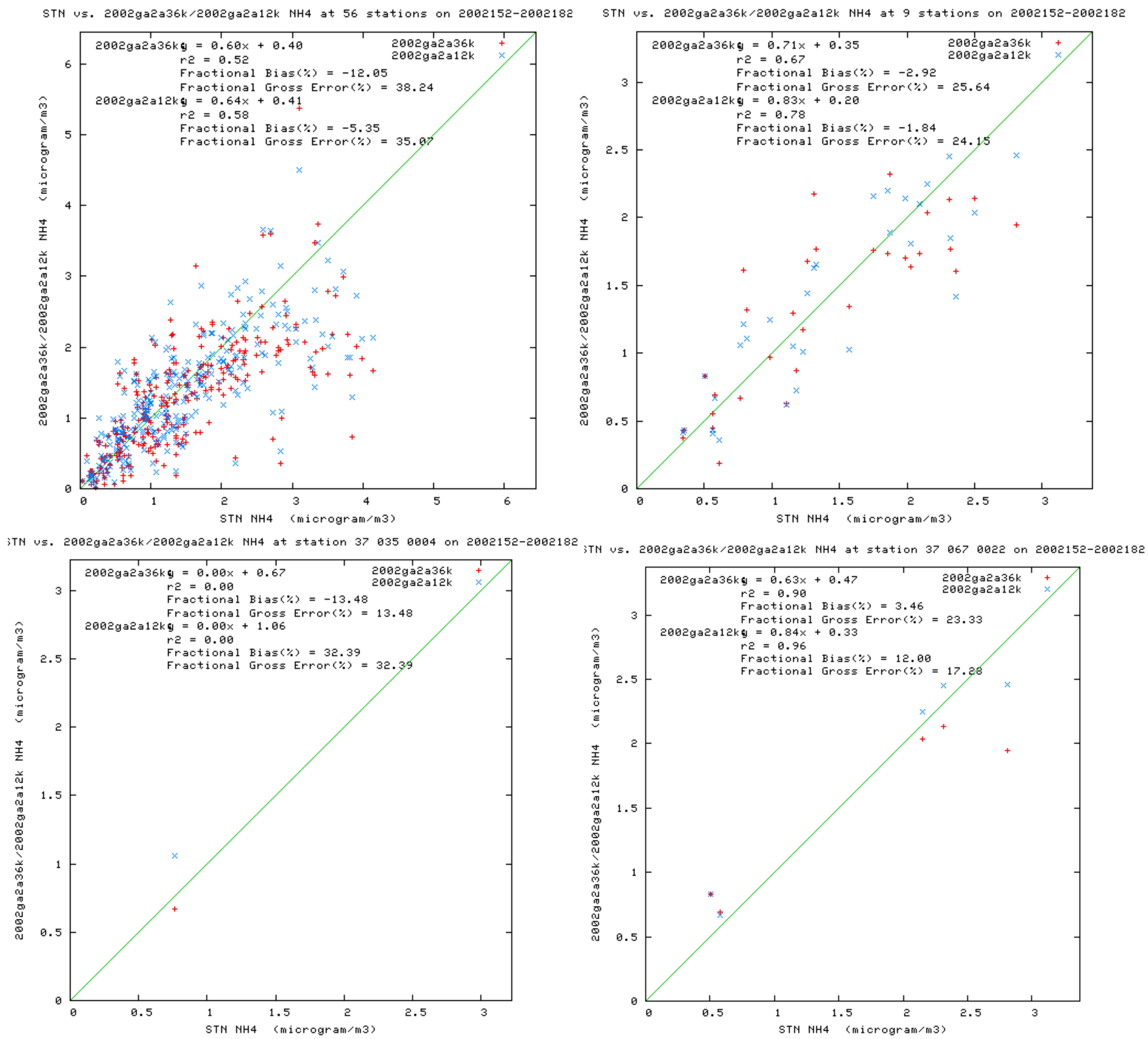


Figure 4-30: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of June.

4.1.3.7 July

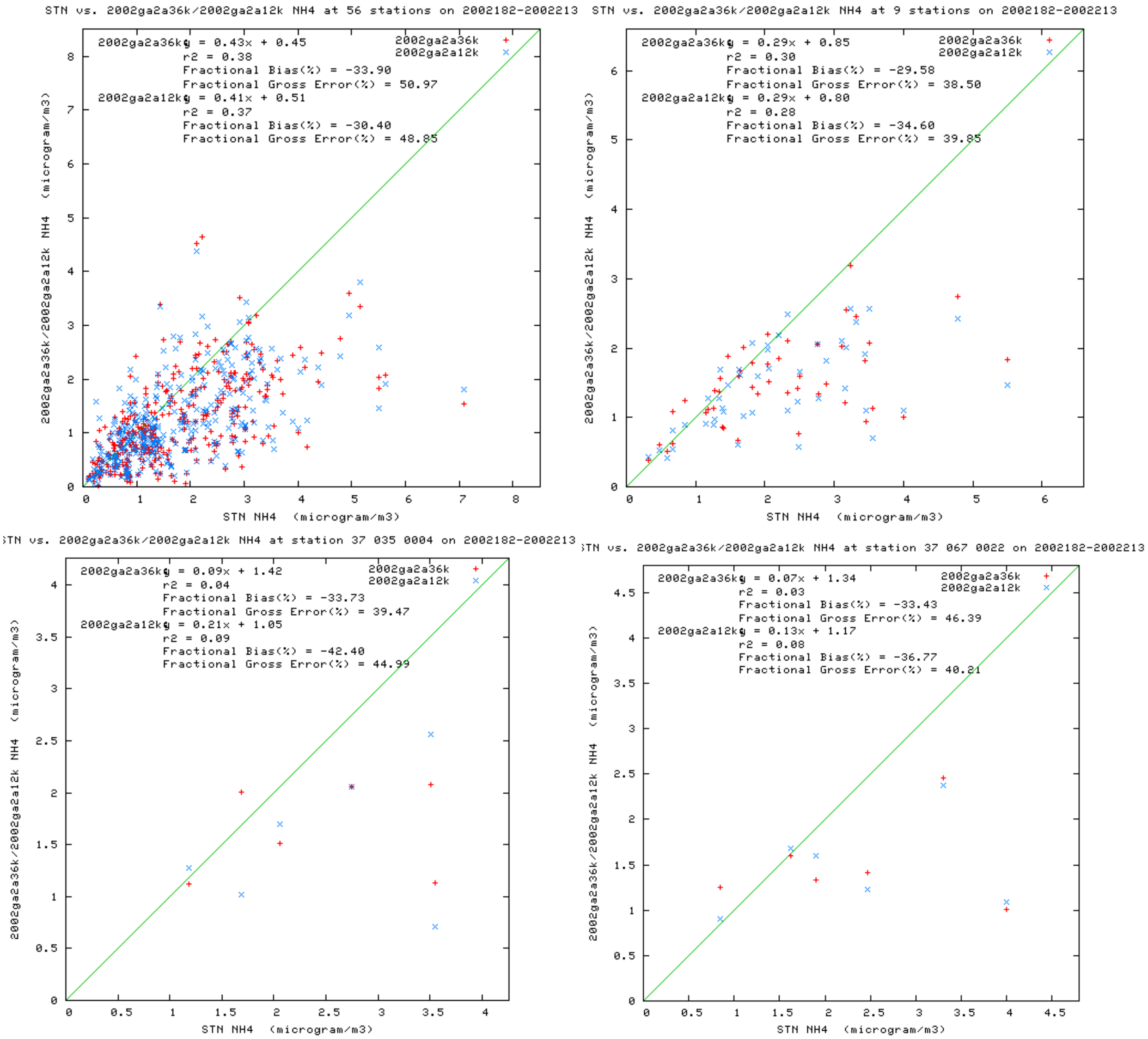


Figure 4-31: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of July.

4.1.3.8 August

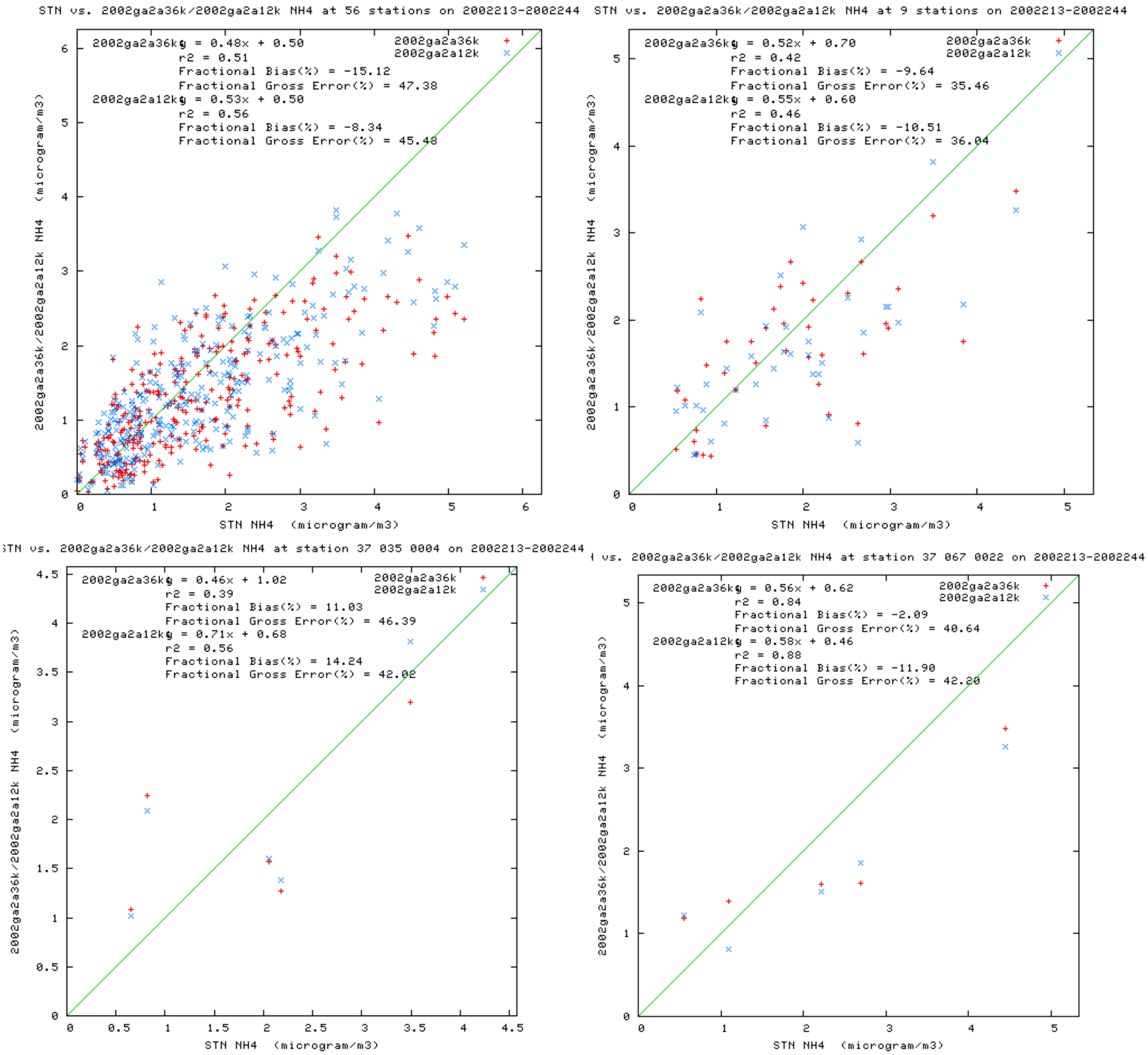


Figure 4-32: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of August.

4.1.3.9 September

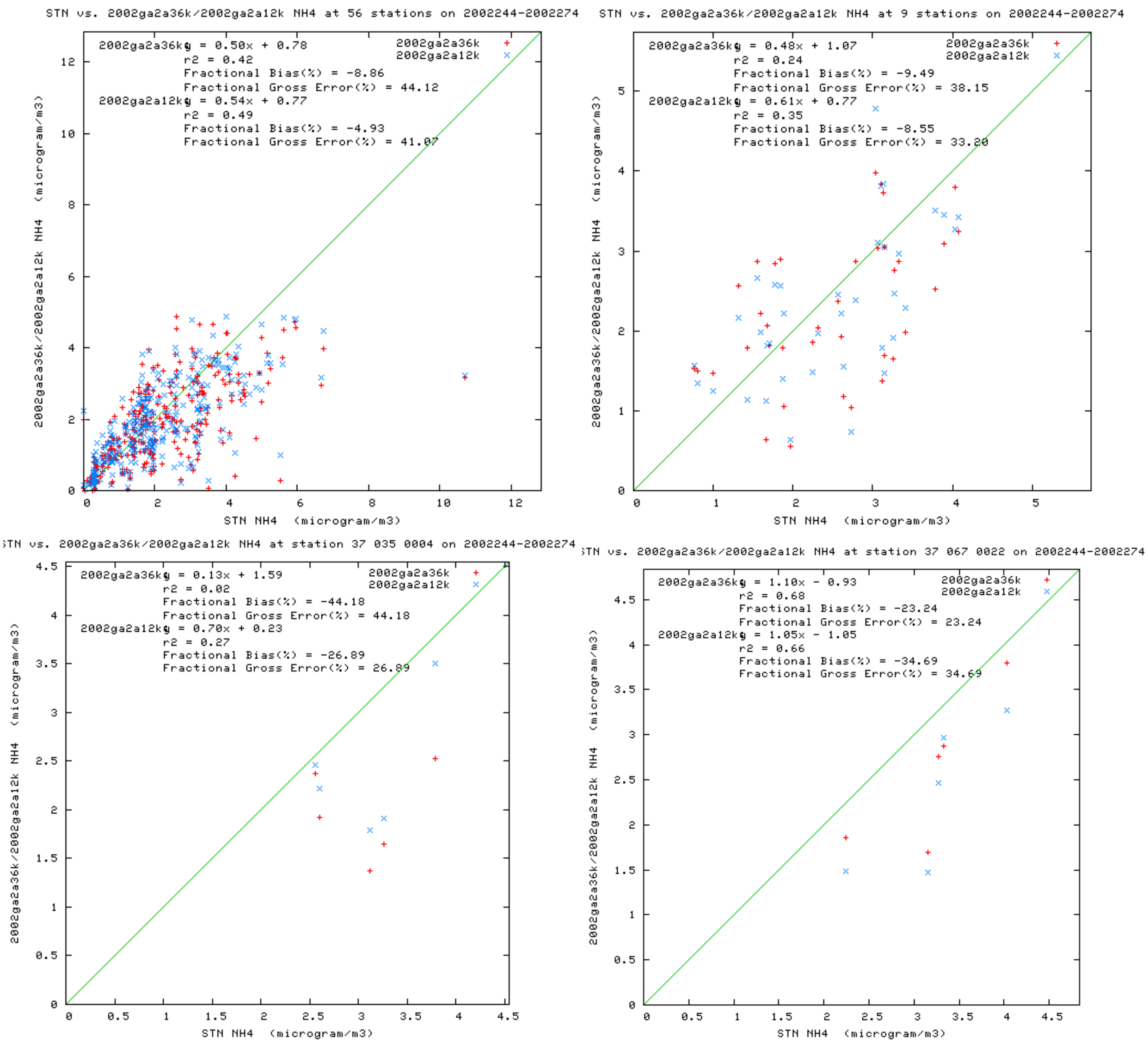


Figure 4-33: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of September.

4.1.3.10 October

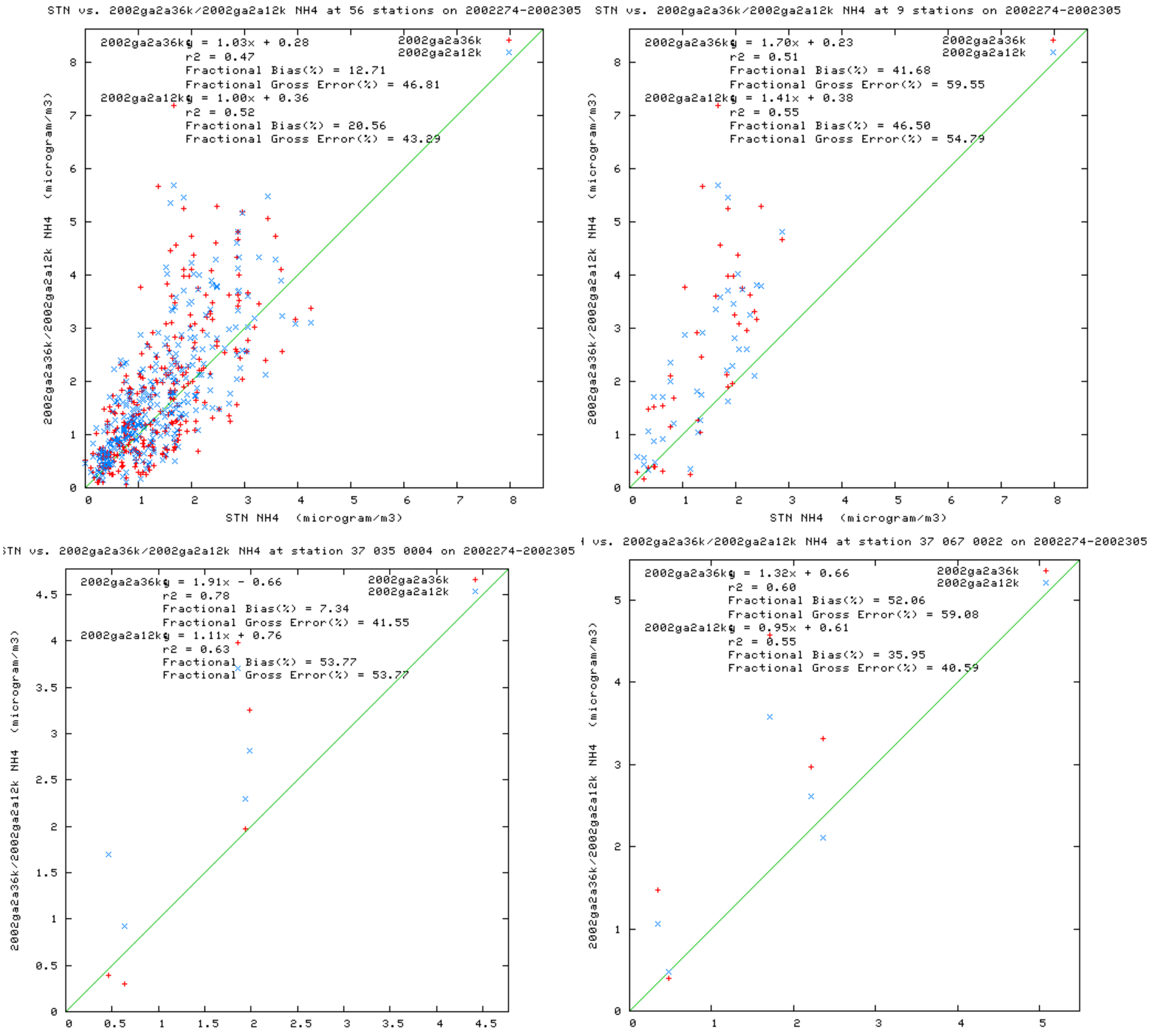


Figure 4-34: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of October.

4.1.3.11 November

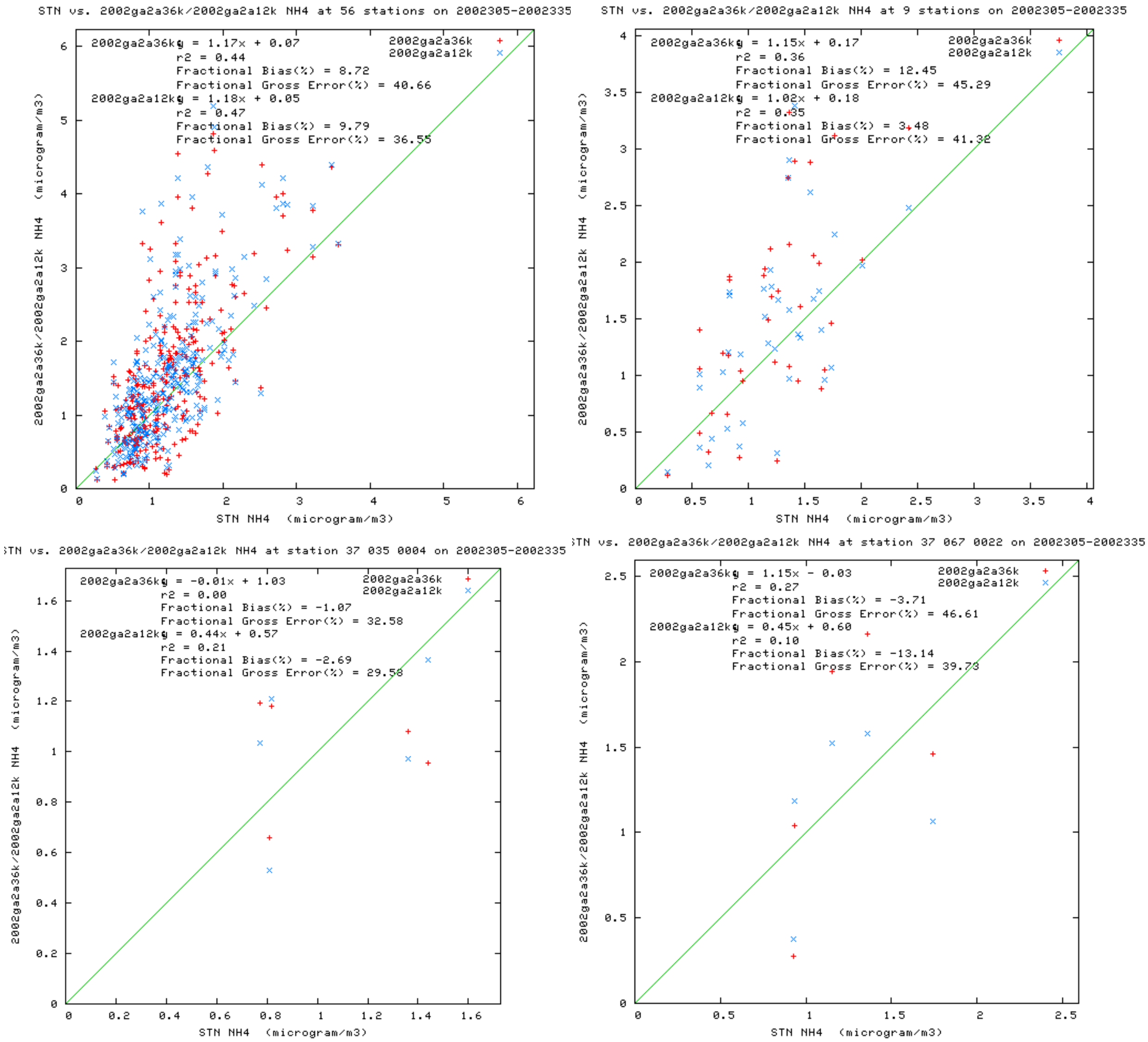


Figure 4-35: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of November.

4.1.3.12 December

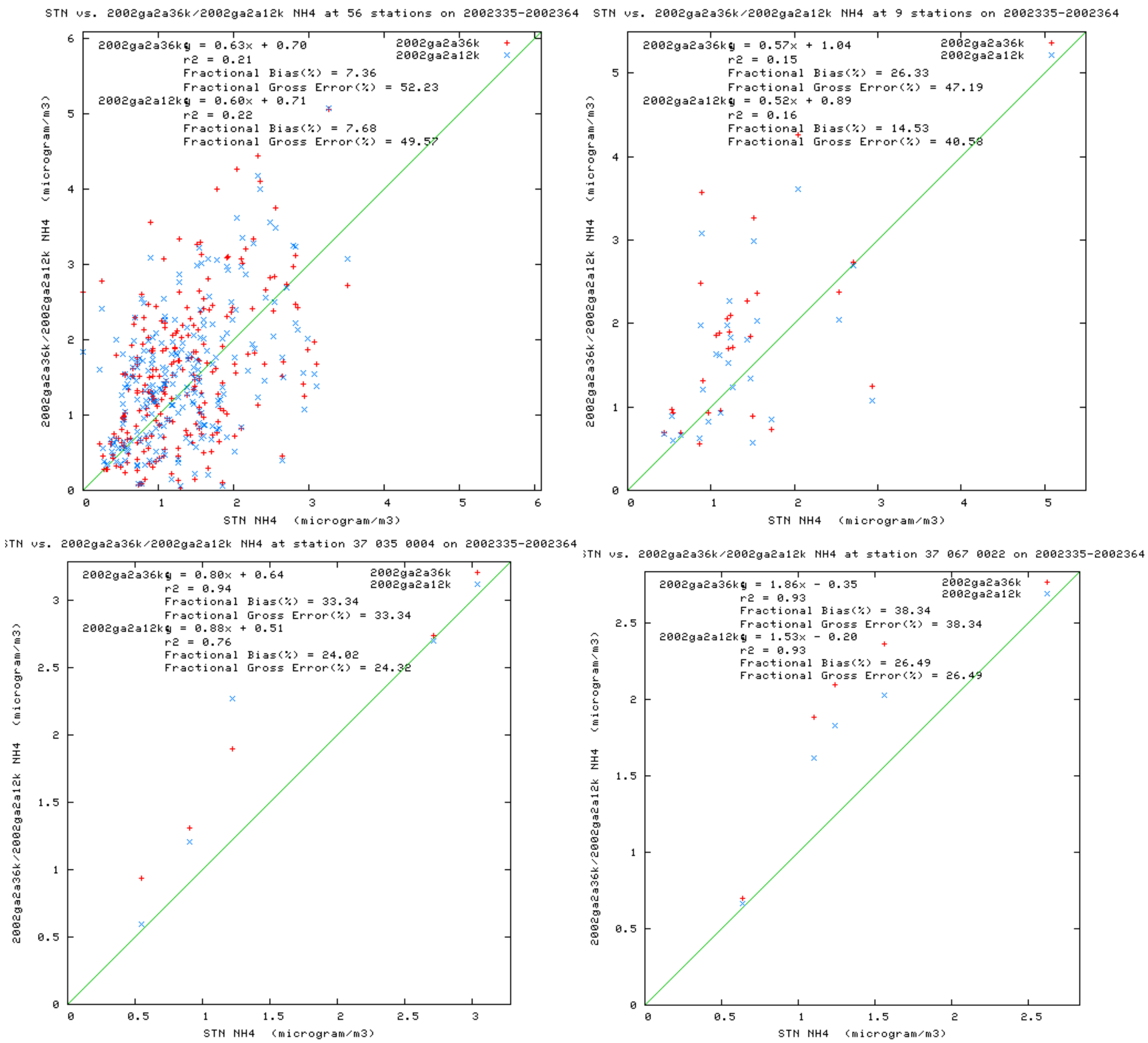


Figure 4-36: Scatter Plot of Observed Ammonium from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of December.

4.1.4 Organic Carbon

4.1.4.1 January

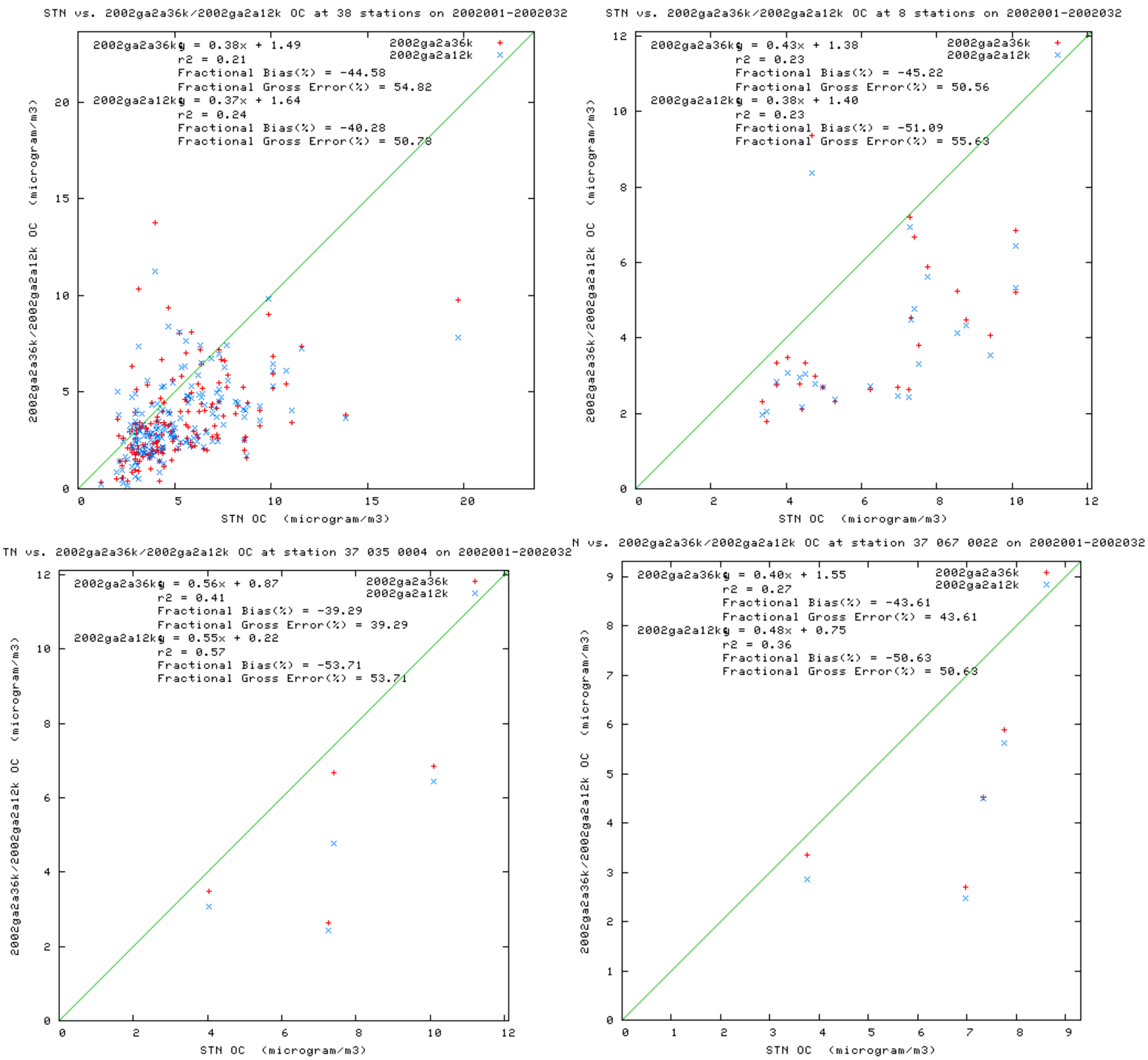


Figure 4-37: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of January.

4.1.4.2 February

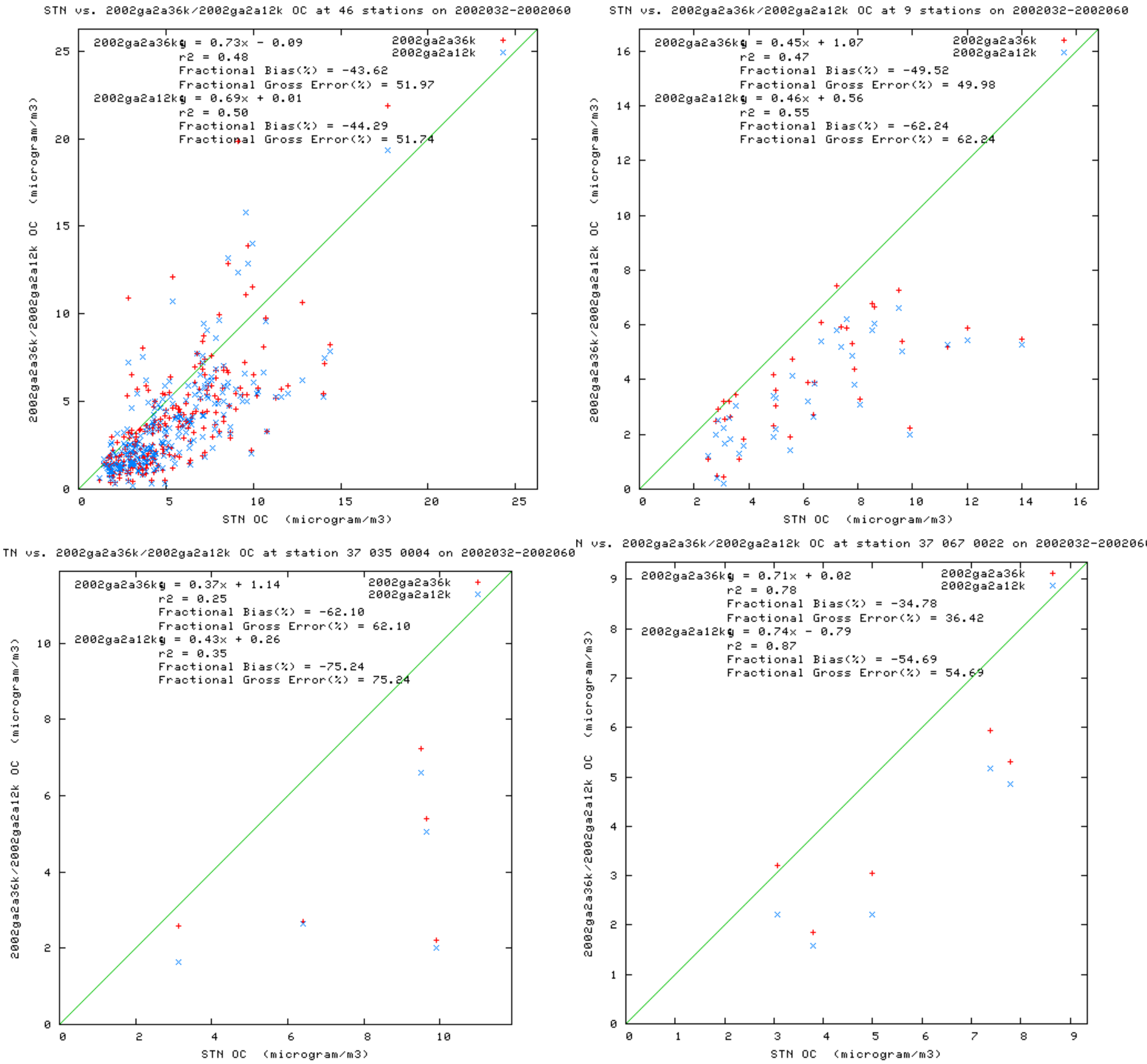


Figure 4-38: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of February.

4.1.4.3 March

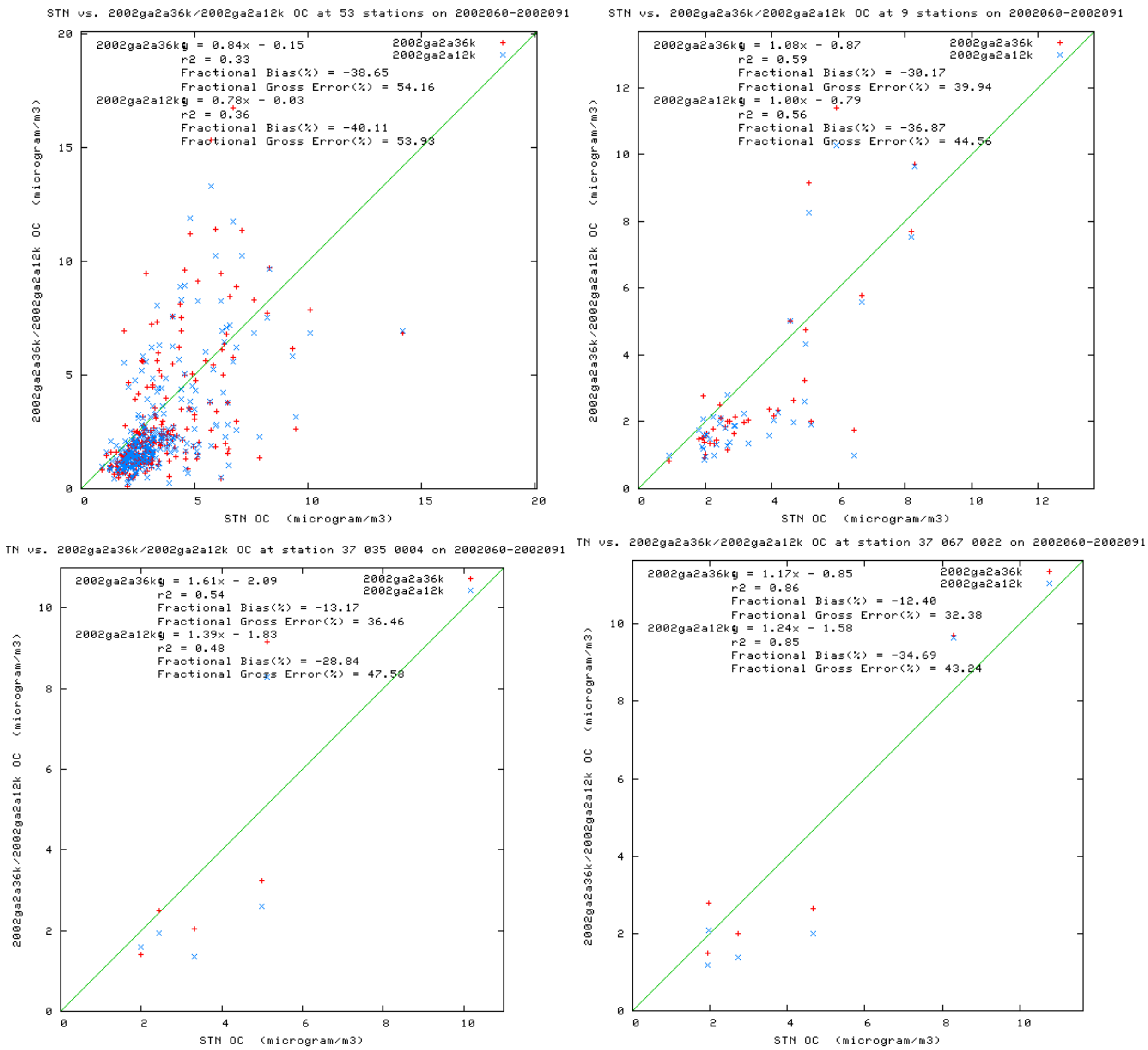


Figure 4-39: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of March.

4.1.4.4 April

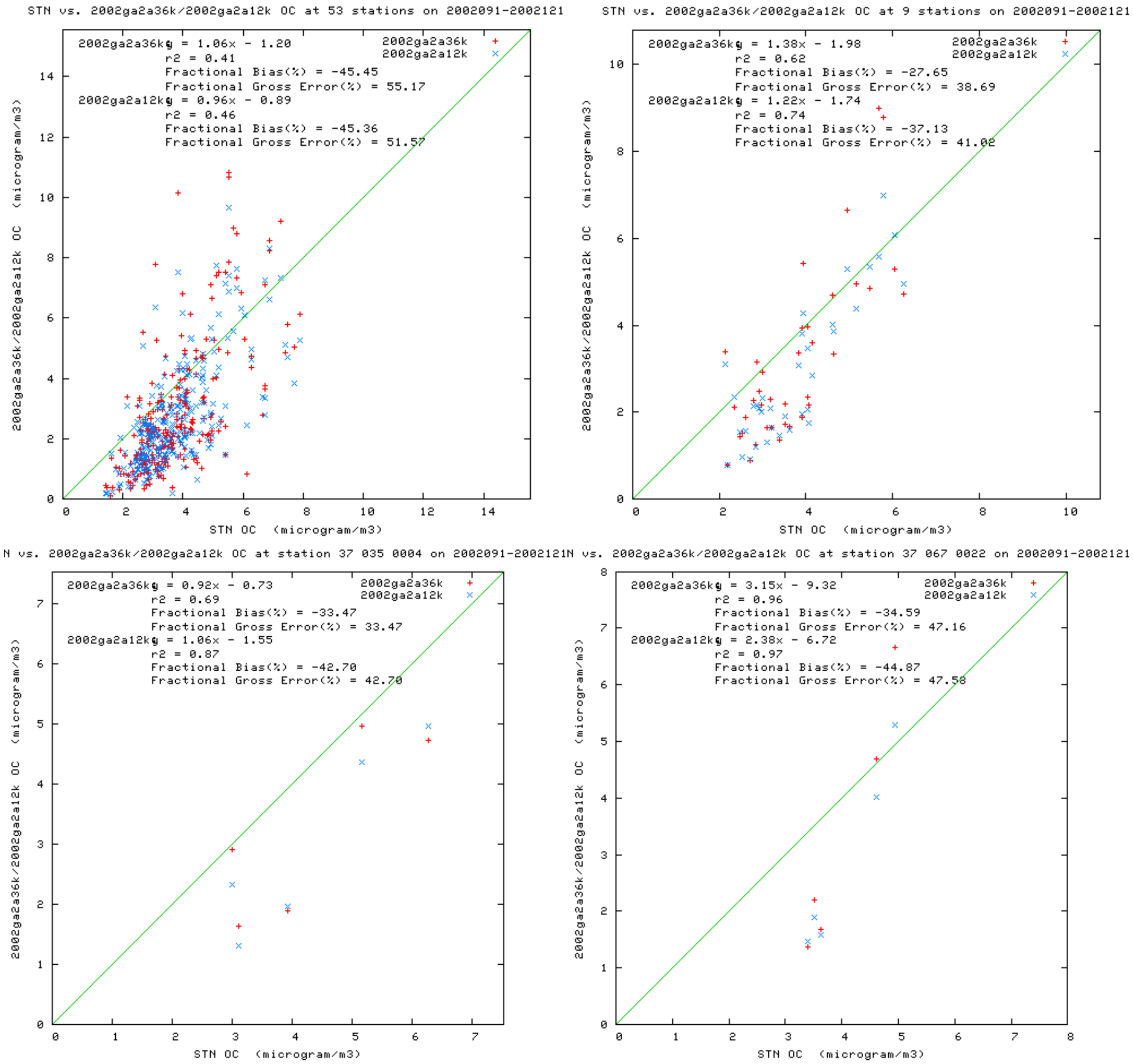


Figure 4-40: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of April.

4.1.4.5 May

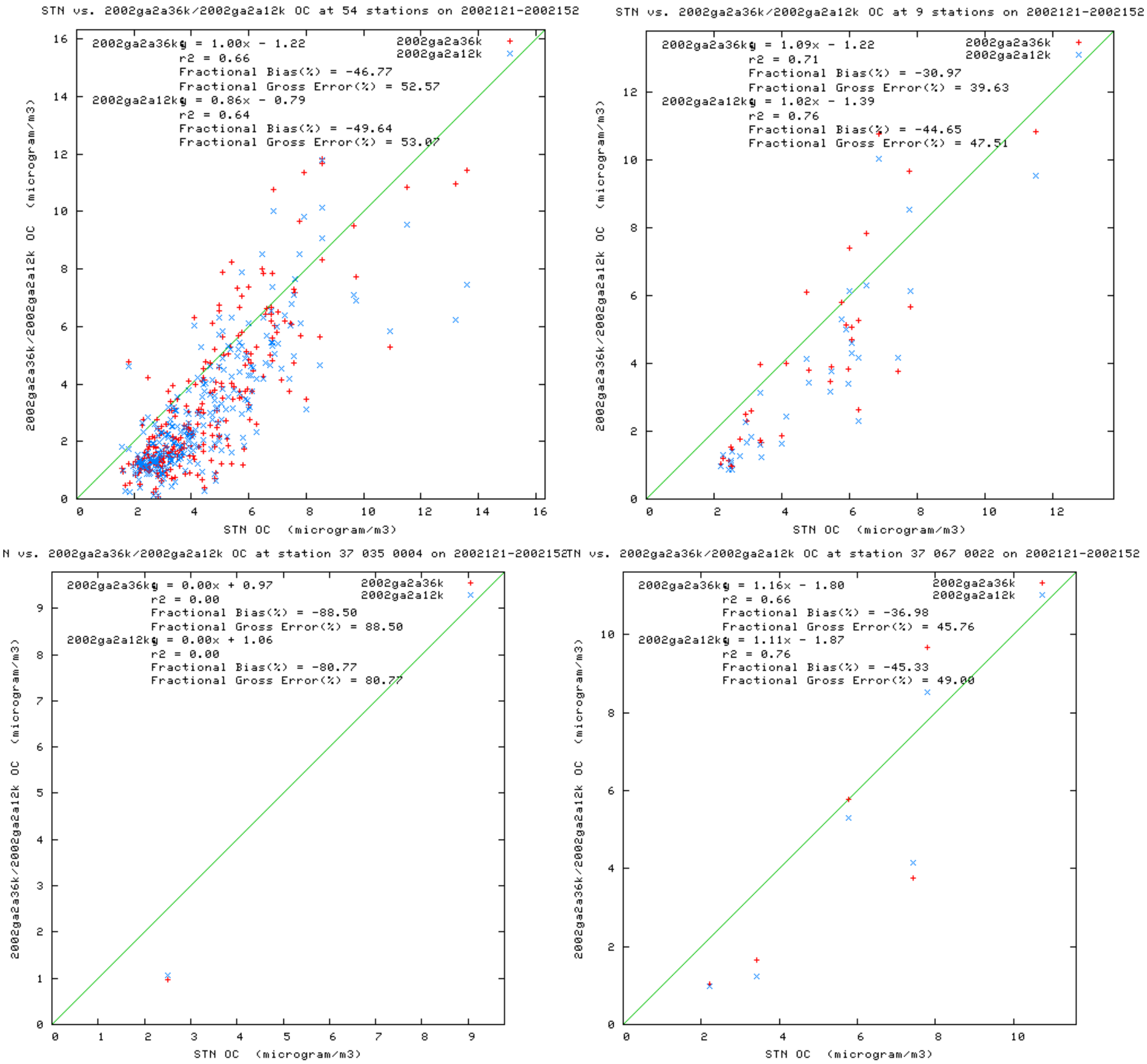


Figure 4-41: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of May.

4.1.4.6 June

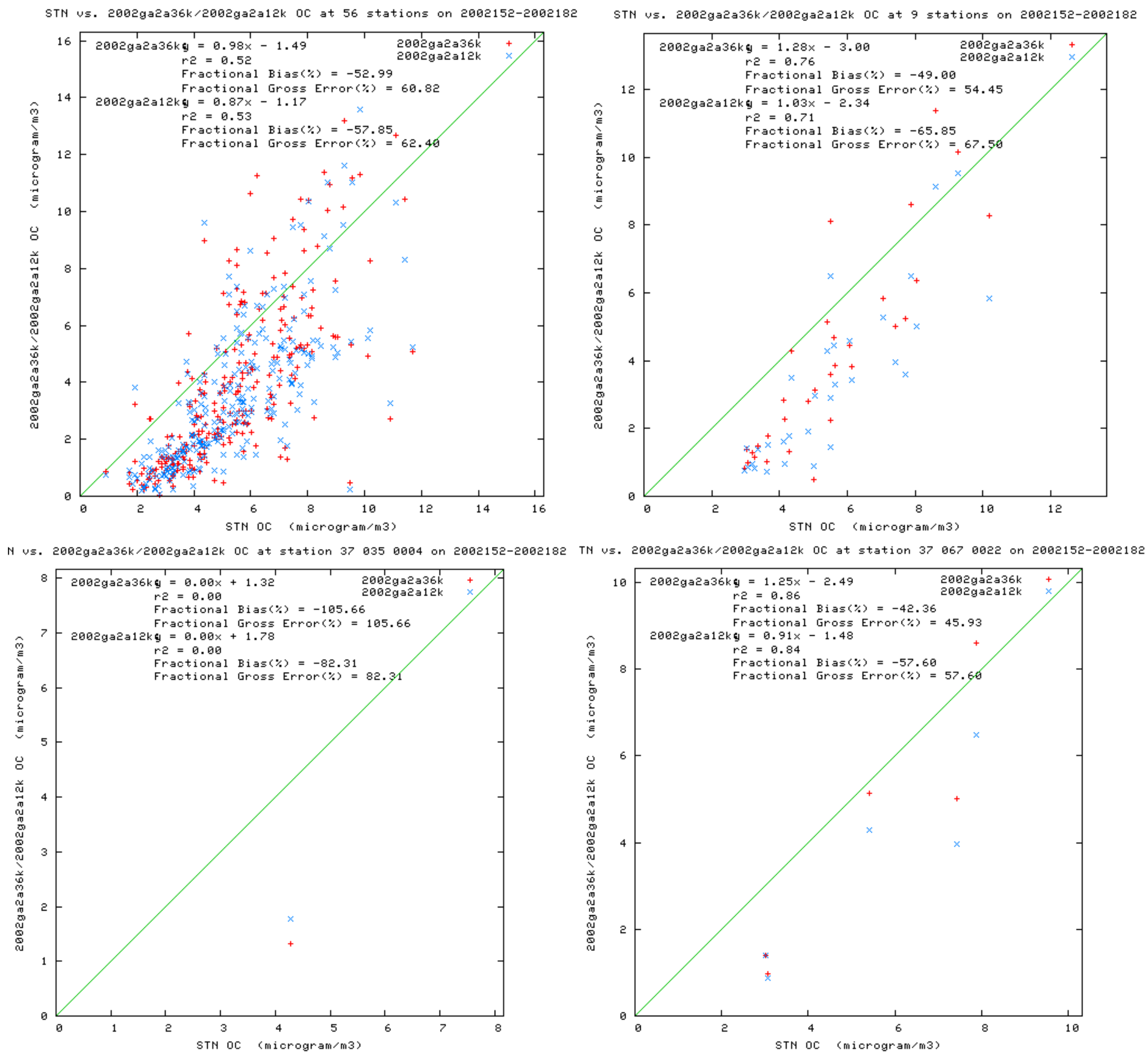


Figure 4-42: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of June.

4.1.4.7 July

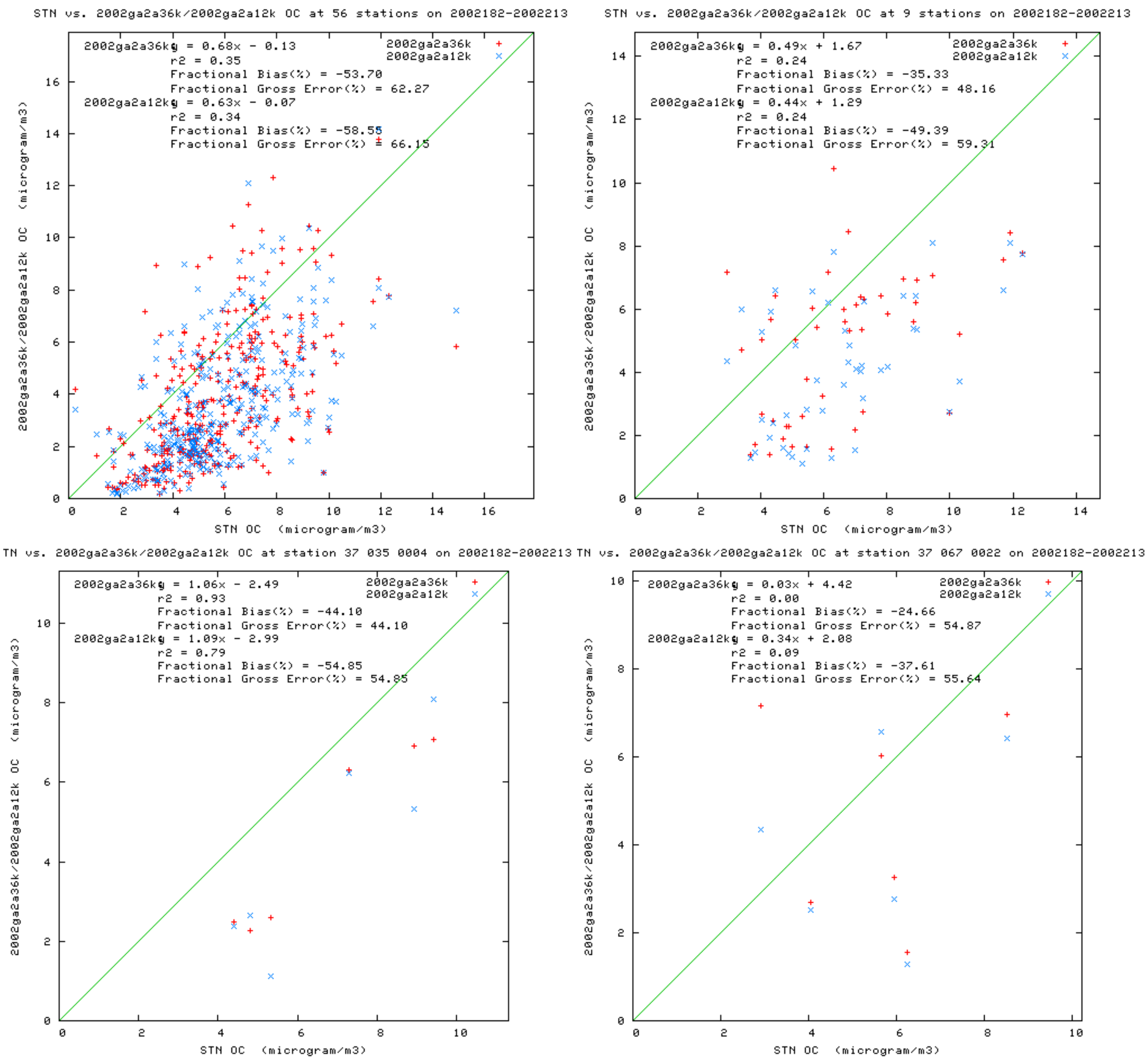


Figure 4-43: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of July.

4.1.4.8 August

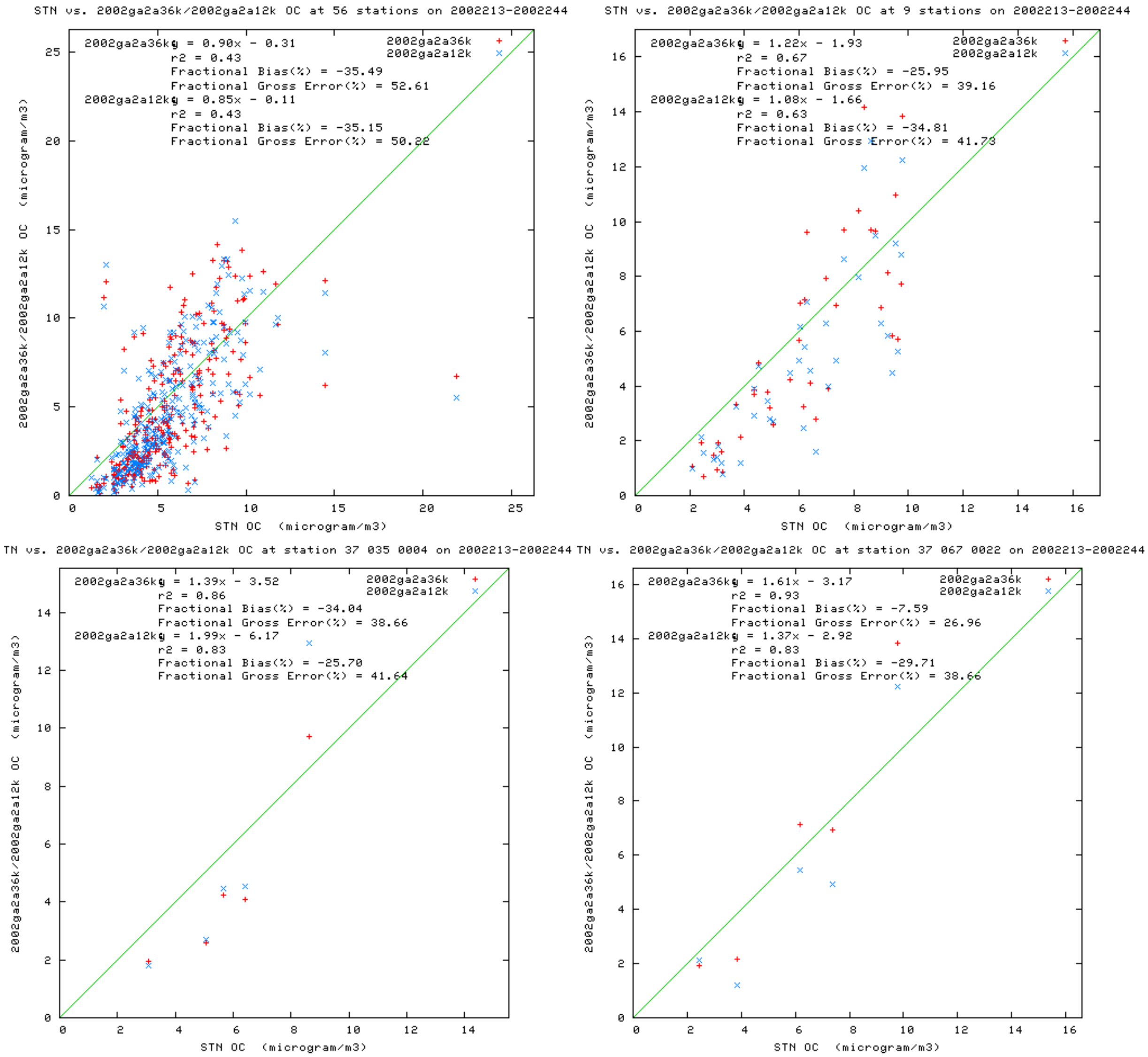


Figure 4-44: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of August.

4.1.4.9 September

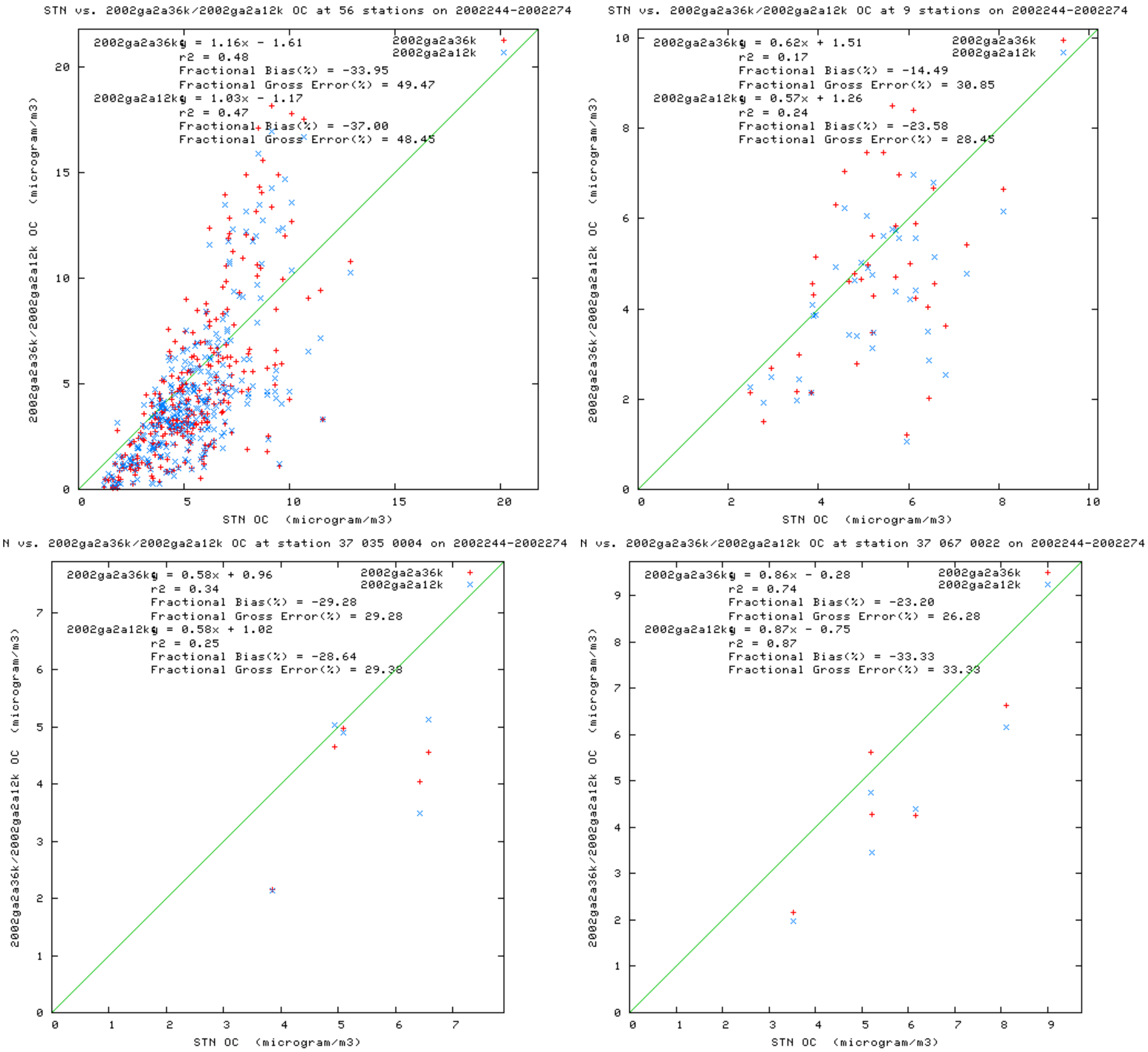


Figure 4-45: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of September.

4.1.4.10 October

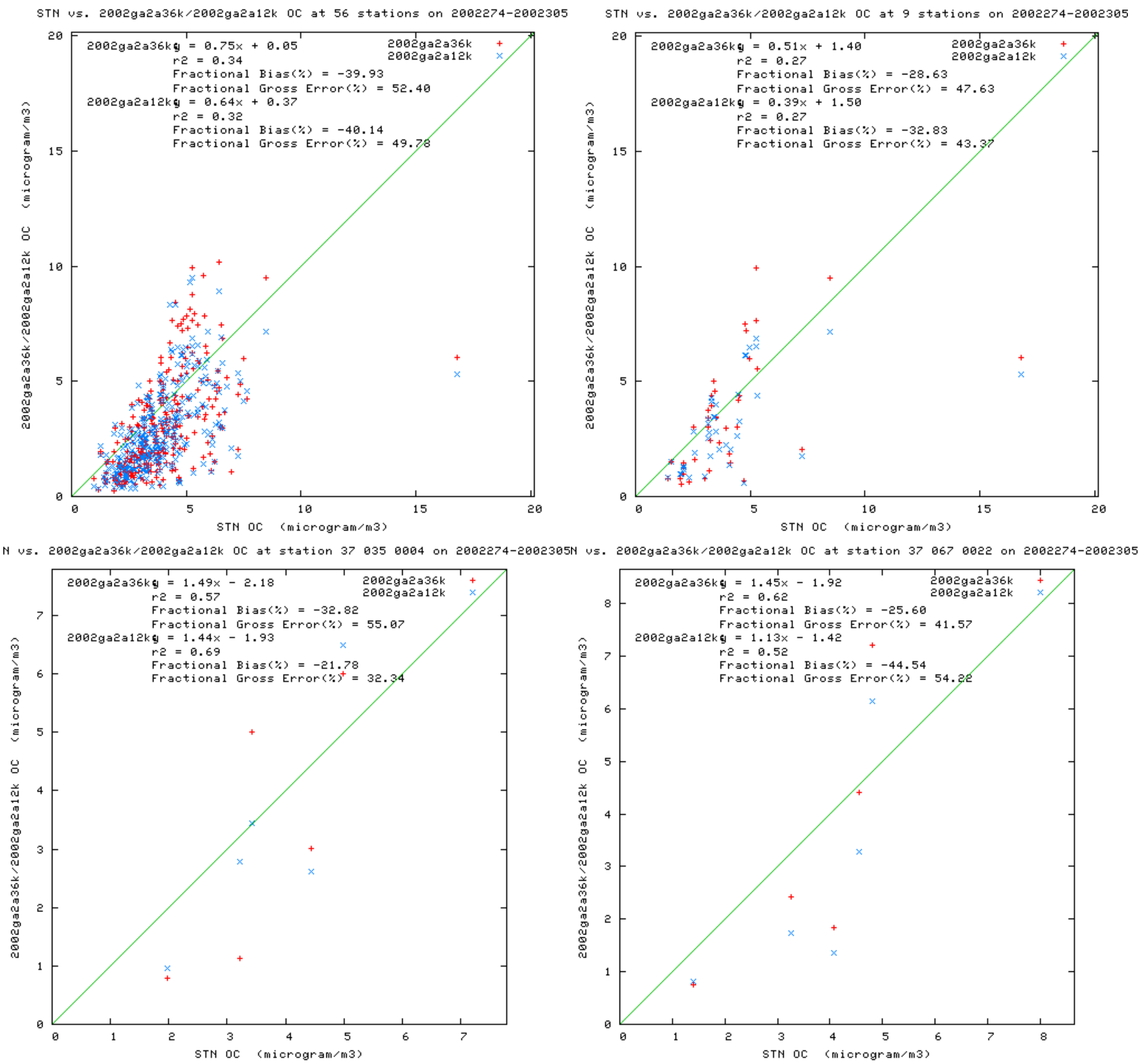


Figure 4-46: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of October.

4.1.4.11 November

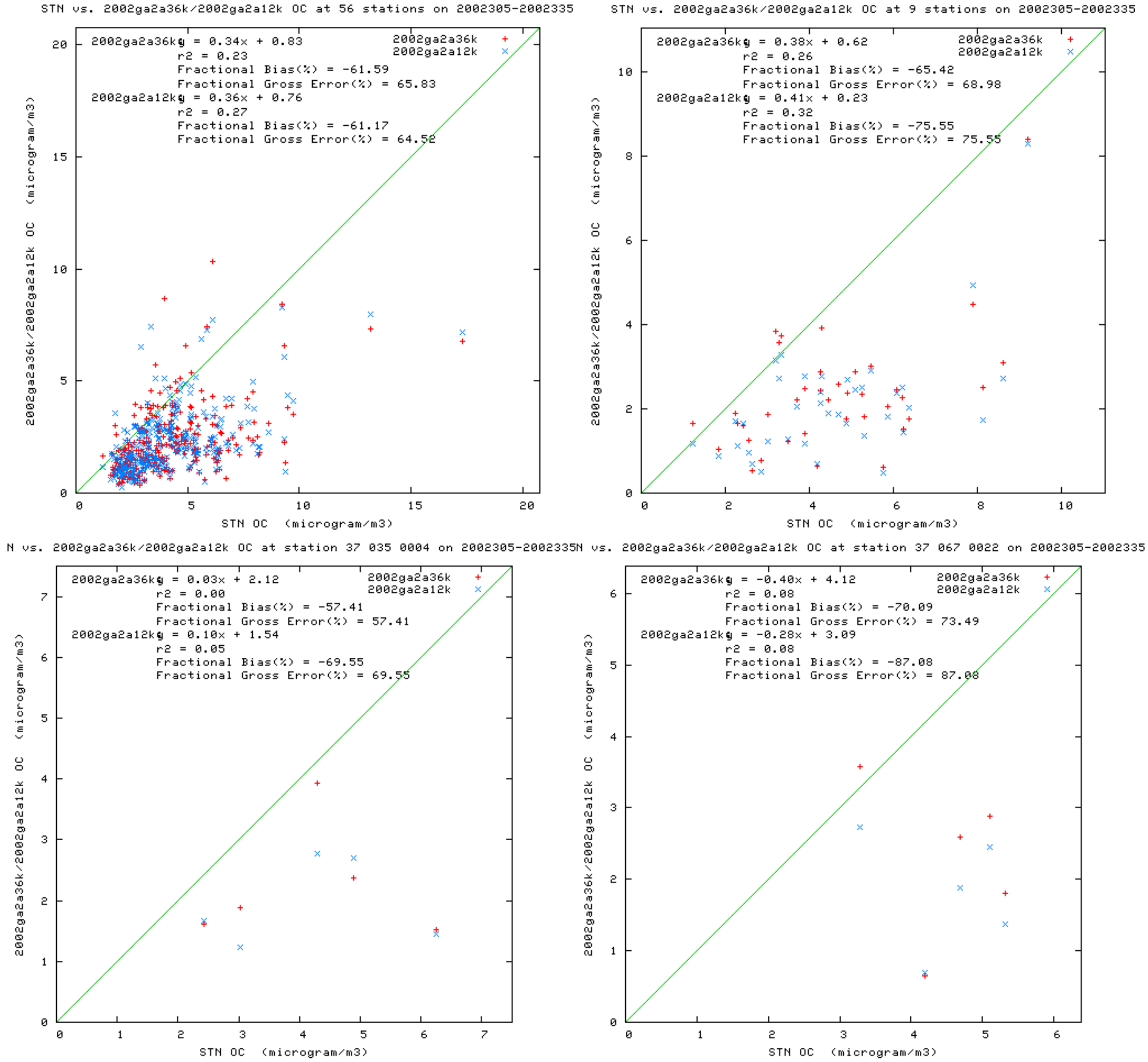


Figure 4-47: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of November.

4.1.4.12 December

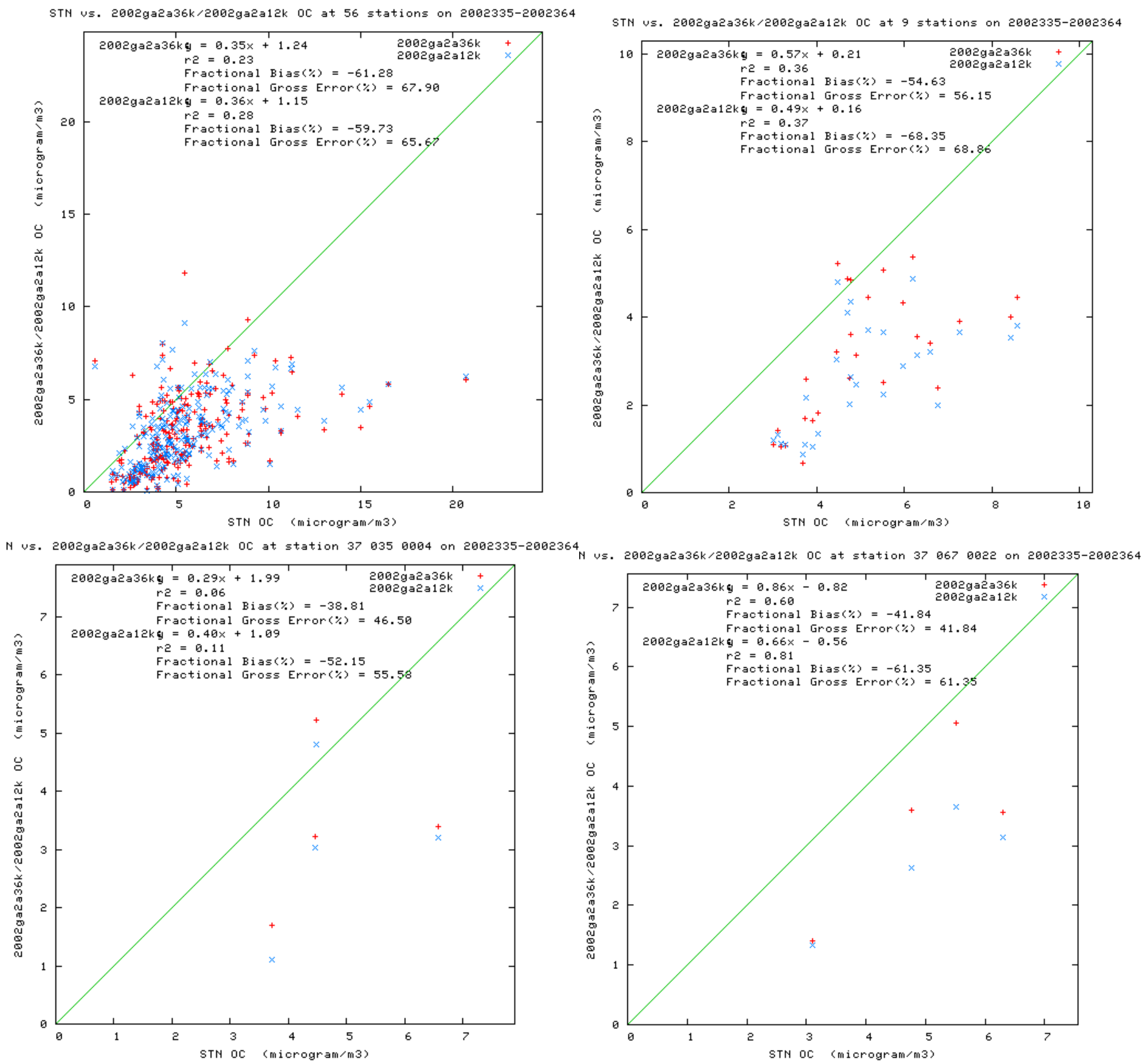


Figure 4-48: Scatter Plot of Observed Organic Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of December.

4.1.5 Elemental Carbon

4.1.5.1 January

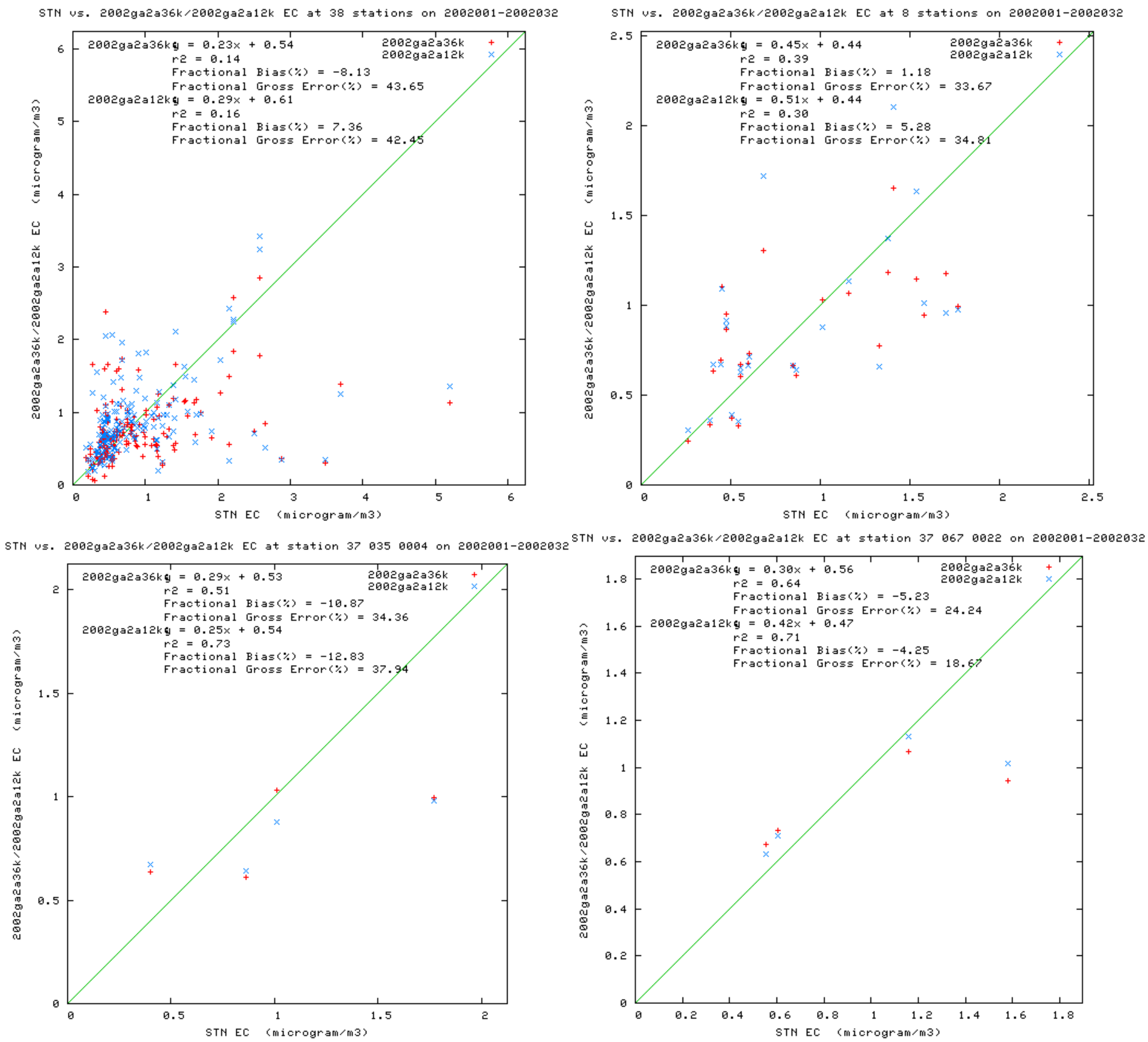


Figure 4-49: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of January.

4.1.5.2 February

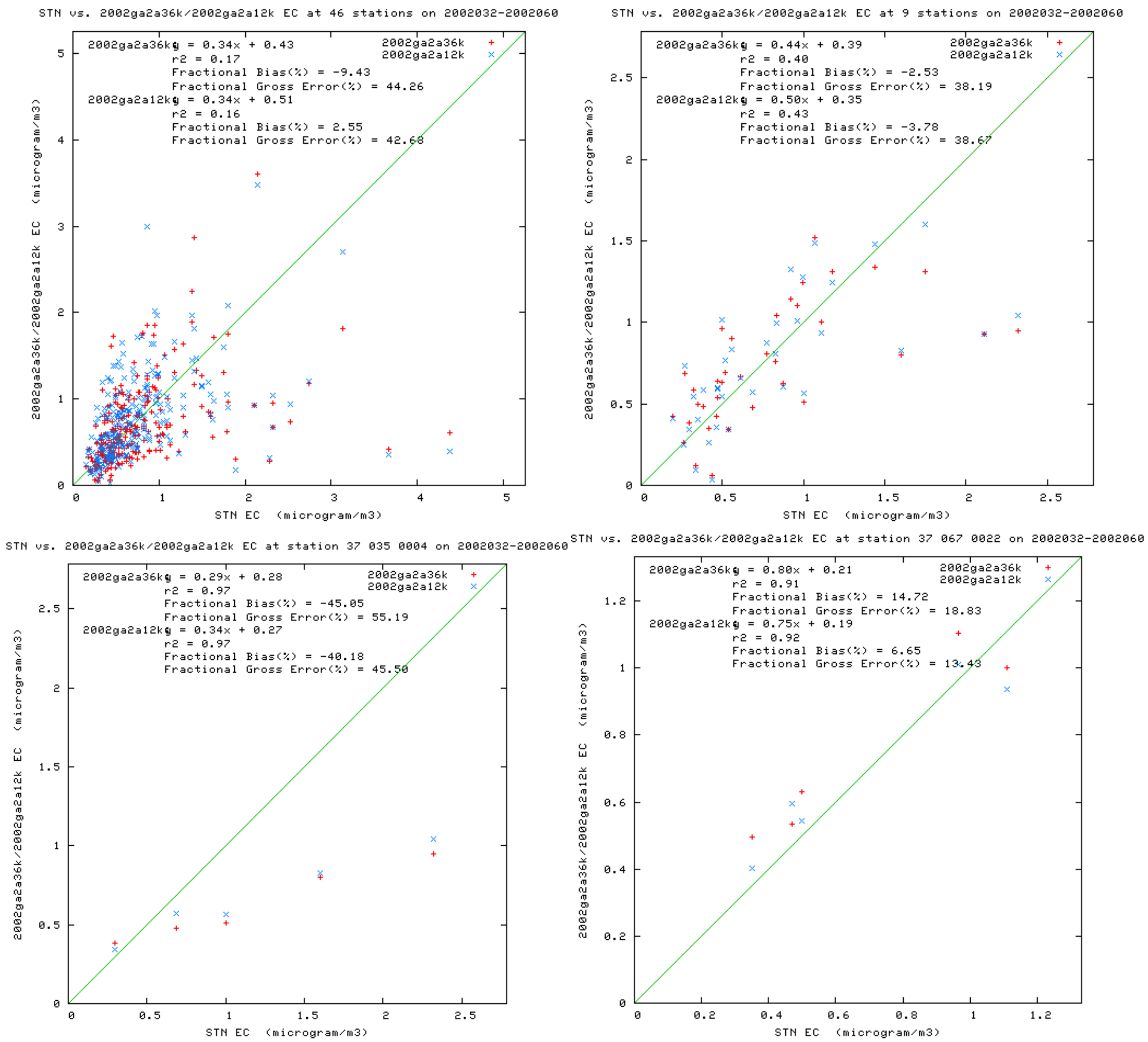


Figure 4-50: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of February.

4.1.5.3 March

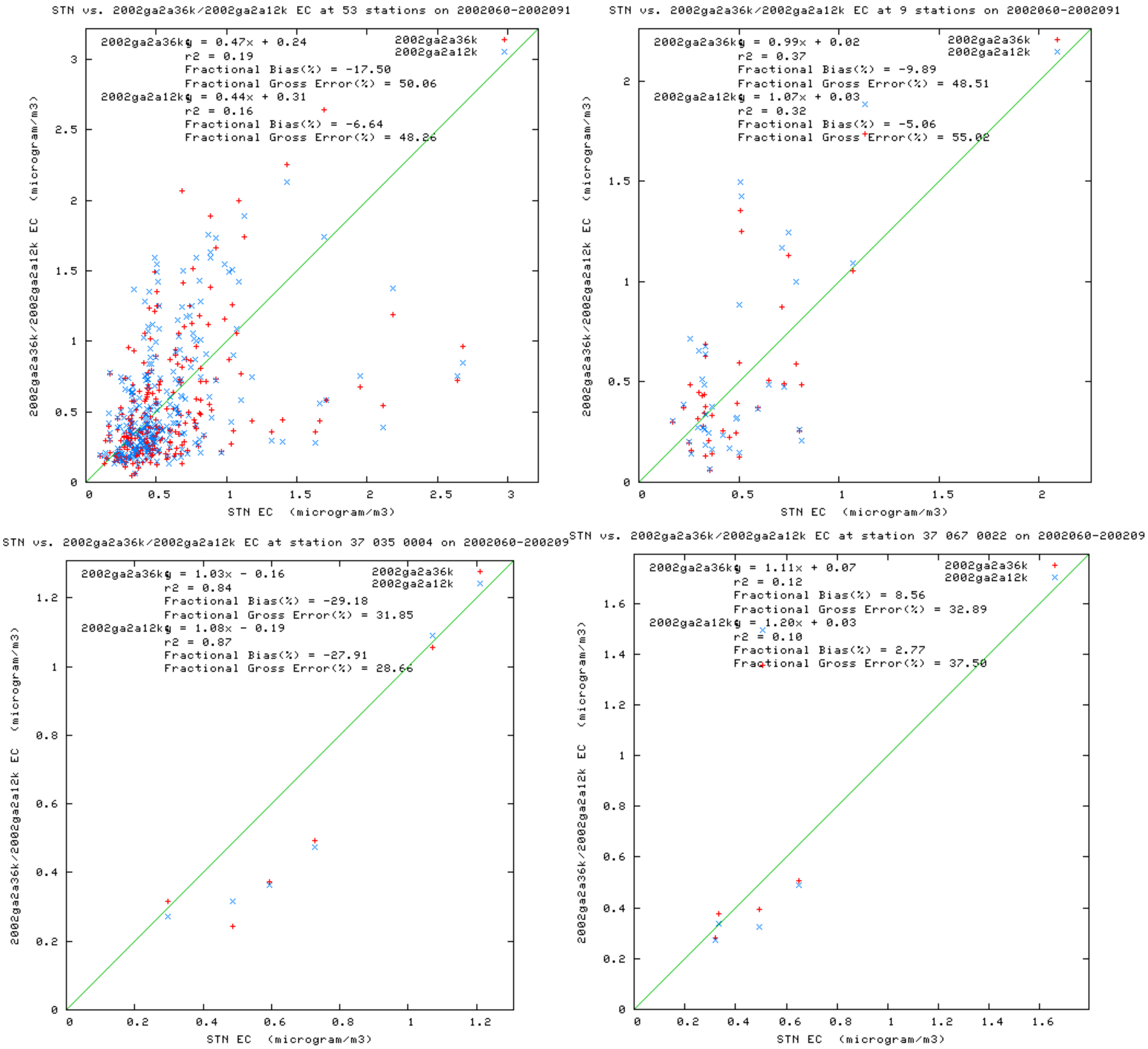


Figure 4-51: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of March.

4.1.5.4 April

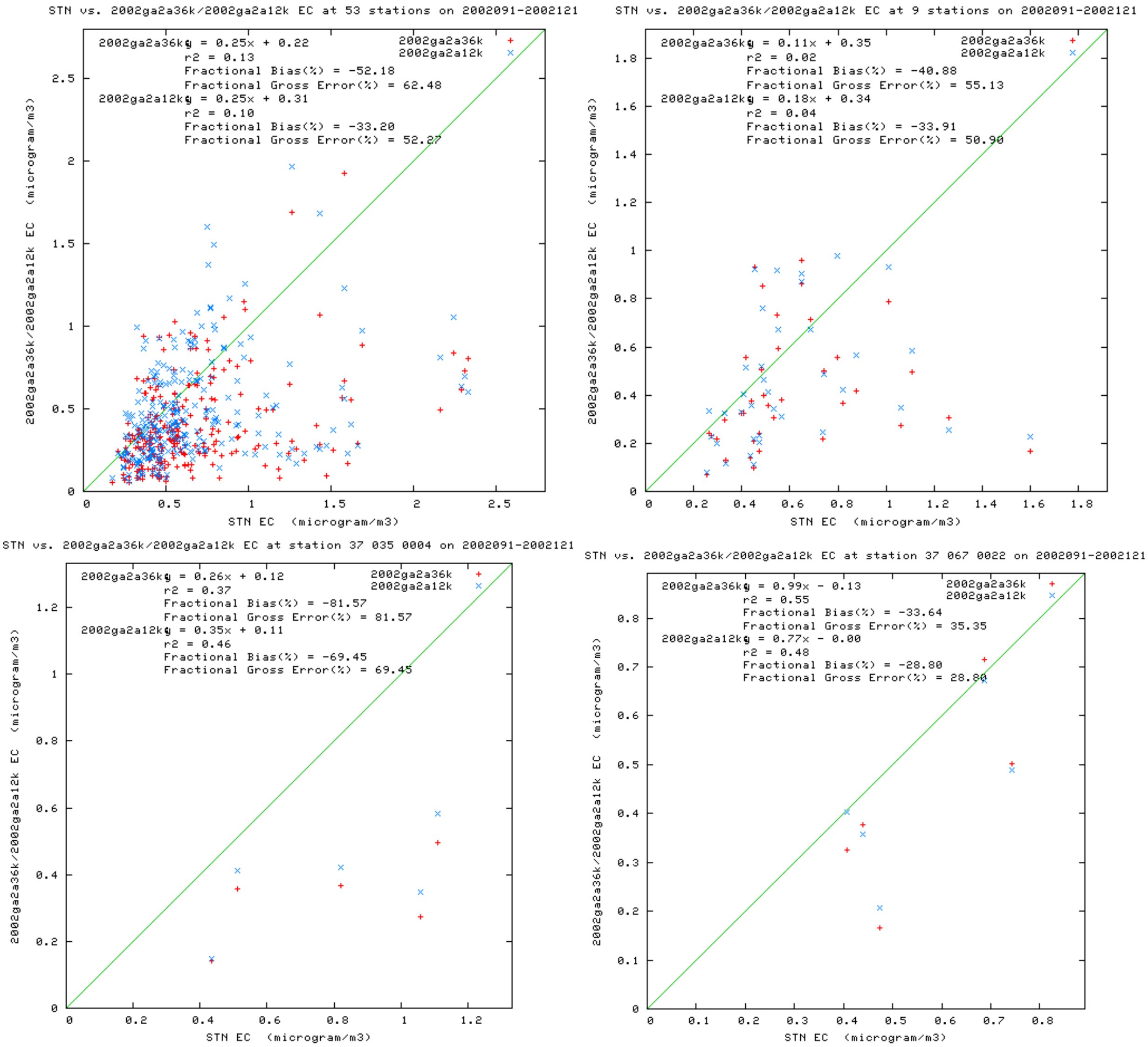


Figure 4-52: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of April.

4.1.5.5 May

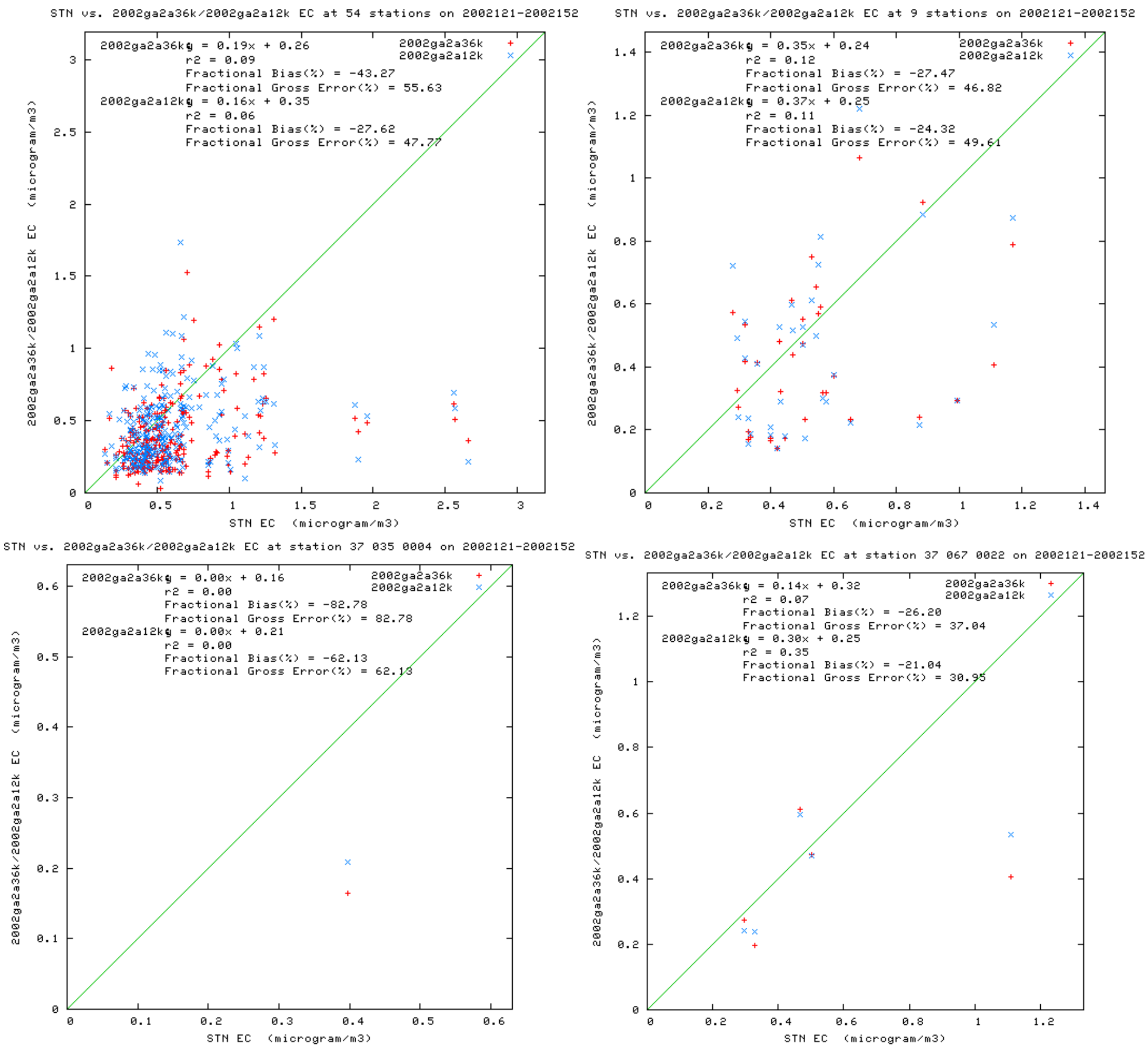


Figure 4-53: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of May.

4.1.5.6 June

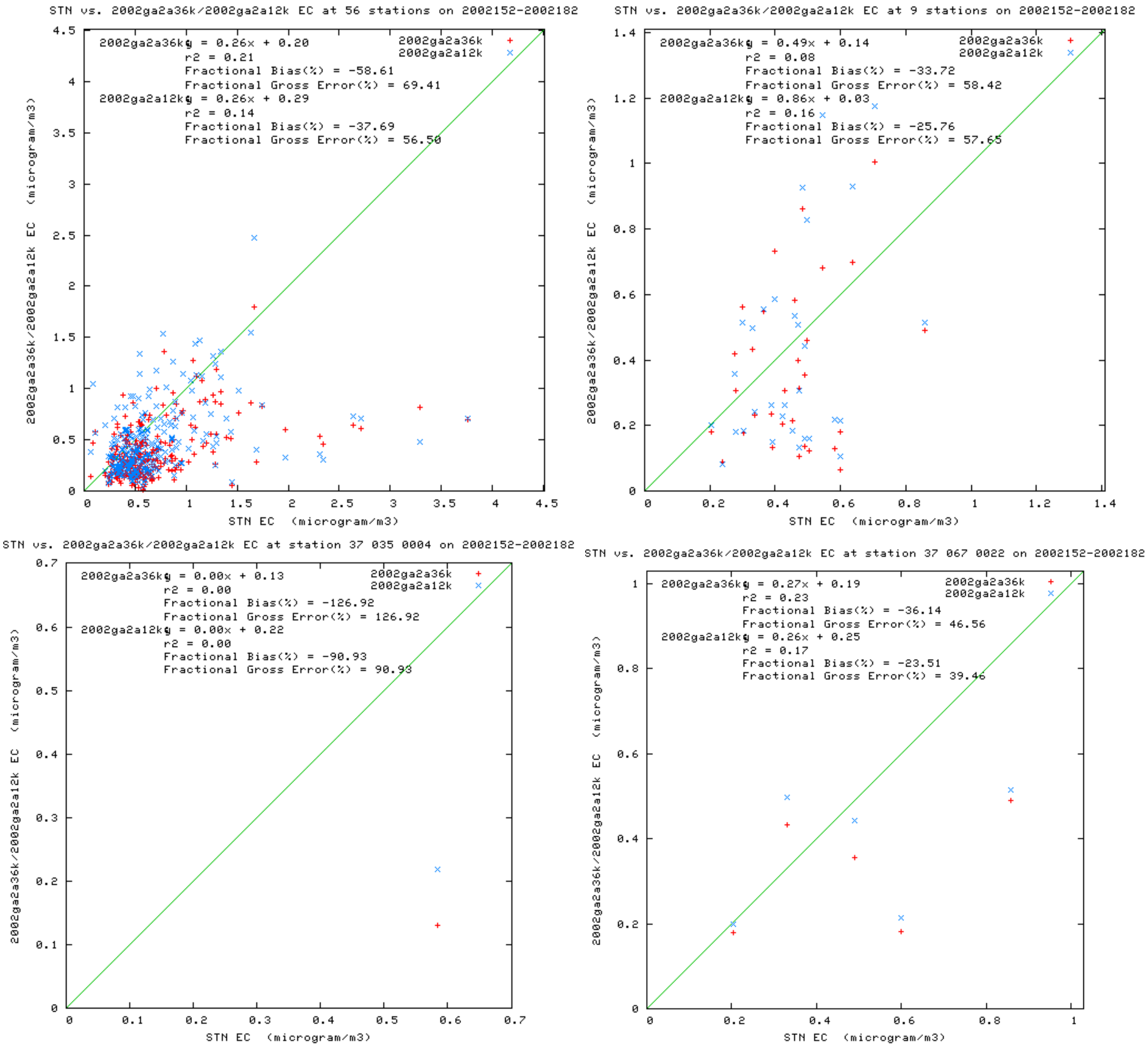


Figure 4-54: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of June.

4.1.5.7 July

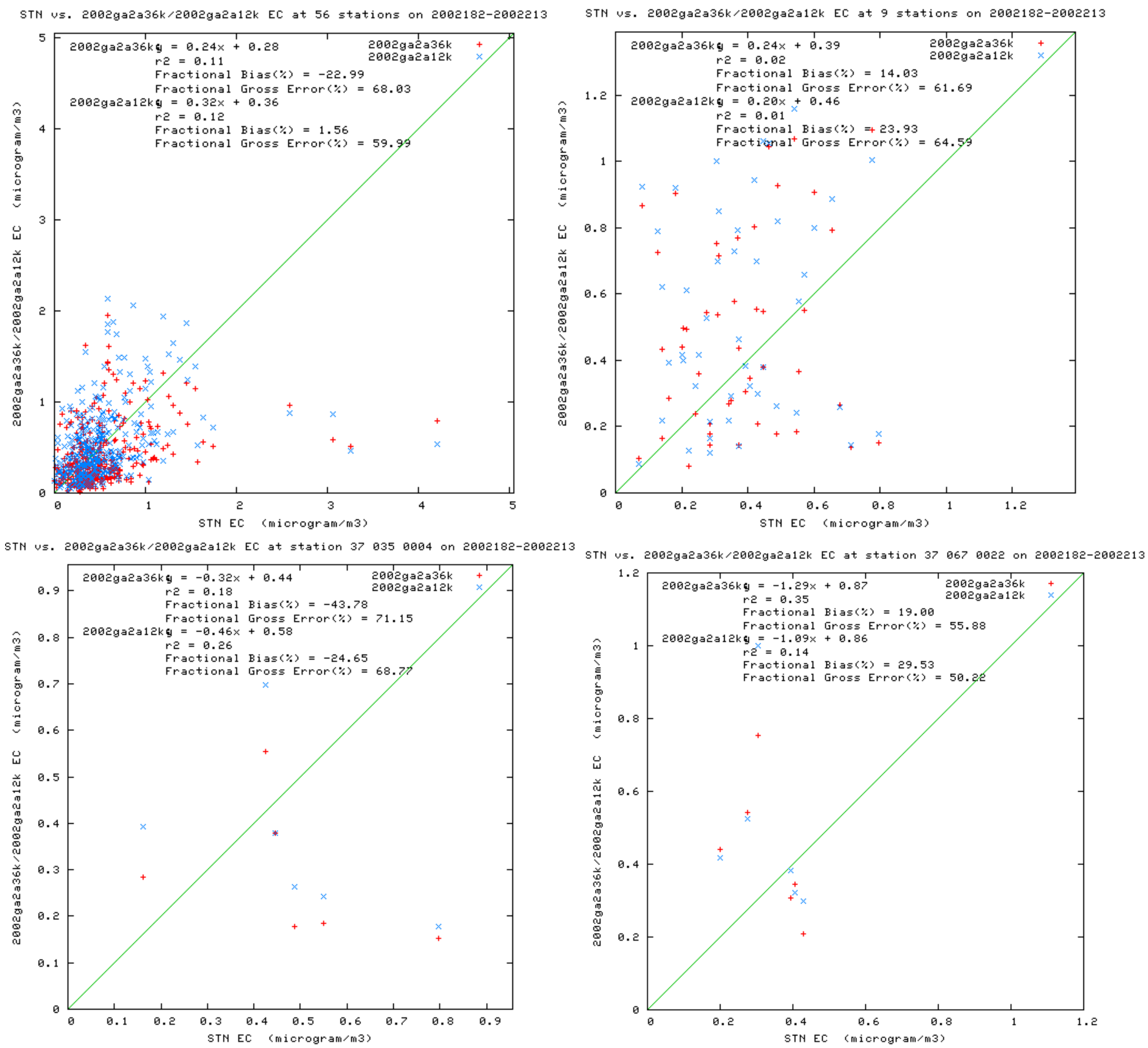


Figure 4-55: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) the month of July.

4.1.5.8 August

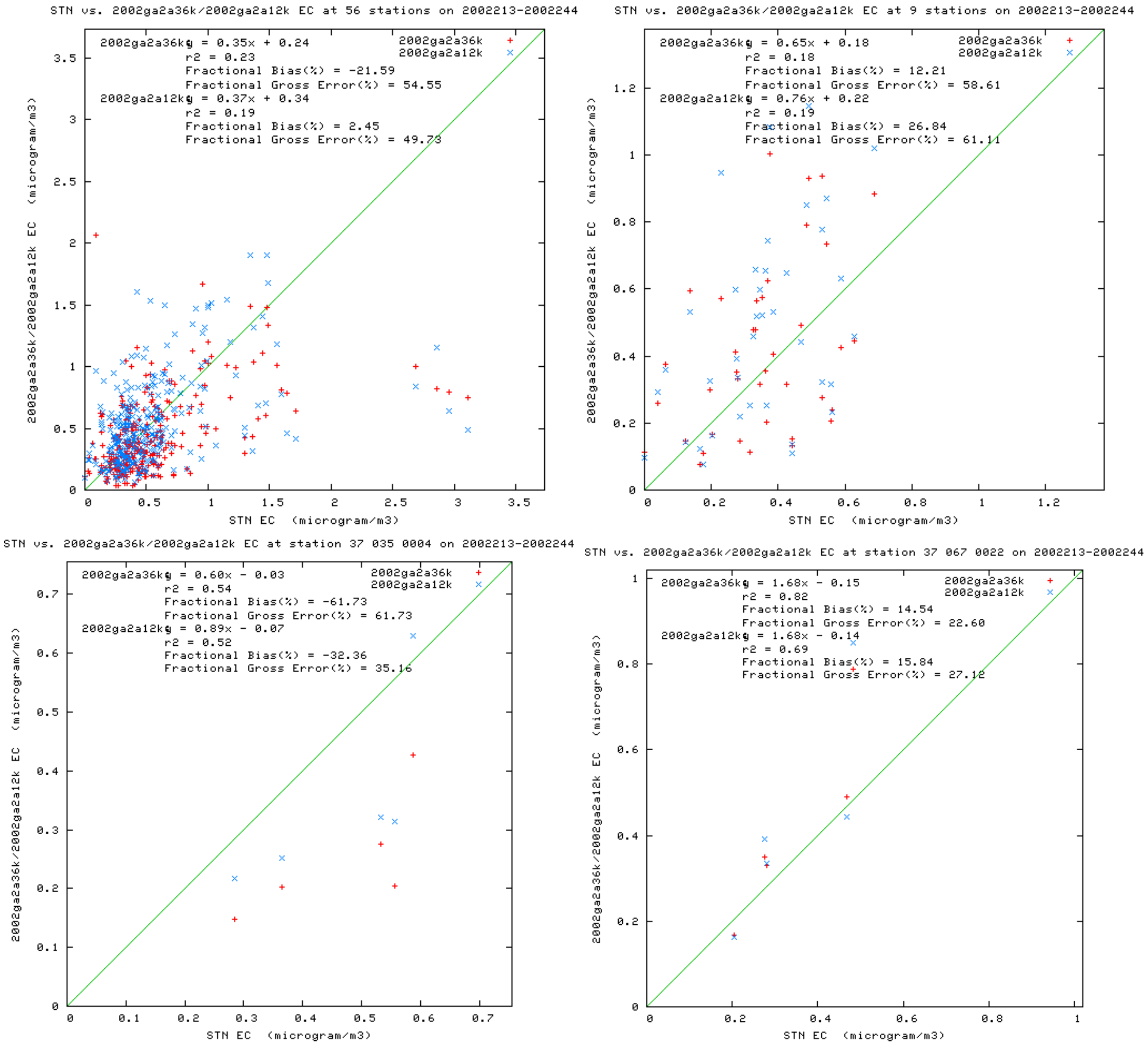


Figure 4-56: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of August.

4.1.5.9 September

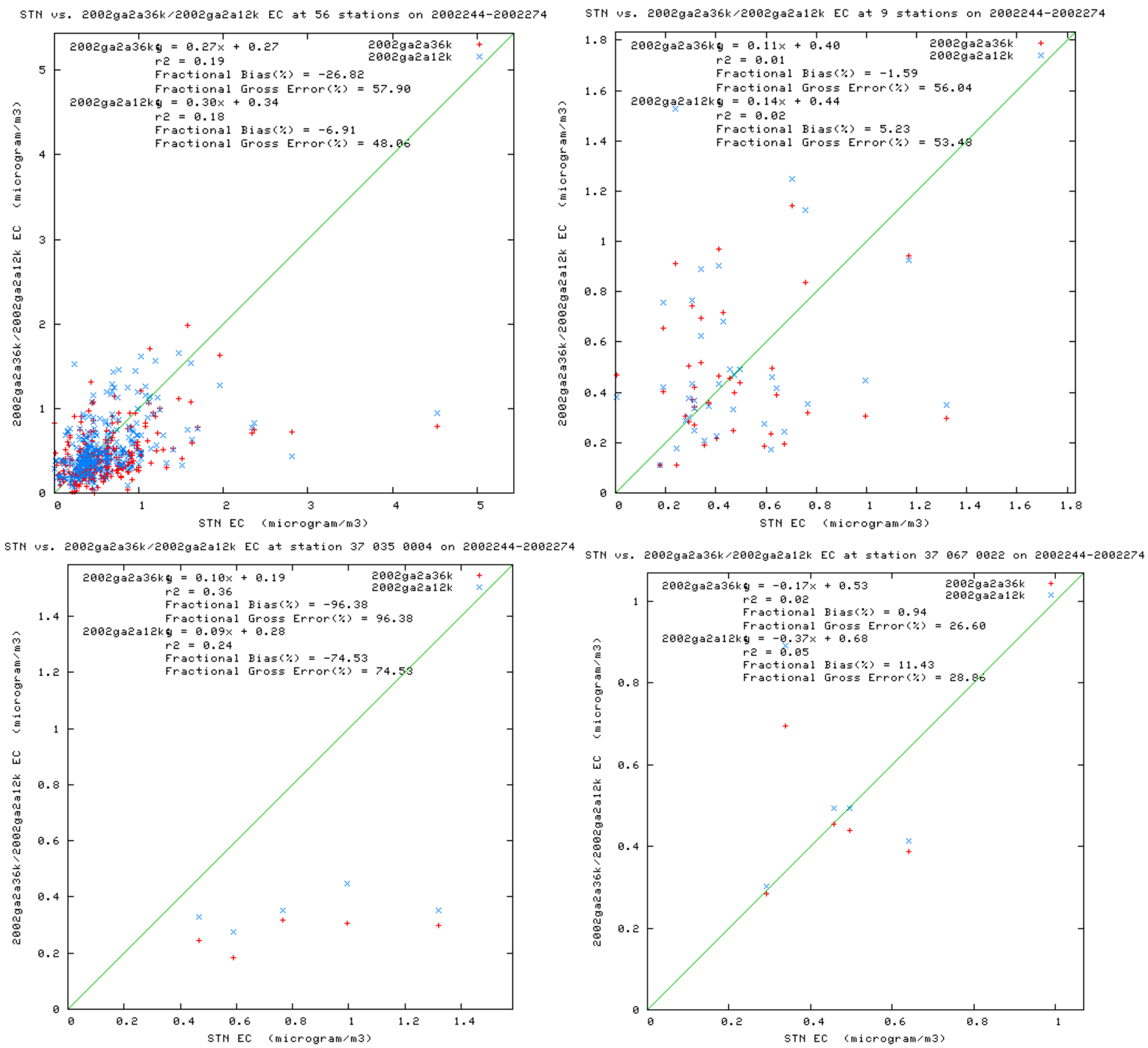


Figure 4-57: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of September.

4.1.5.10 October

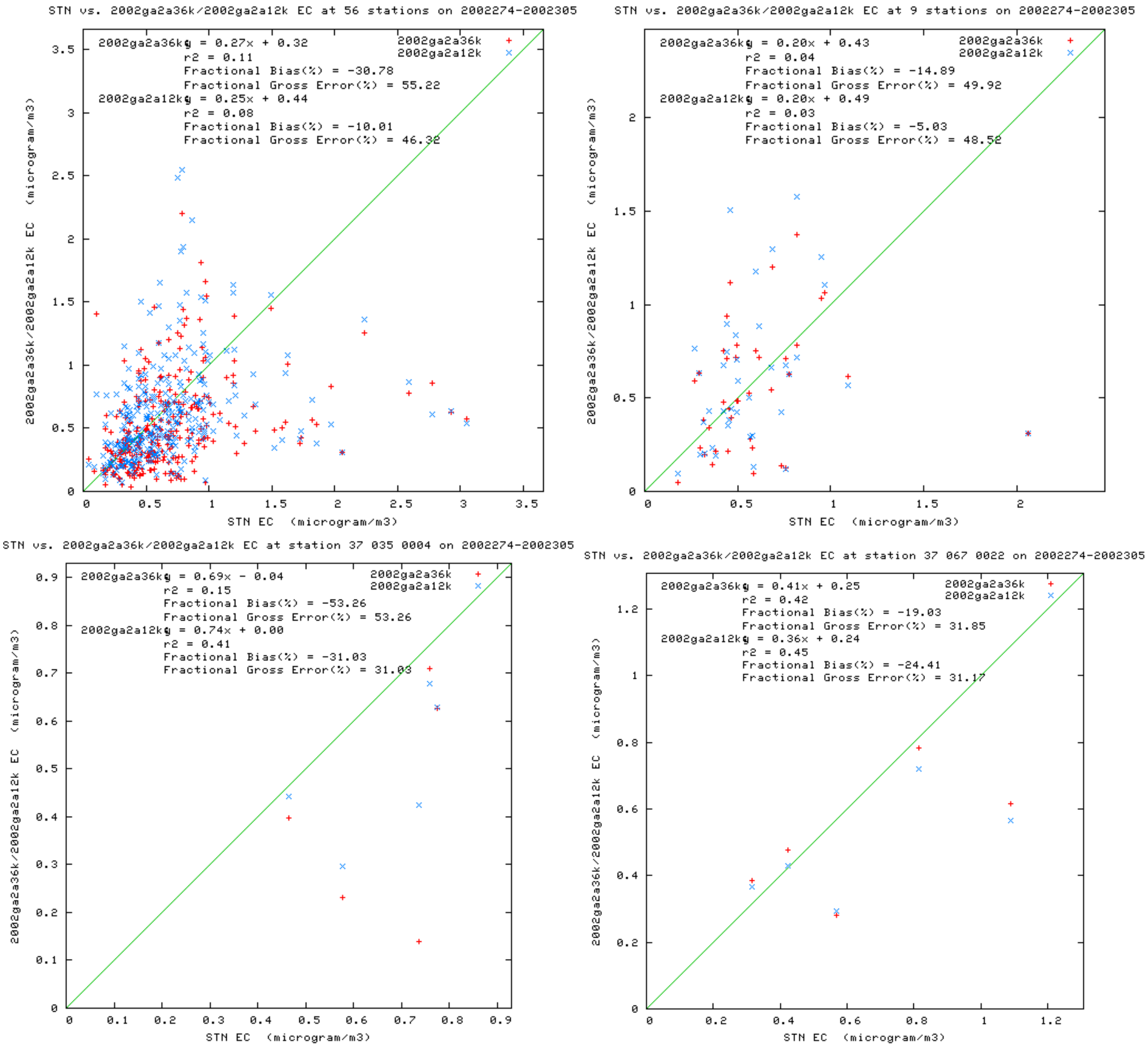


Figure 4-58: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of October.

4.1.5.11 November

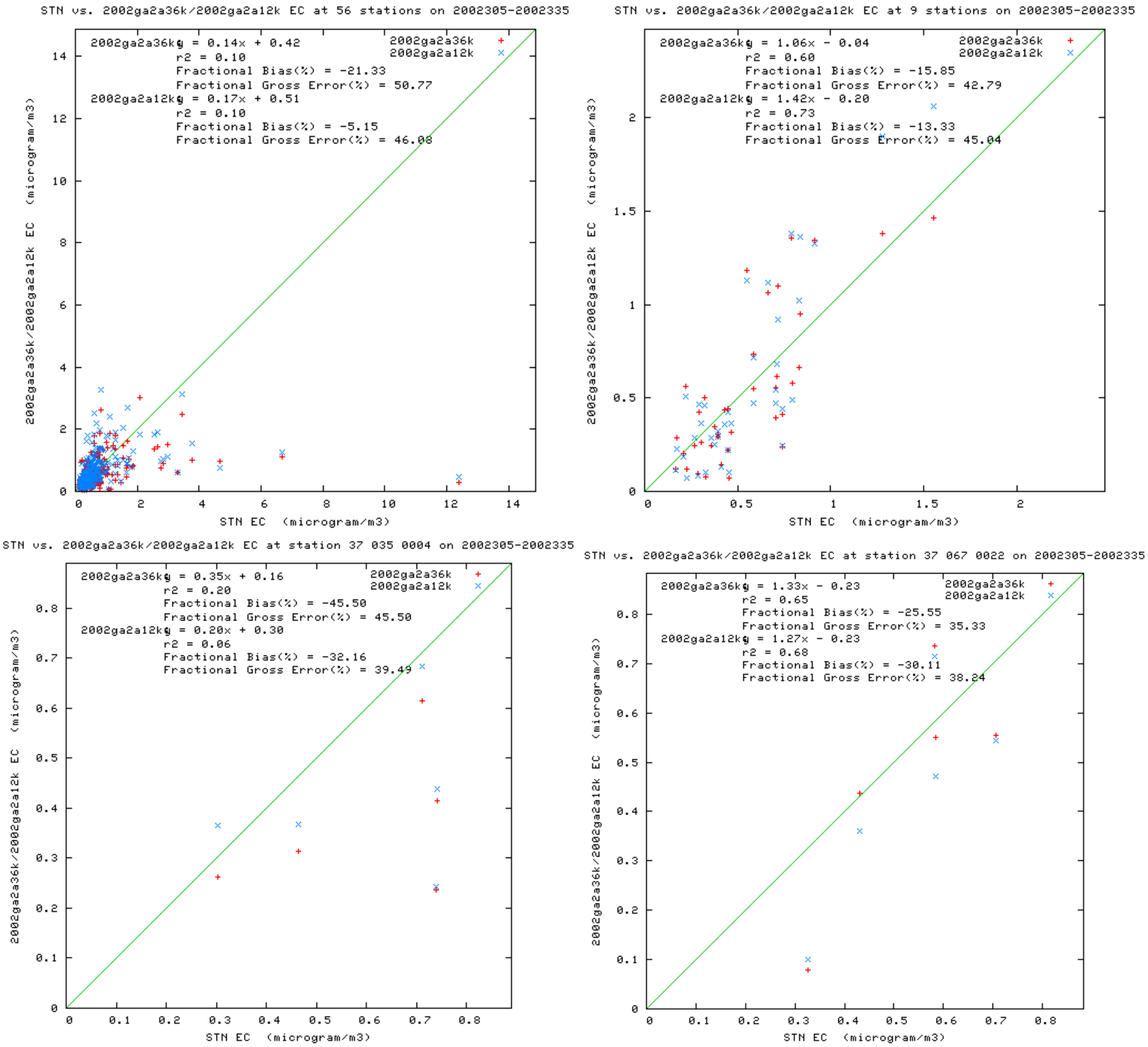


Figure 4-59: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of November.

4.1.5.12 December

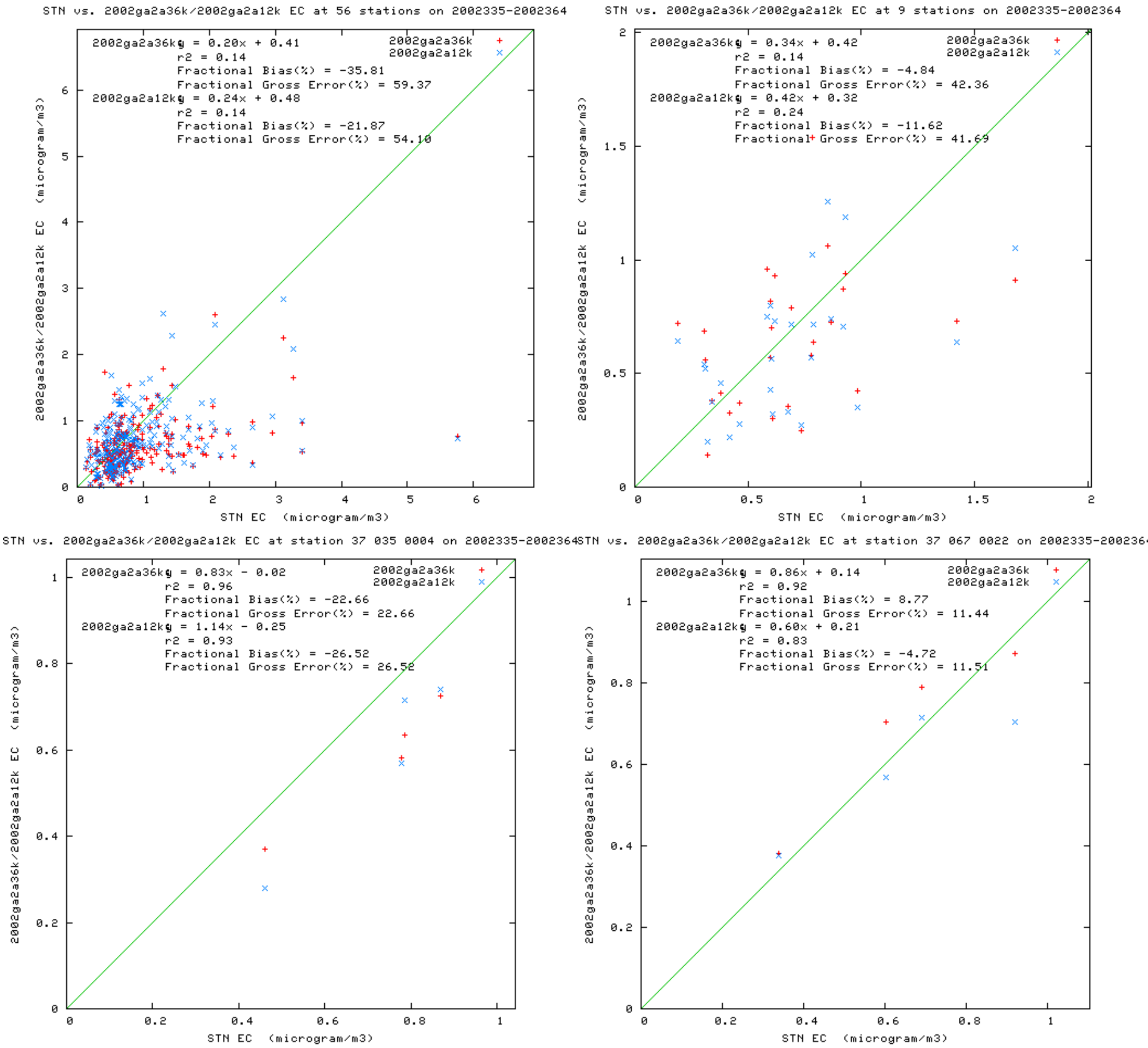


Figure 4-60: Scatter Plot of Observed Elemental Carbon from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of December.

4.1.6 Total $PM_{2.5}$

4.1.6.1 January

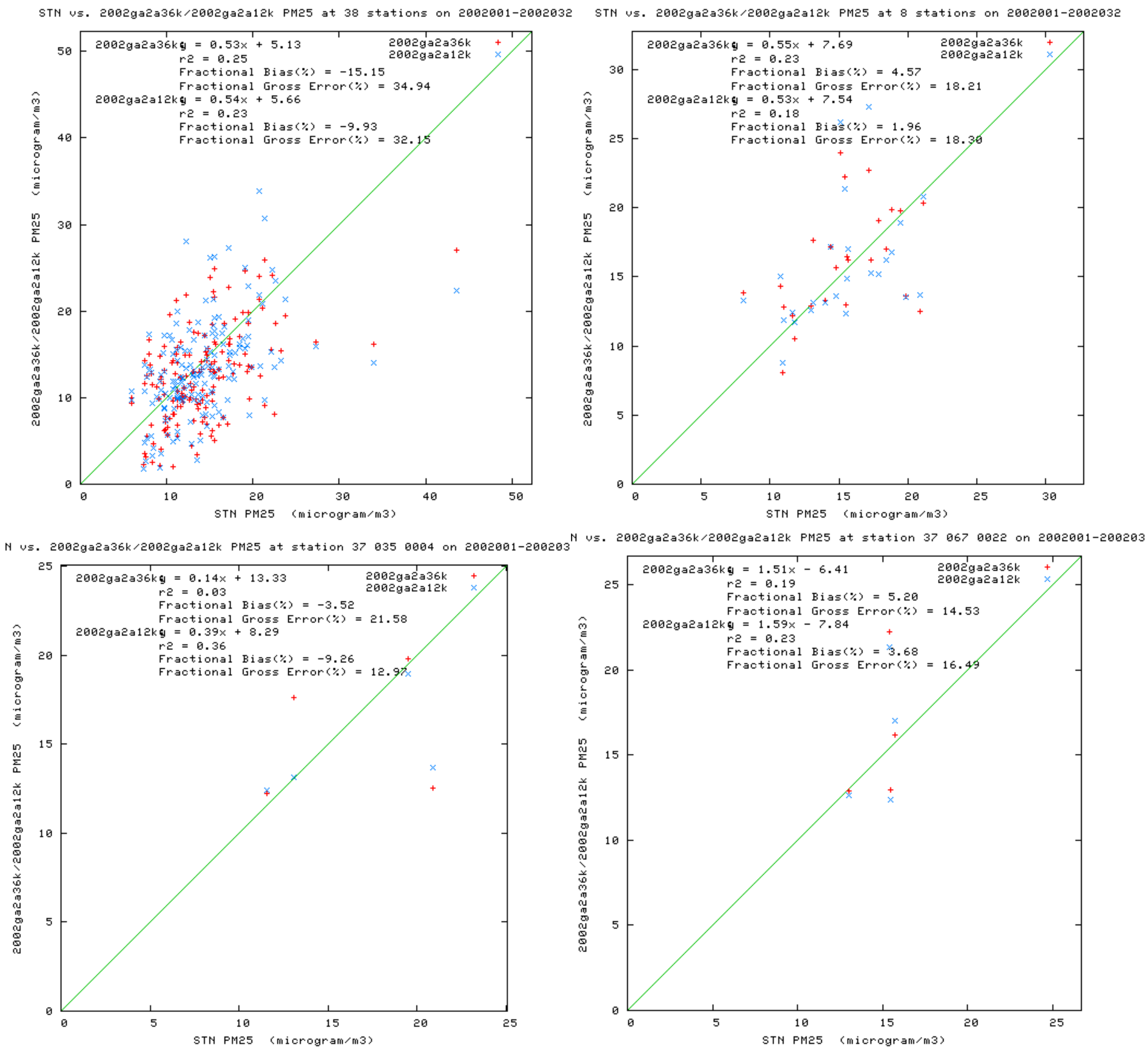


Figure 4-61: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of January.

4.1.6.2 February

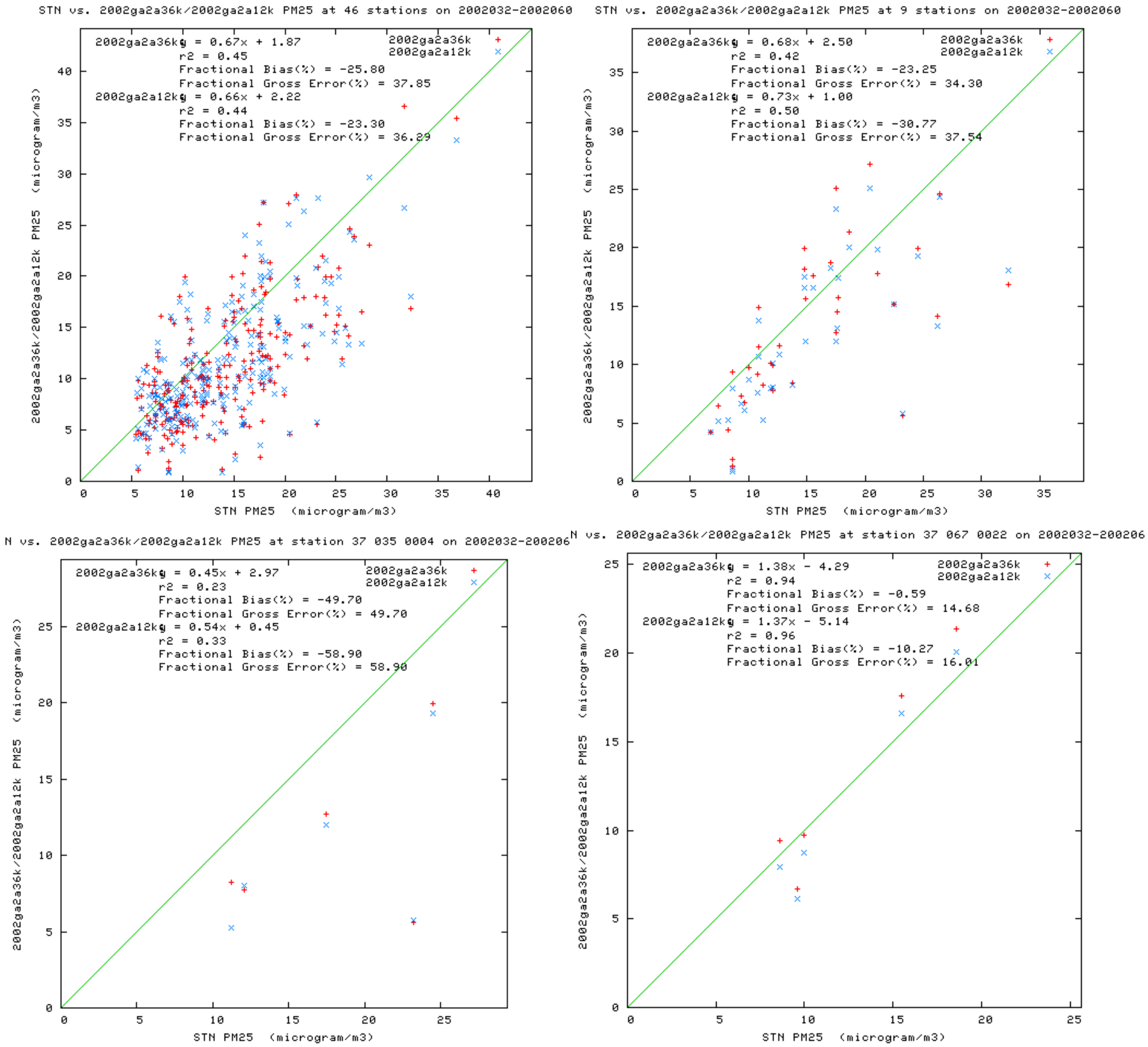


Figure 4-62: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of February.

4.1.6.3 March

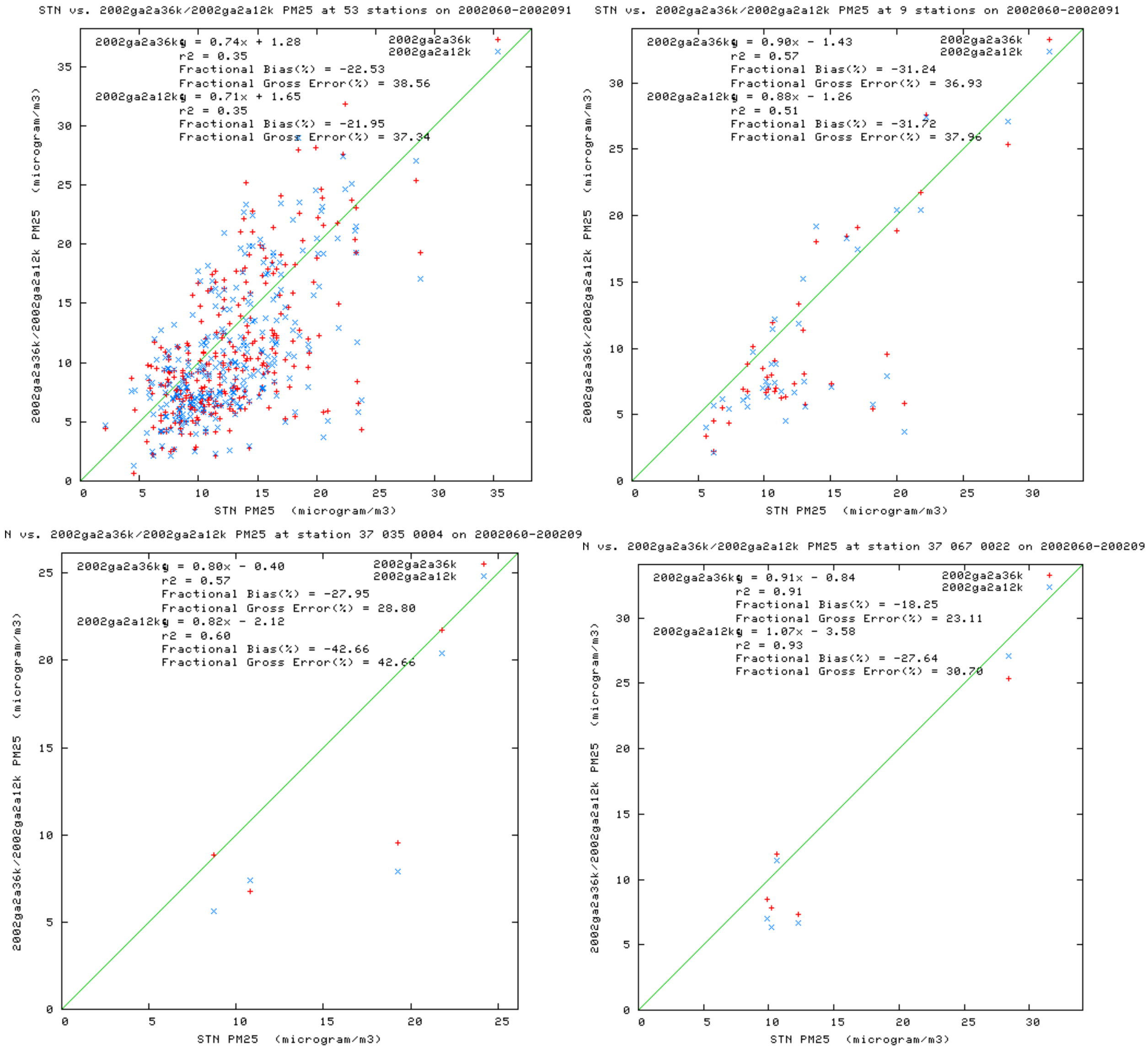


Figure 4-63: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of March.

4.1.6.4 April

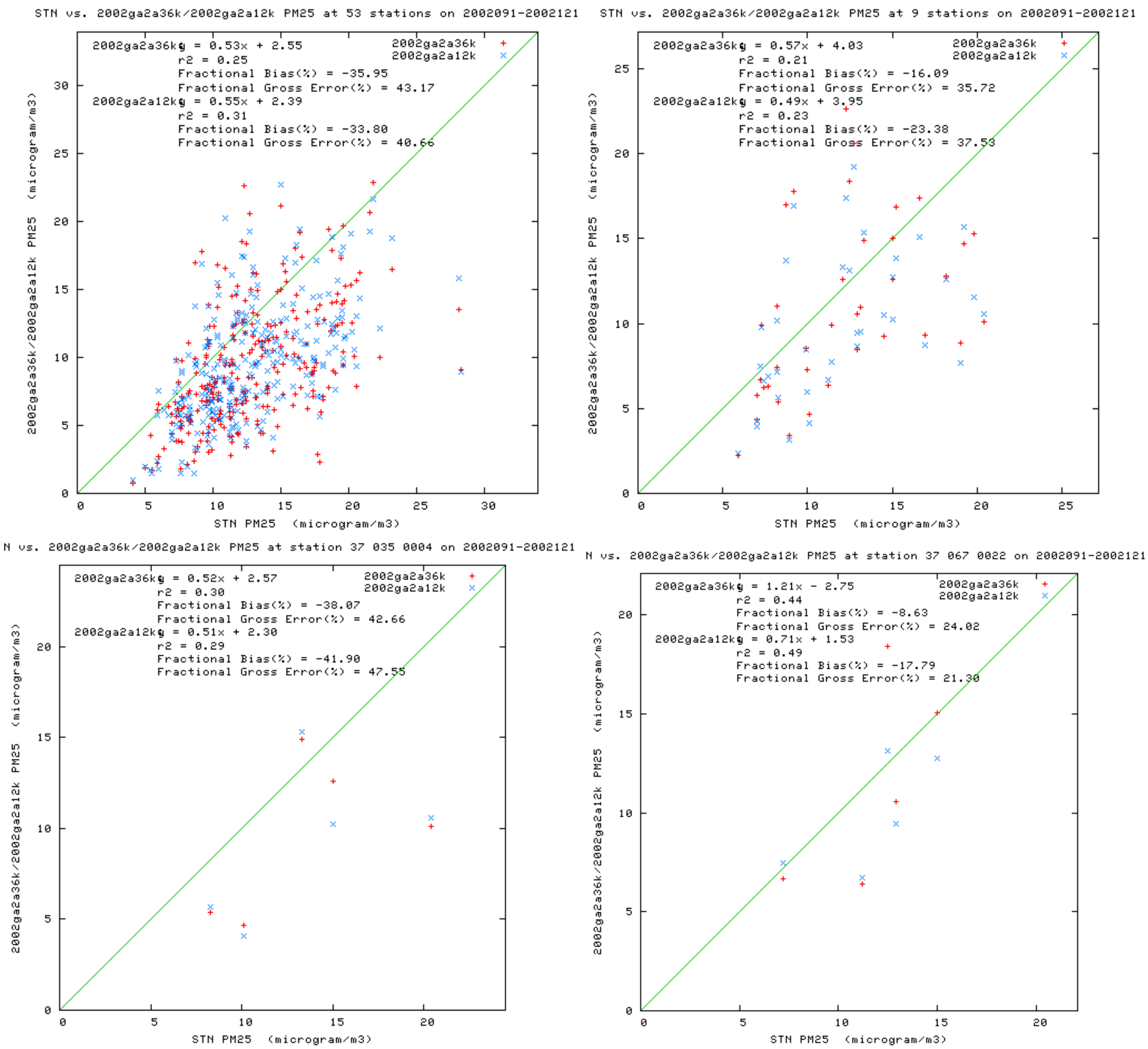


Figure 4-64: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of April.

4.1.6.5 May

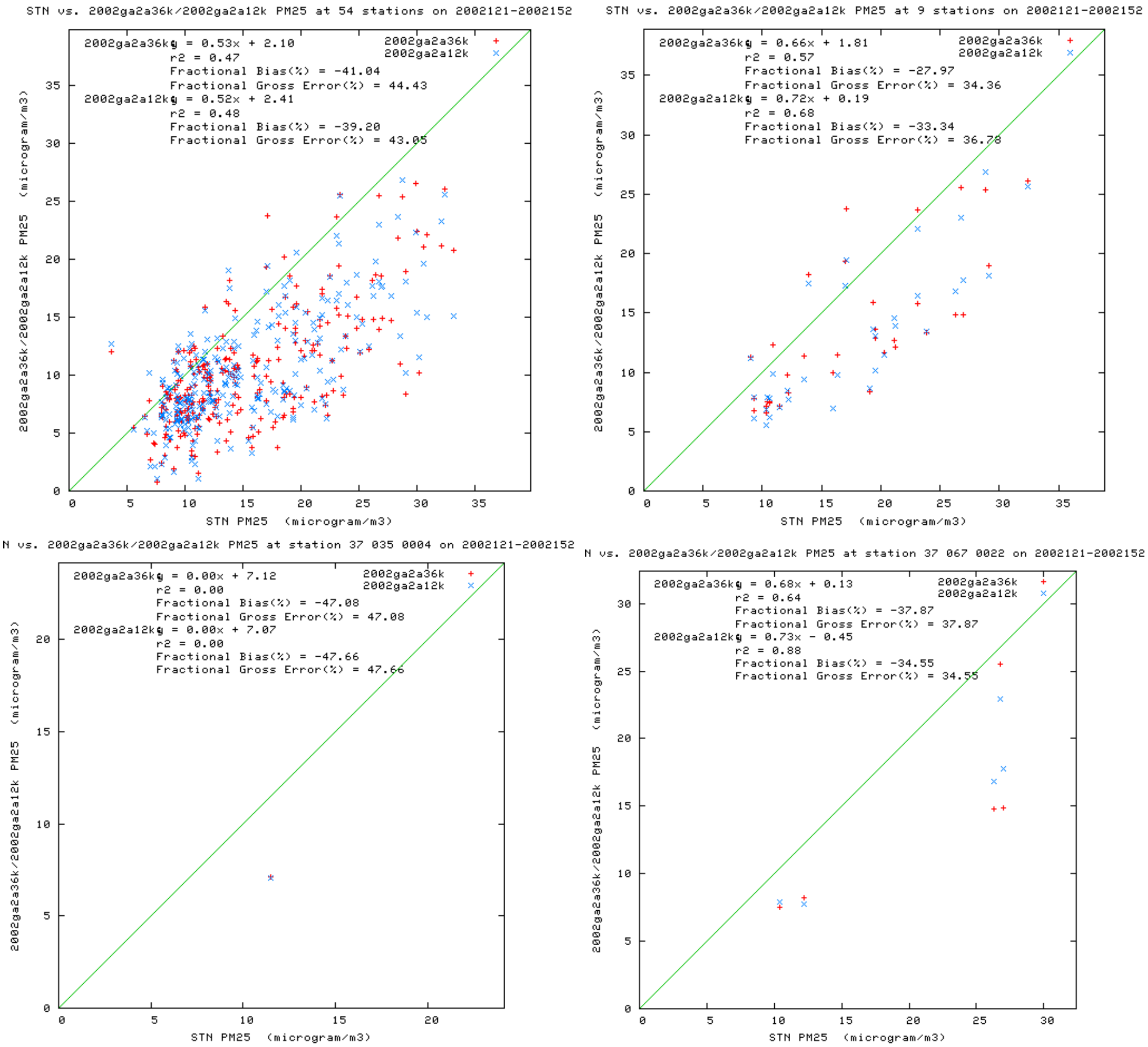


Figure 4-65: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of May.

4.1.6.6 June

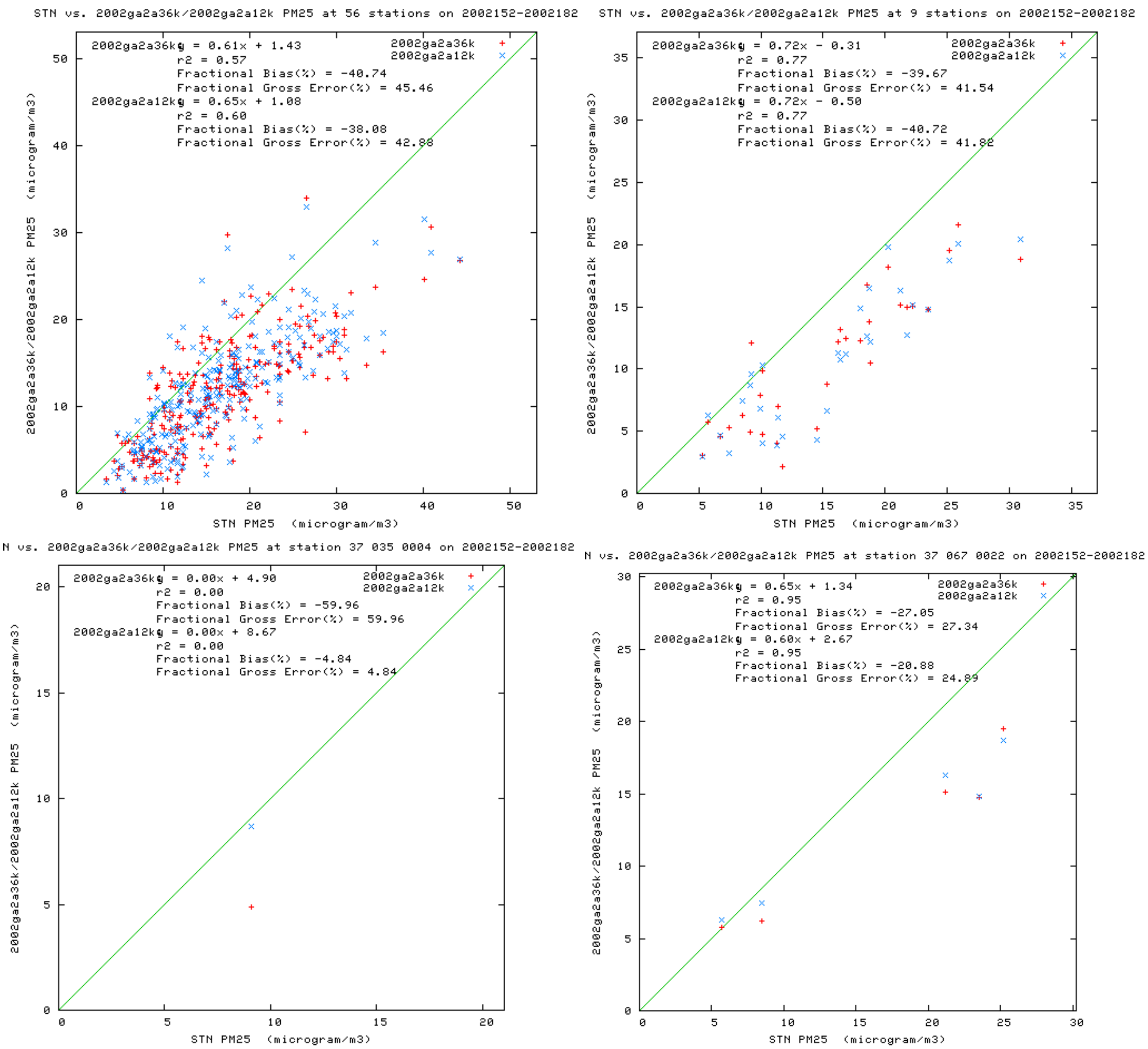


Figure 4-66: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of June.

4.1.6.7 July

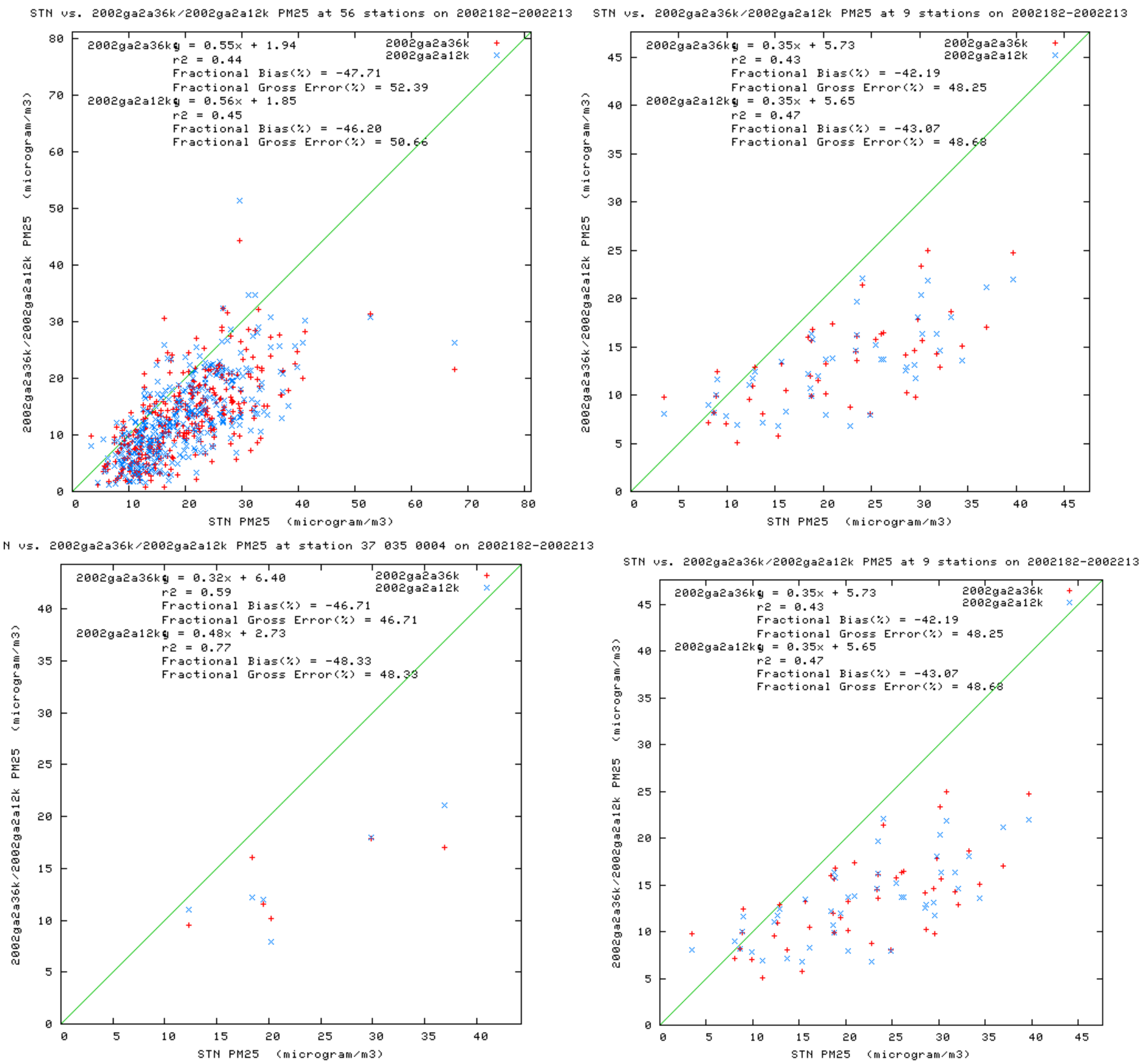


Figure 4-67: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of July.

4.1.6.8 August

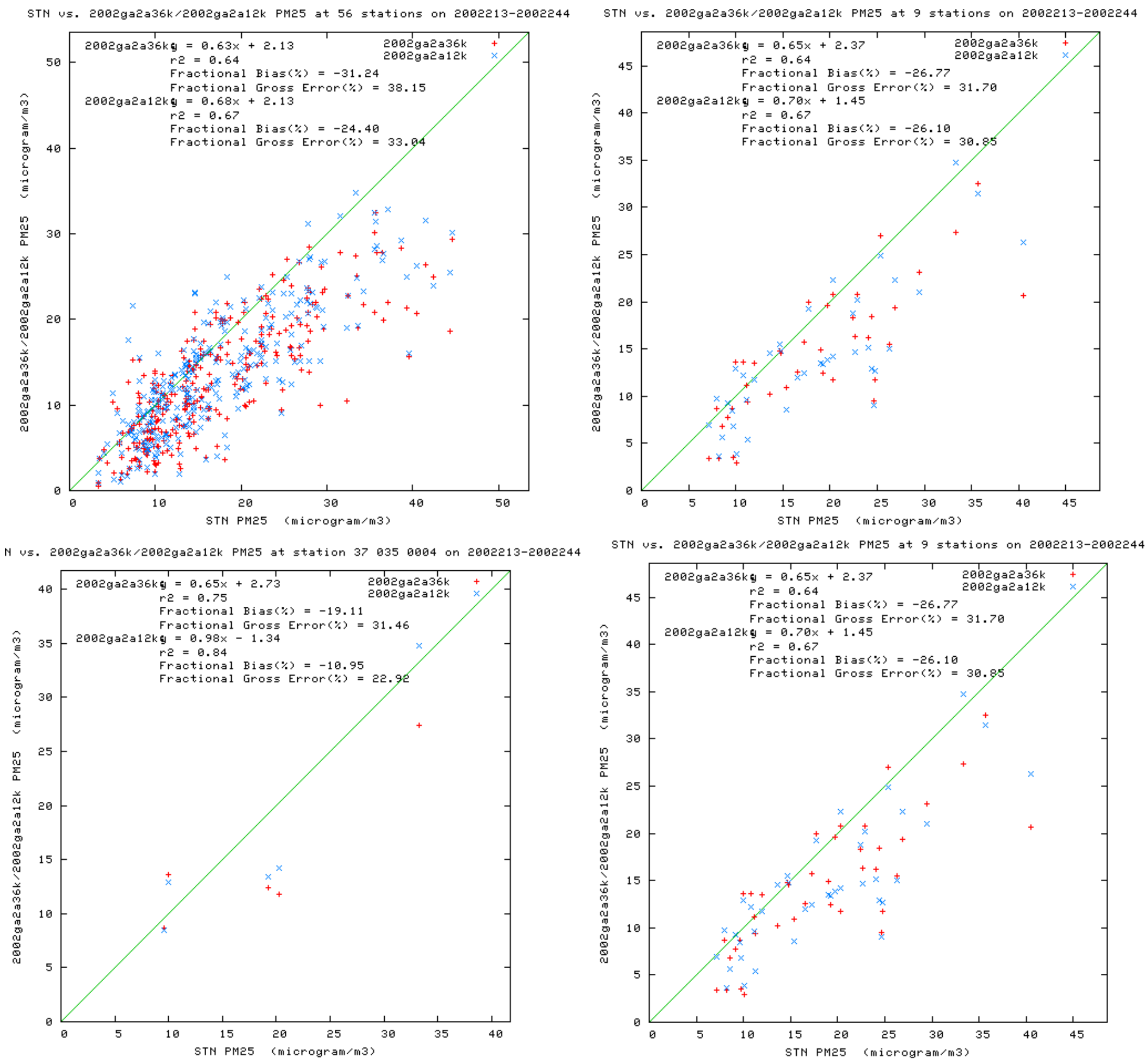


Figure 4-68: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of August.

4.1.6.9 September

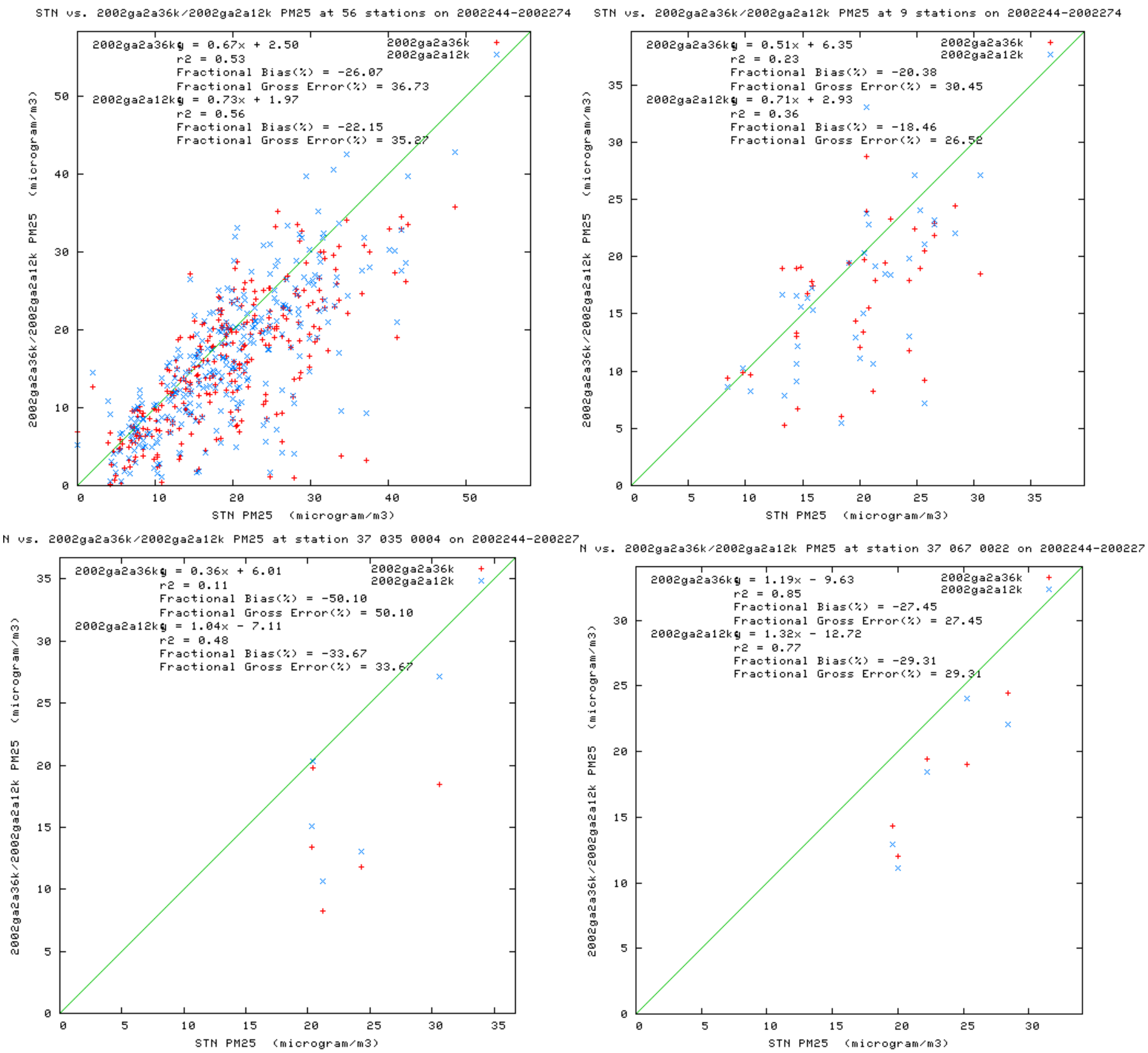


Figure 4-69: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of September.

4.1.6.10 October

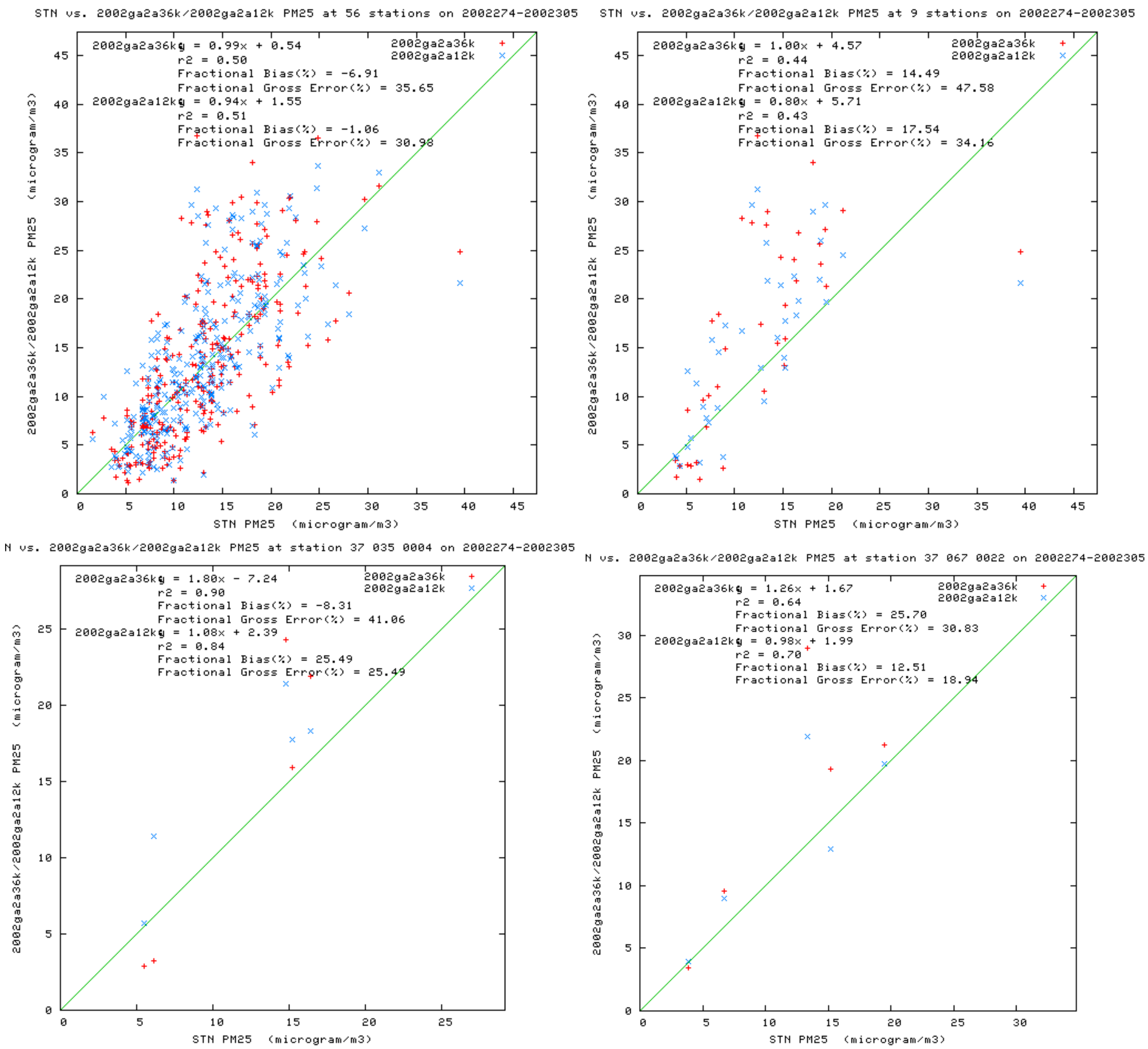


Figure 4-70: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of October.

4.1.6.11 November

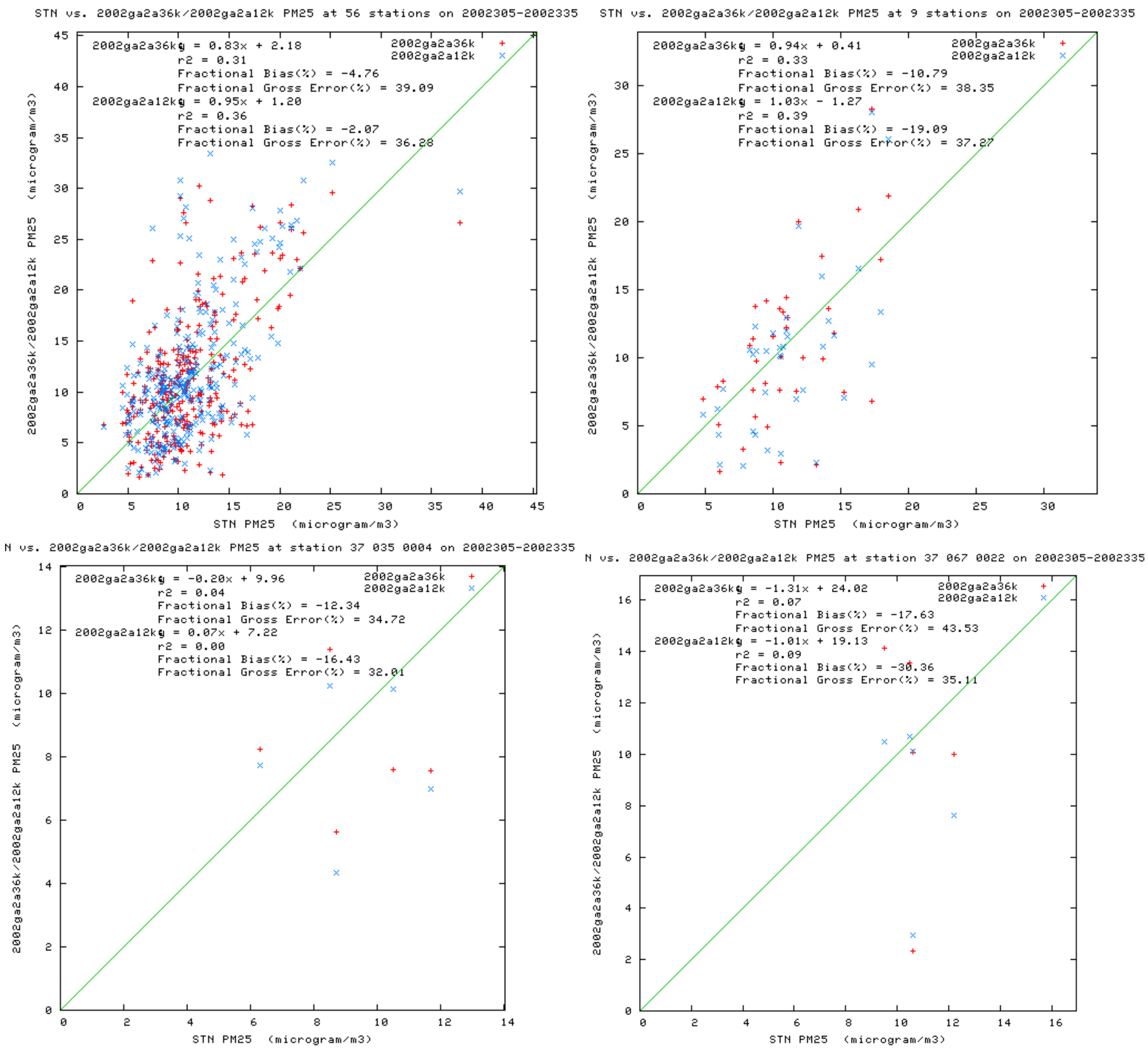


Figure 4-71: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of November.

4.1.6.12 December

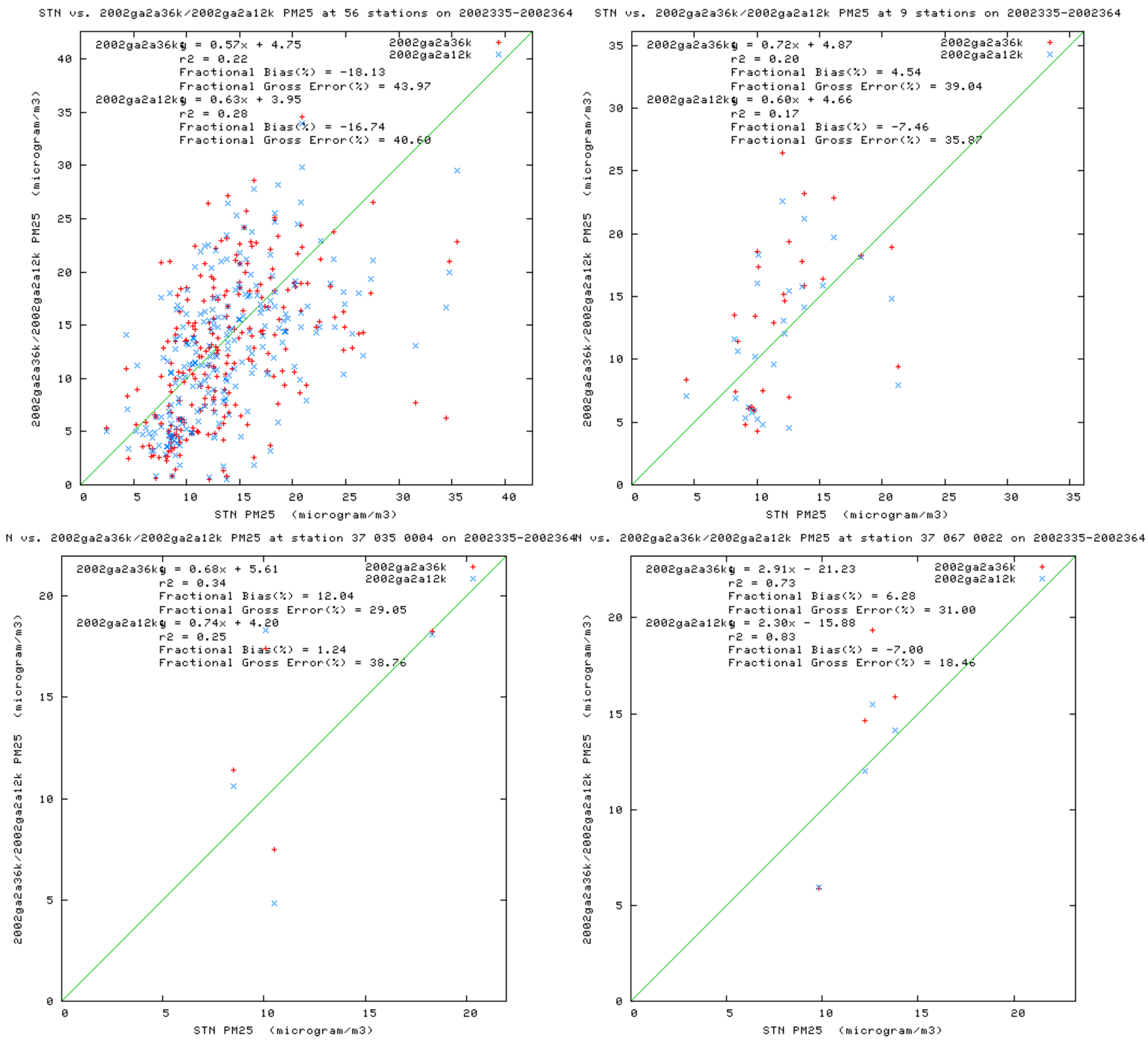
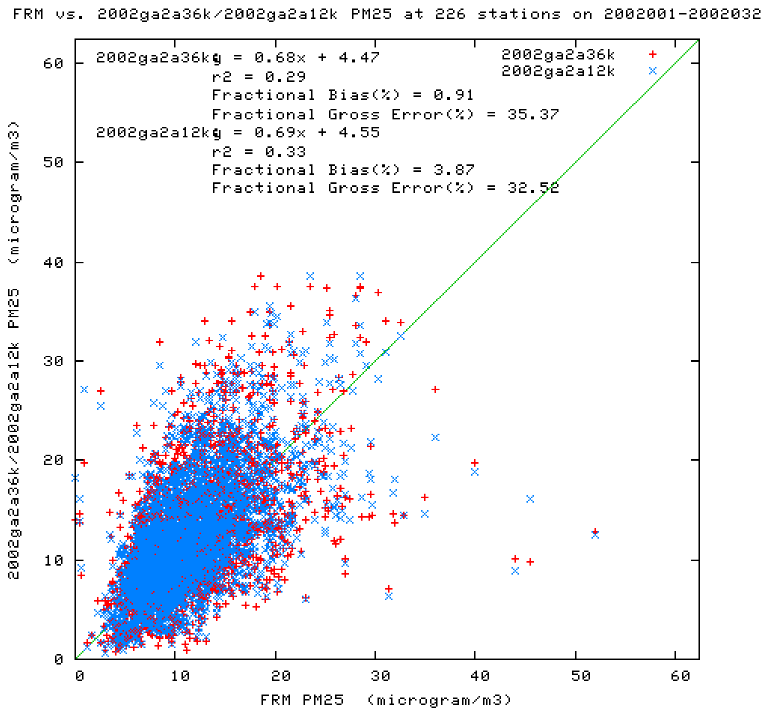


Figure 4-72: Scatter Plot of Reconstructed $PM_{2.5}$ from the STN network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS STN sites collectively (top left), all North Carolina STN sites collectively (top right), the Hickory STN site (37-035-0004)(bottom left), and the Hattie Avenue STN site (37-067-0022) (bottom right) for the month of December.

4.2 FRM Scatter plots

4.2.1 January



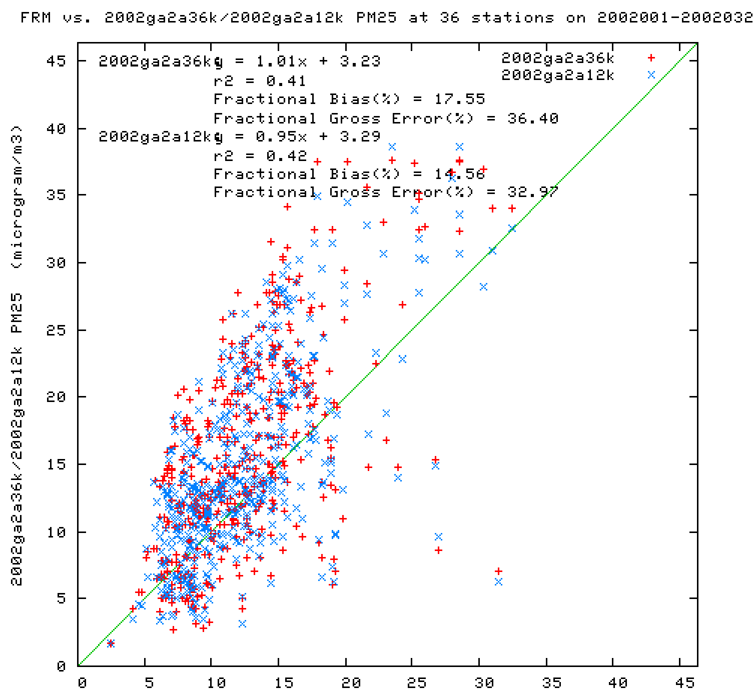


Figure 4-73: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of January.

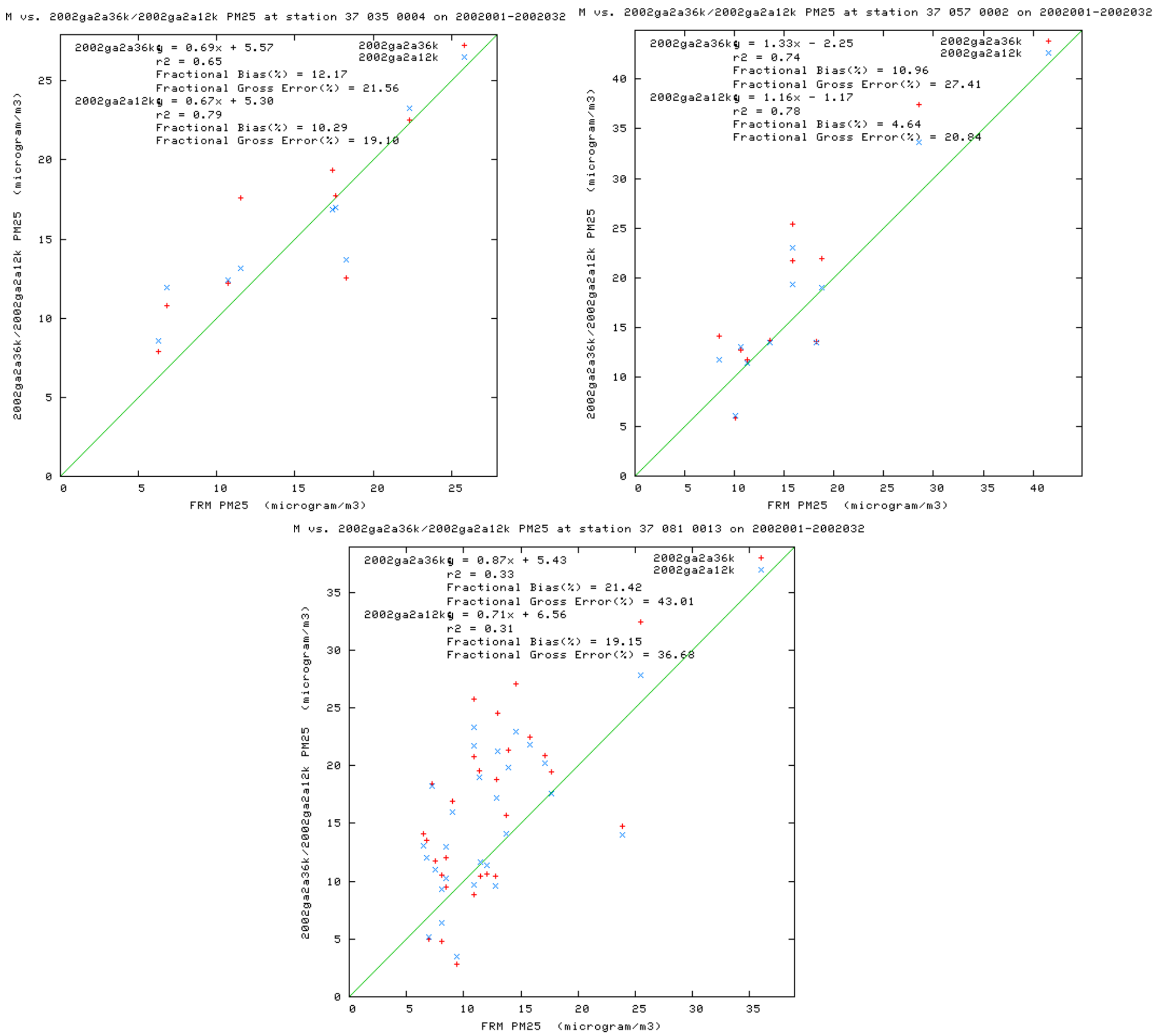
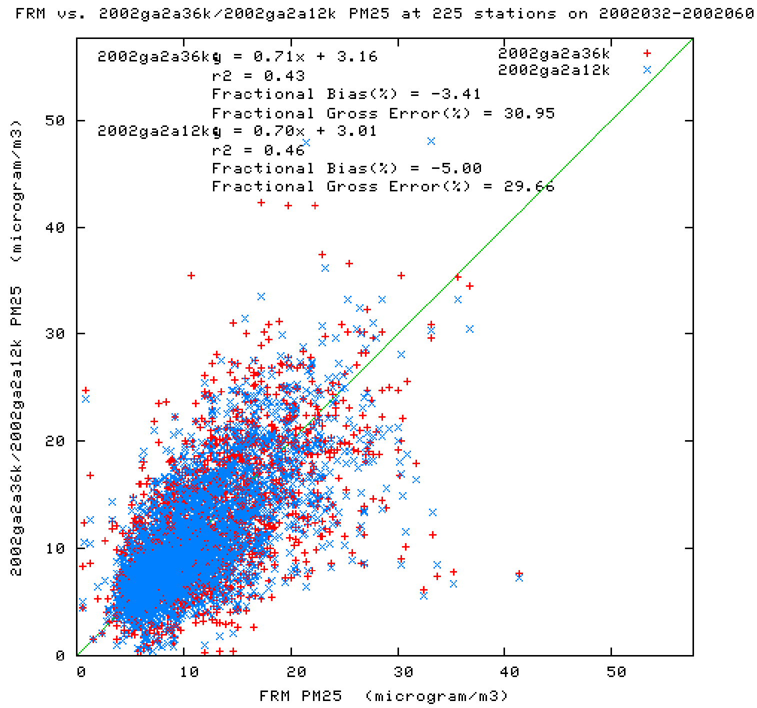


Figure 4-74: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of January.

4.2.2 February



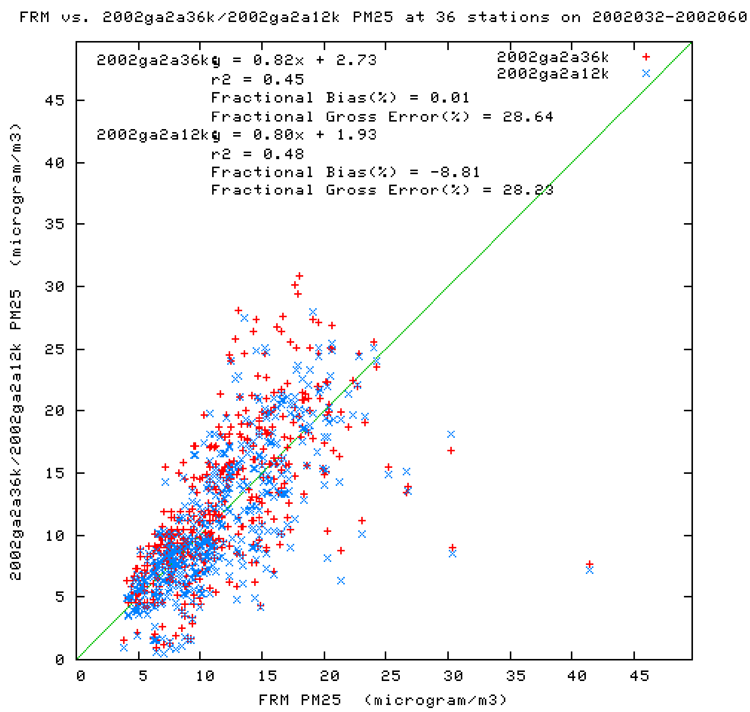


Figure 4-75: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of February.

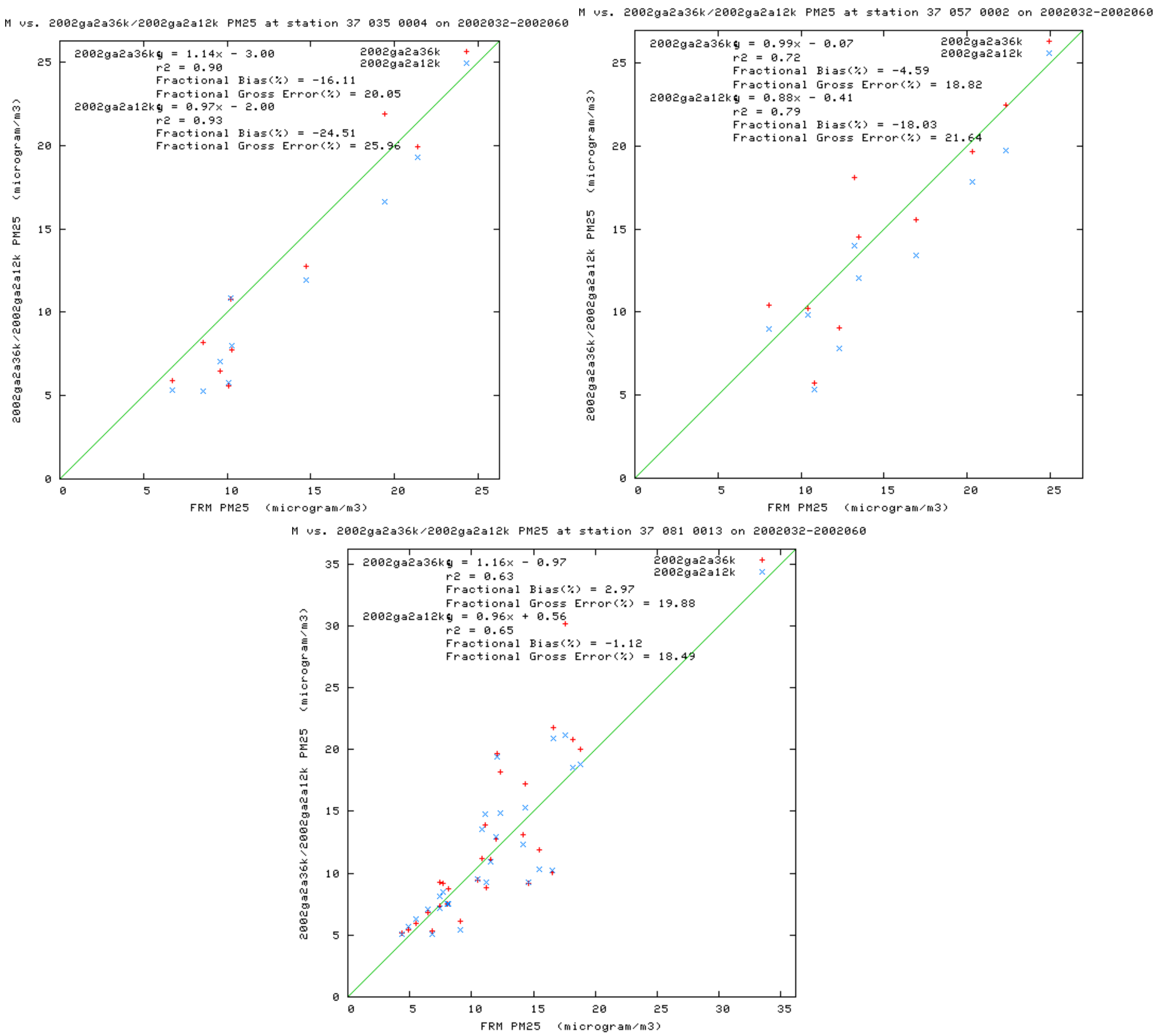
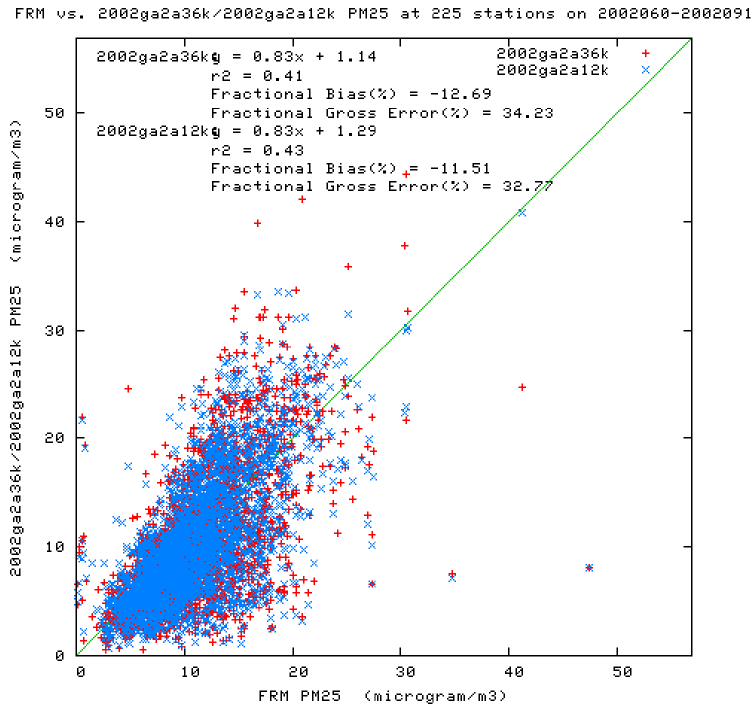


Figure 4-76: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of February.

4.2.3 March



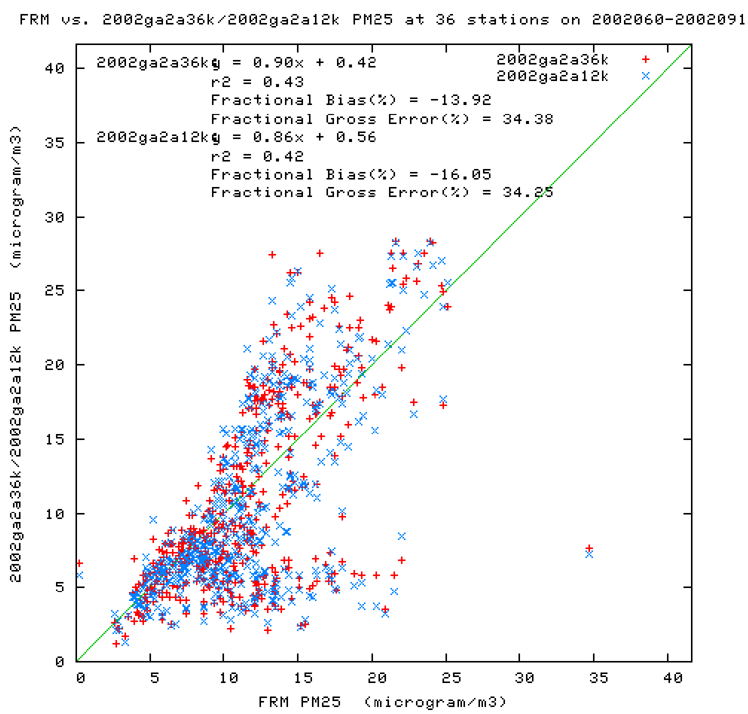


Figure 4-77: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of March.

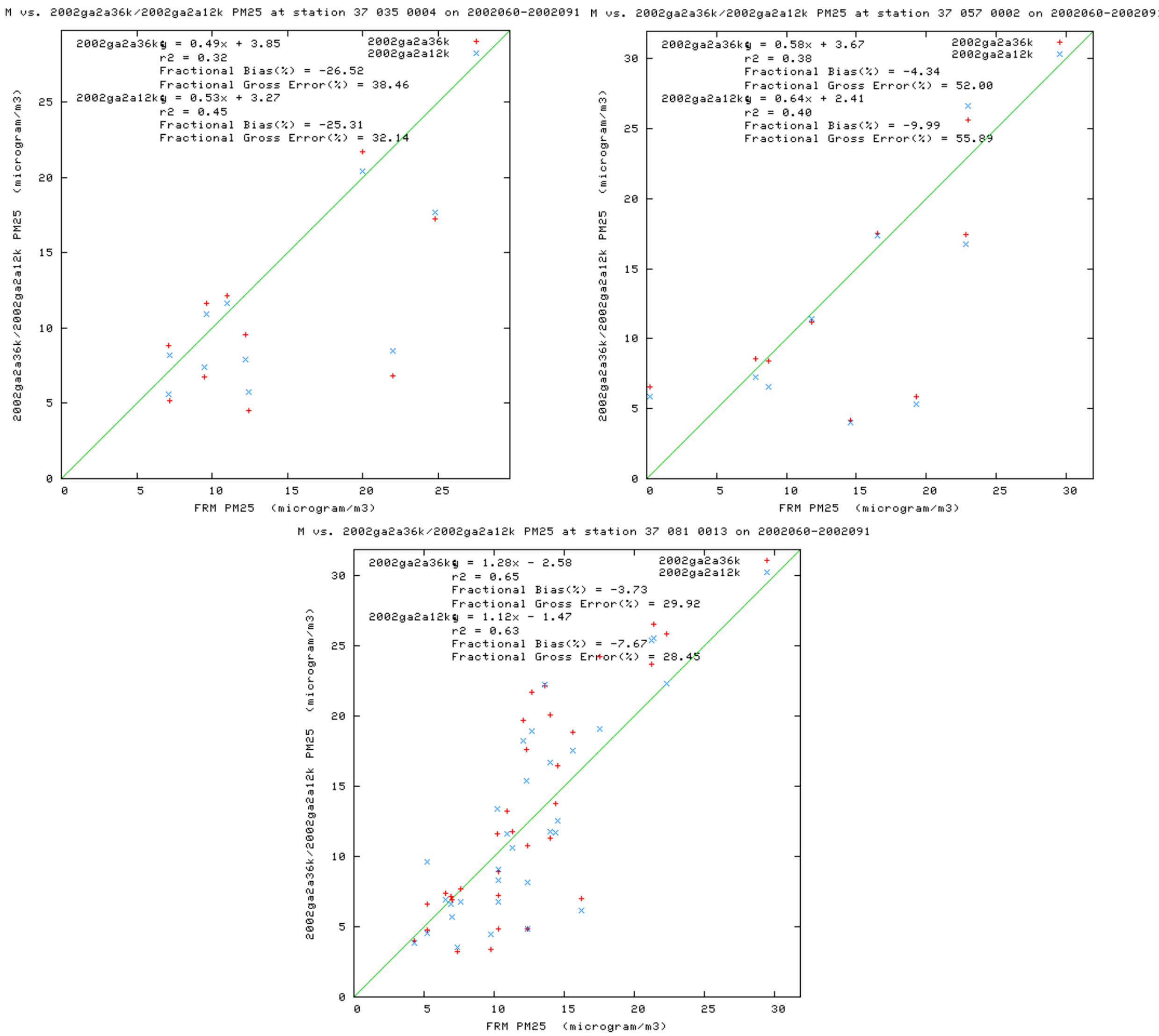


Figure 4-78: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of March.

4.2.4 April

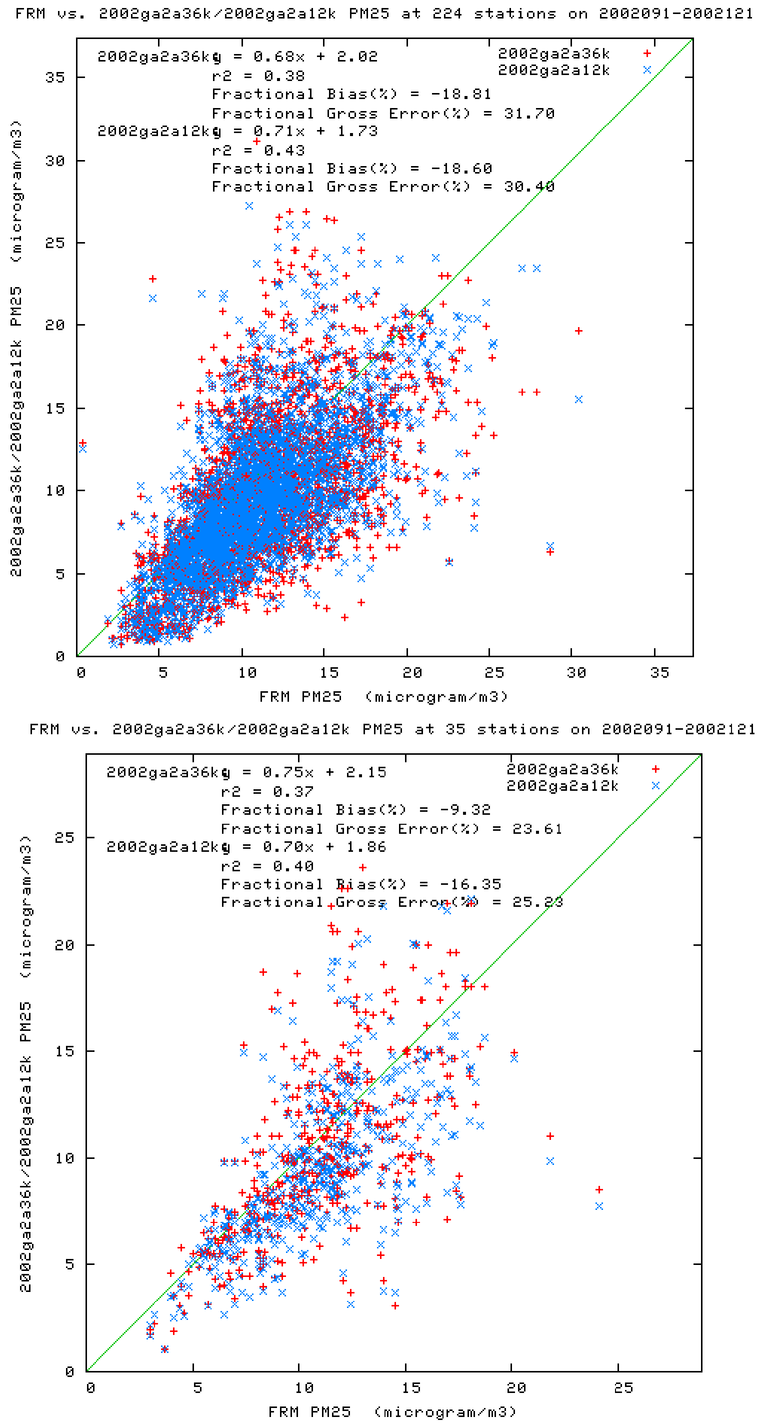


Figure 4-79: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of April.

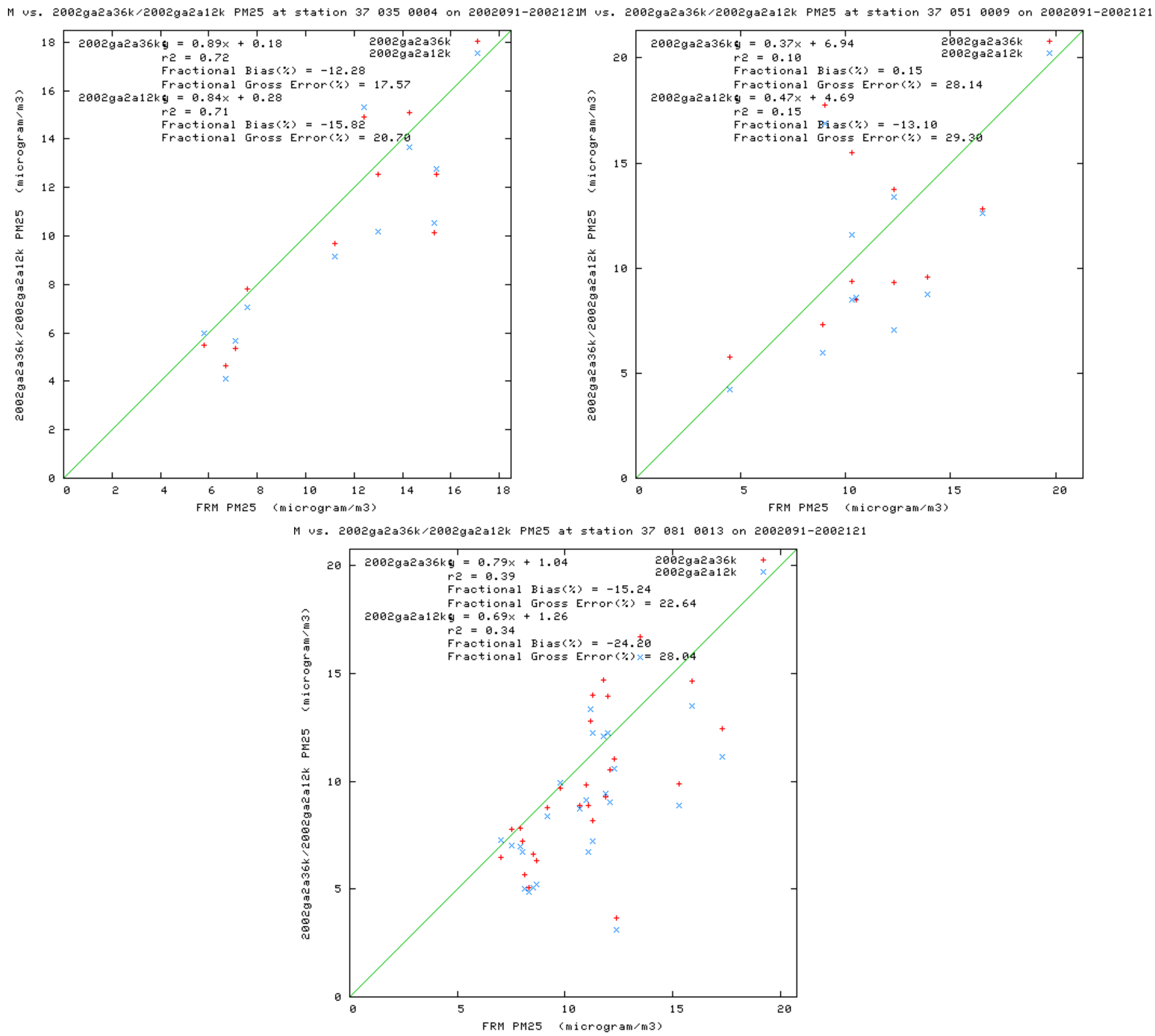
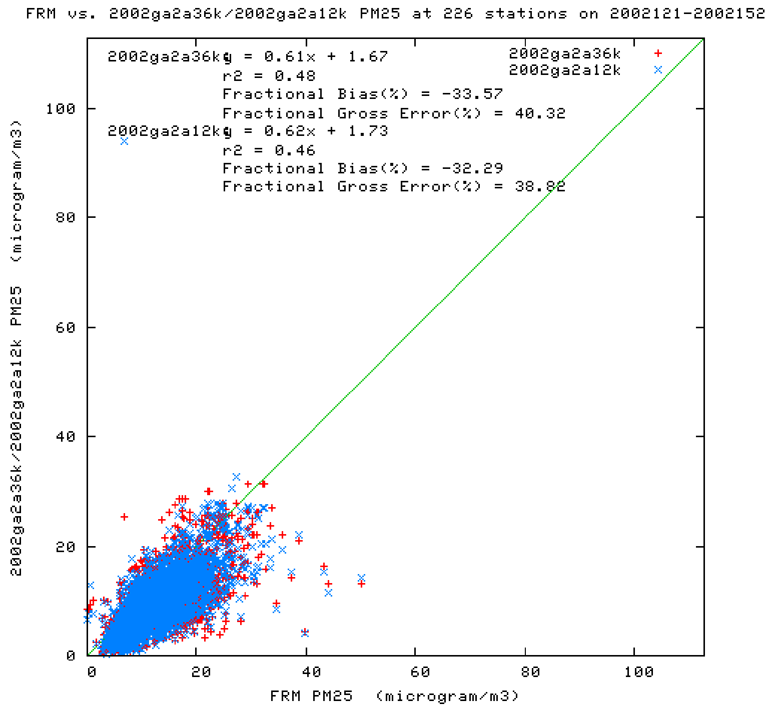


Figure 4-80: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of April.

4.2.5 May



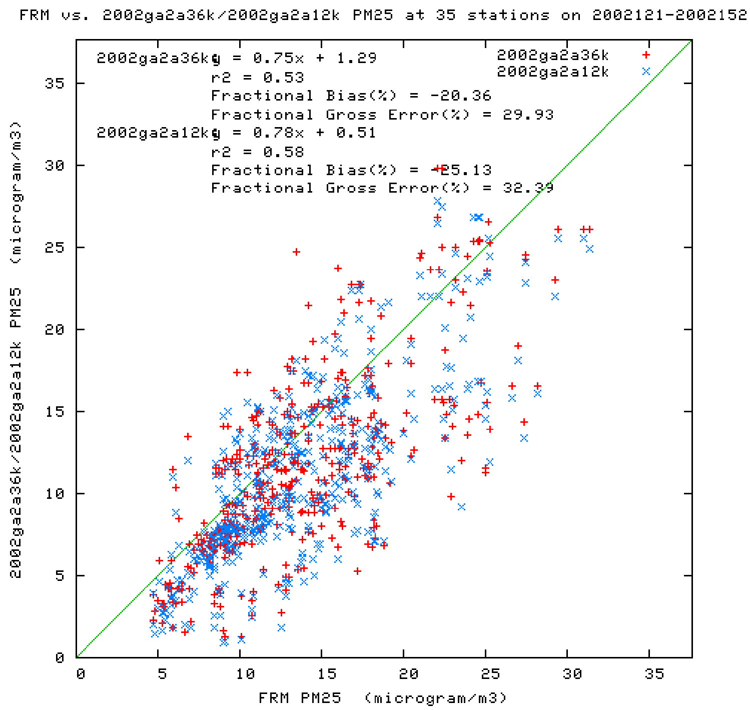


Figure 4-81: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of May.

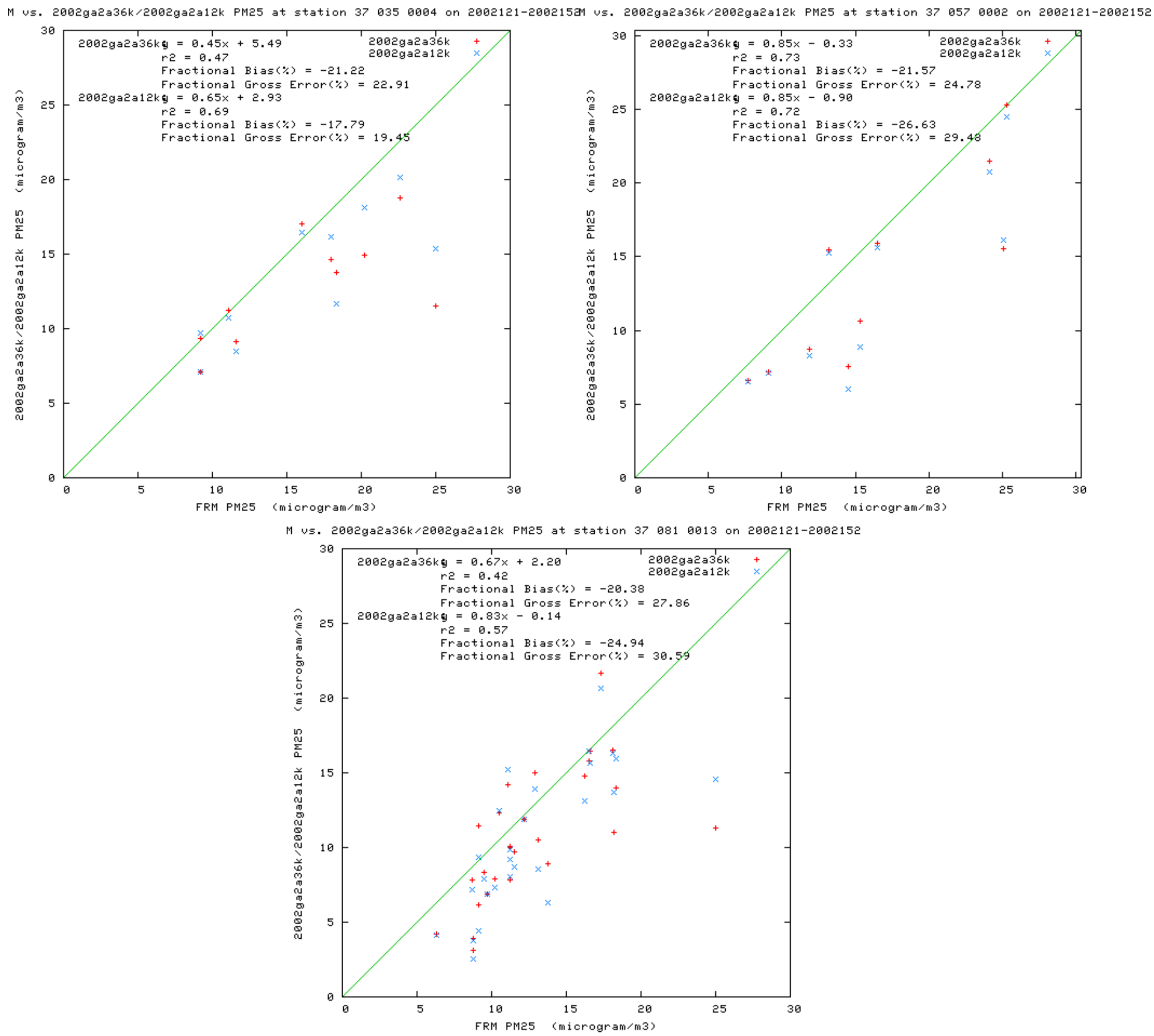
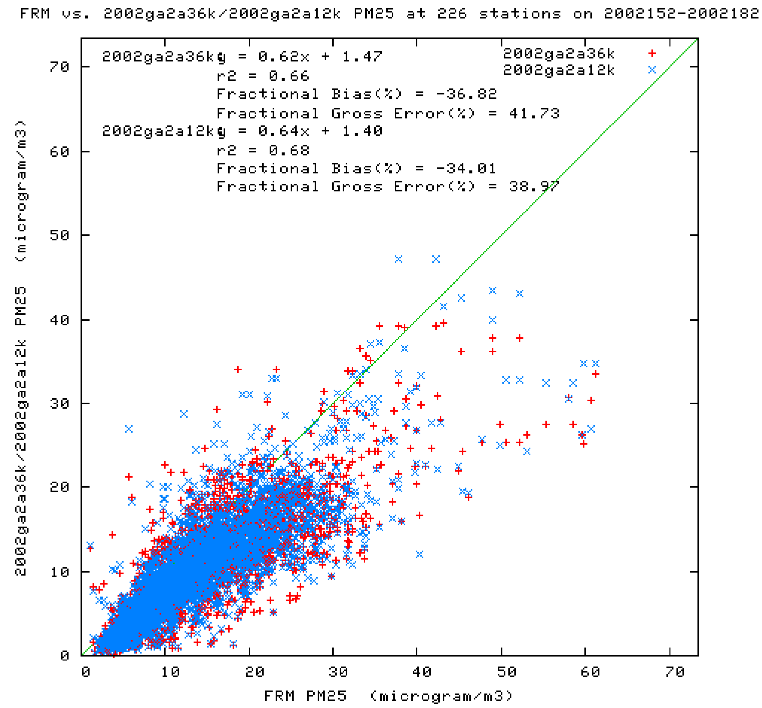


Figure 4-82: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of May.

4.2.6 June



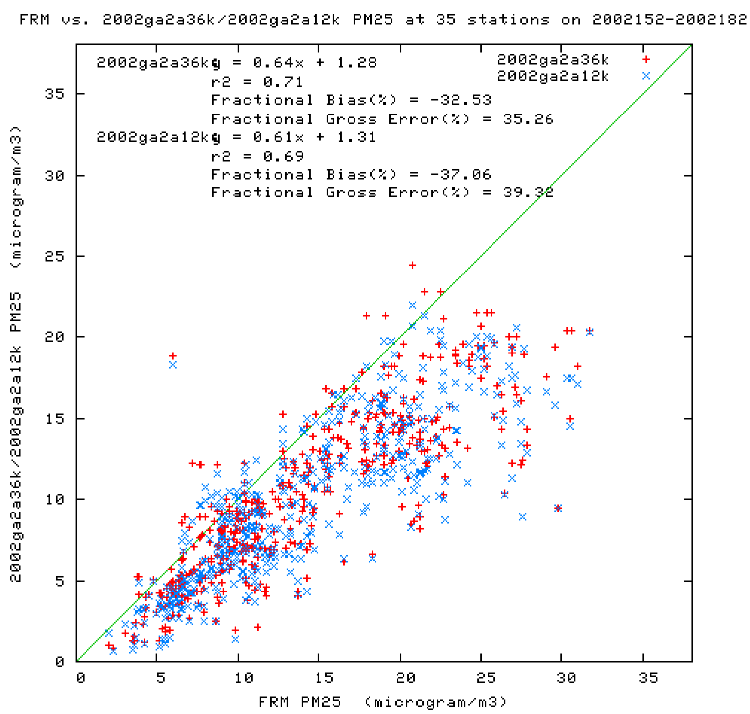


Figure 4-83: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of June.

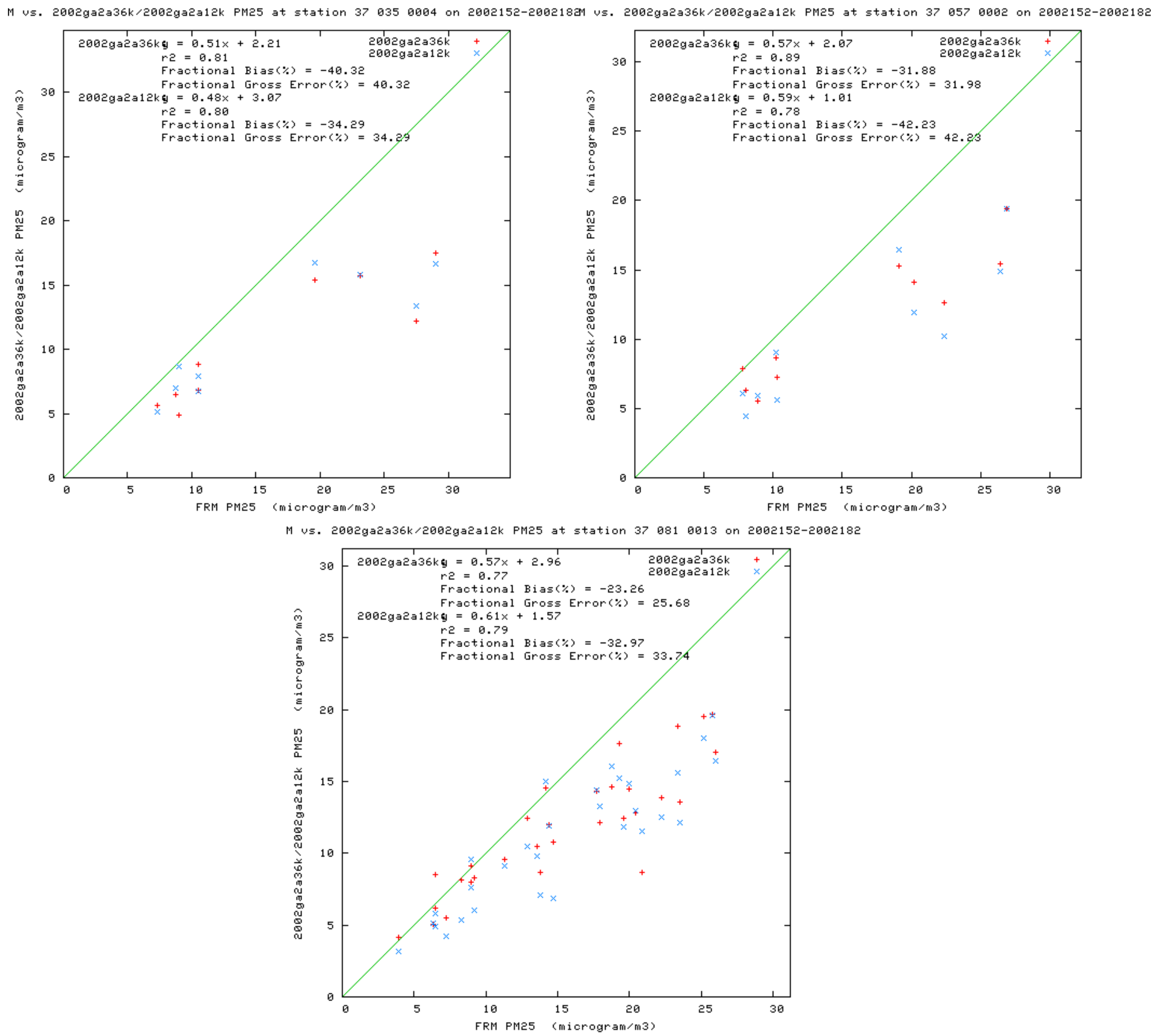
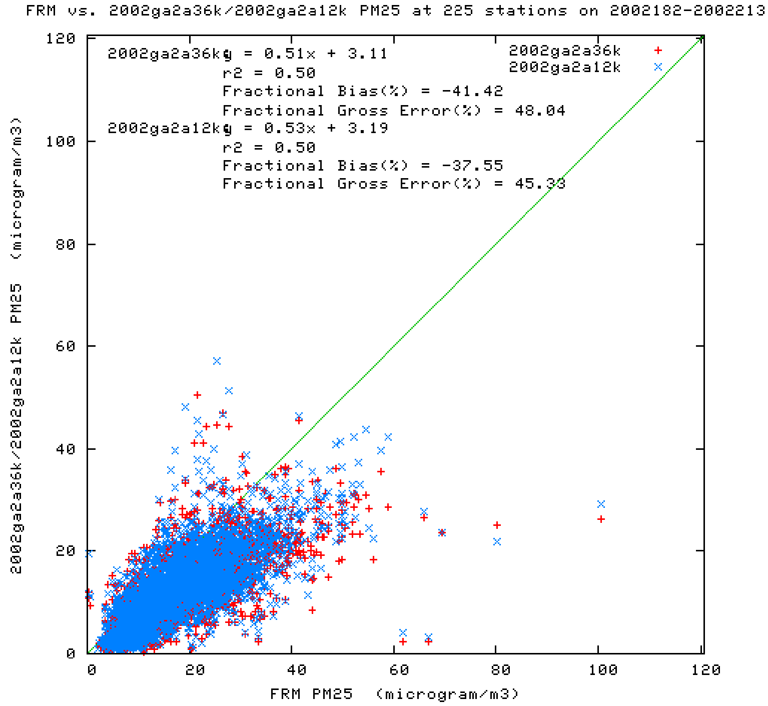


Figure 4-84: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of June.

4.2.7 July



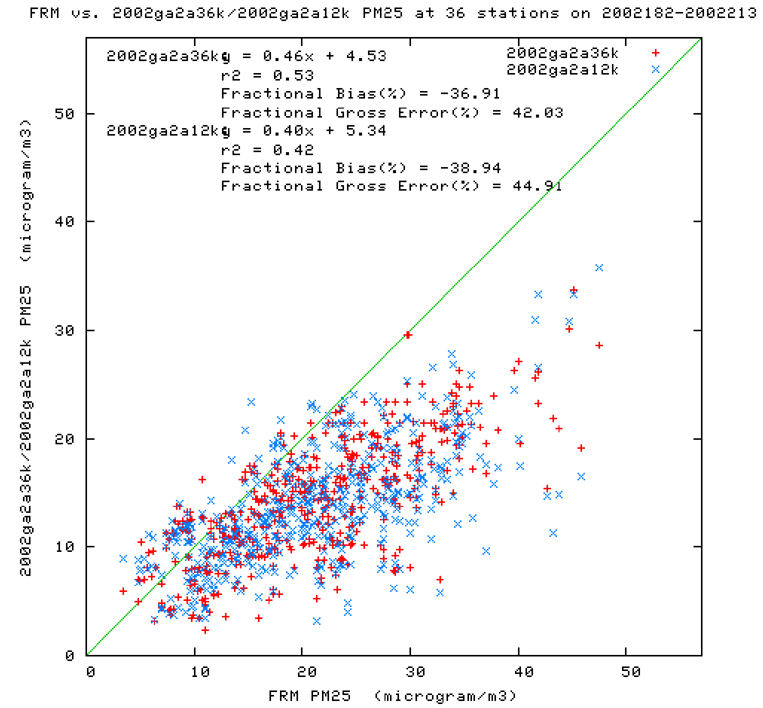


Figure 4-85: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of July.

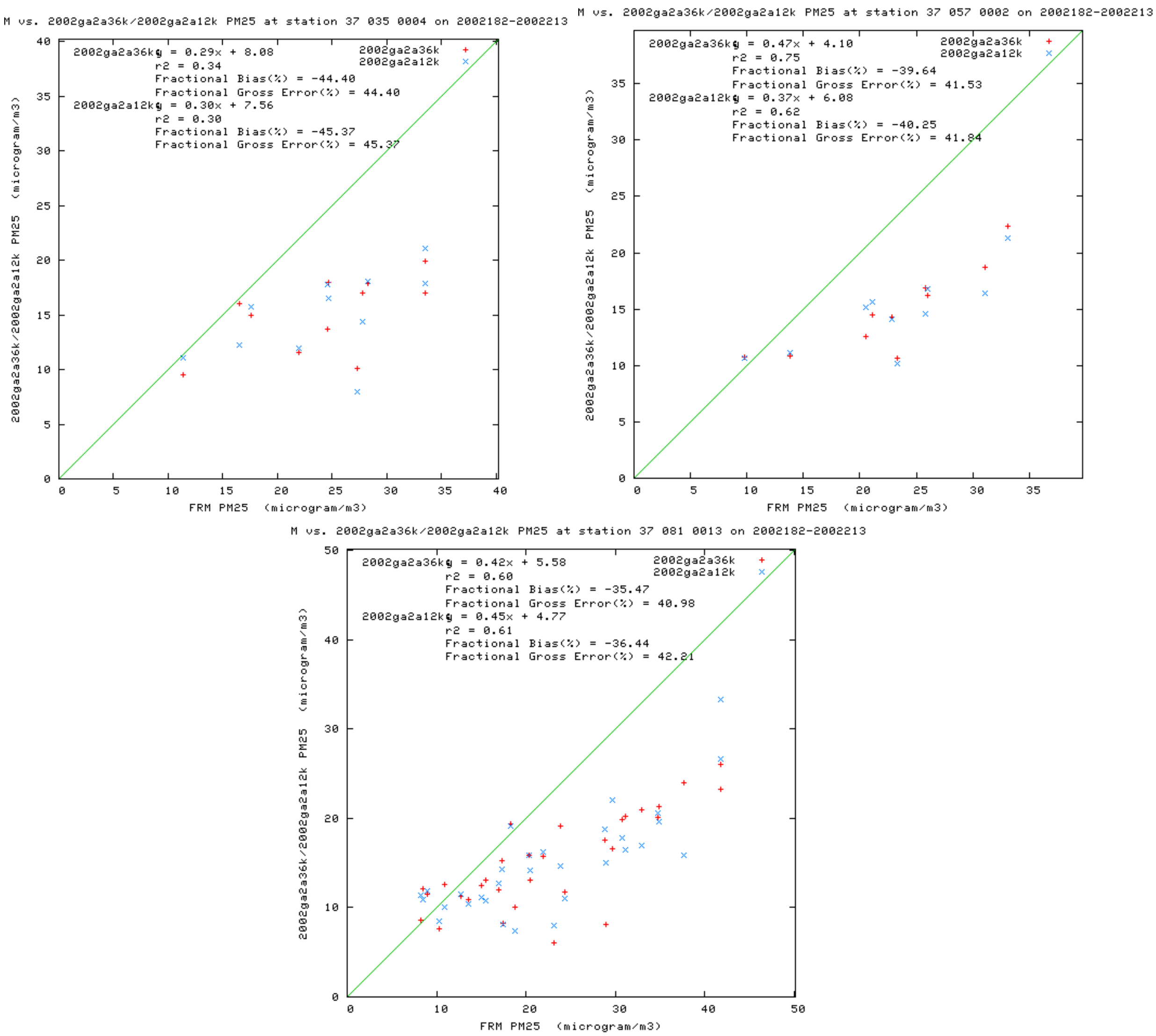


Figure 4-86: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of July.

4.2.8 August

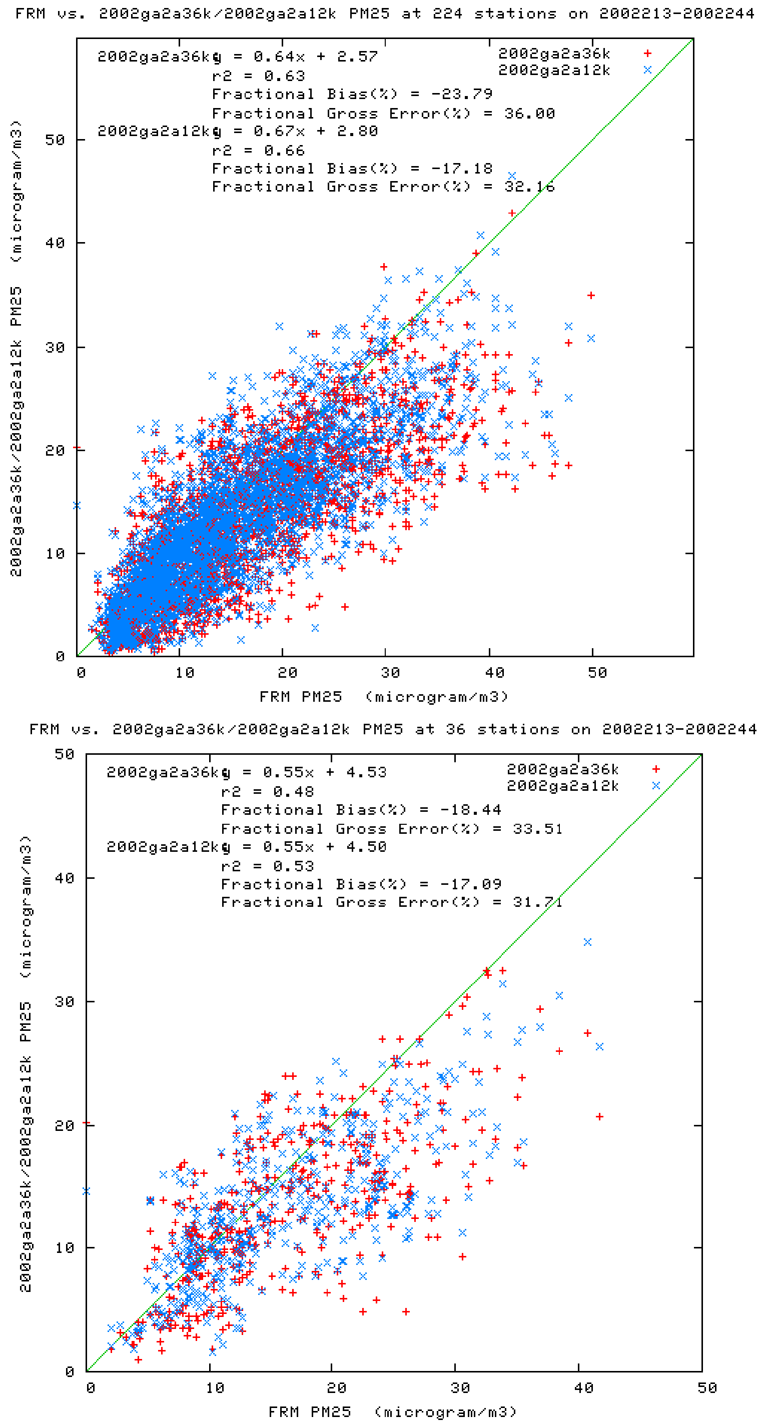


Figure 4-87: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of August.

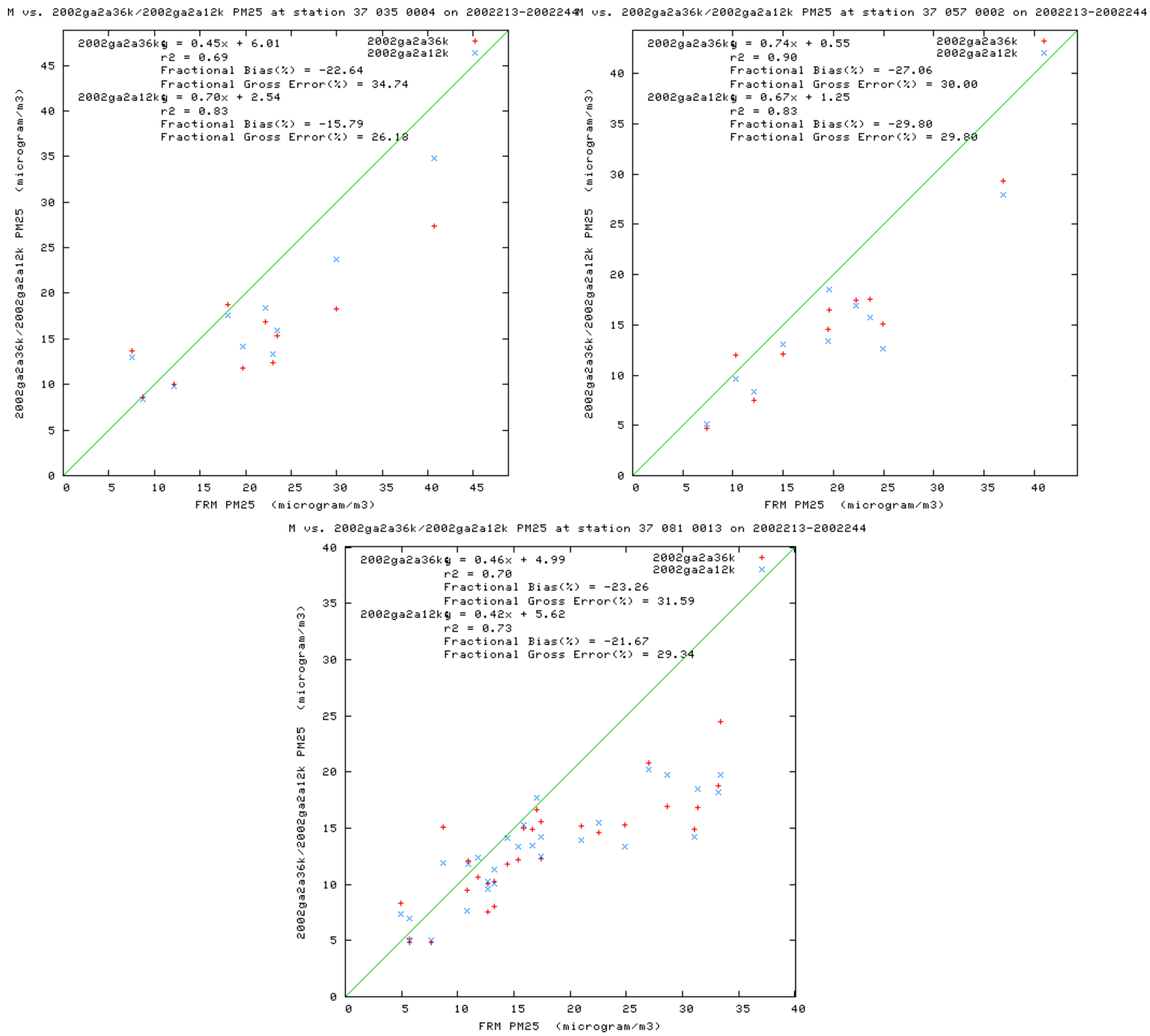
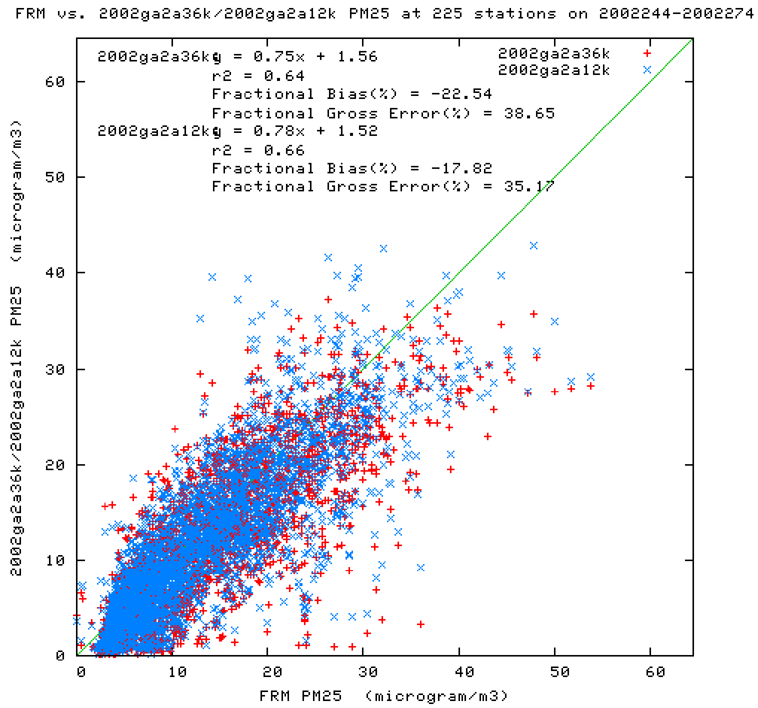


Figure 4-88: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of August.

4.2.9 September



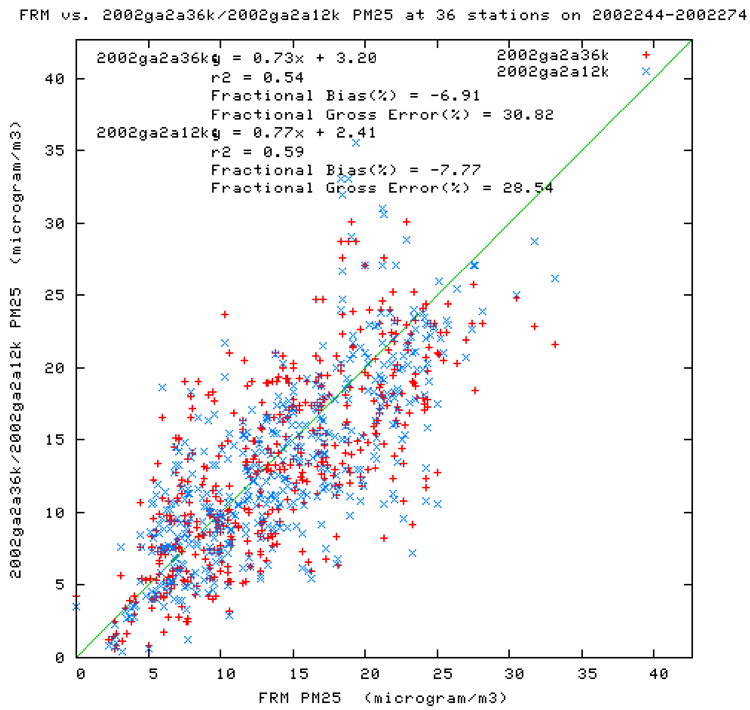


Figure 4-89: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of September.

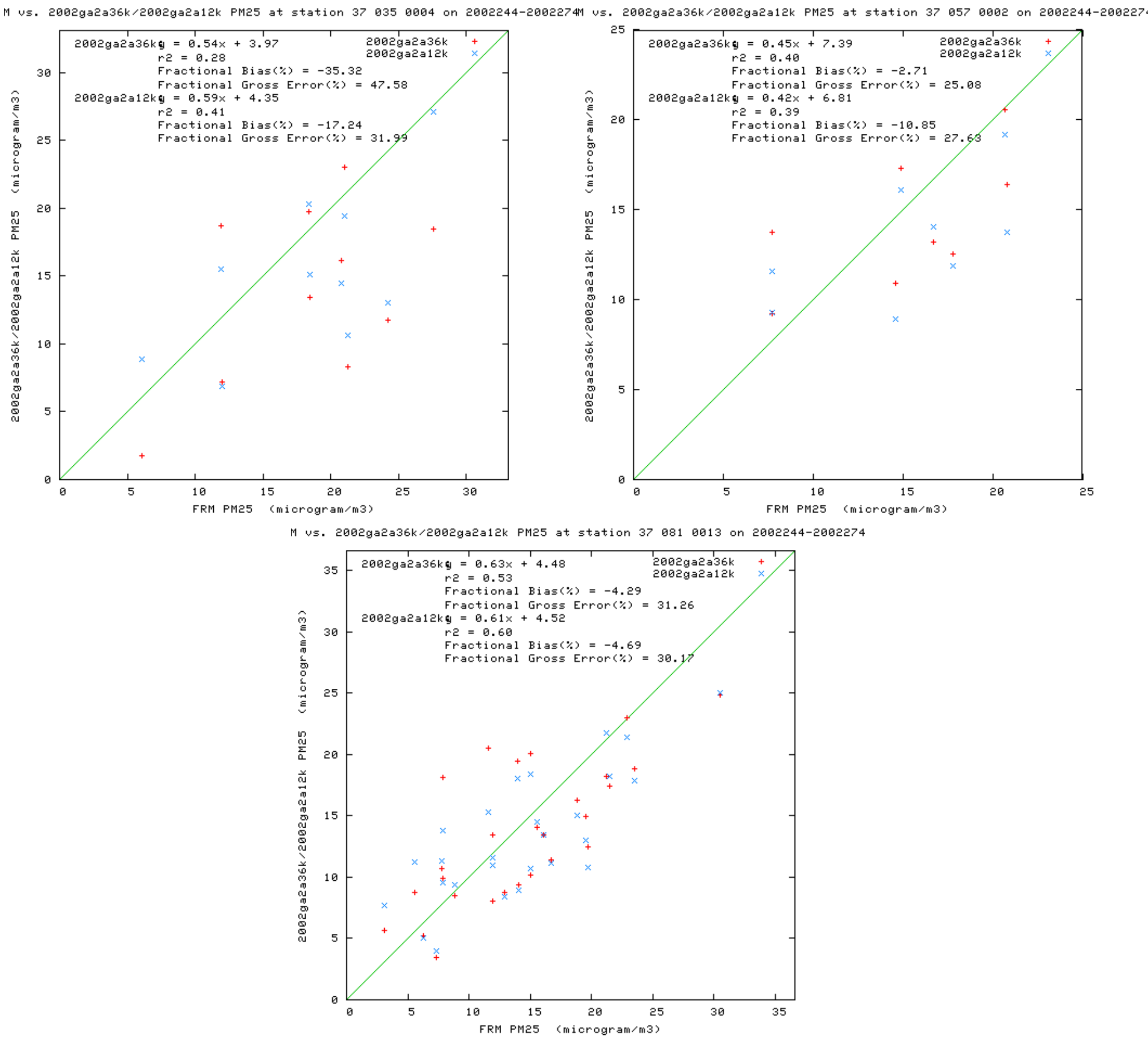


Figure 4-90: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of September.

4.2.10 October

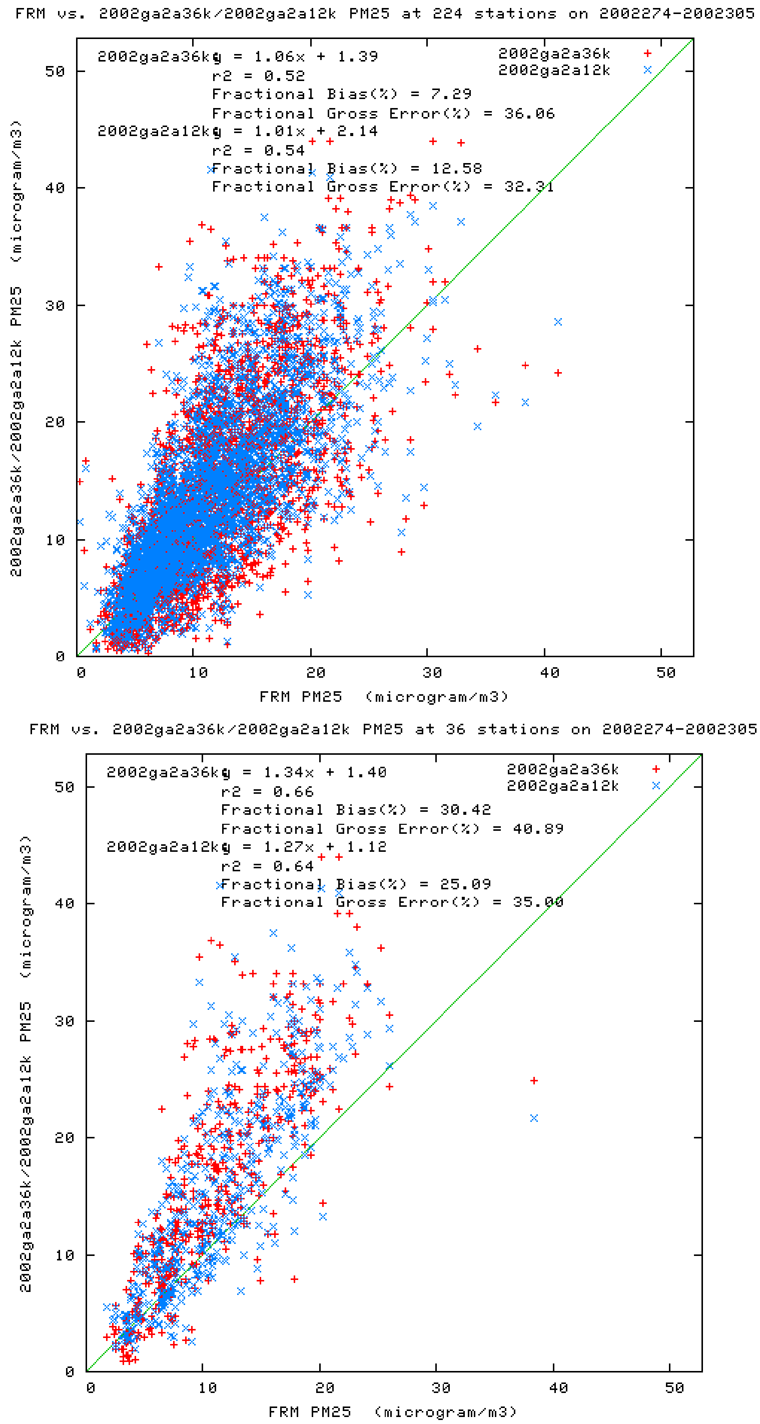


Figure 4-91: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of October.

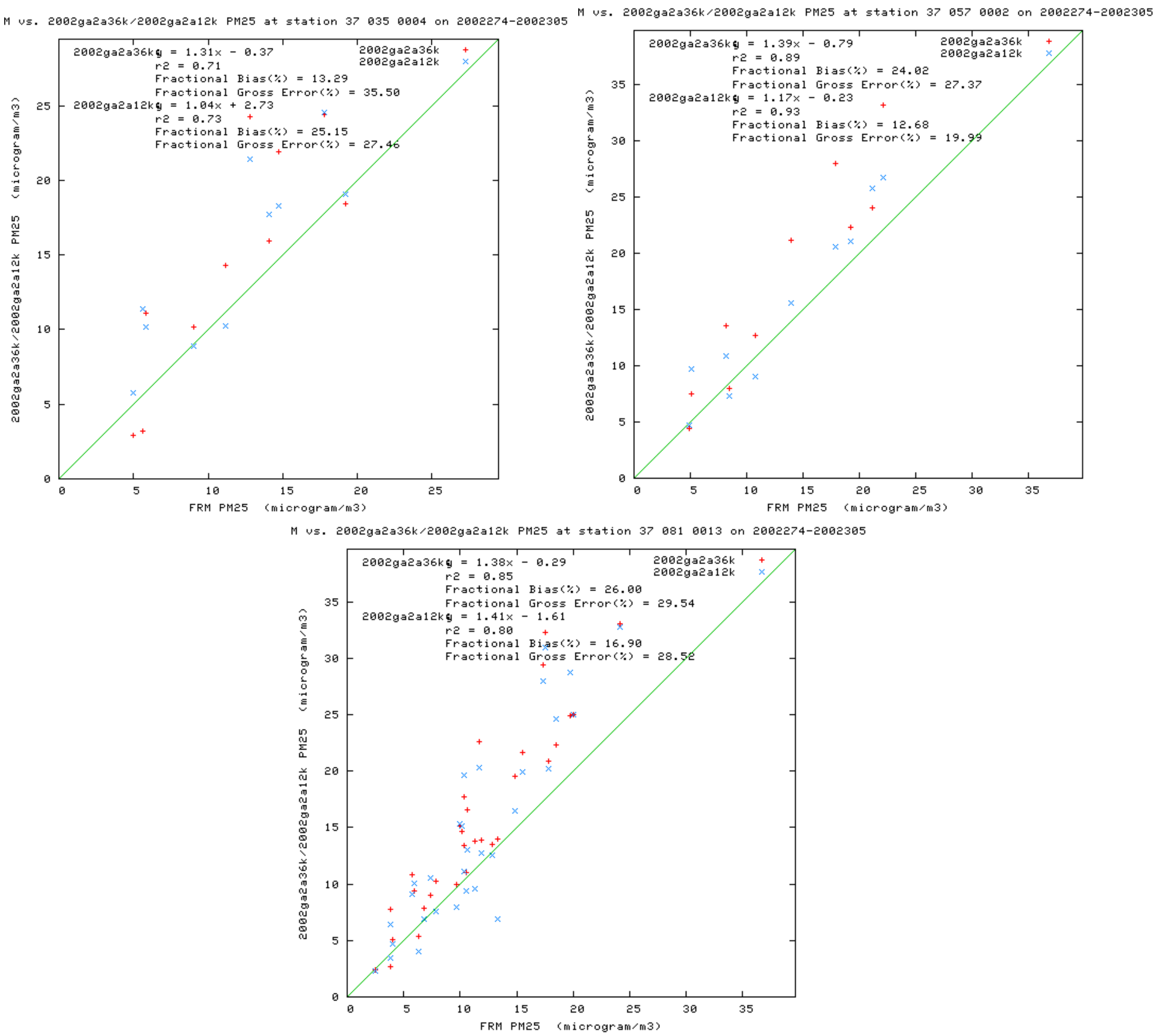
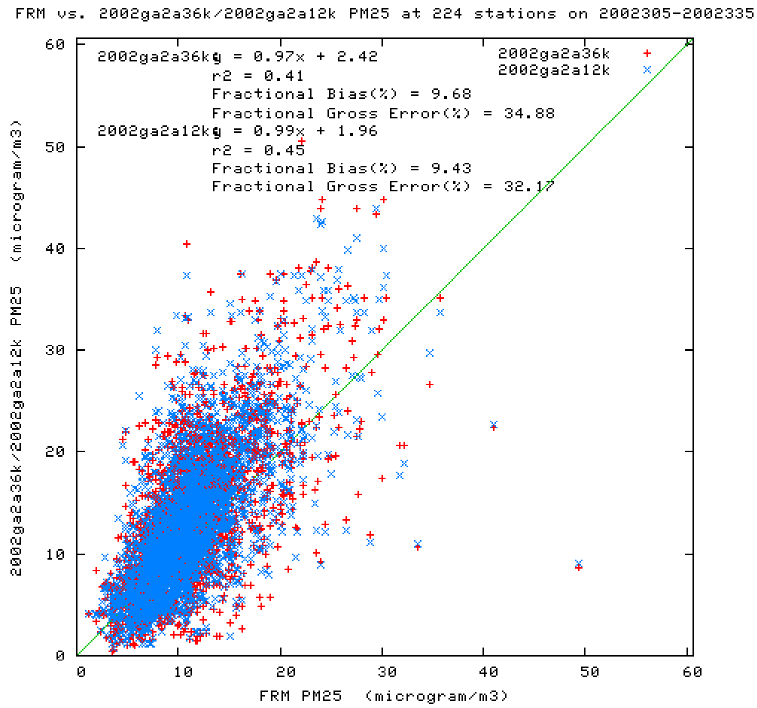


Figure 4-92: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of October.

4.2.11 November



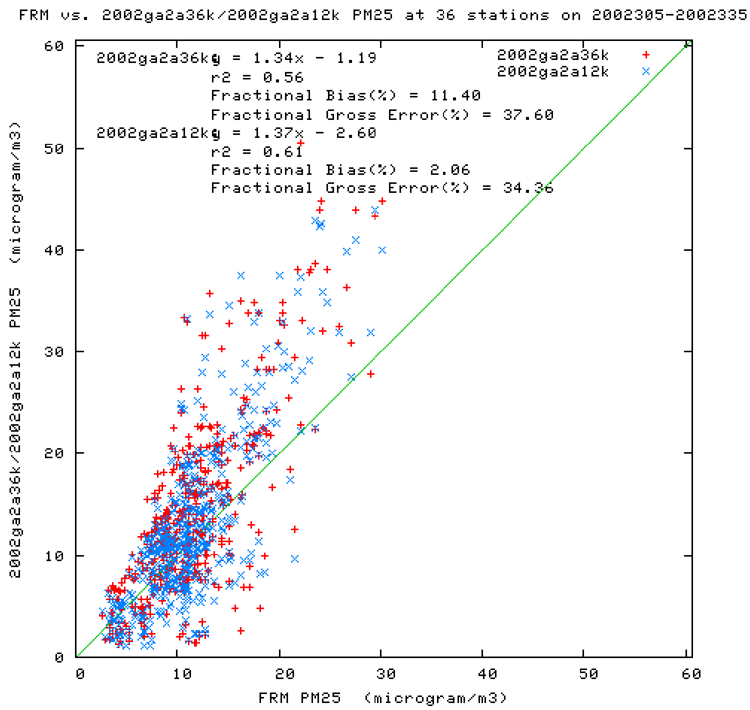


Figure 4-93: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of November.

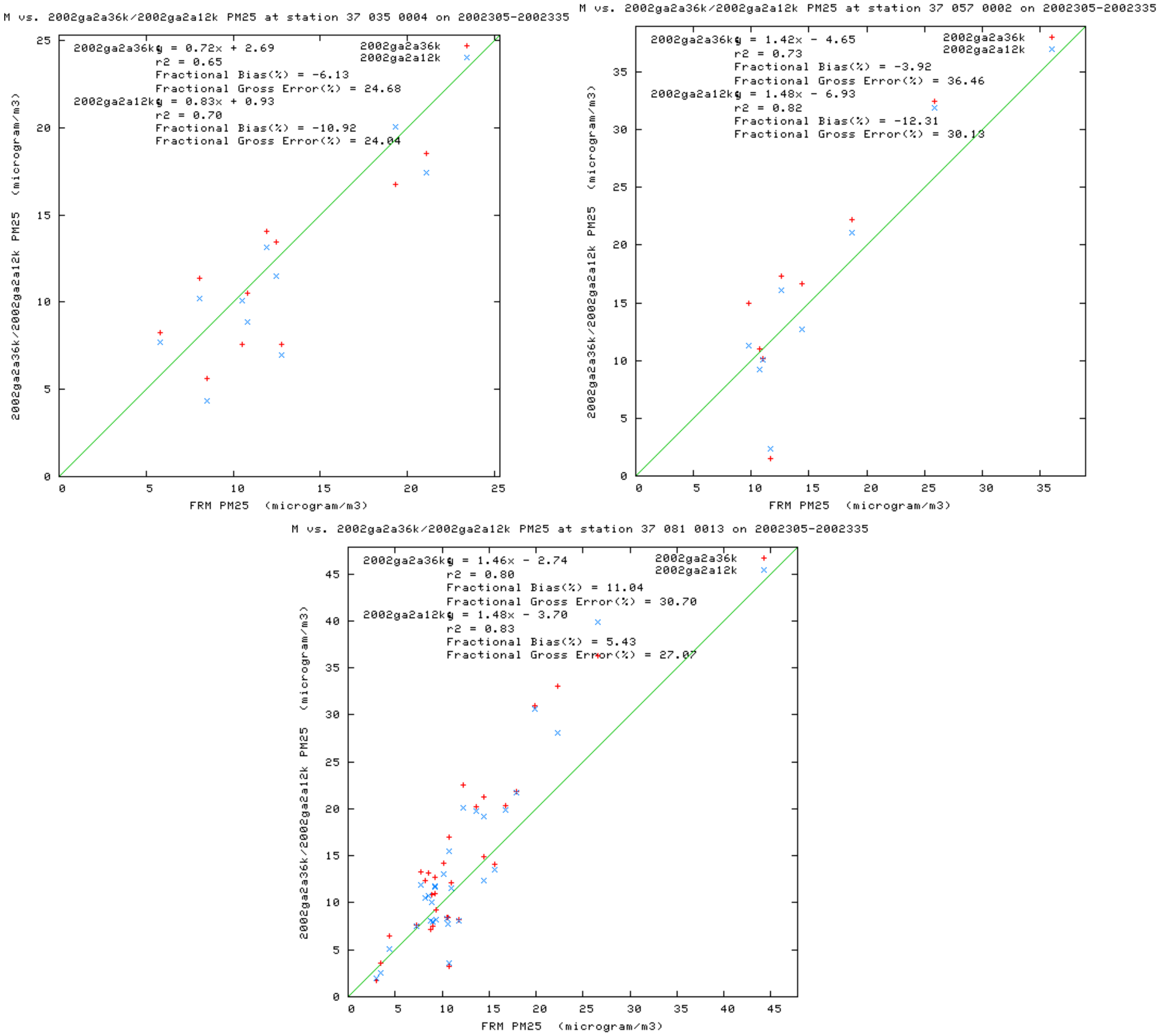
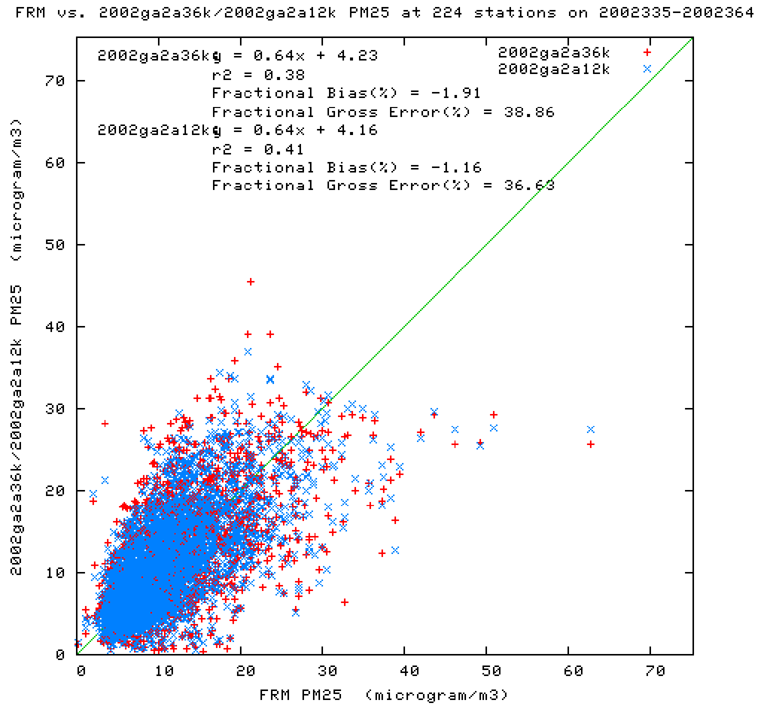


Figure 4-94: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of November.

4.2.12 December



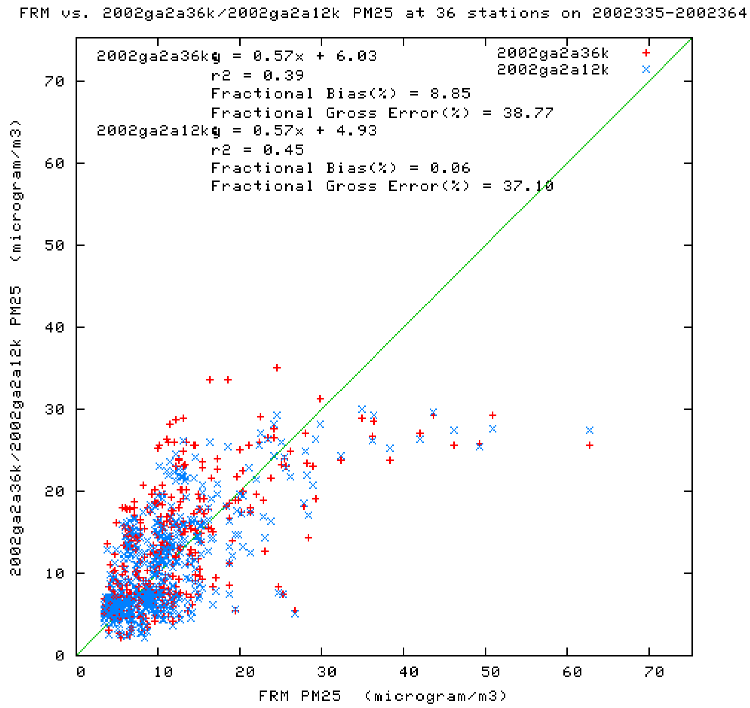


Figure 4-95: Scatter Plot of $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for all VISTAS FRM sites collectively (top), all North Carolina FRM sites collectively (bottom) for the month of December.

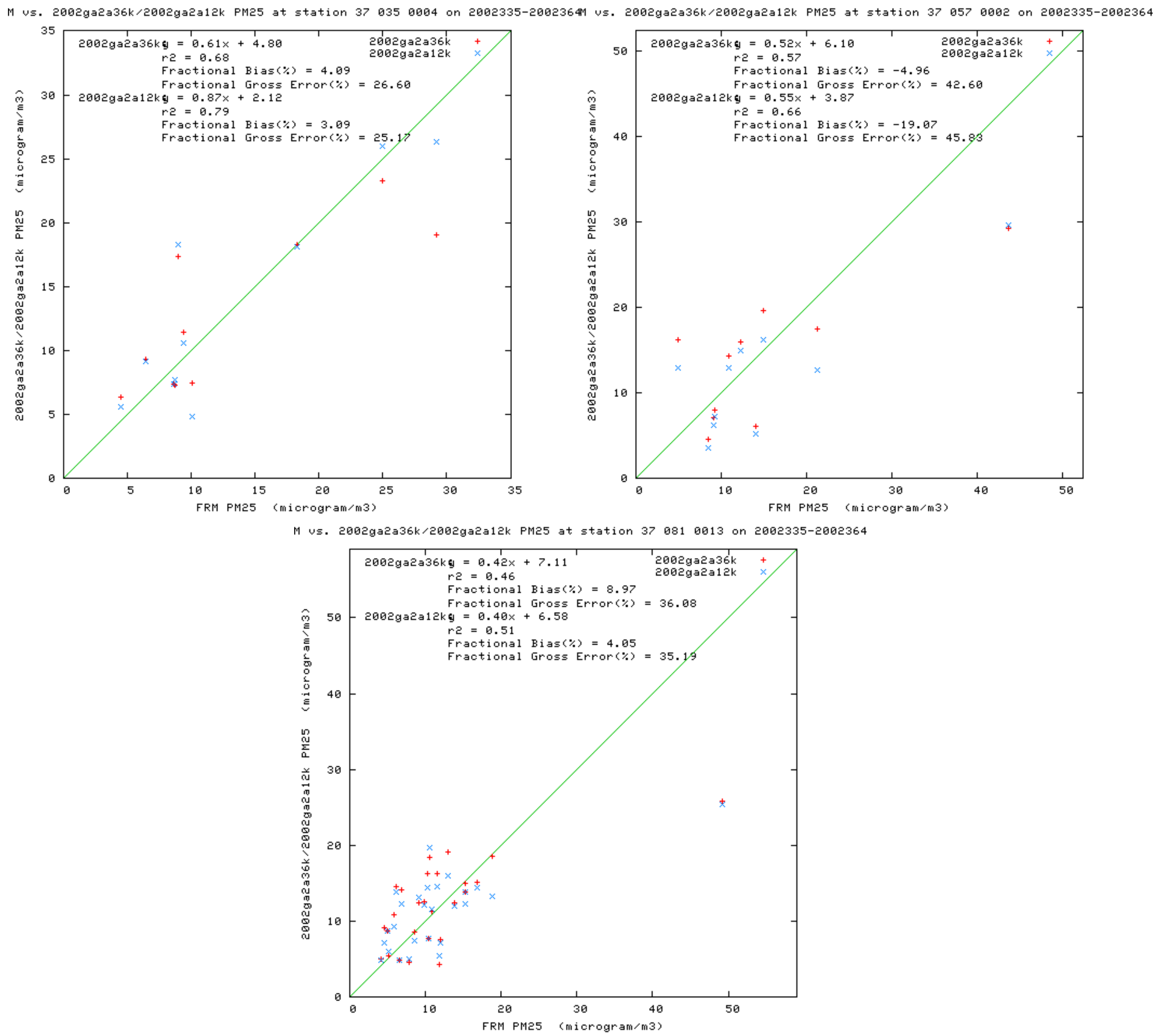


Figure 4-96: Scatter Plot of Observed $PM_{2.5}$ from the FRM network versus the Modeled Sulfate for the 12km domain (blue x's) and the 36km domain (red +'s) for the Hickory FRM site (37-035-0004)(top left), the Lexington FRM site (37-057-0002) (top right), and the Mendenhall FRM site (37-081-0013) for the month of December.

5. Time Series

The time series plots that display model predicted particulate matter component concentrations for the 12km grid resolution (purple line), the 36 km grid resolution (blue line), and observed concentrations (red line) are presented in this section. Observations are reported per the polling frequency of the site presented, and have been paired with their corresponding model predicted value. Time series for five of component species of particulate matter (sulfates, nitrates, ammonium, organic carbon, and elemental carbon) are presented by species, for both the Hickory and Hattie Avenue STN monitoring sites, for each month of the year in Section 5.1. Time series for the total reconstructed fine particulate mass for the STN monitors follows the species plots in Section 5.1.6. Additionally, the total observed $PM_{2.5}$ mass form FRM sites are plotted with the 12km and 36 km grid resolution modeled values in Section 5.2. The annual fractional bias and fractional error for the site for both 12km and 36km grid resolution is presented in top right corner of all the graphs for reference.

Overall, the model captures the cycle of pollutant build up and clean out very well across the major constituents of $PM_{2.5}$. Nitrates performance is the weakest, but the general pattern of increase and decreases is still reasonably captured, with most of the poor performance occurring in the later half of the year. The ammonium cycle is actually captured quite well, especially in the April to May timeframe. The general good performance of the components translates to good performance in the total reconstructed $PM_{2.5}$ mass from the STN sites. The FRM data also shows the model responds appropriately to shift in weather patterns and pollutant patterns, as the FRM modeled response mirrors the observed response quite well.

The negative bias in the model is still apparent in the times series; however, the plots show that the model is doing a good job of capturing the pattern of increases and decreases in $PM_{2.5}$ and it's constituents. This is encouraging because it shows the model chemistry is reacting appropriately to meteorology and is performing well.

5.1 STN Time Series

5.1.1 Sulfates

5.1.1.1 January

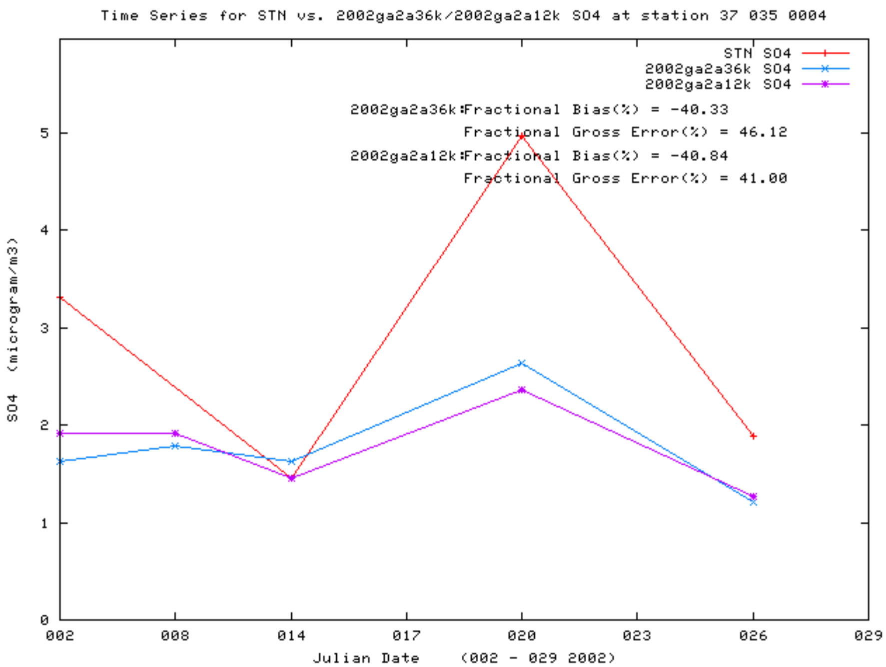


Figure 5-1: January 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

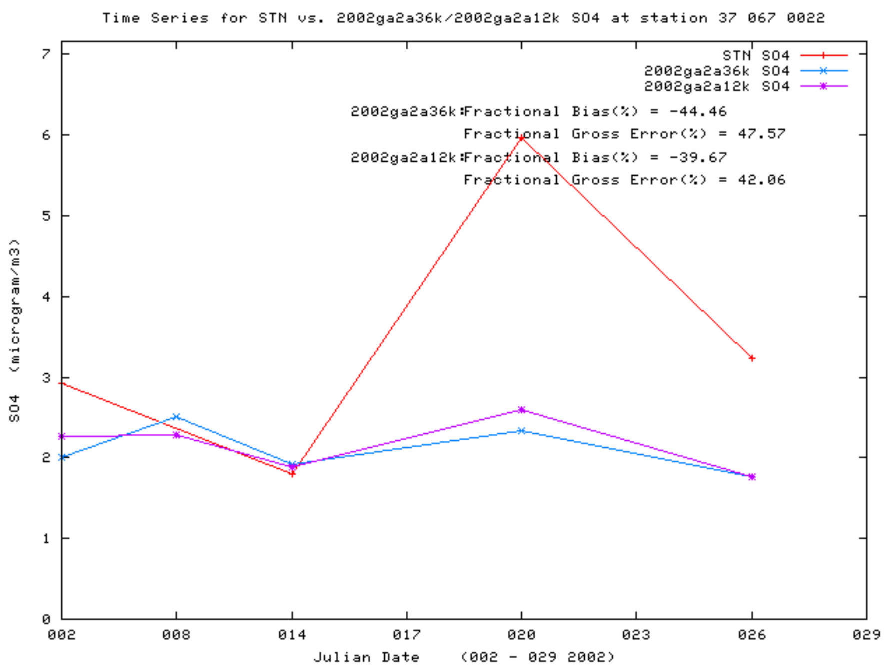


Figure 5-2: January 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.2 February

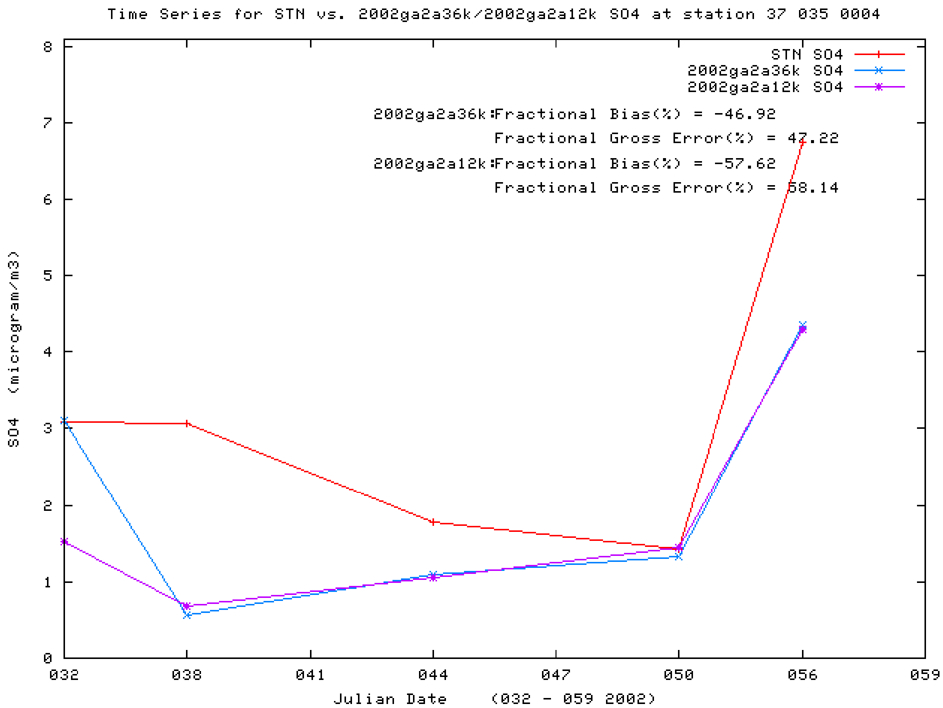


Figure 5-3: February 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

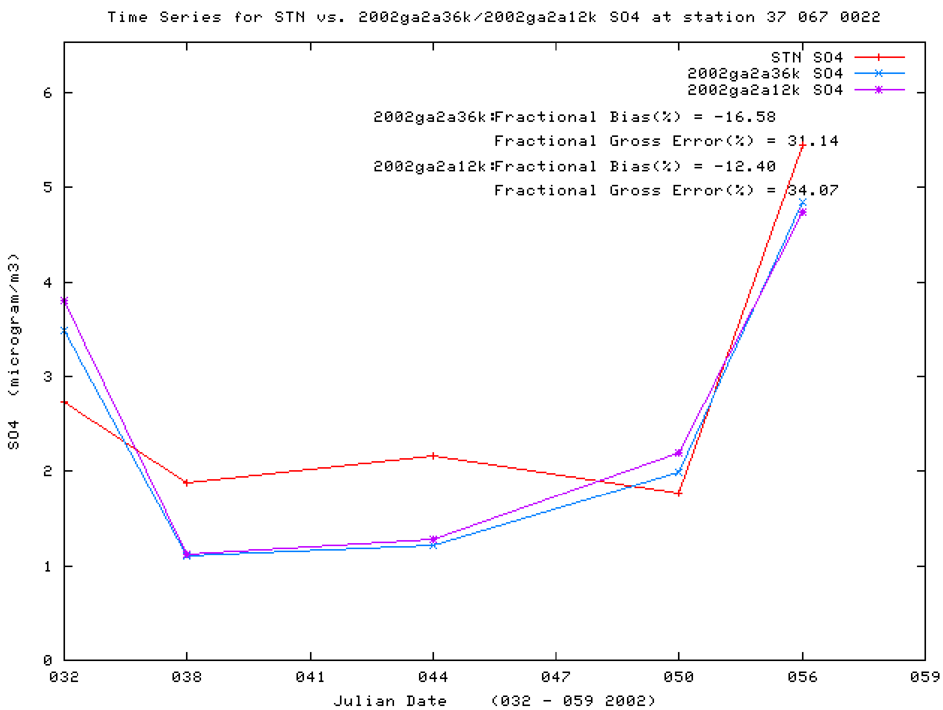


Figure 5-4: February 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.3 March

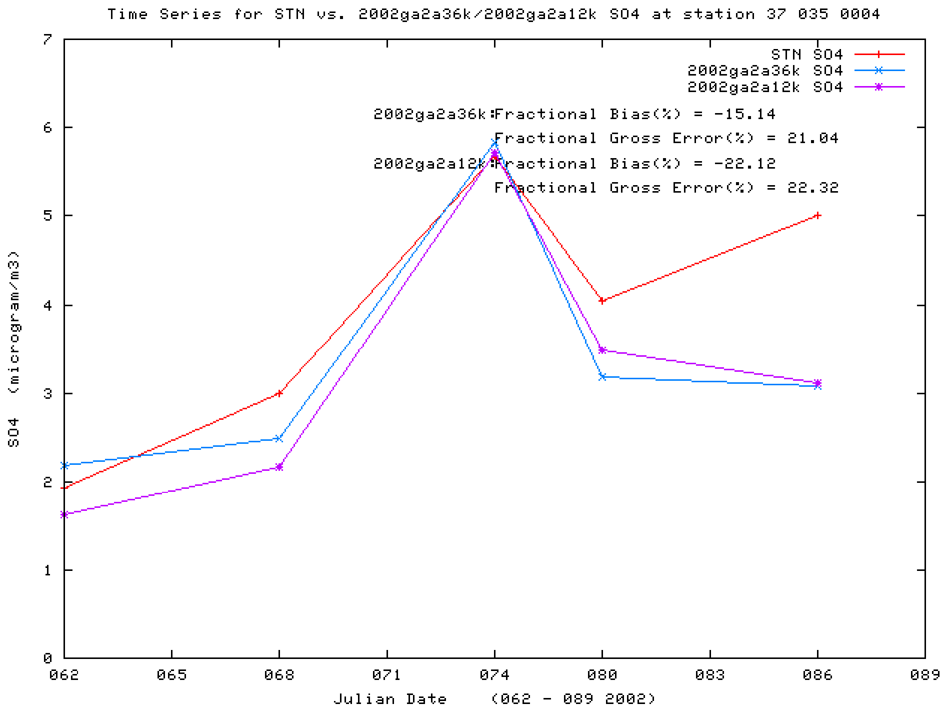


Figure 5-5: March 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

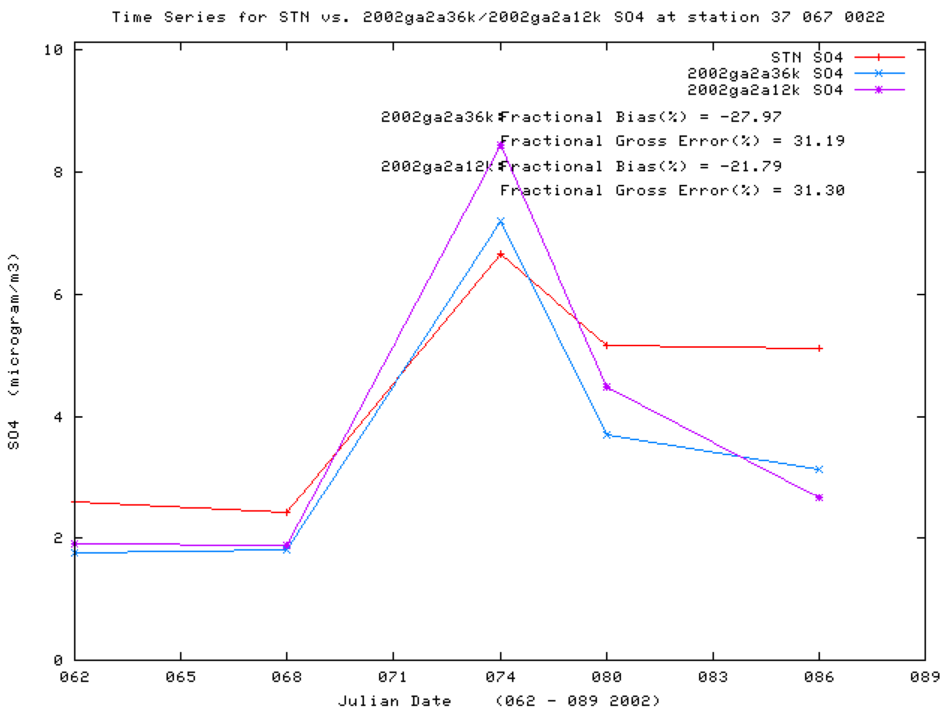


Figure 5-6: March 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.4 April

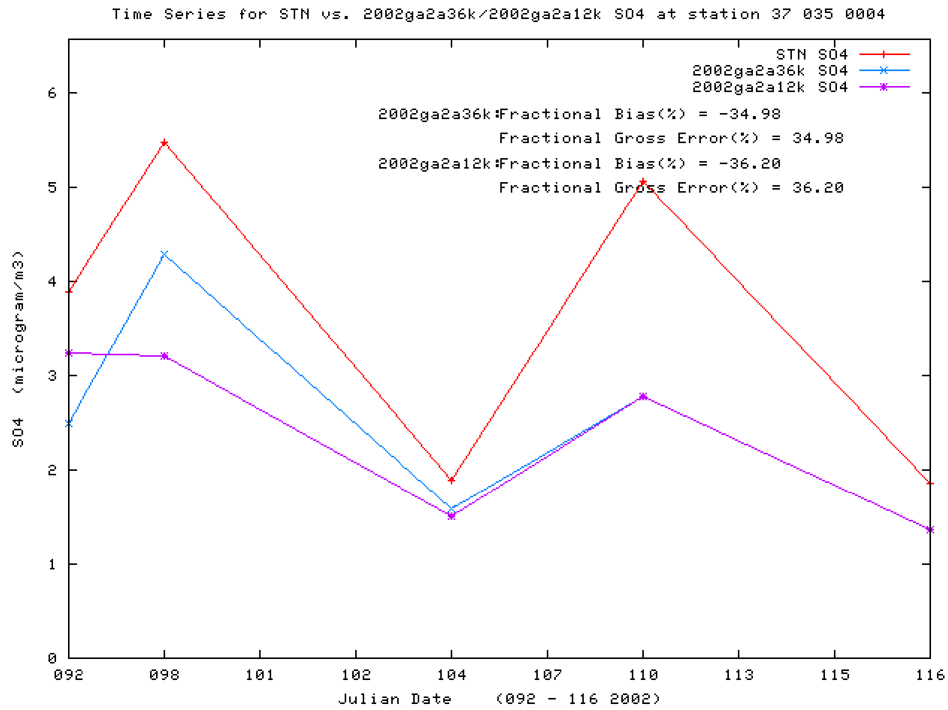


Figure 5-7: April 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

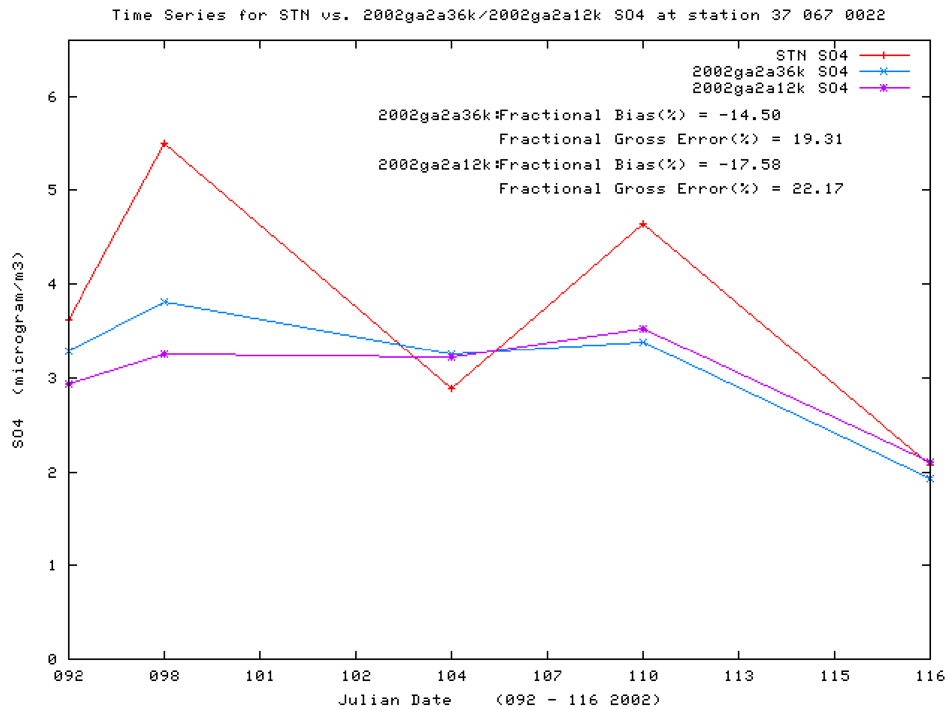


Figure 5-8: April 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.5 May

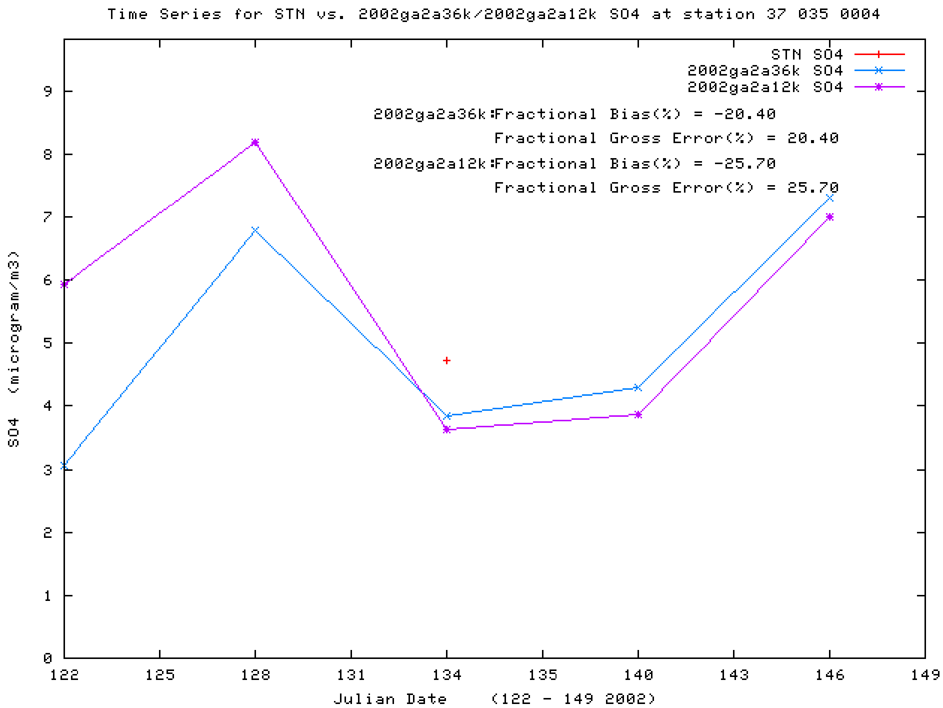


Figure 5-9: May 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

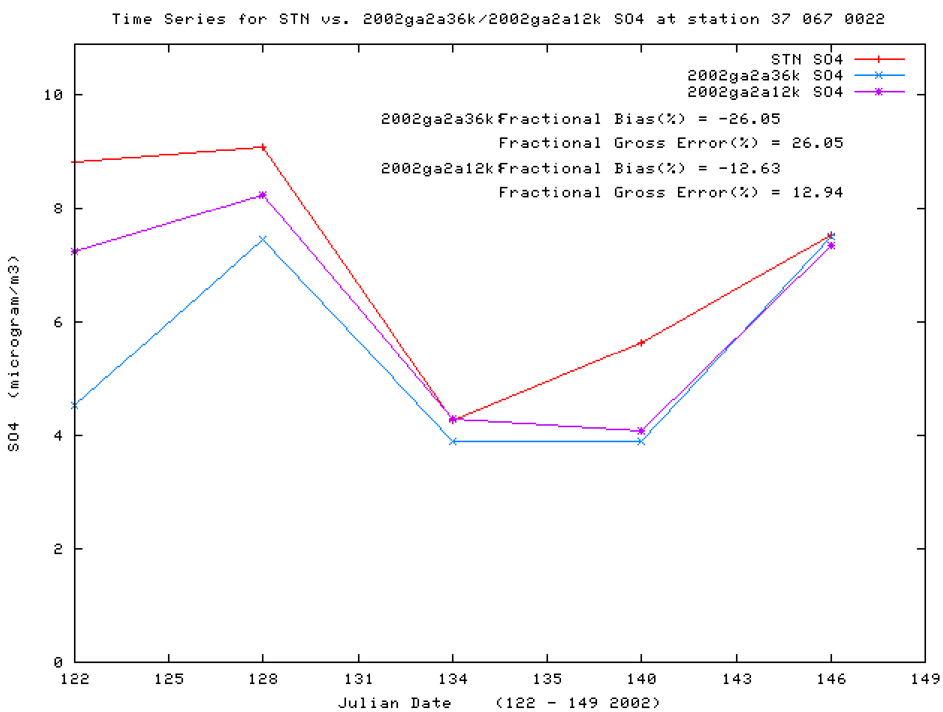


Figure 5-10: May 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.6 June

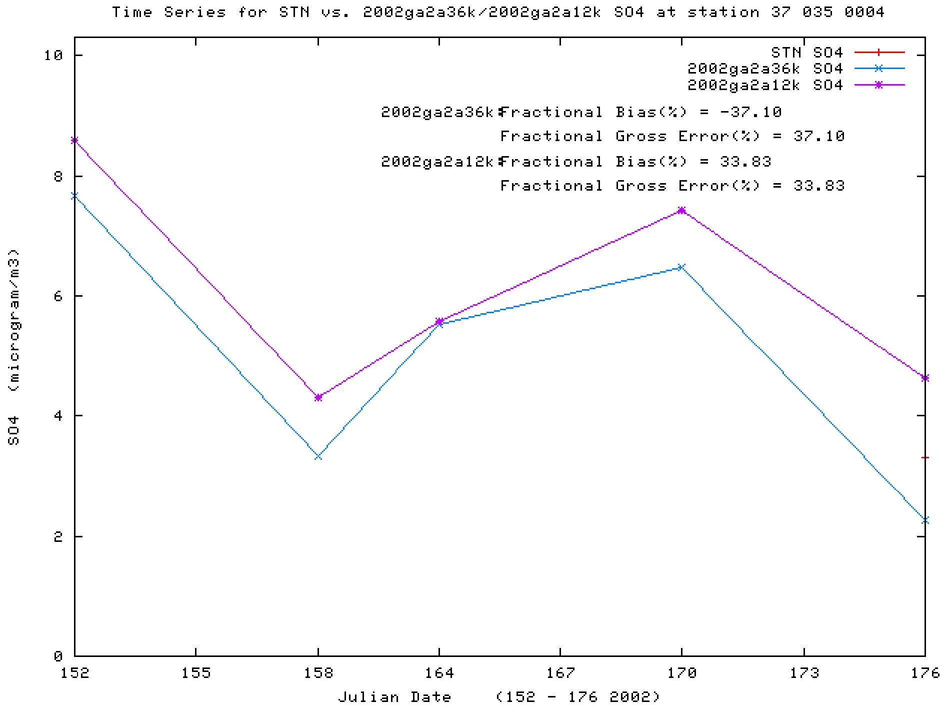


Figure 5-11: June 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

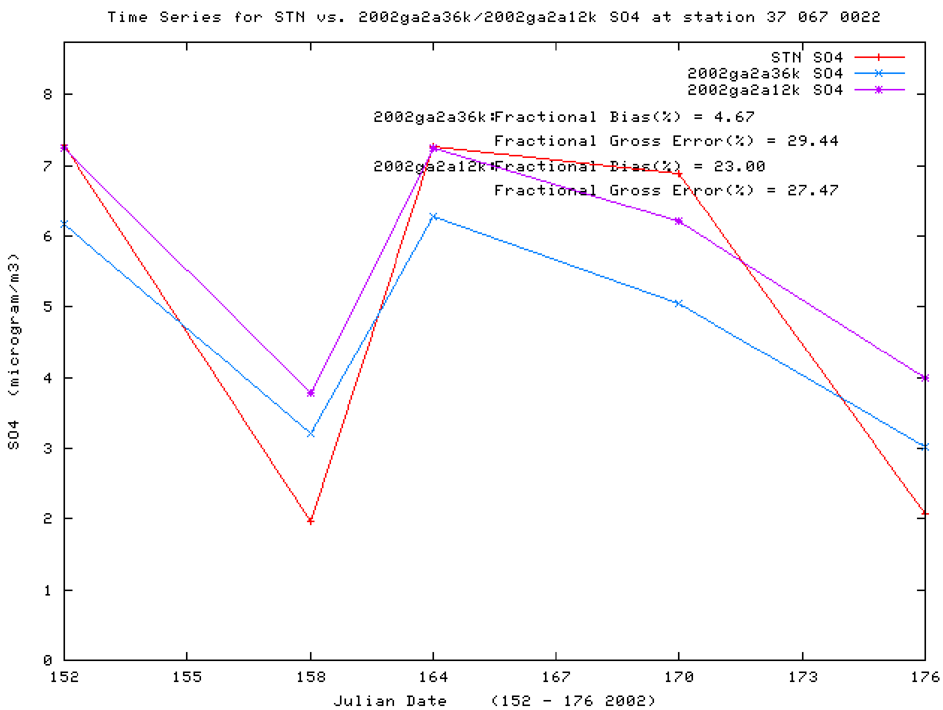


Figure 5-12: June 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.7 July

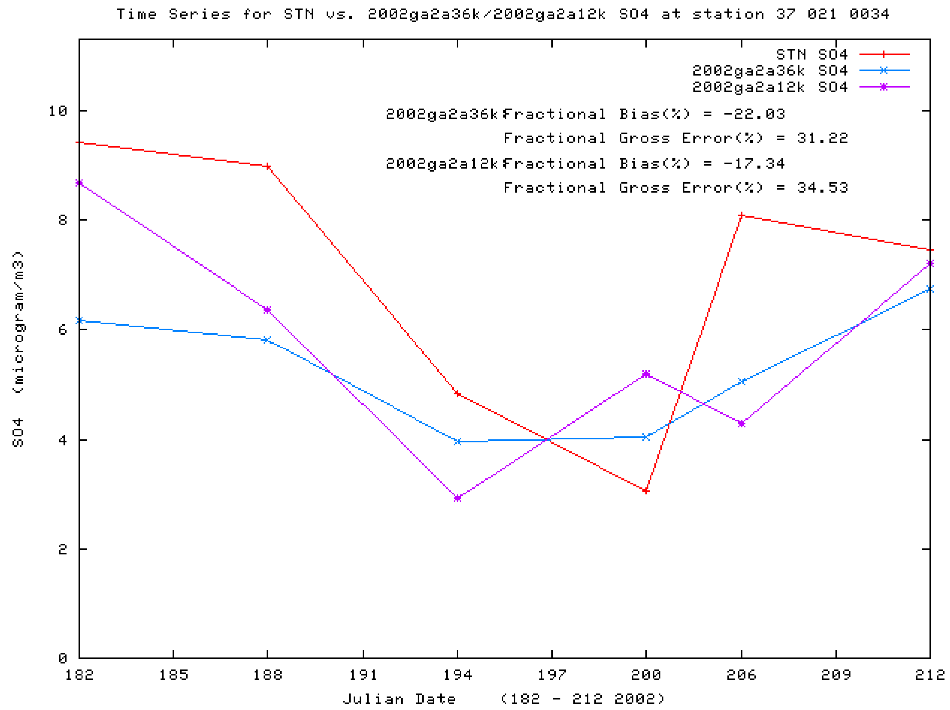


Figure 5-13: July 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

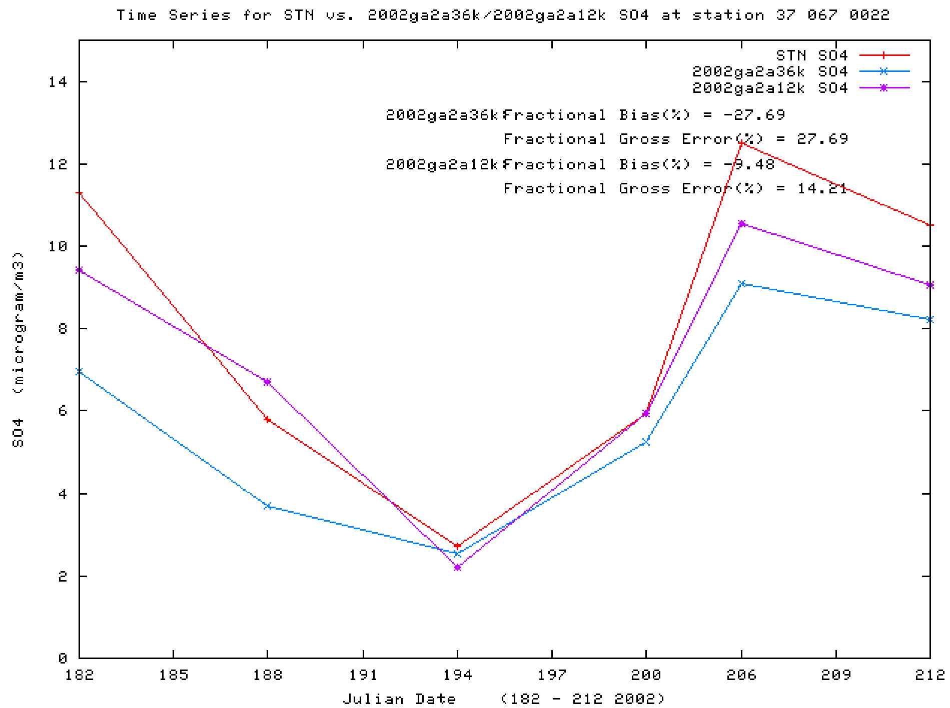


Figure 5-14: July 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.8 August

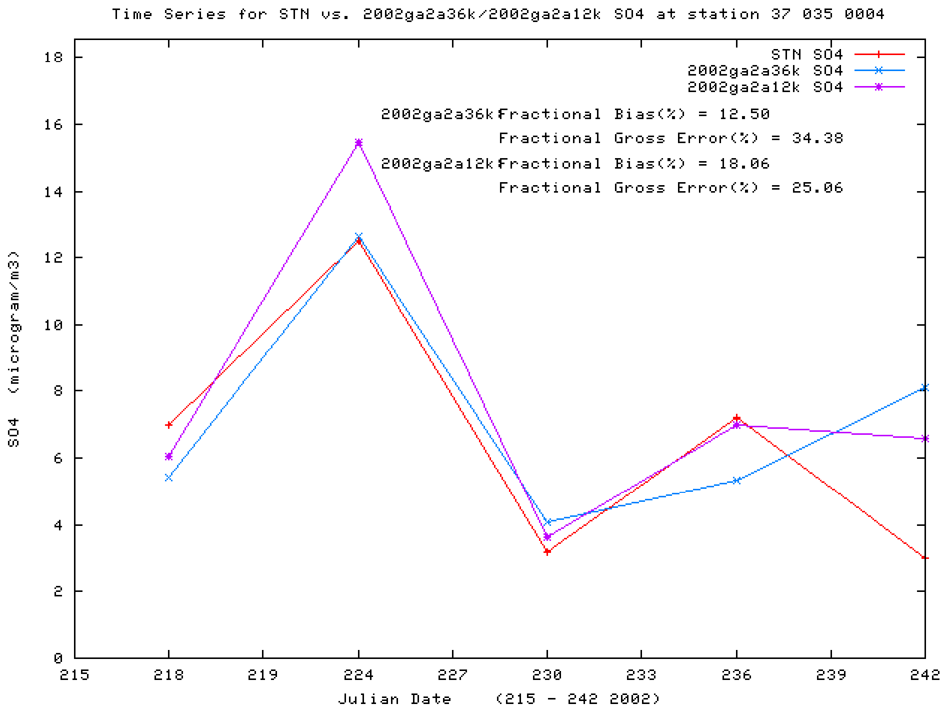


Figure 5-15: August 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

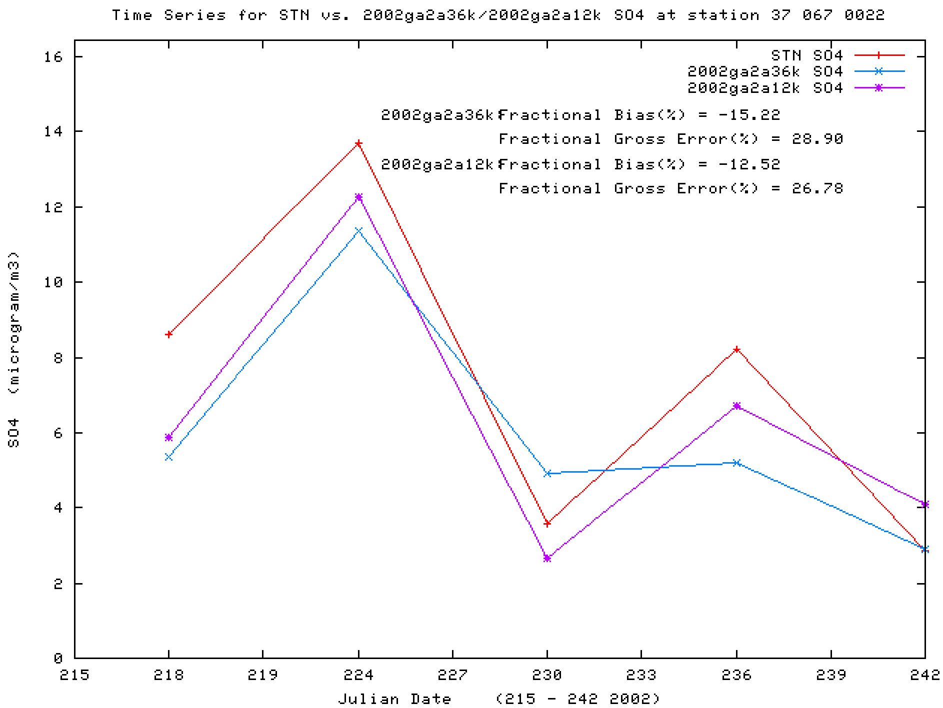


Figure 5-16: August 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.9 September

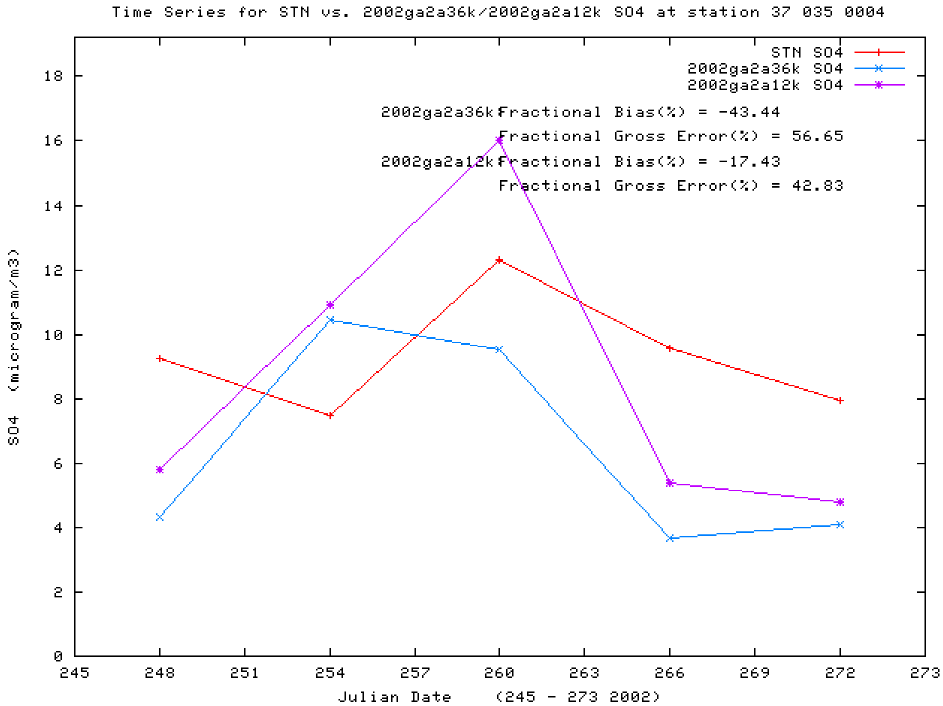


Figure 5-17: September 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

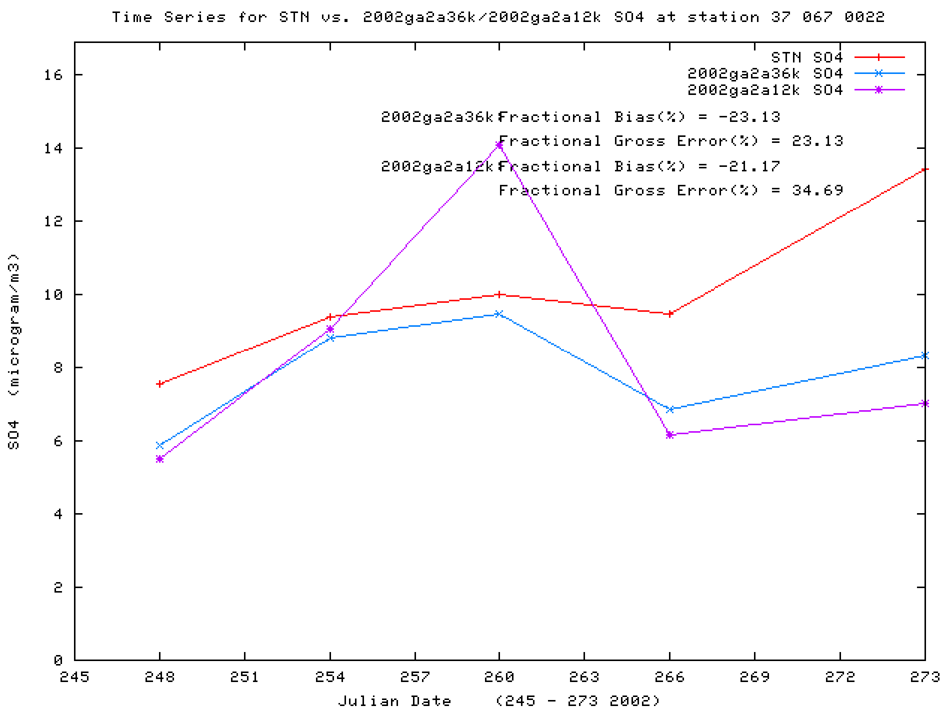


Figure 5-18: September 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.10 October

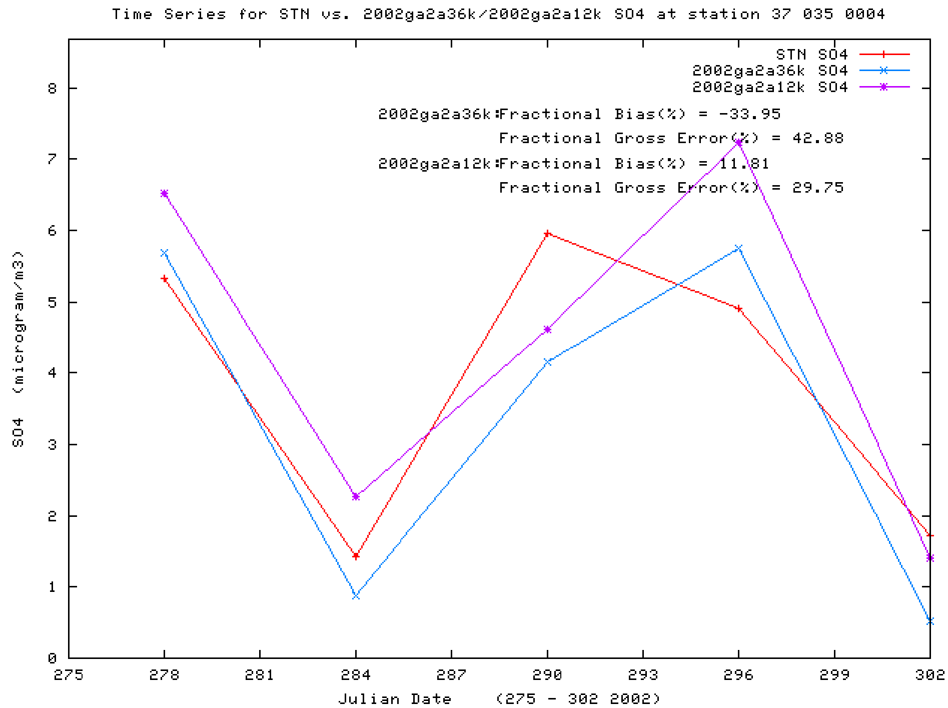


Figure 5-19: October 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

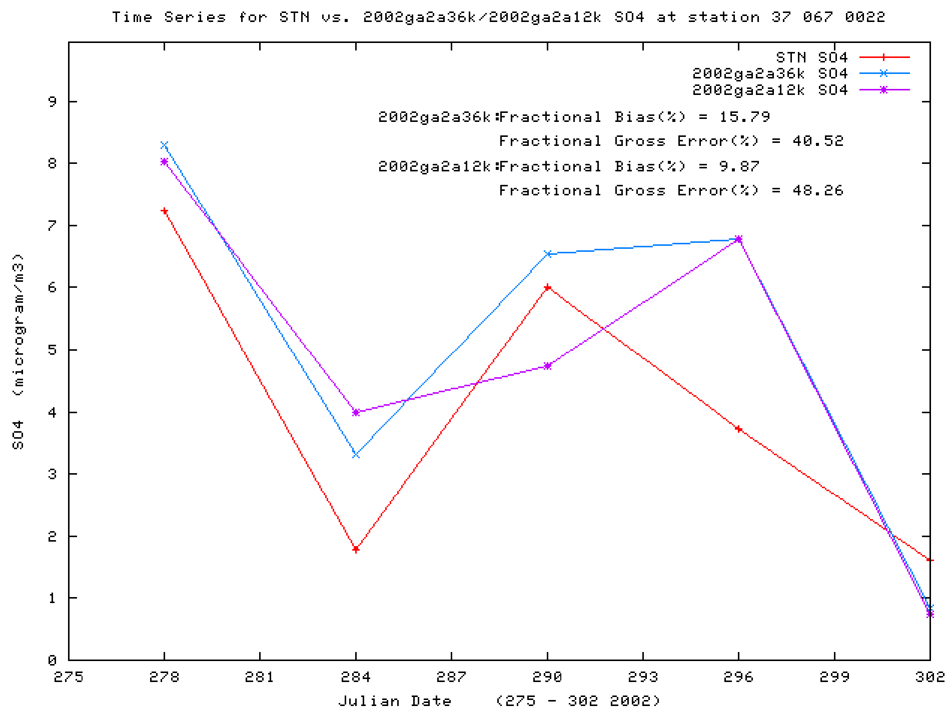


Figure 5-20: October 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.11 November

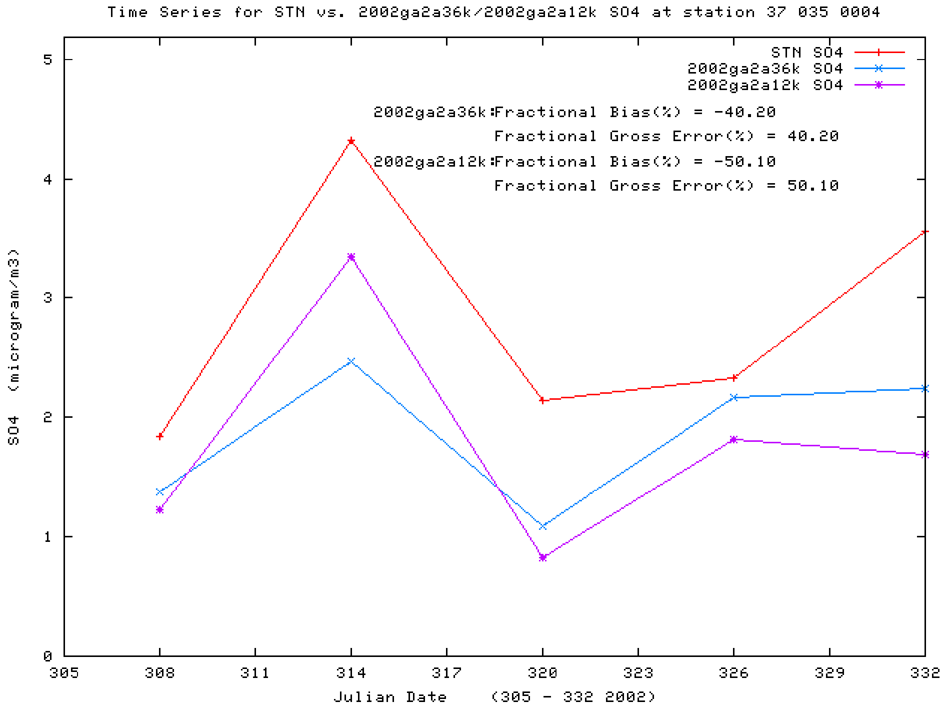


Figure 5-21: November 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

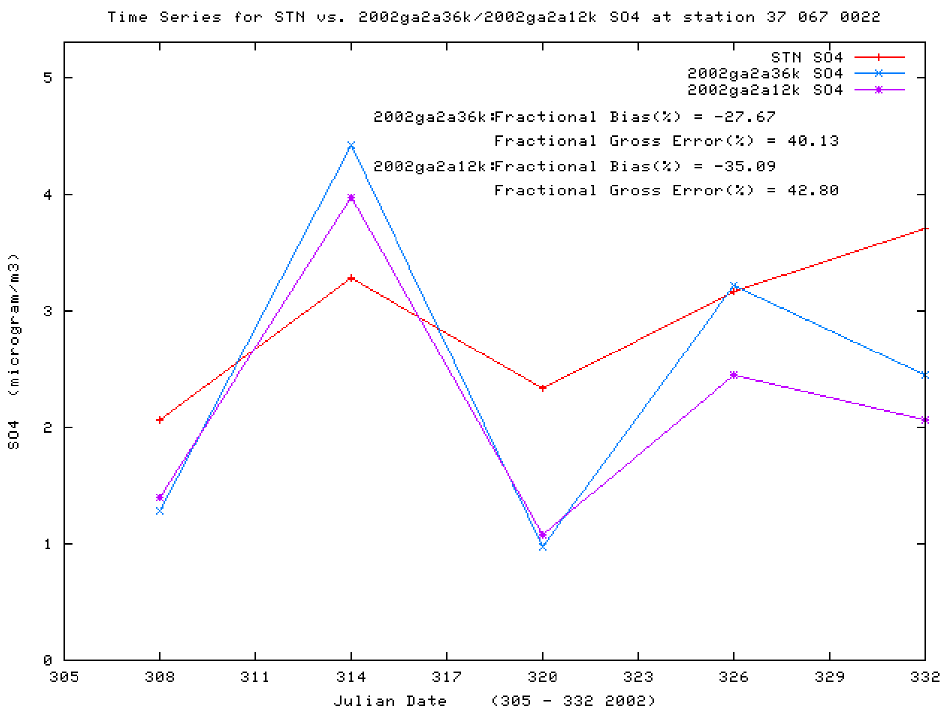


Figure 5-22: November 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.1.12 December

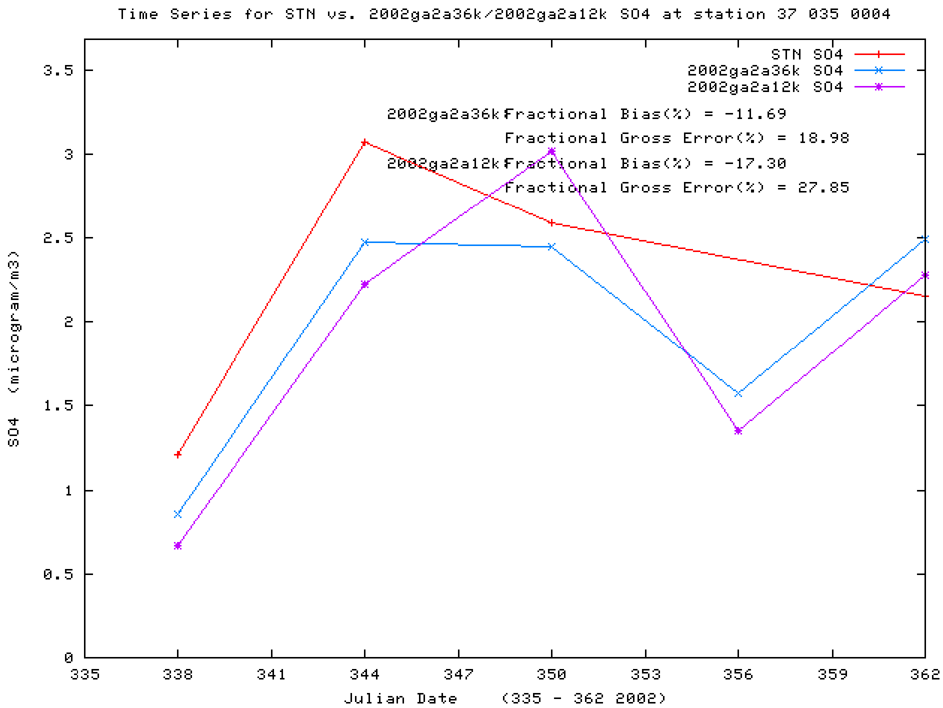


Figure 5-23: December 2002Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

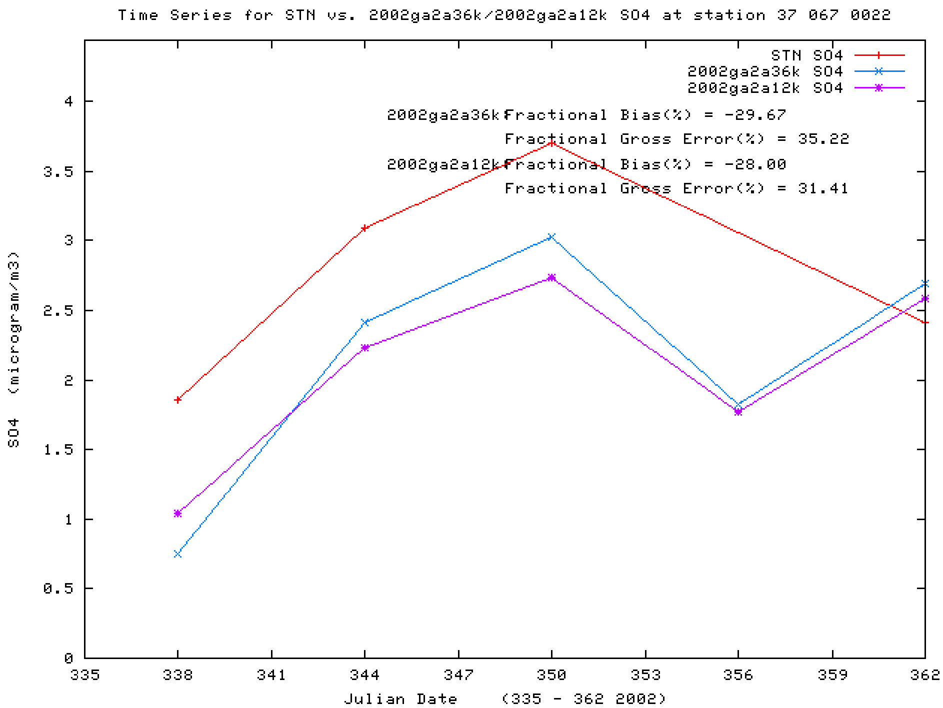


Figure 5-24: December 2002 Time Series of Observed Sulfate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2 Nitrates

5.1.2.1 January

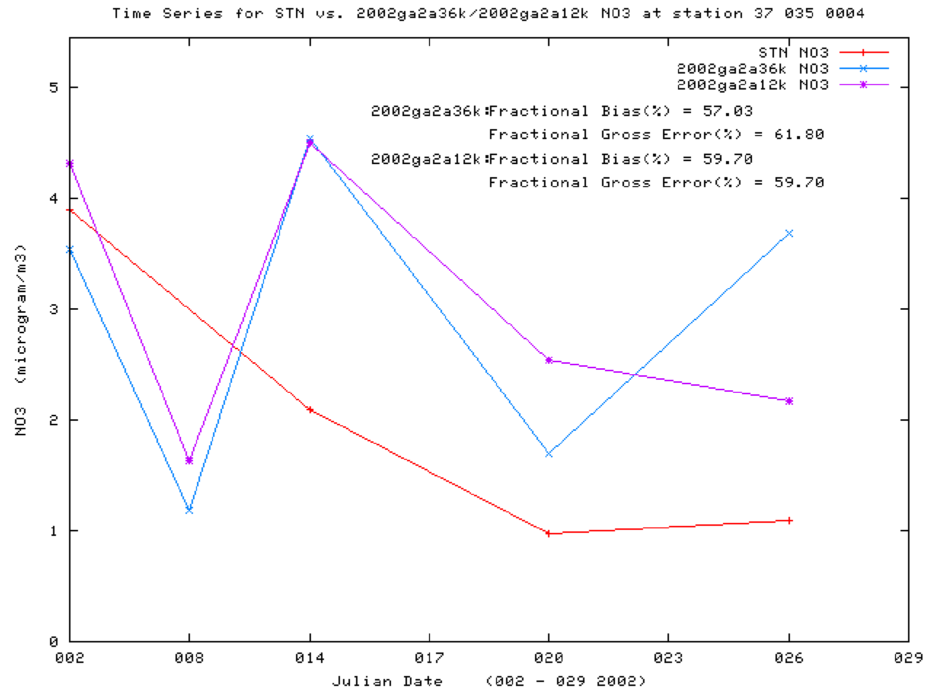


Figure 5-25: January 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

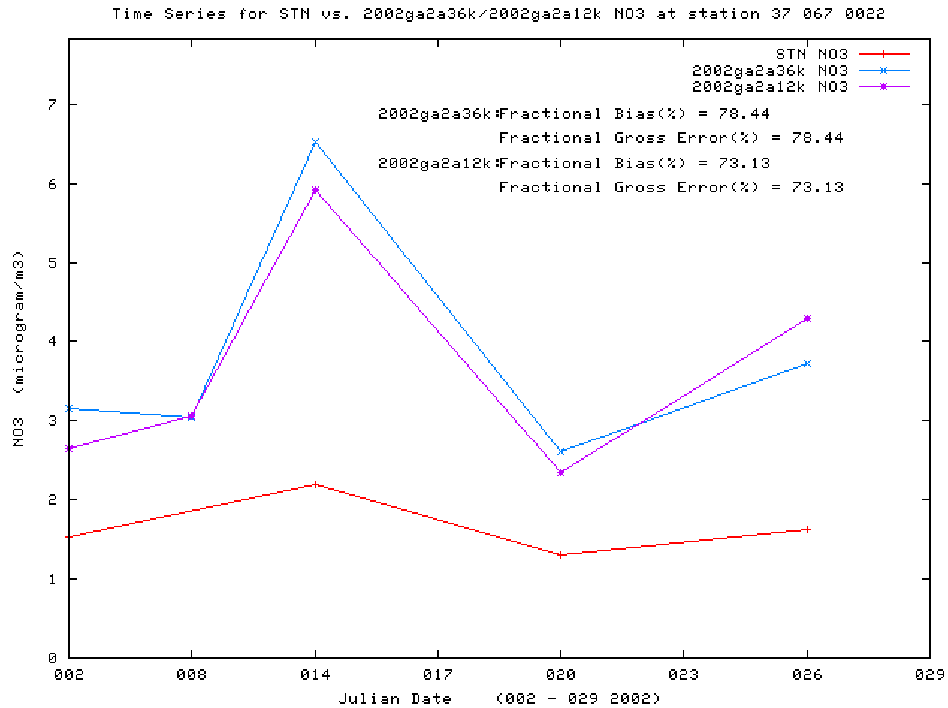


Figure 5-26: January 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.2 February

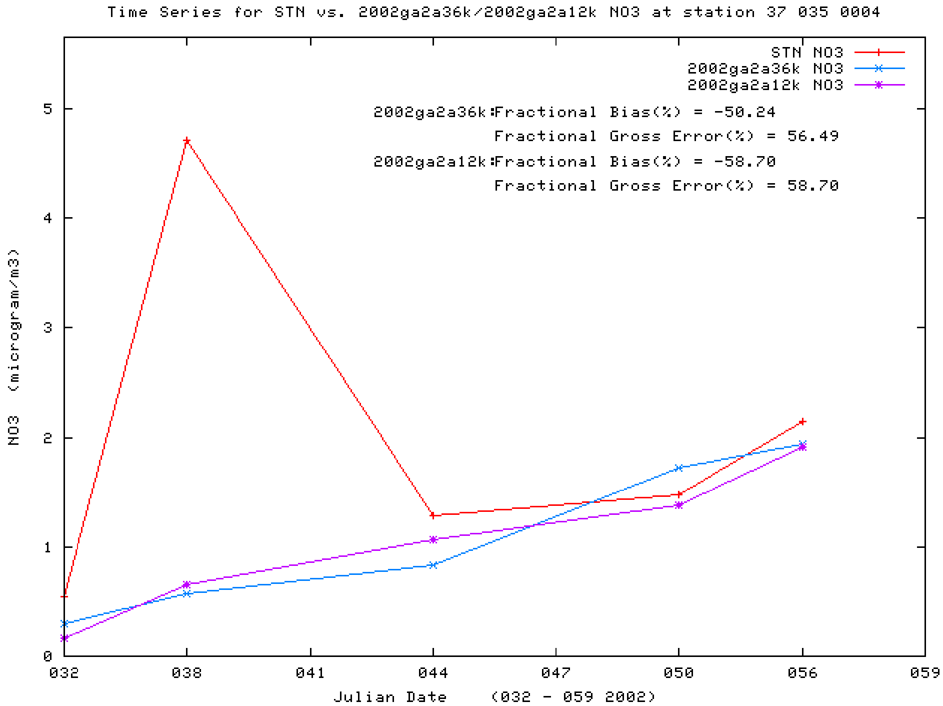


Figure 5-27: February 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

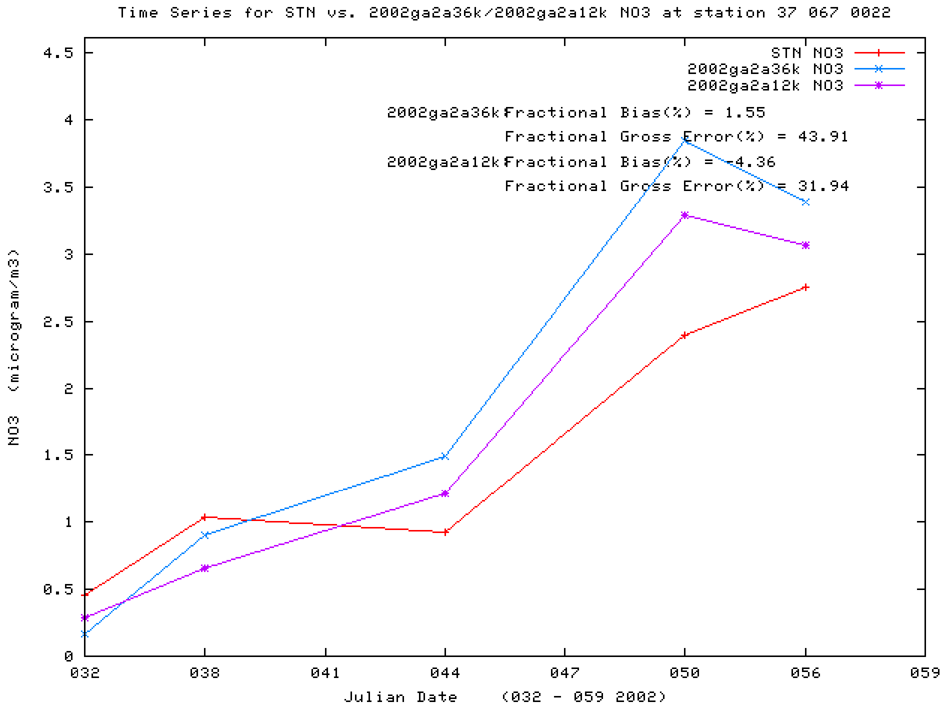


Figure 5-28: February 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.3 March

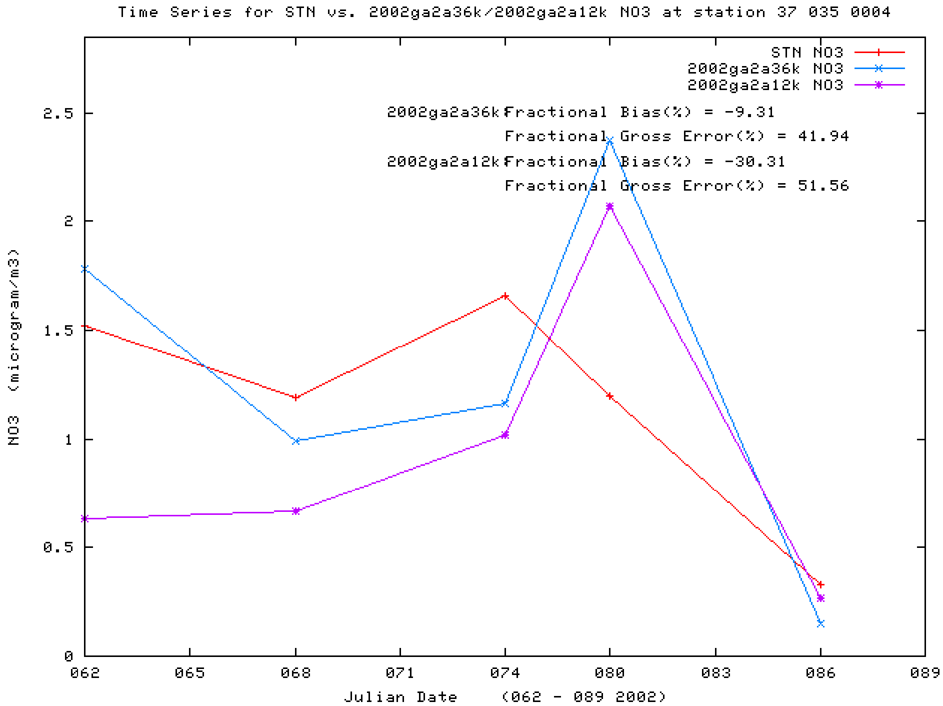


Figure 5-29: March 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

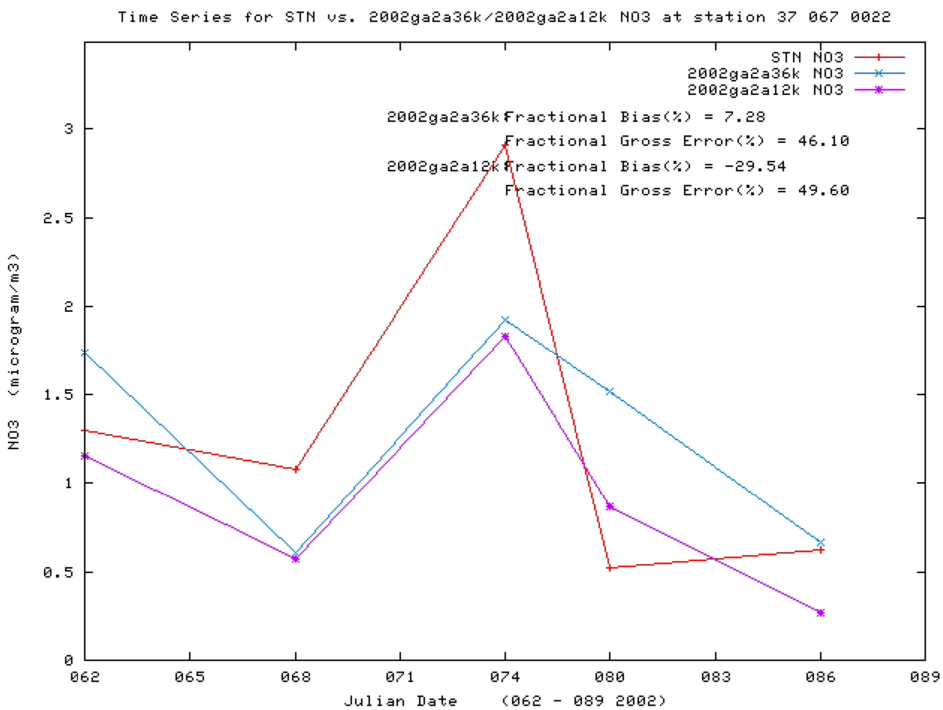


Figure 5-30: March 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.4 April

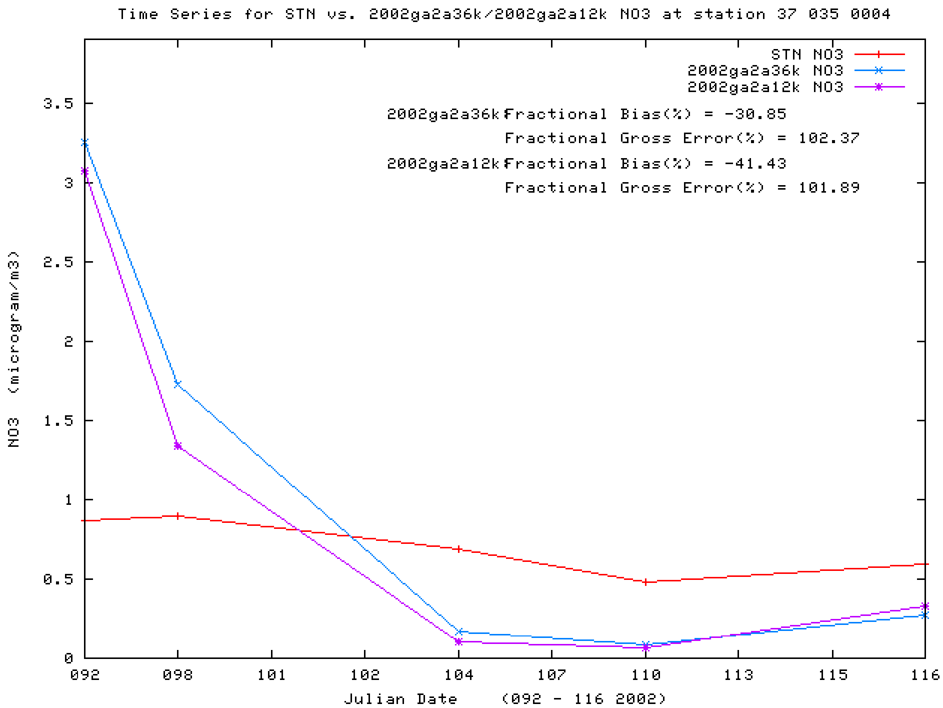


Figure 5-31: April 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

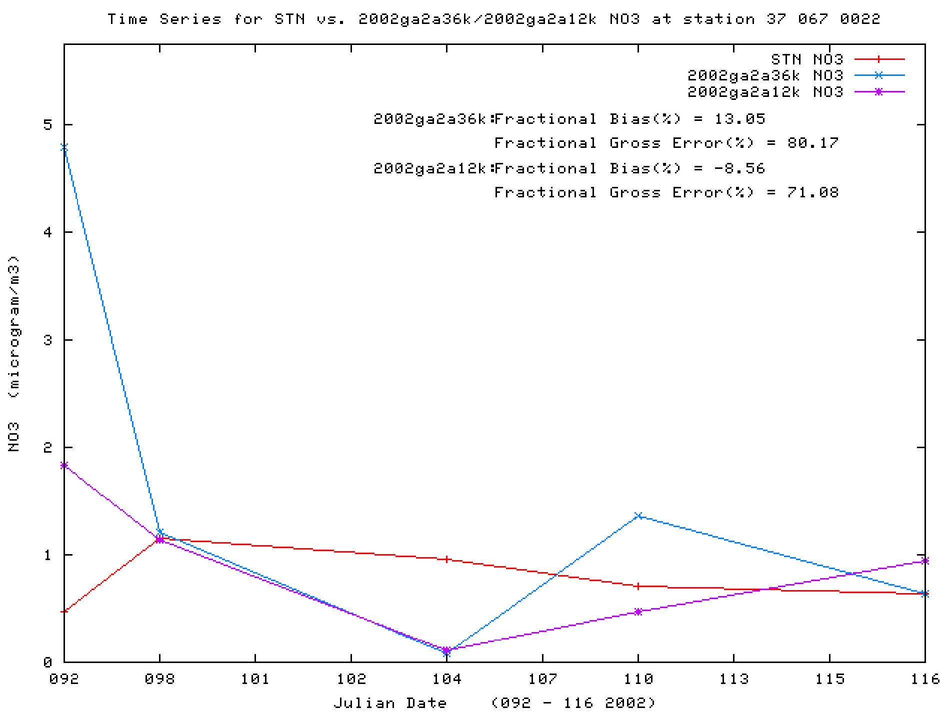


Figure 5-32: April 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.5 May

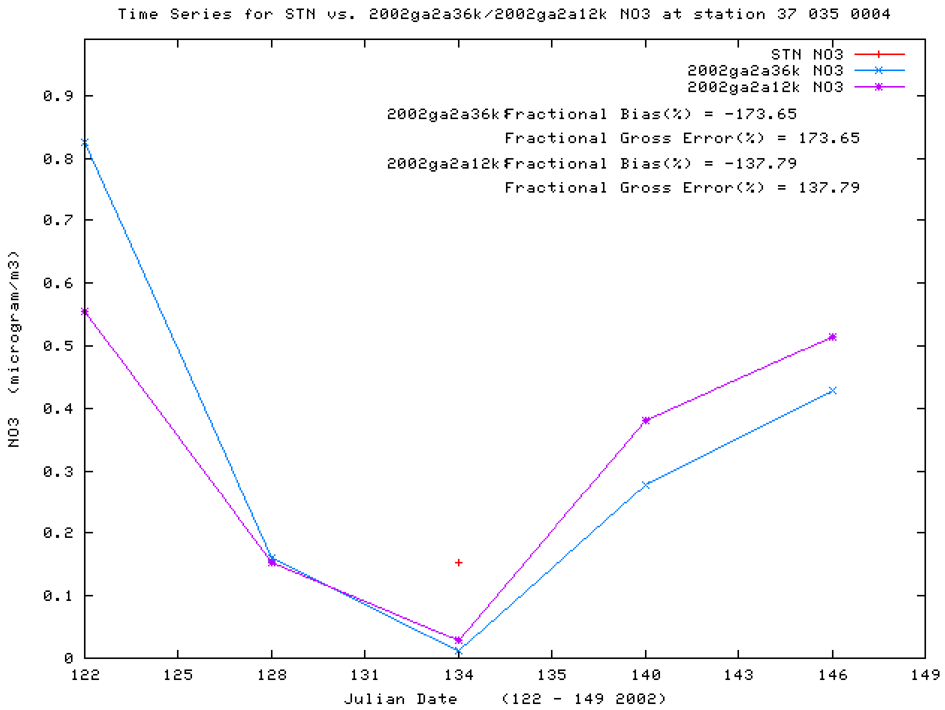


Figure 5-33: May 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

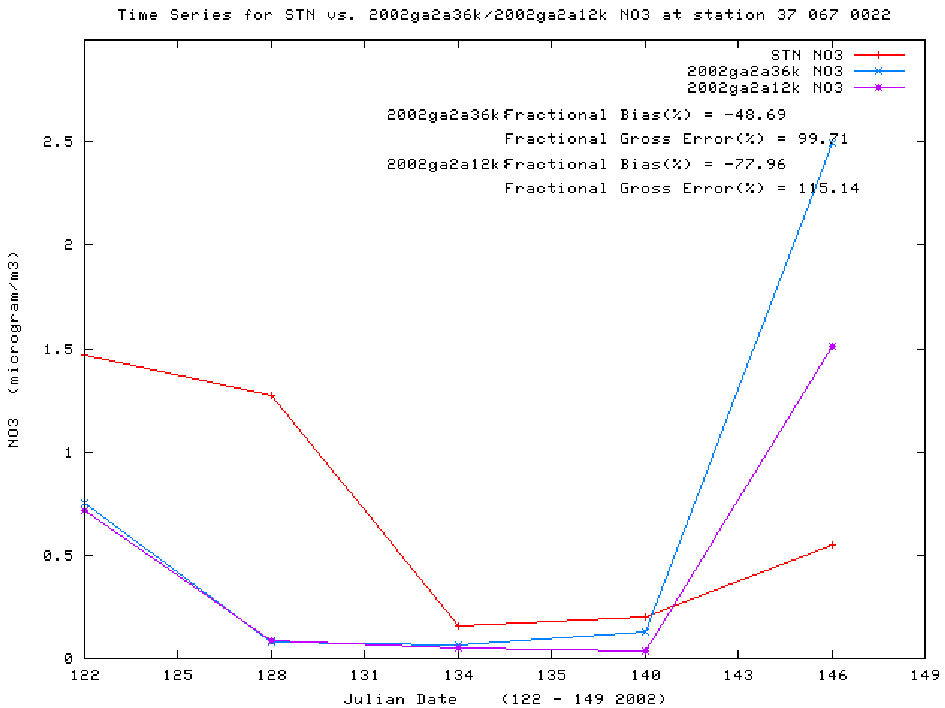


Figure 5-34: May 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.6 June

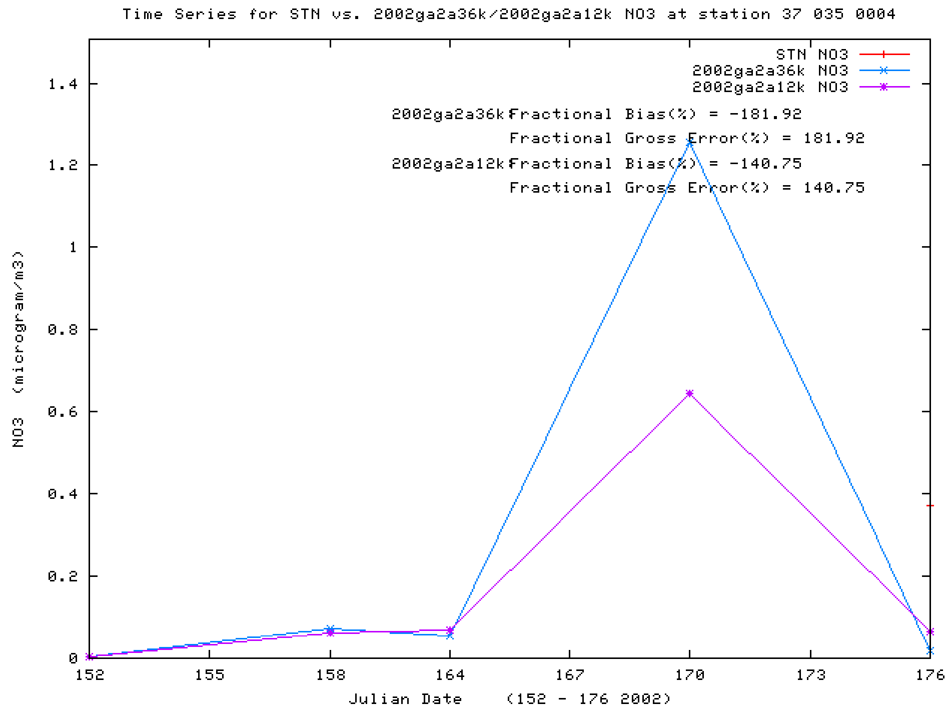


Figure 5-35: June 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

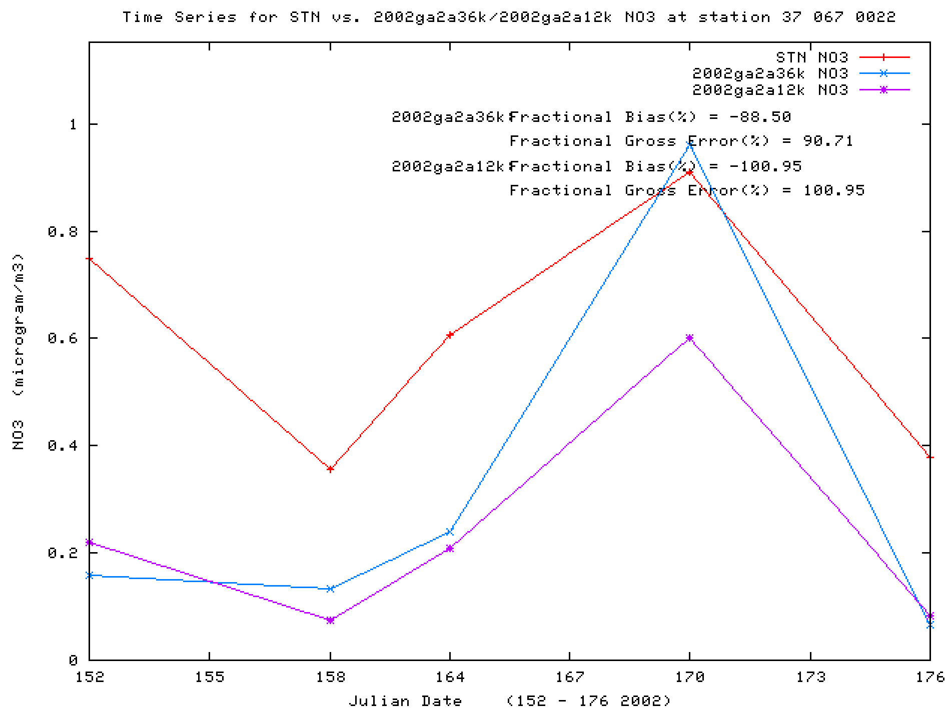


Figure 5-36: June 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.7 July

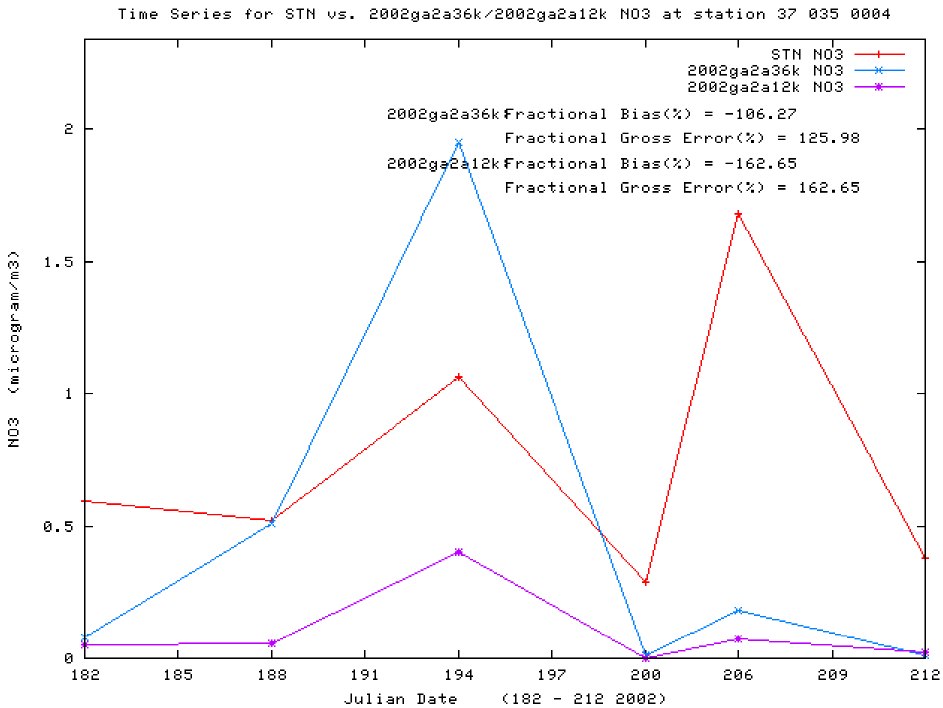


Figure 5-37: July 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

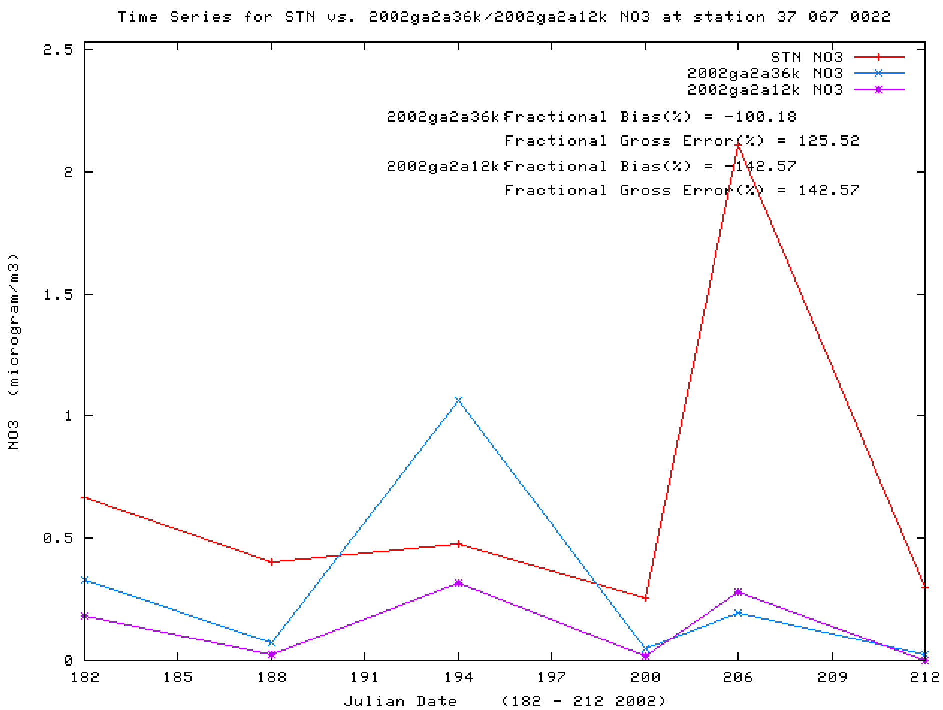


Figure 5-38: July 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.8 August

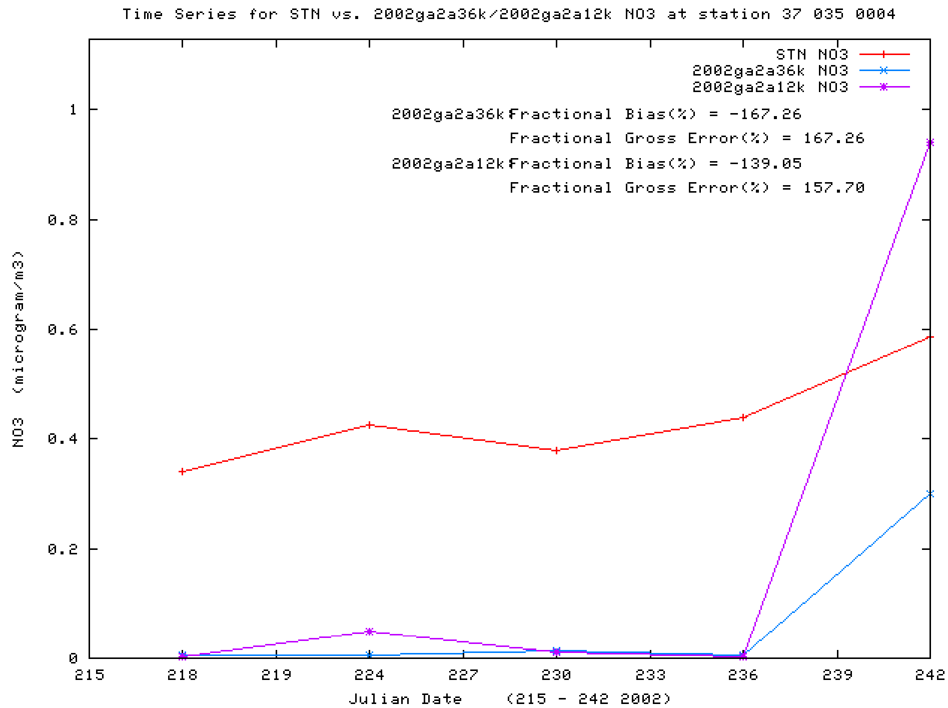


Figure 5-39: August 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

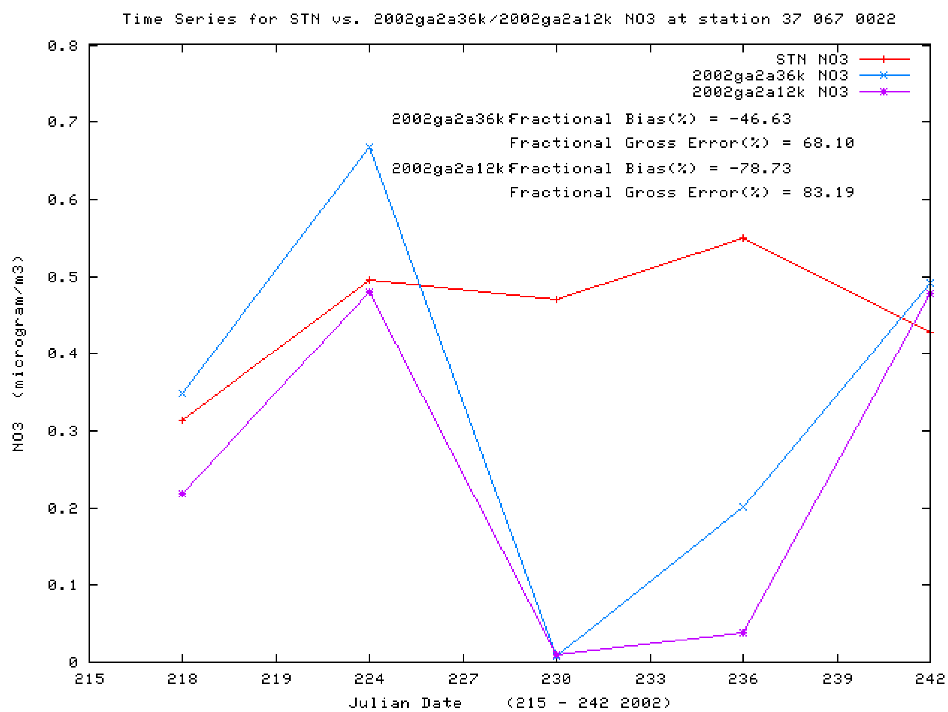


Figure 5-40: August 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.9 September

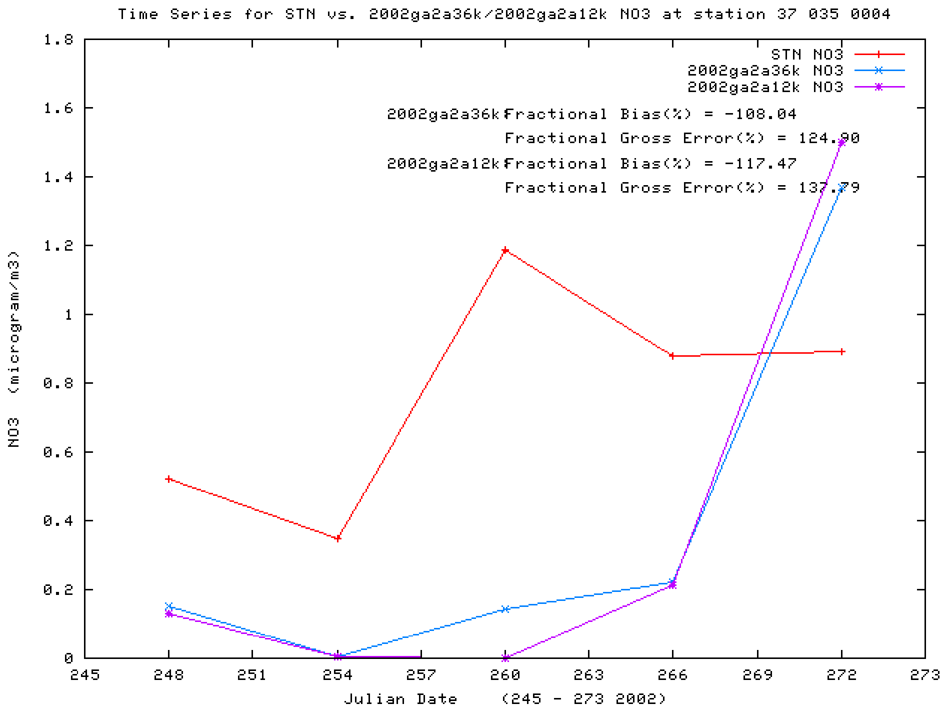


Figure 5-41: September 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

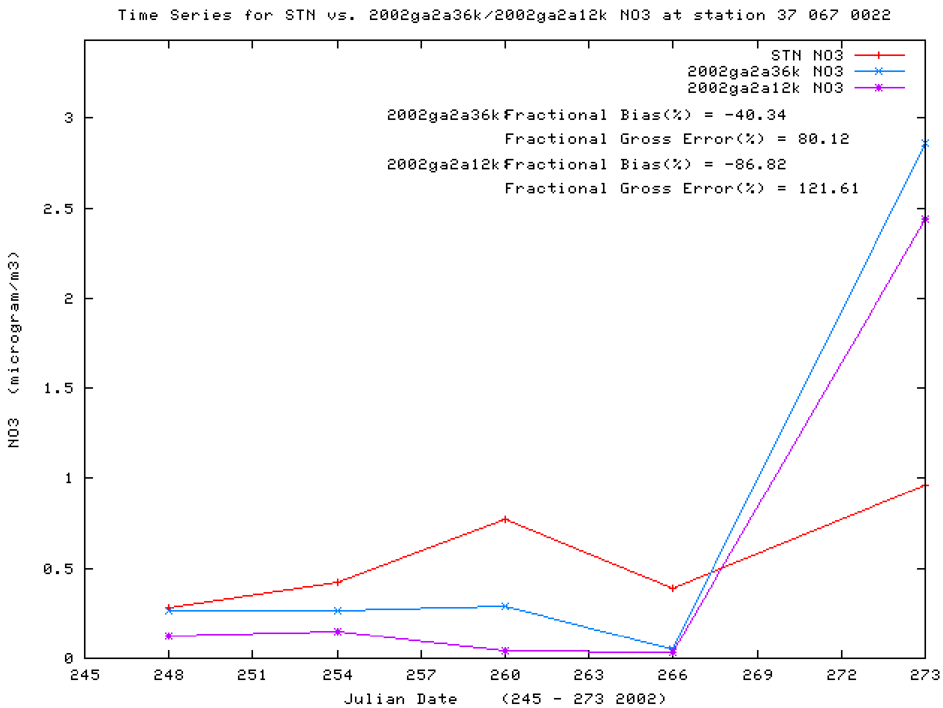


Figure 5-42: September 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.10 October

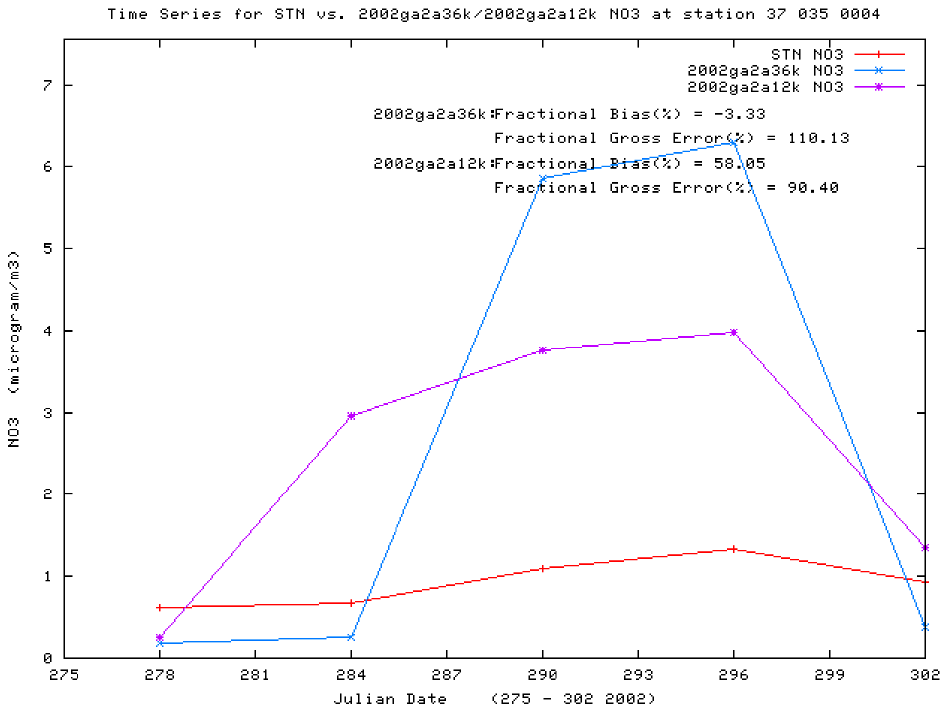


Figure 5-43: October 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

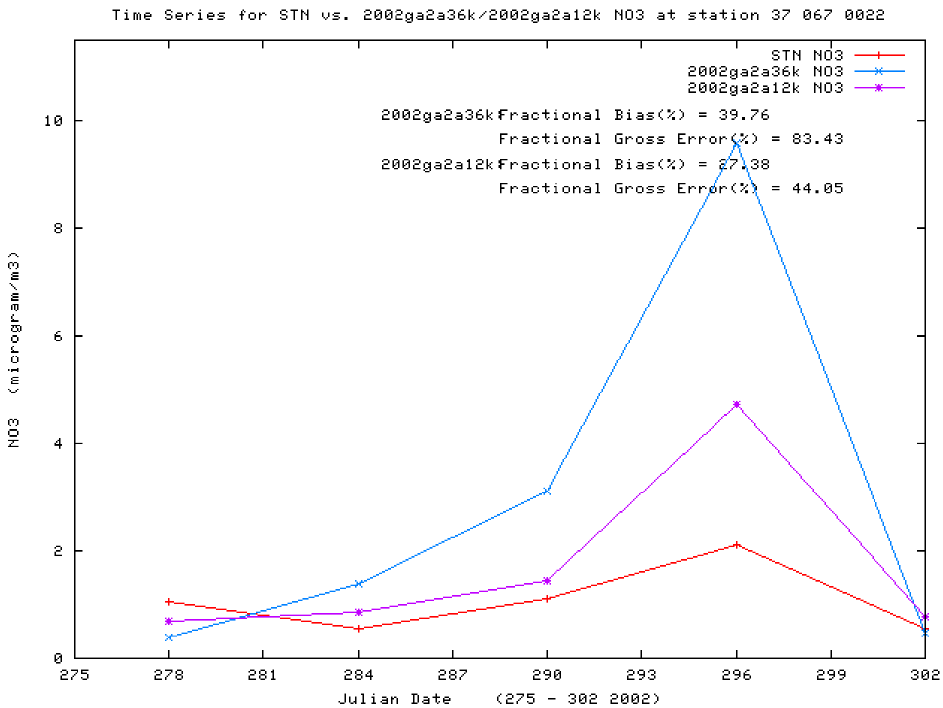


Figure 5-44: October 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.11 November

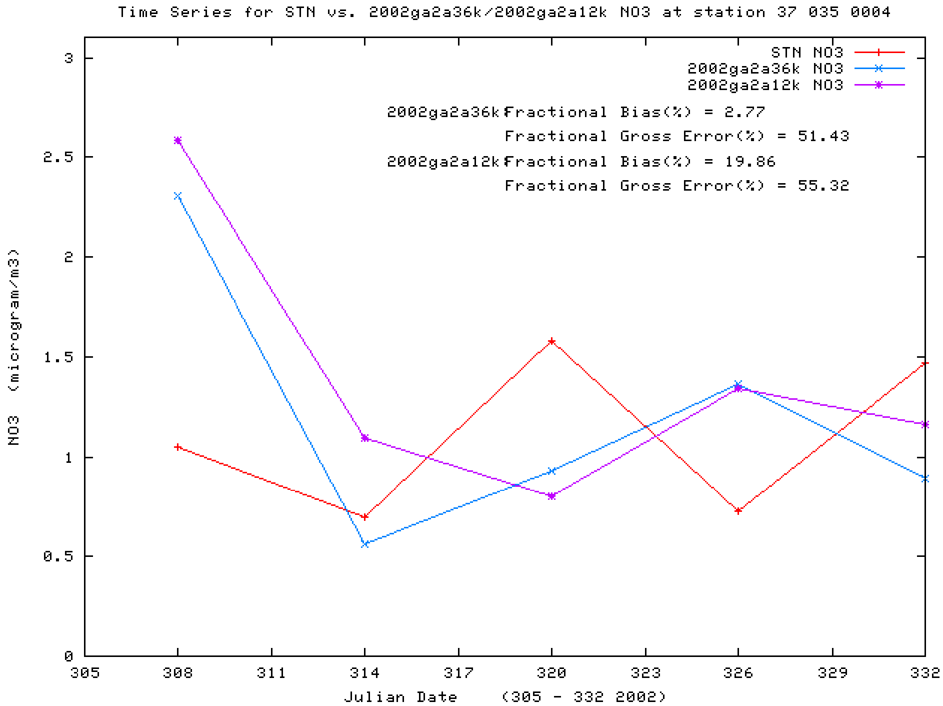


Figure 5-45: November 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

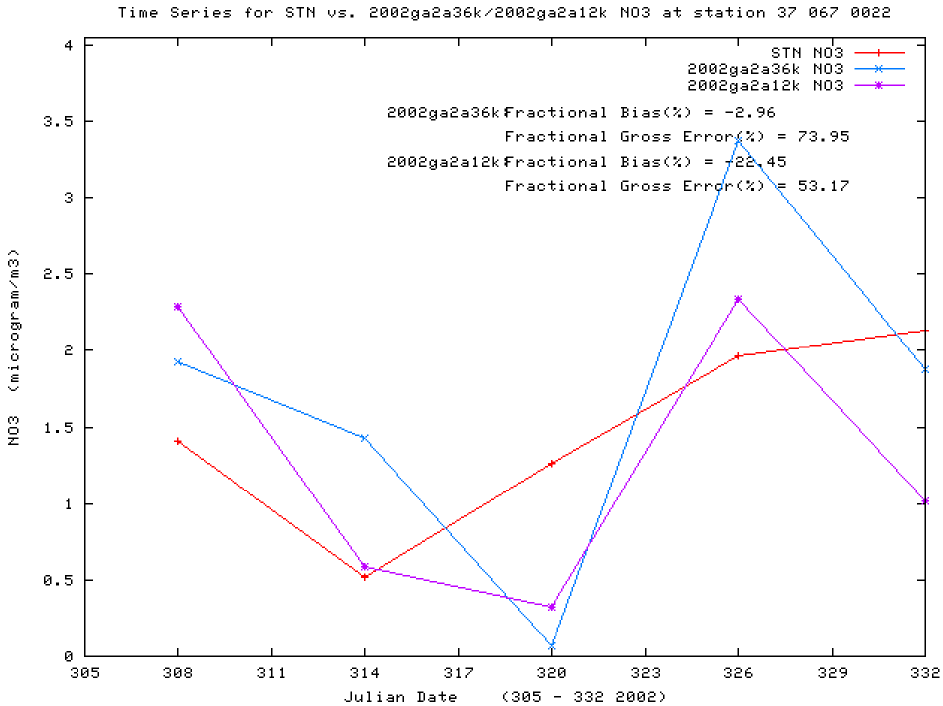


Figure 5-46: November 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.2.12 December

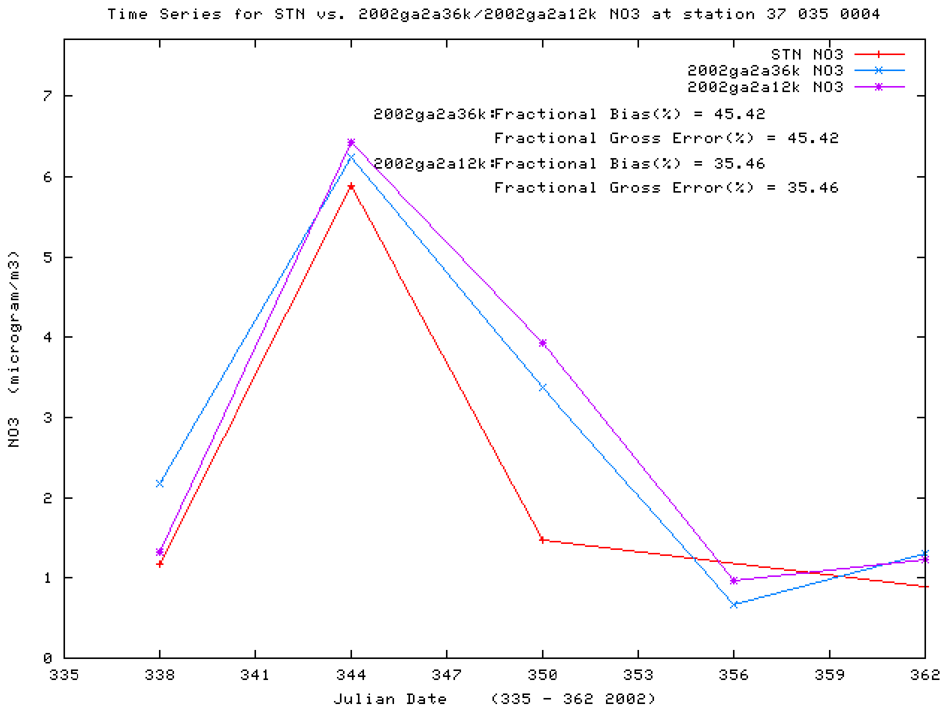


Figure 5-47: December 2002Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

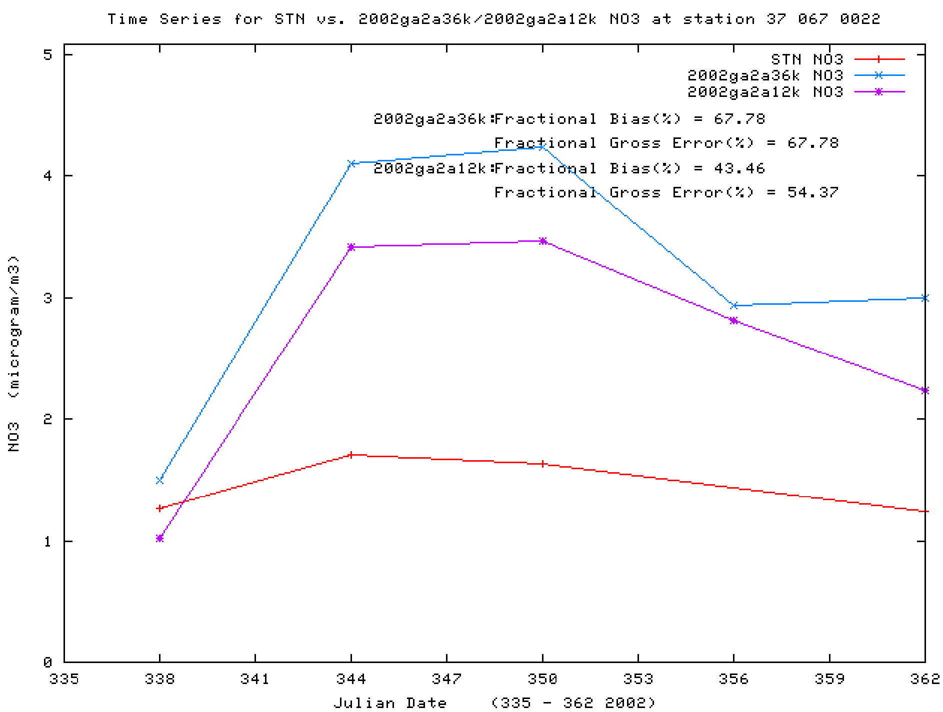


Figure 5-48: December 2002 Time Series of Observed Nitrate levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3 NH4

5.1.3.1 January

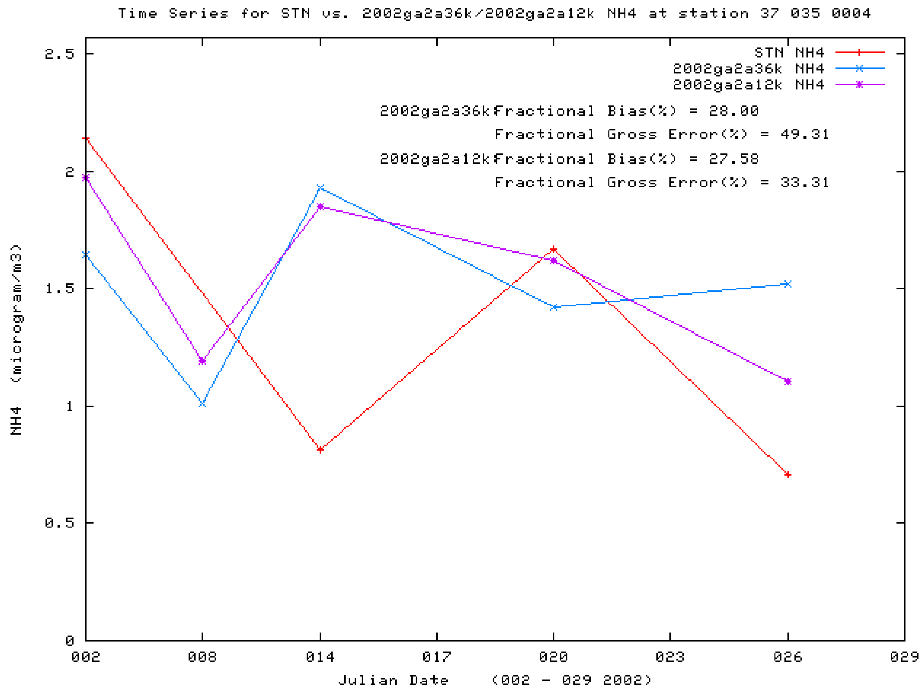


Figure 5-49: January 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

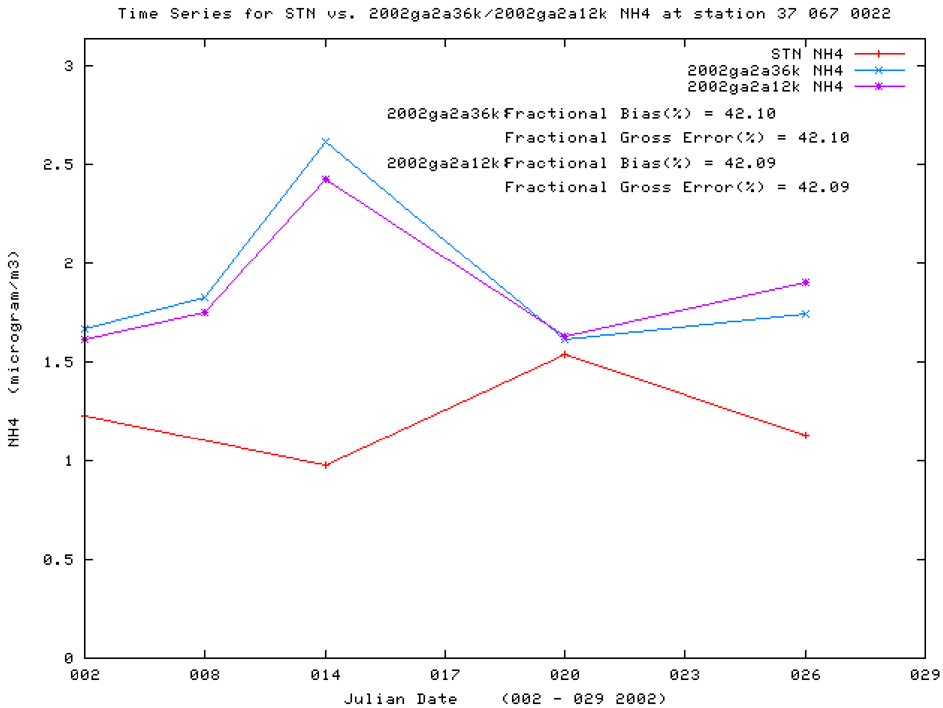


Figure 5-50: January 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.2 February

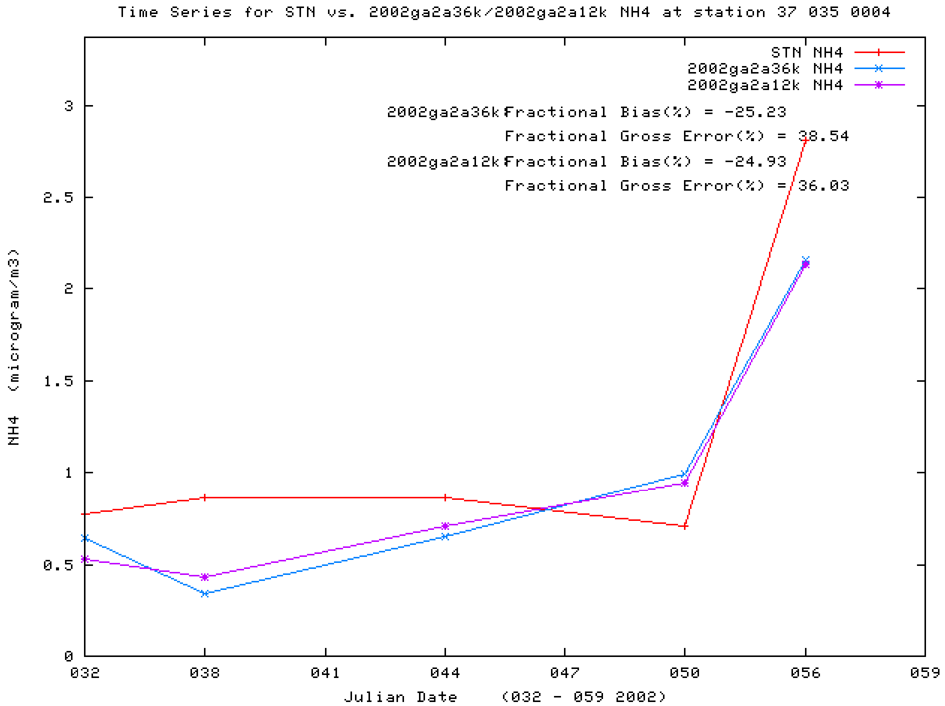


Figure 5-51: February 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

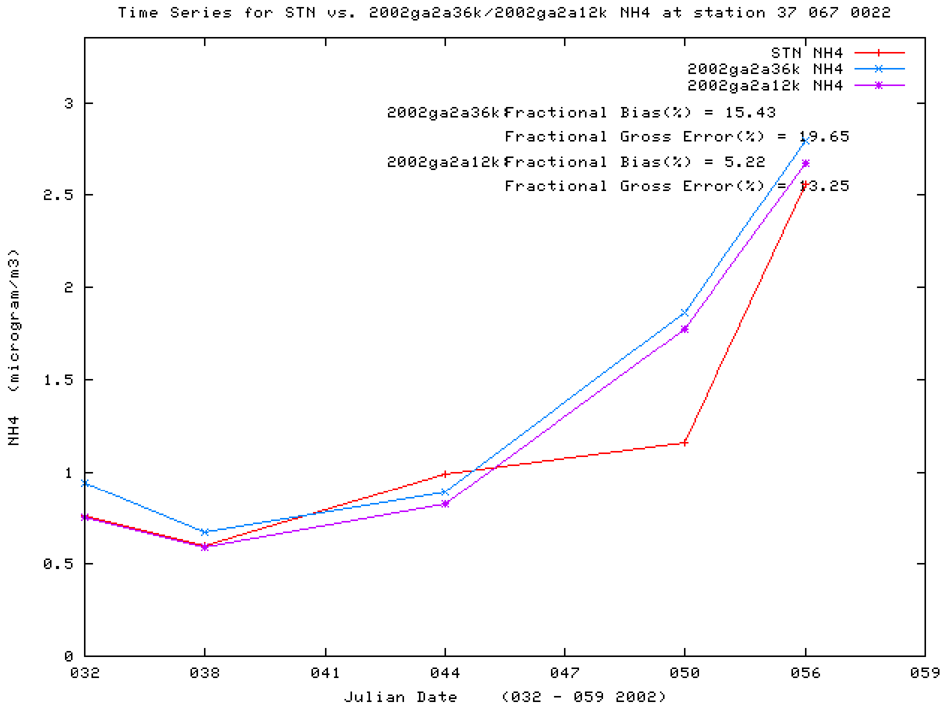


Figure 5-52: February 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.3 March

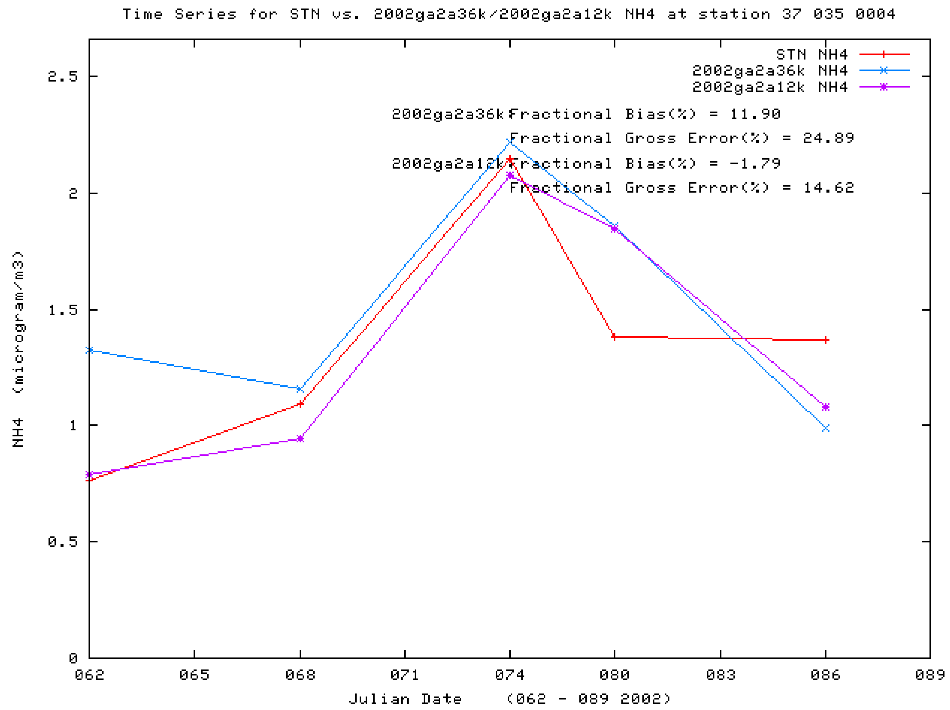


Figure 5-53: March 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

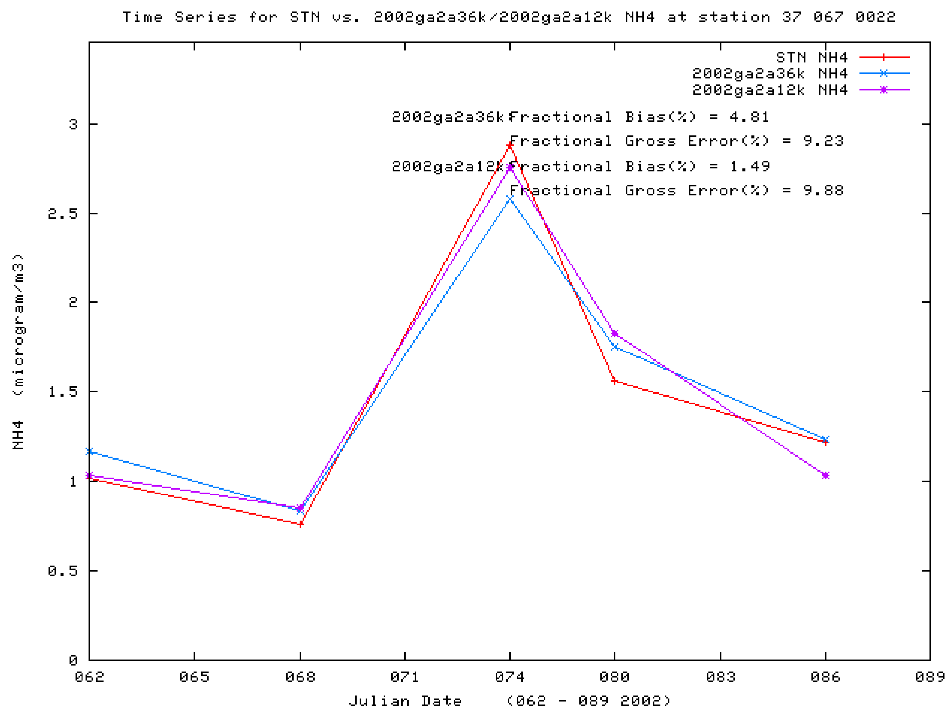


Figure 5-54: March 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.4 April

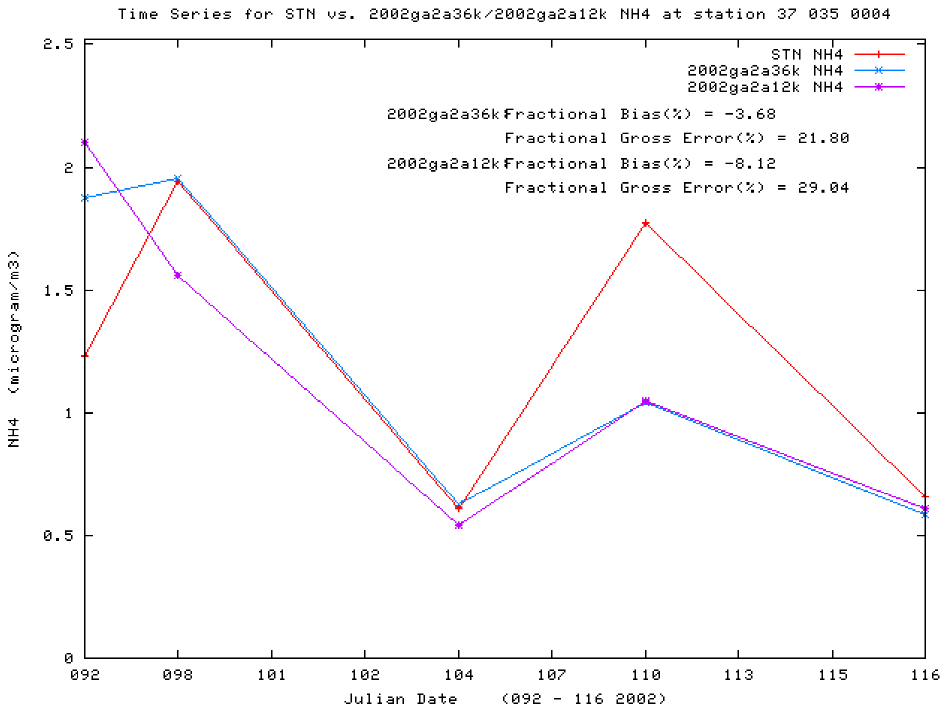


Figure 5-55: April 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

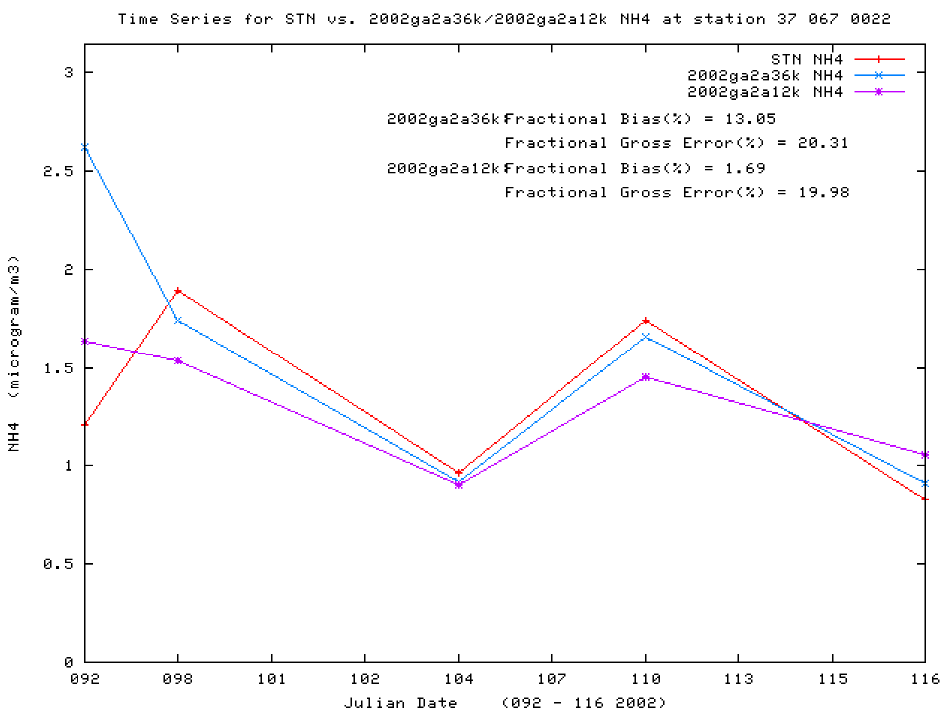


Figure 5-56: April 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.5 May

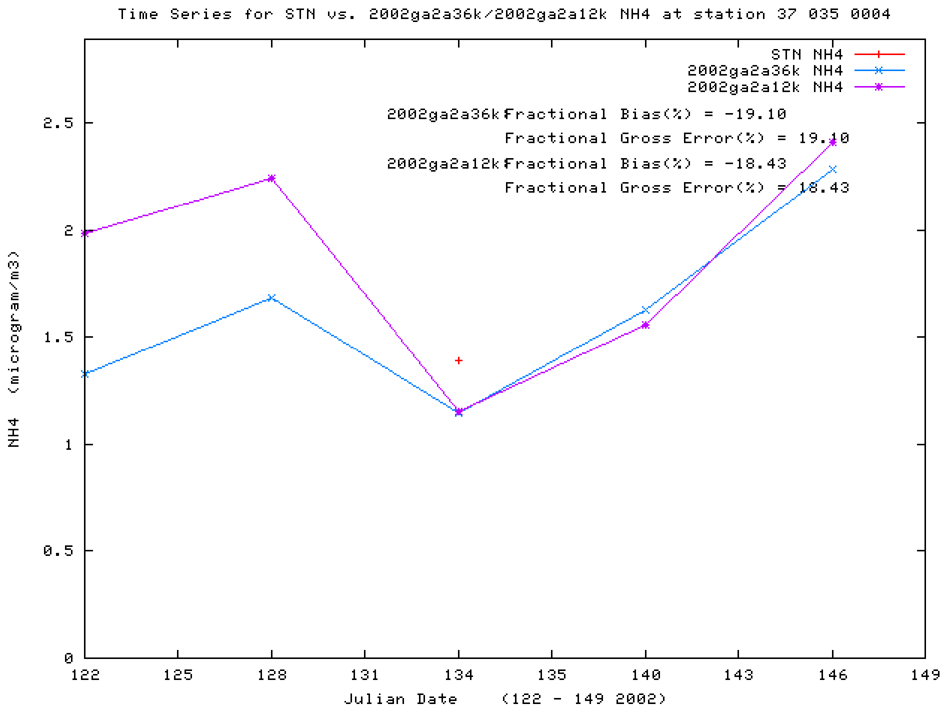


Figure 5-57: May 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

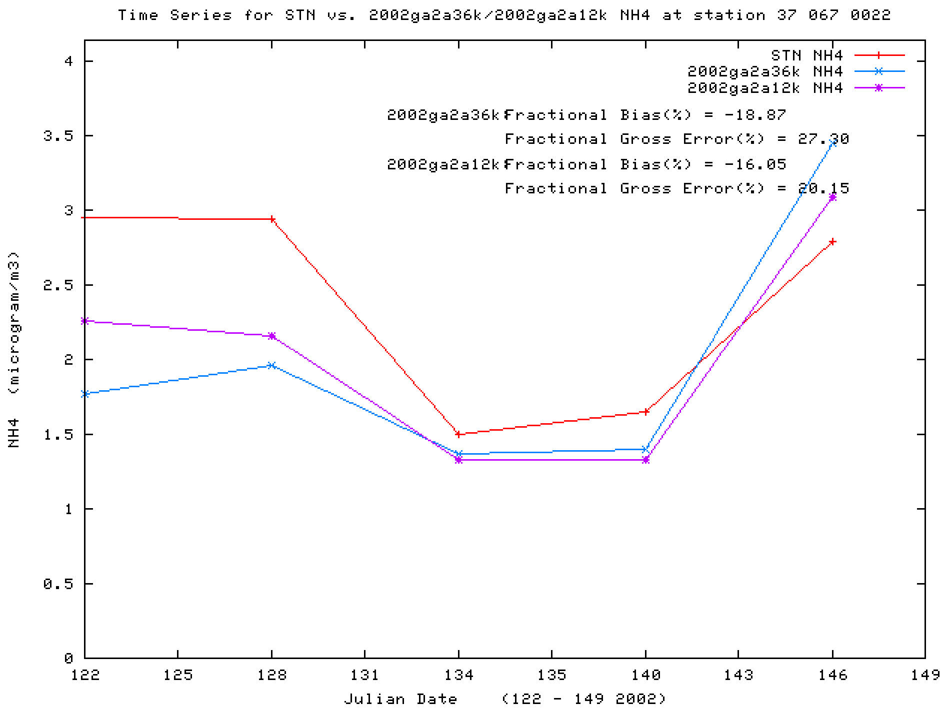


Figure 5-58: May 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.6 June

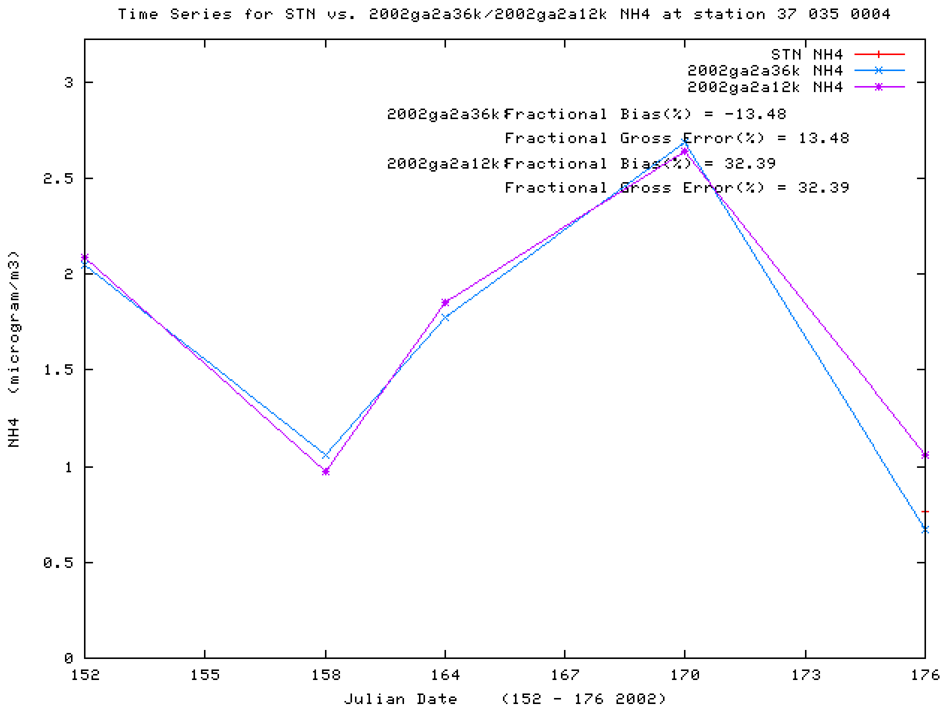


Figure 5-59: June 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

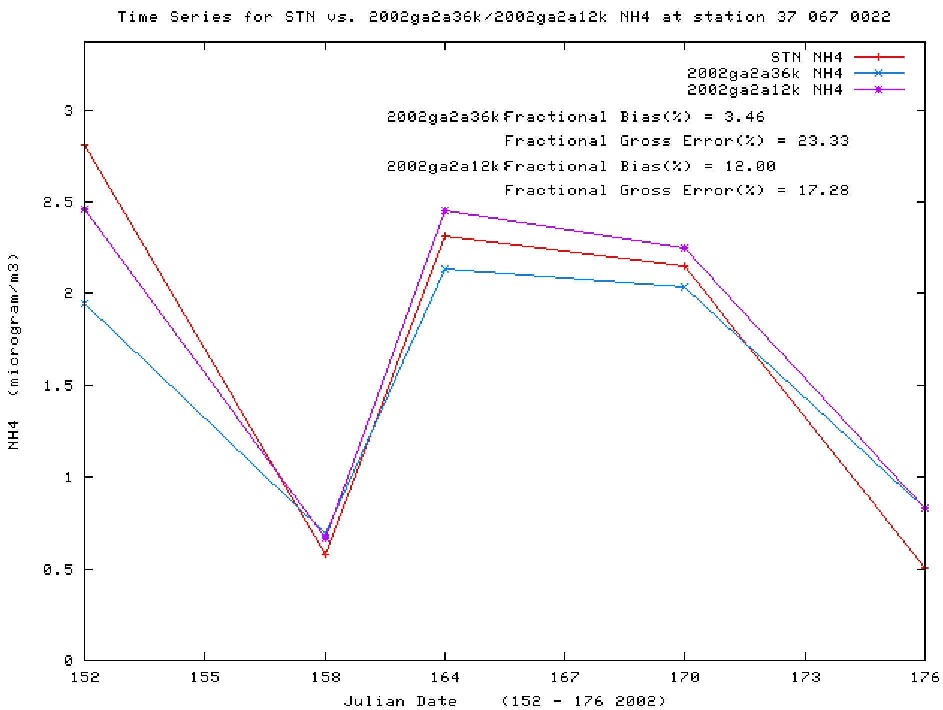


Figure 5-60: June 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.7 July

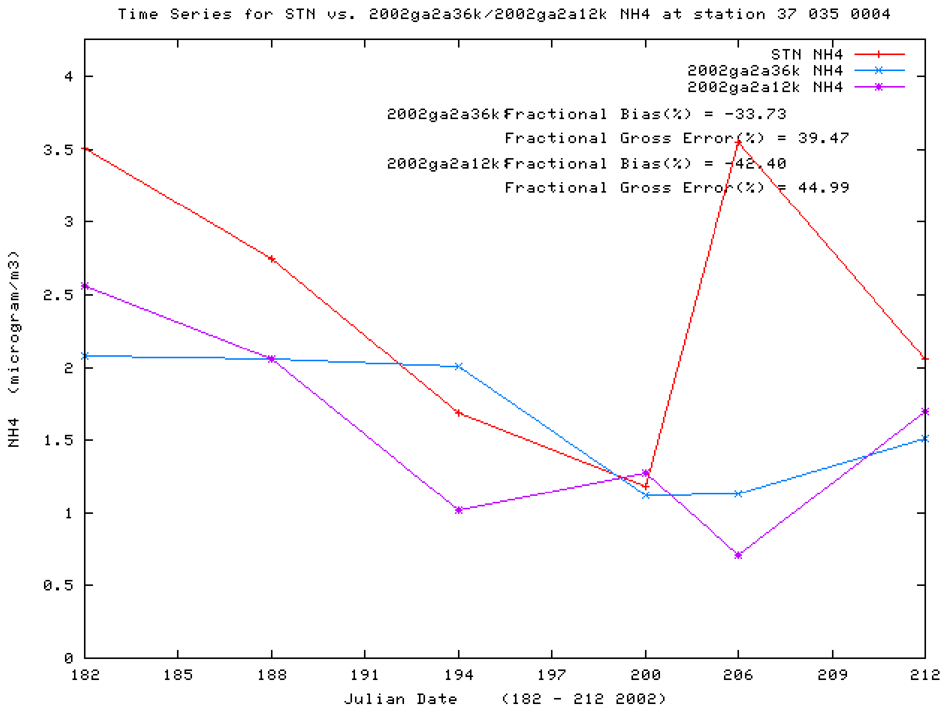


Figure 5-61: July 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

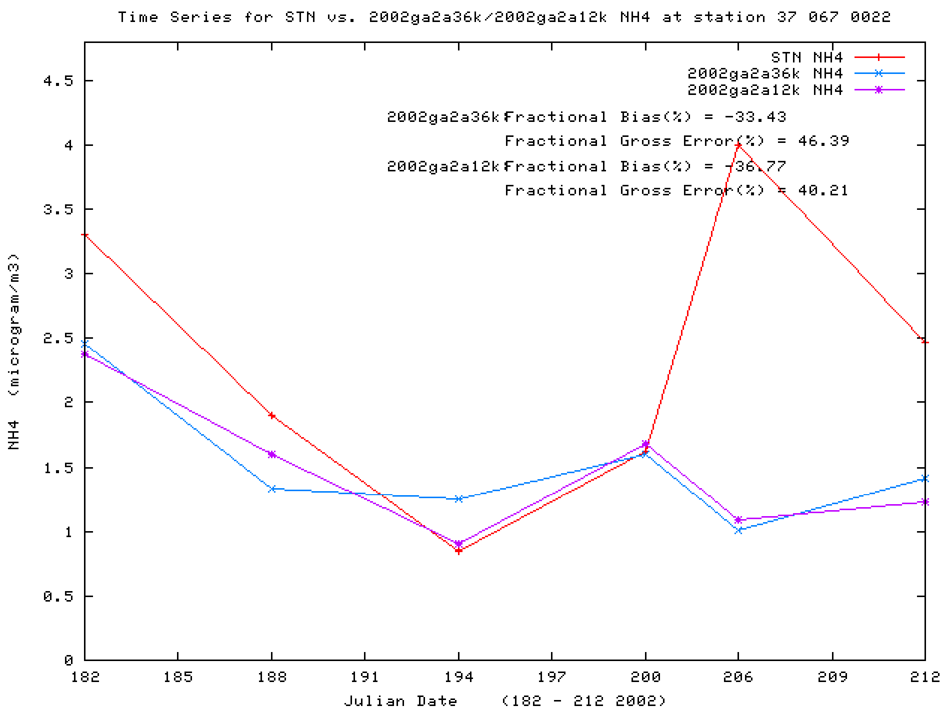


Figure 5-62: July 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.8 August

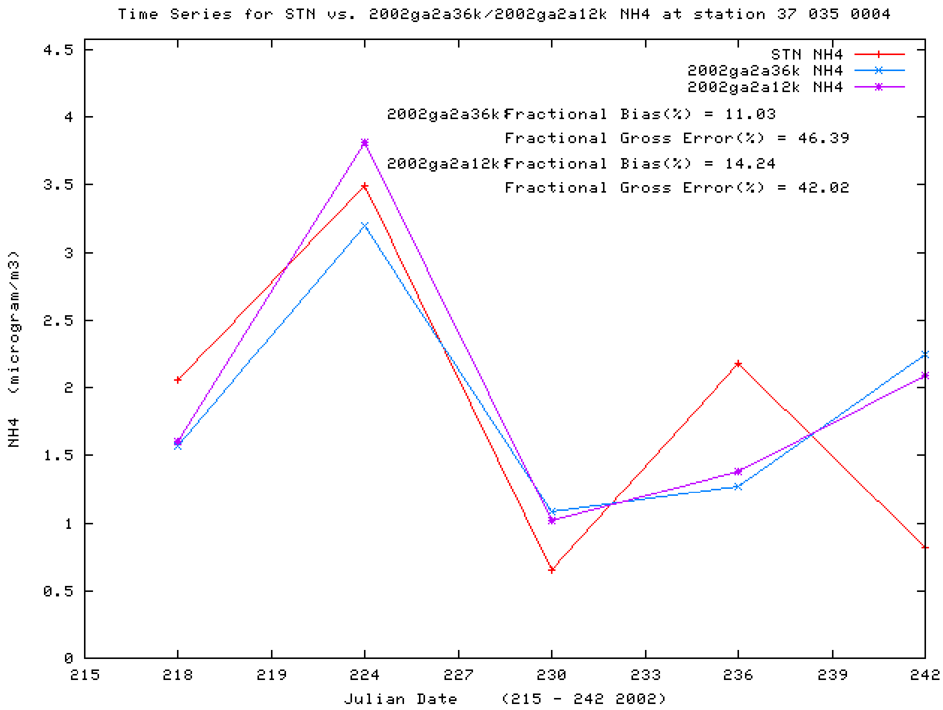


Figure 5-63: August 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

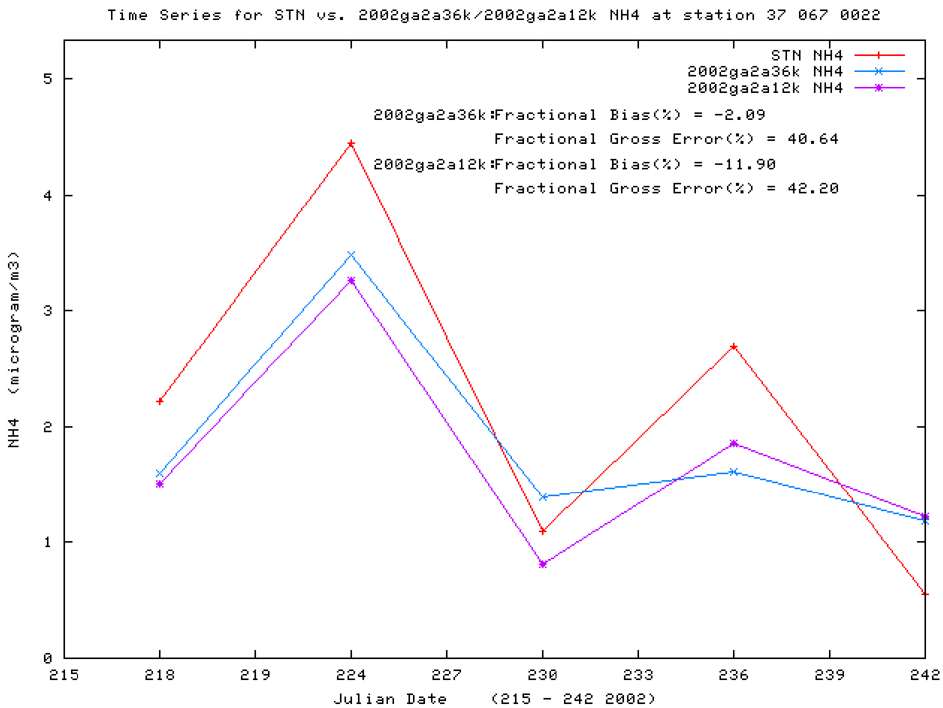


Figure 5-64: August 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.9 September

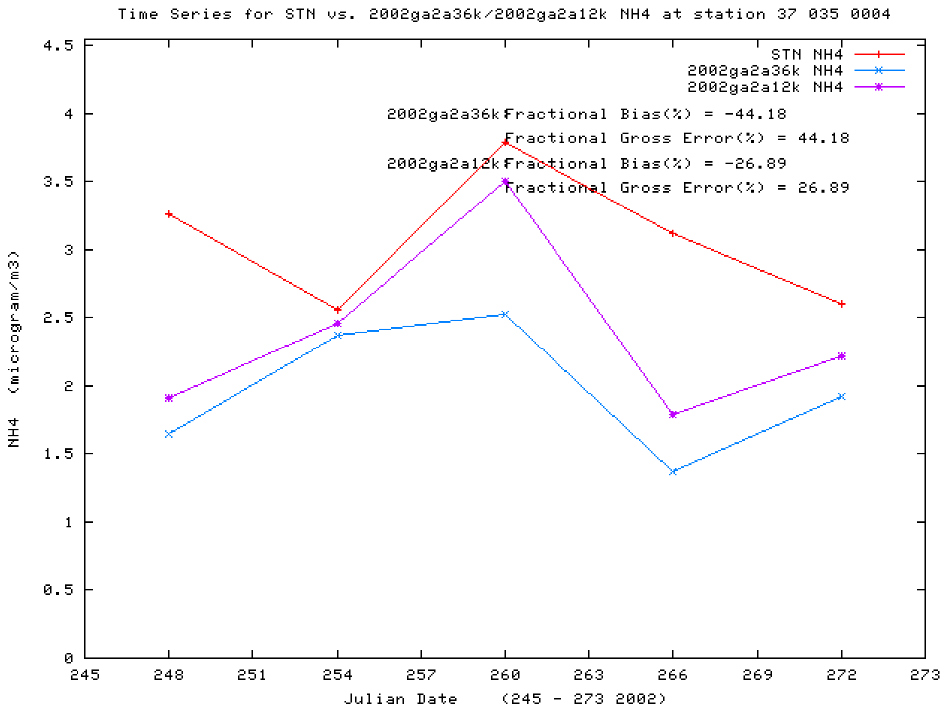


Figure 5-65: September 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

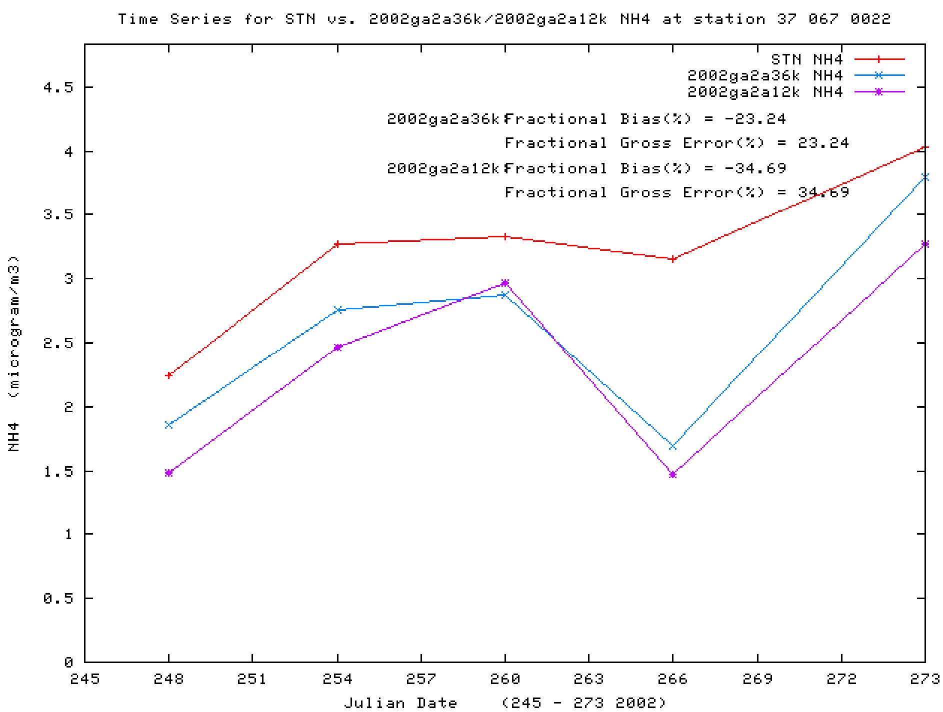


Figure 5-66: September 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.10 October

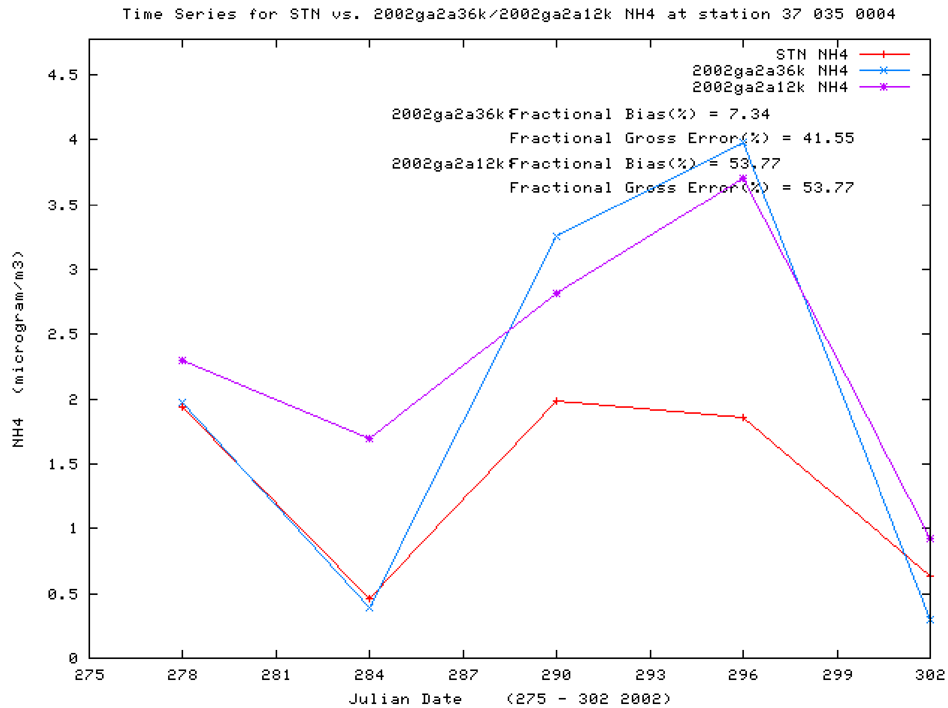


Figure 5-67: October 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

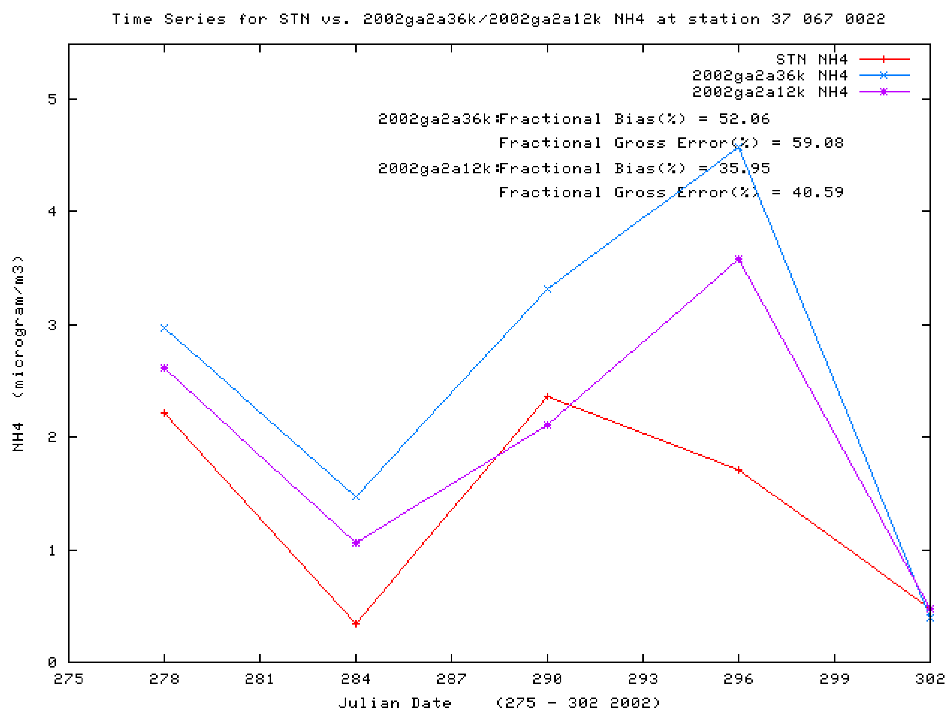


Figure 5-68: October 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.11 November

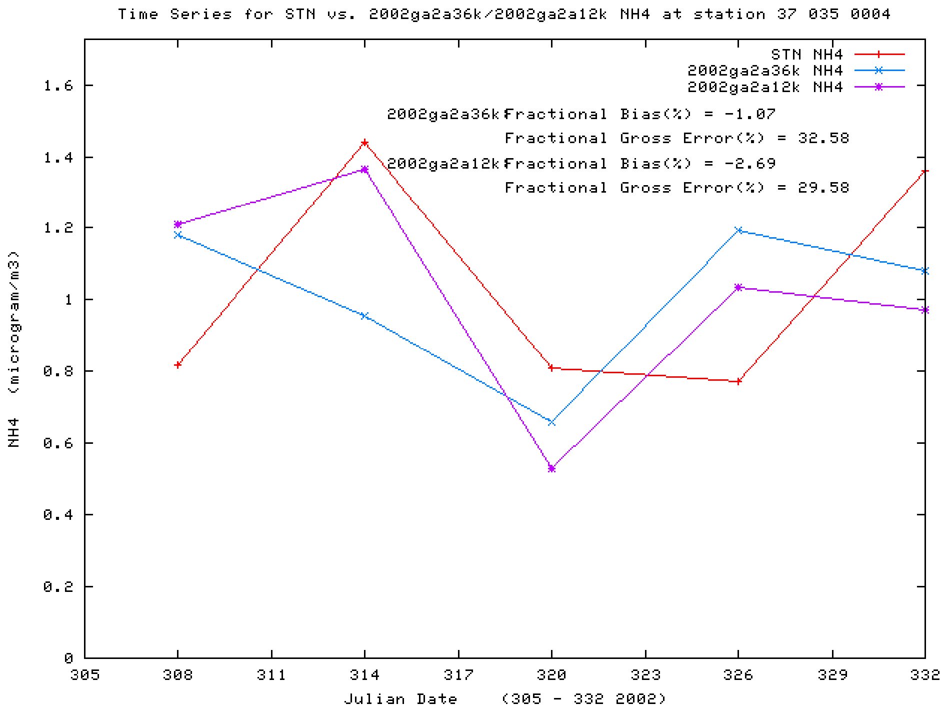


Figure 5-69: November 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

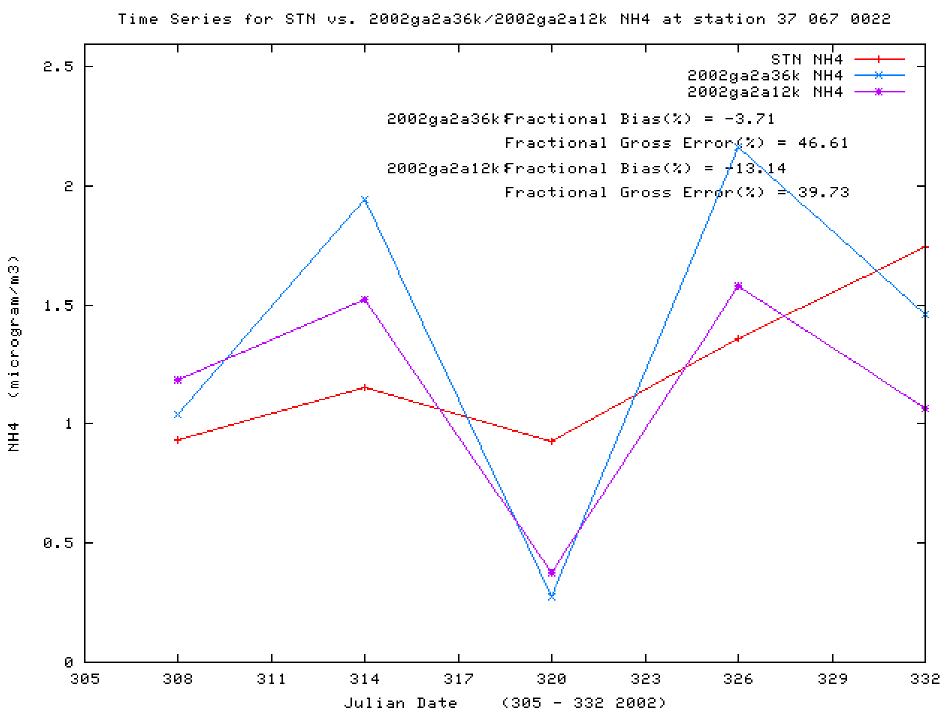


Figure 5-70: November 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.3.12 December

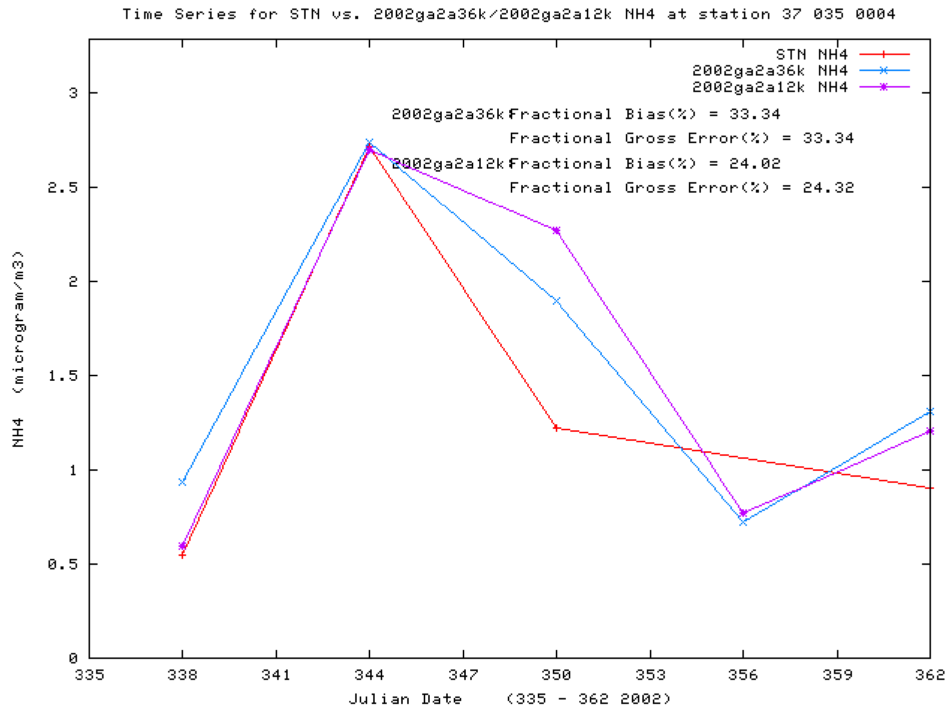


Figure 5-71: December 2002Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

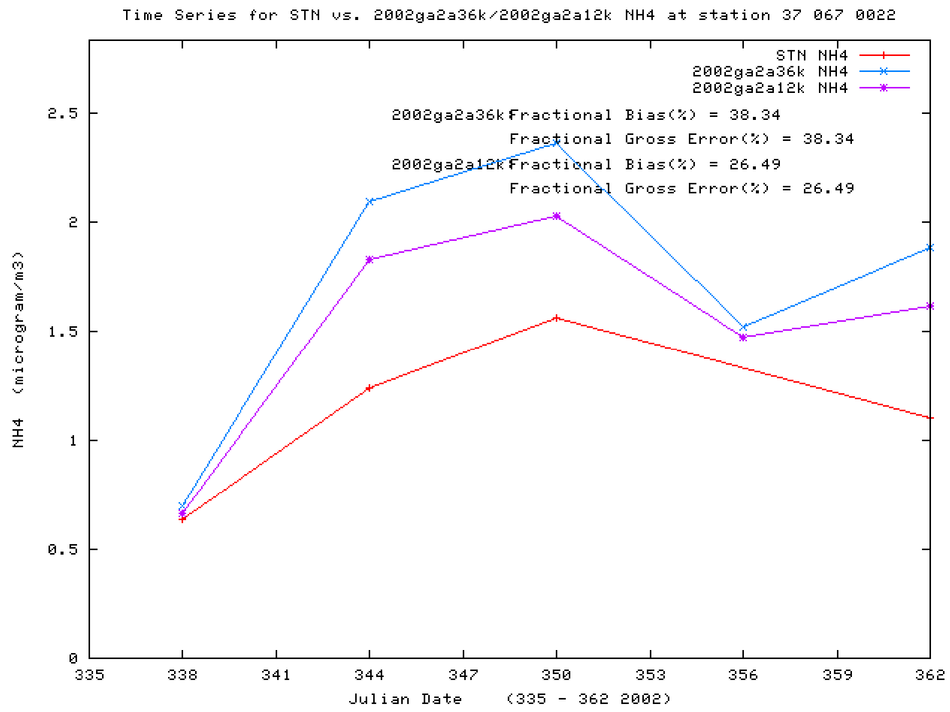


Figure 5-72: December 2002 Time Series of Observed Ammonium levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4 Organic Carbon

5.1.4.1 January

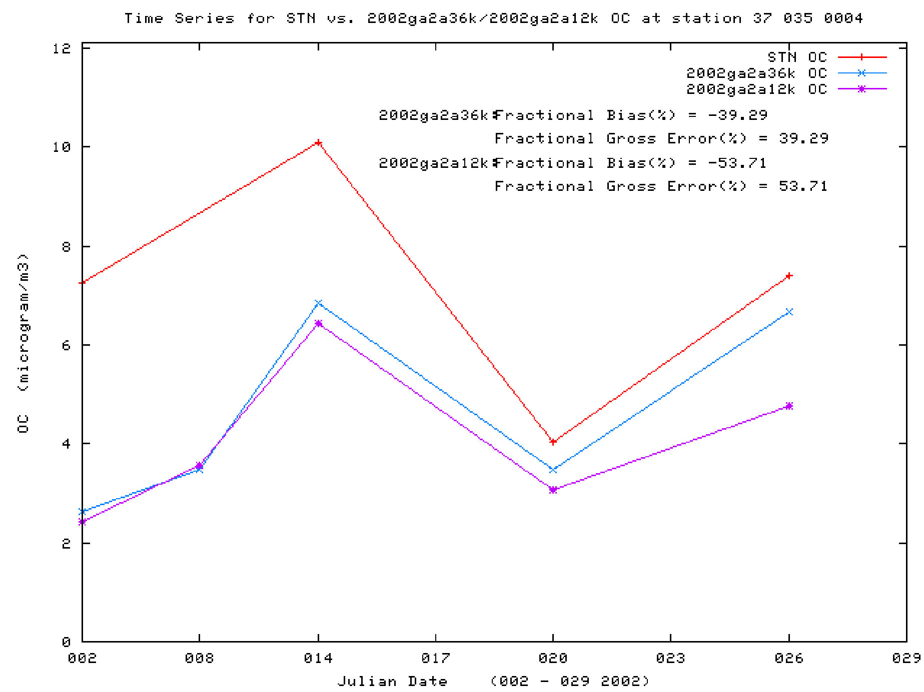


Figure 5-73: January 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

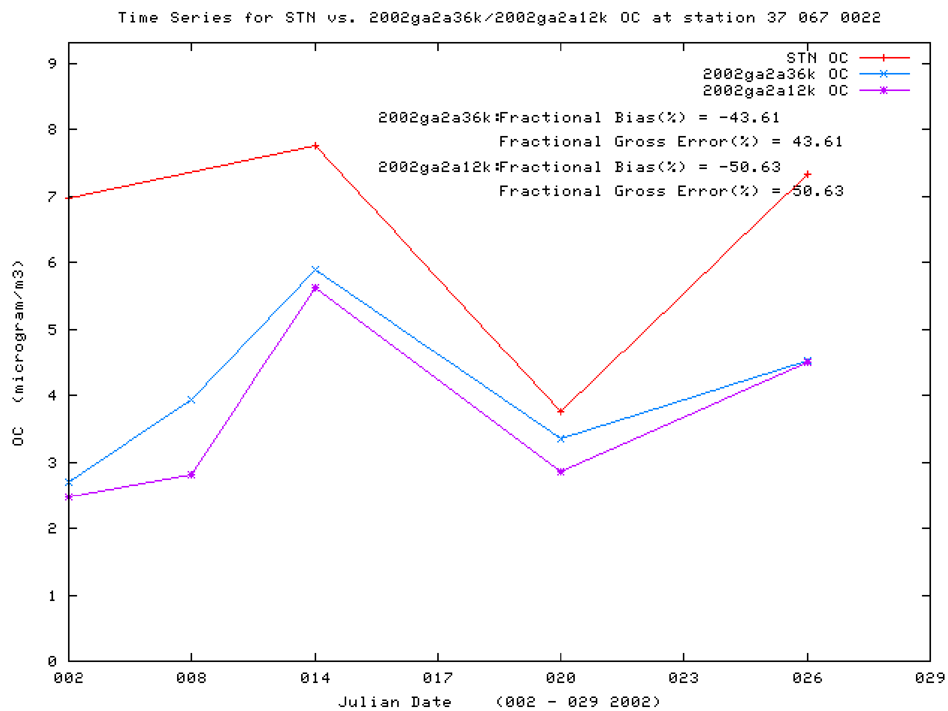


Figure 5-74: January 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.2 February

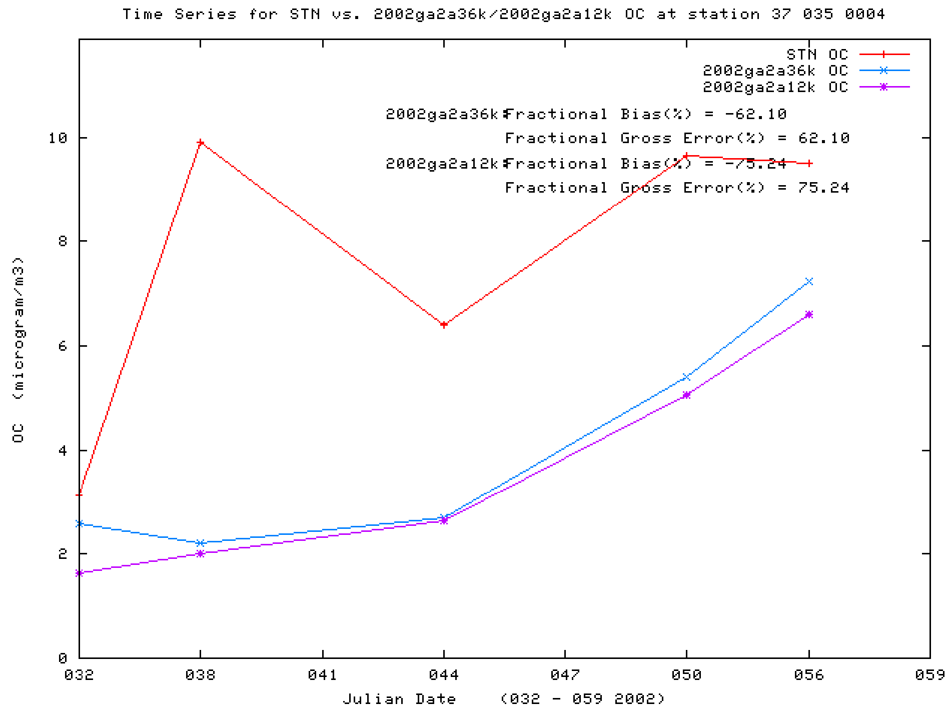


Figure 5-75: February 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

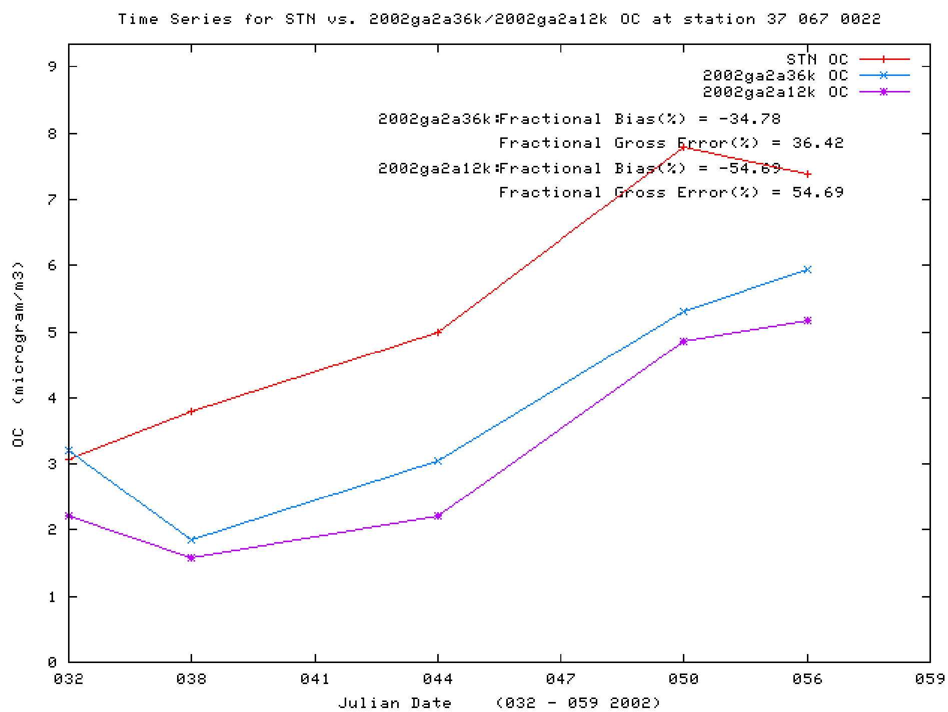


Figure 5-76: February 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.3 March

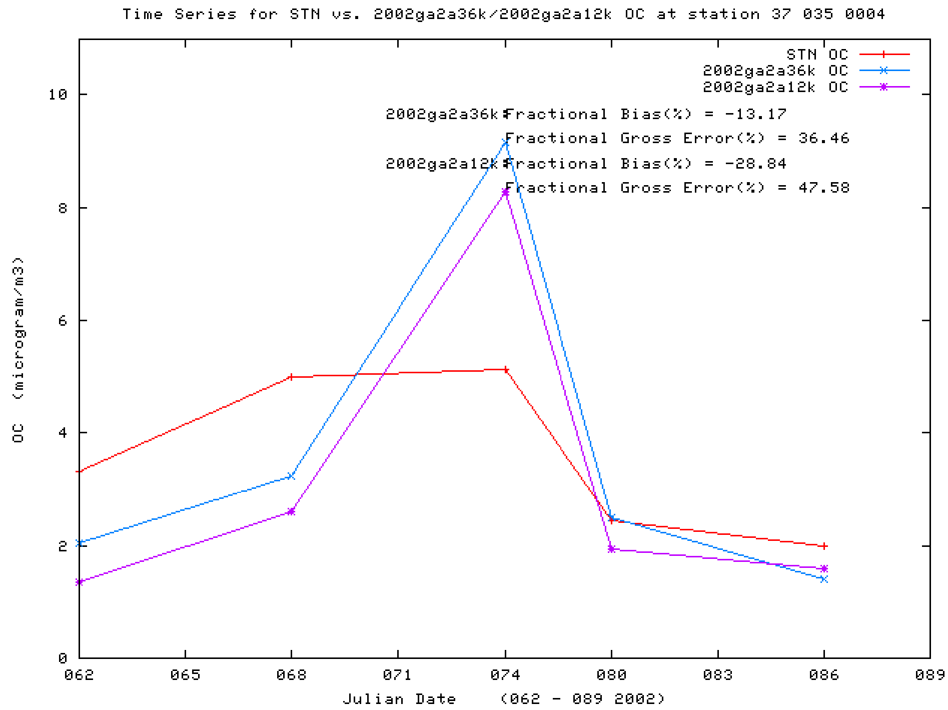


Figure 5-77: March 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

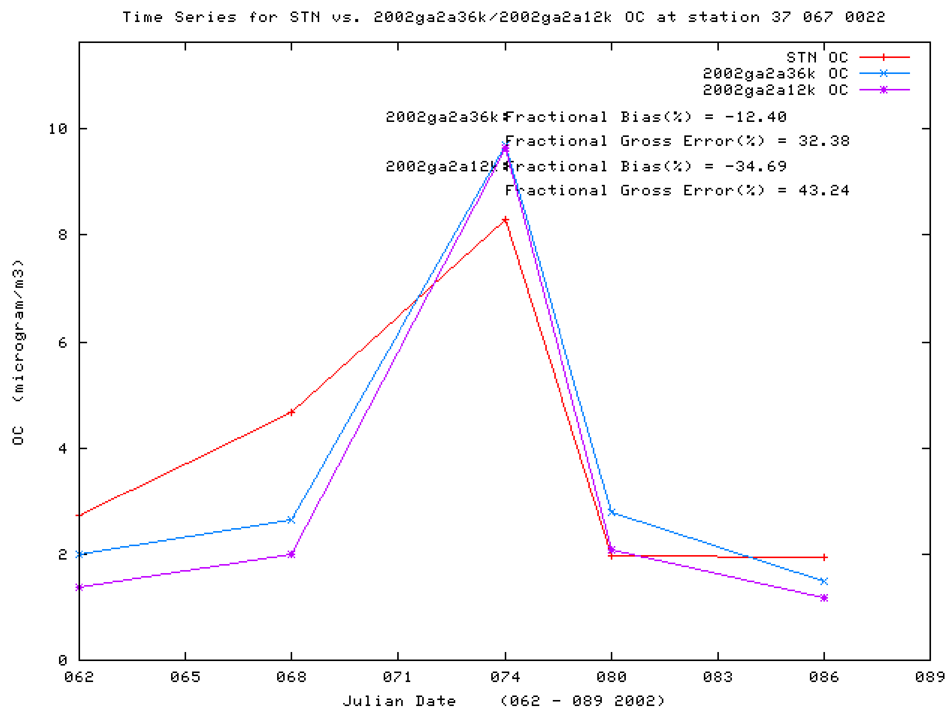


Figure 5-78: March 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.4 April

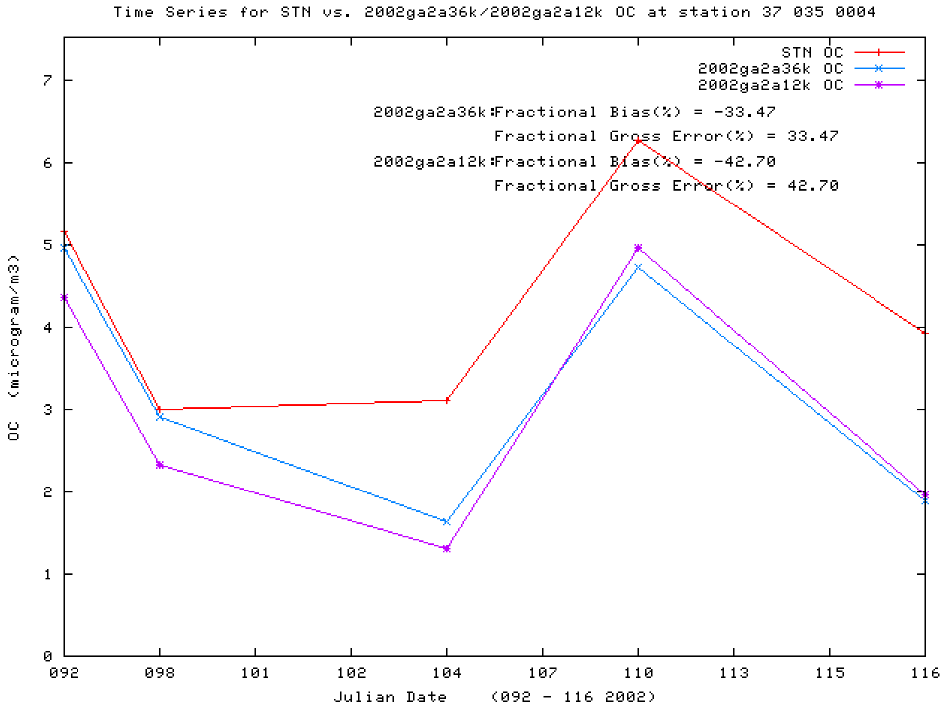


Figure 5-79: April 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

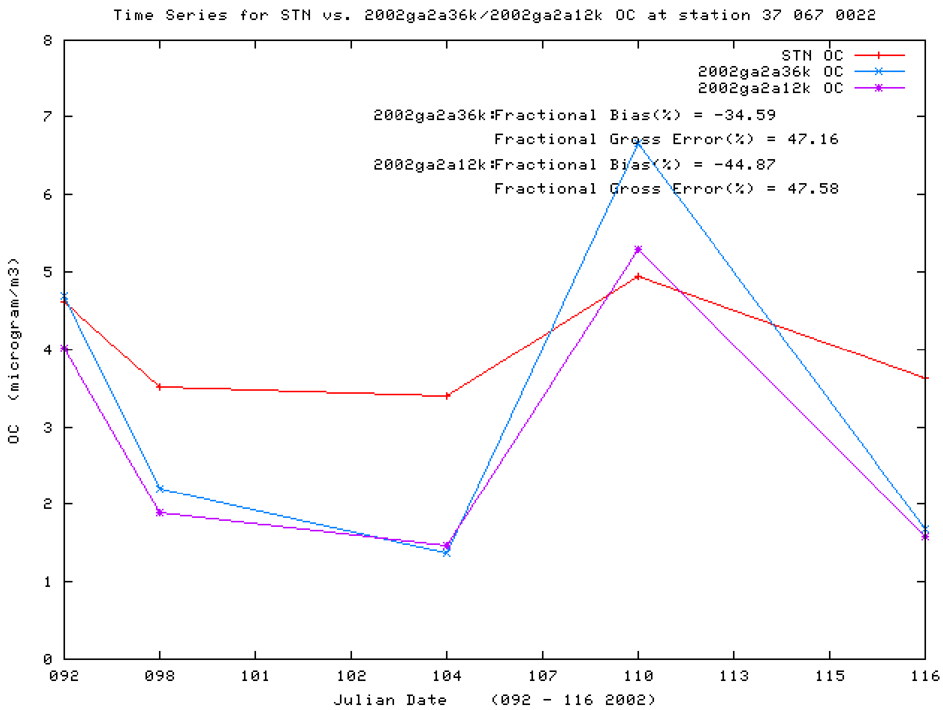


Figure 5-80: April 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.5 May

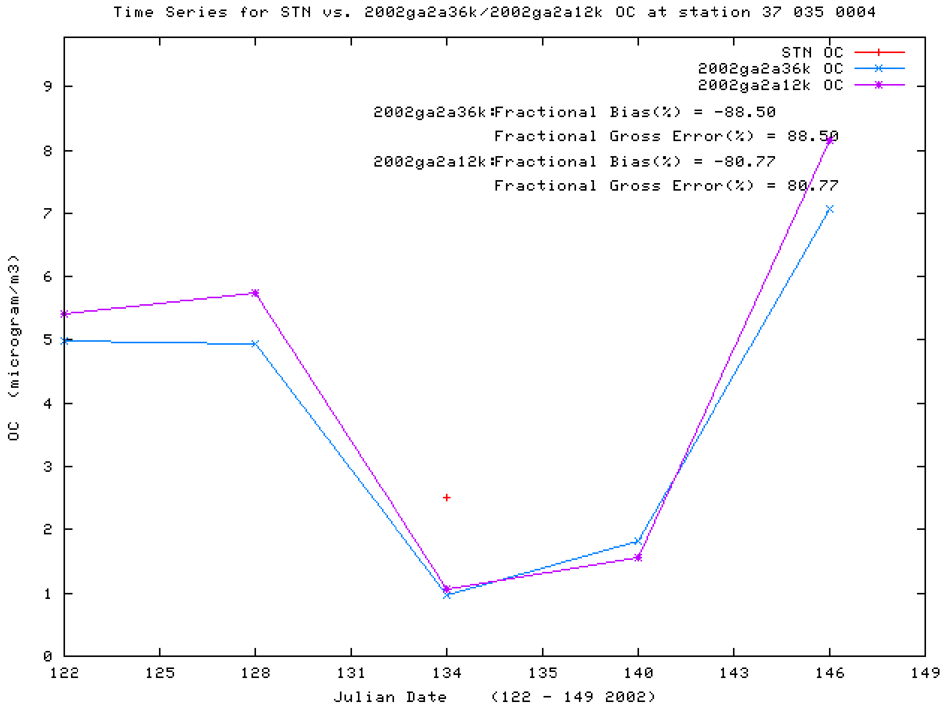


Figure 5-81: May 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

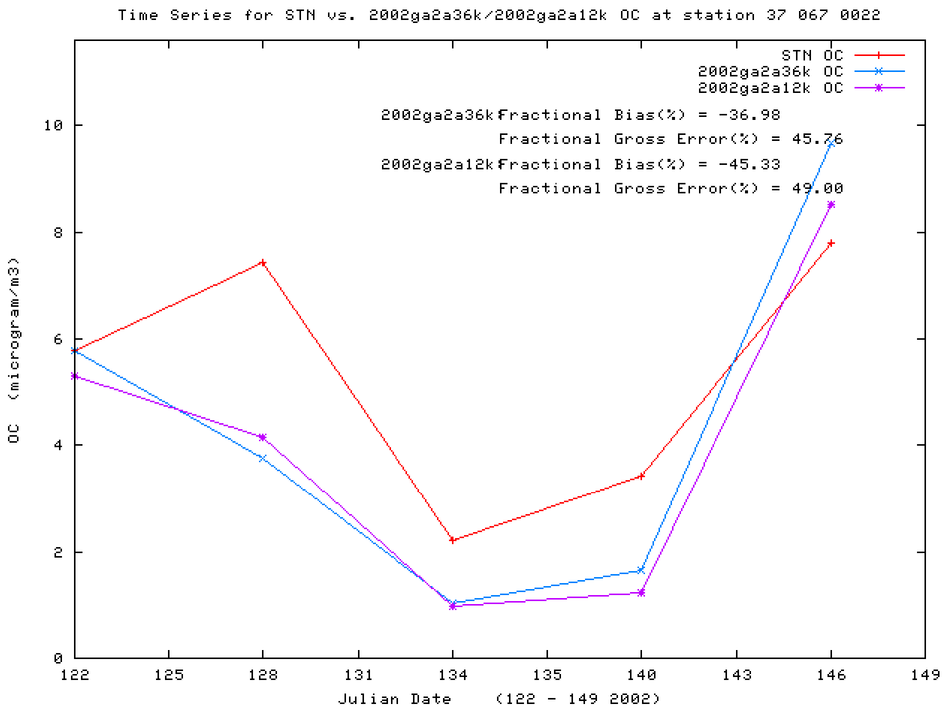


Figure 5-82: May 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.6 June

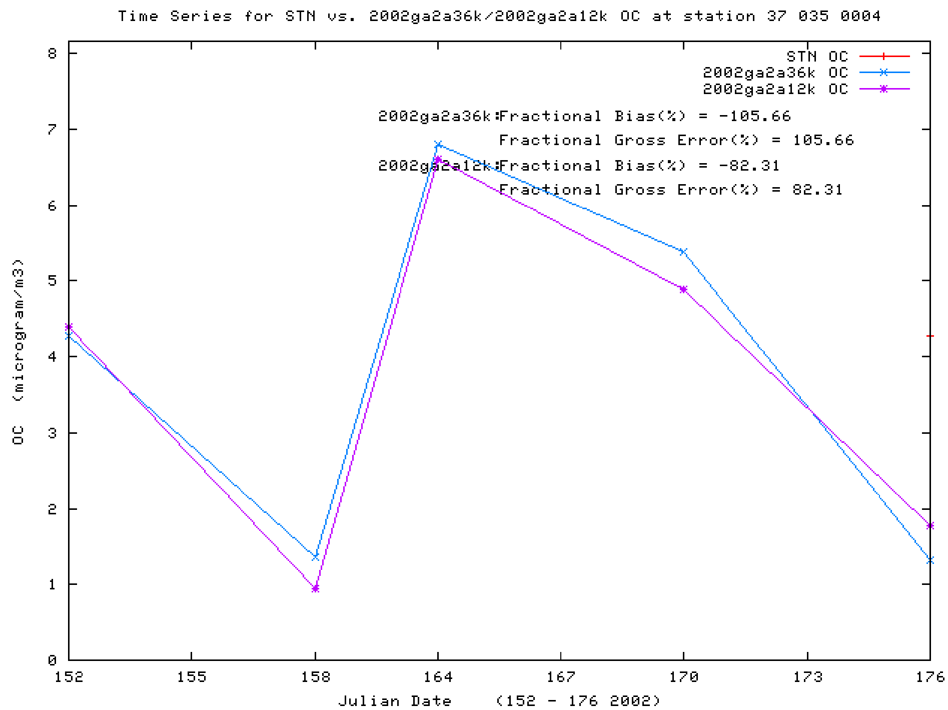


Figure 5-83: June 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

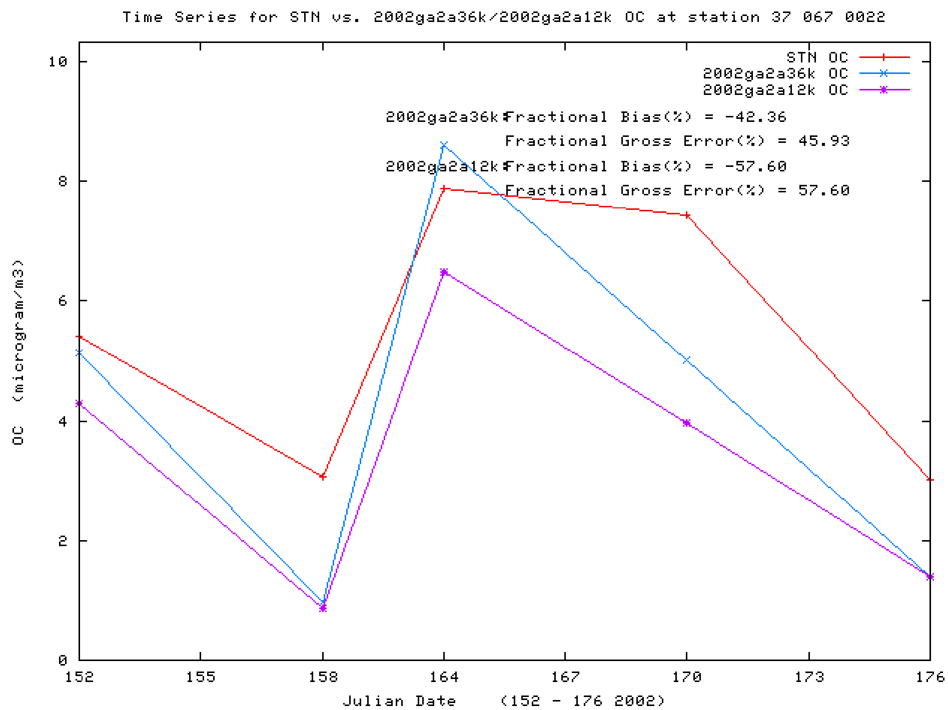


Figure 5-84: June 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.7 July

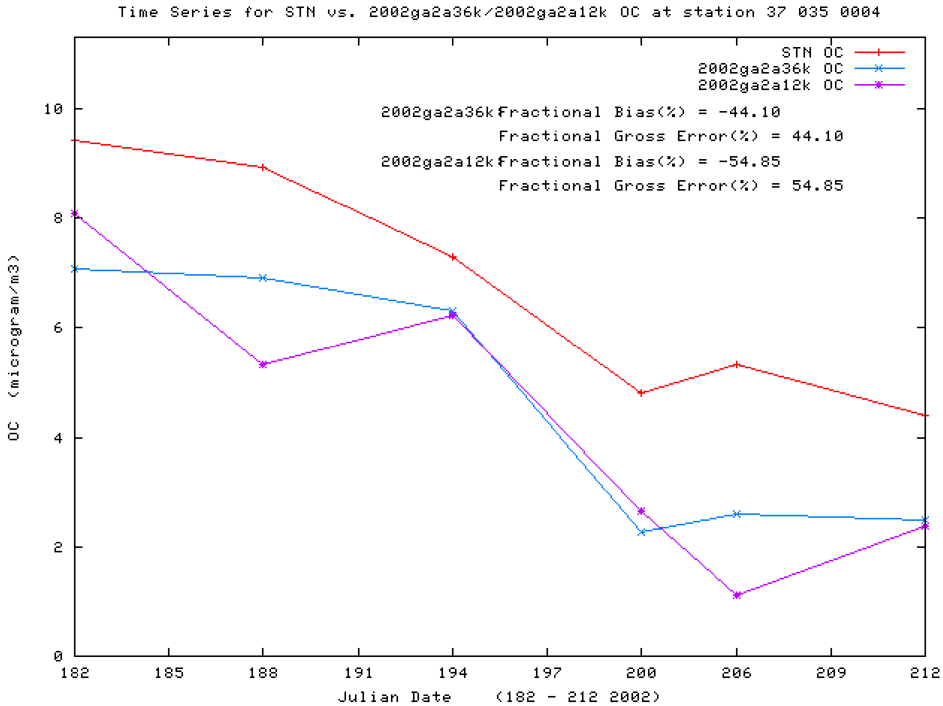


Figure 5-85: July 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

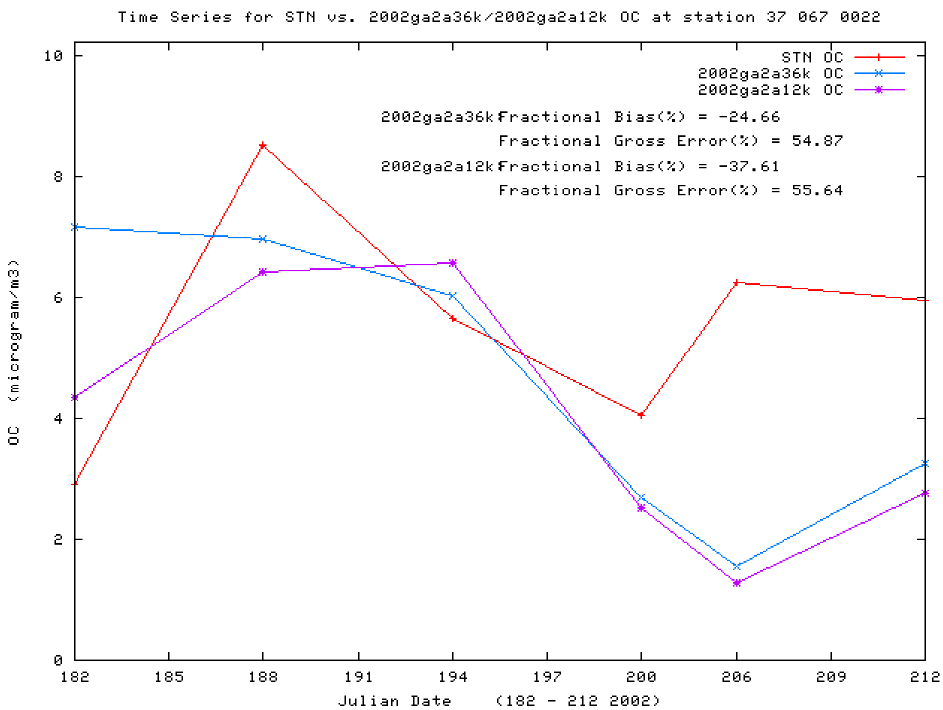


Figure 5-86: July 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.8 August

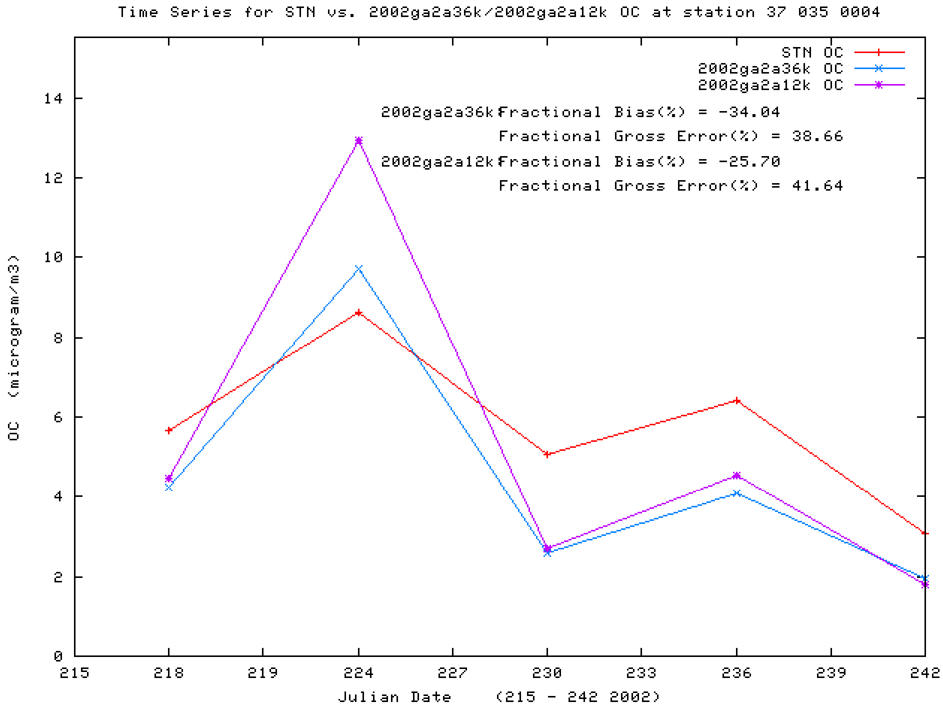


Figure 5-87: August 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

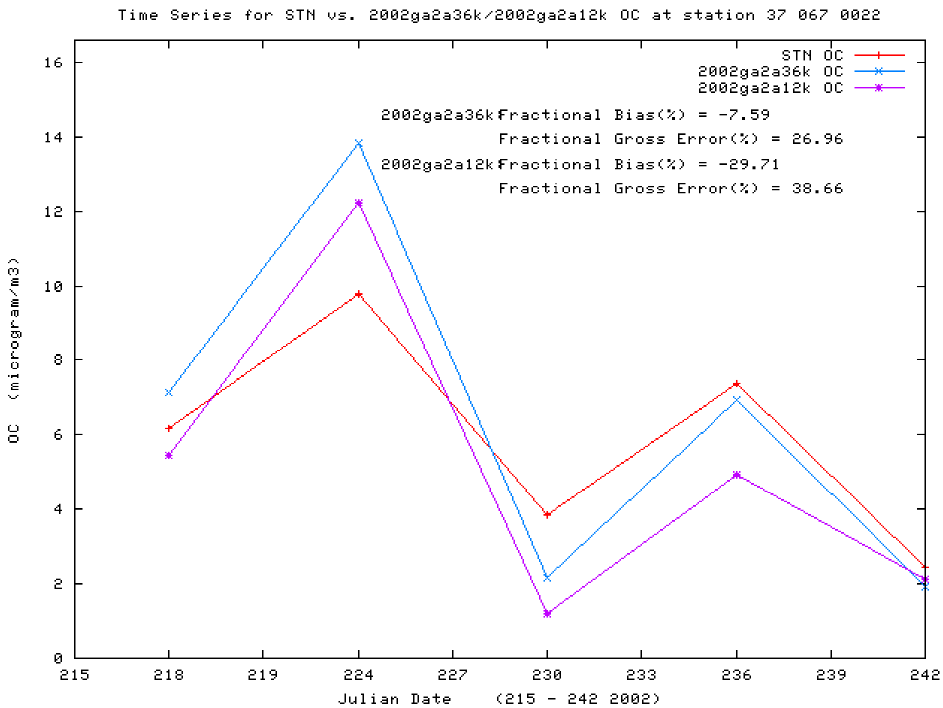


Figure 5-88: August 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.9 September

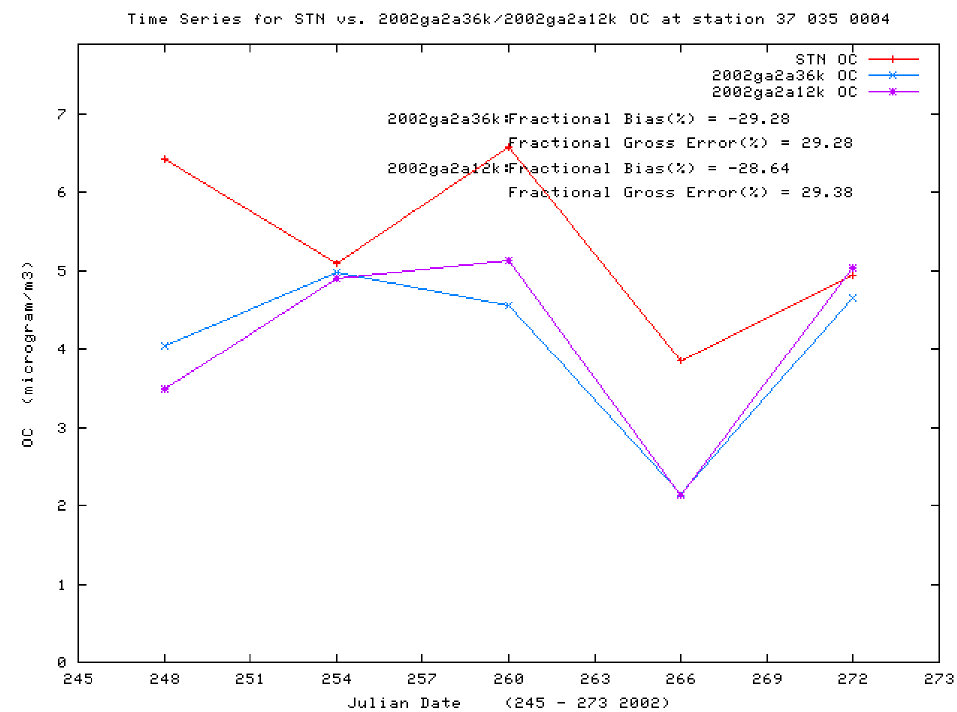


Figure 5-89: September 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

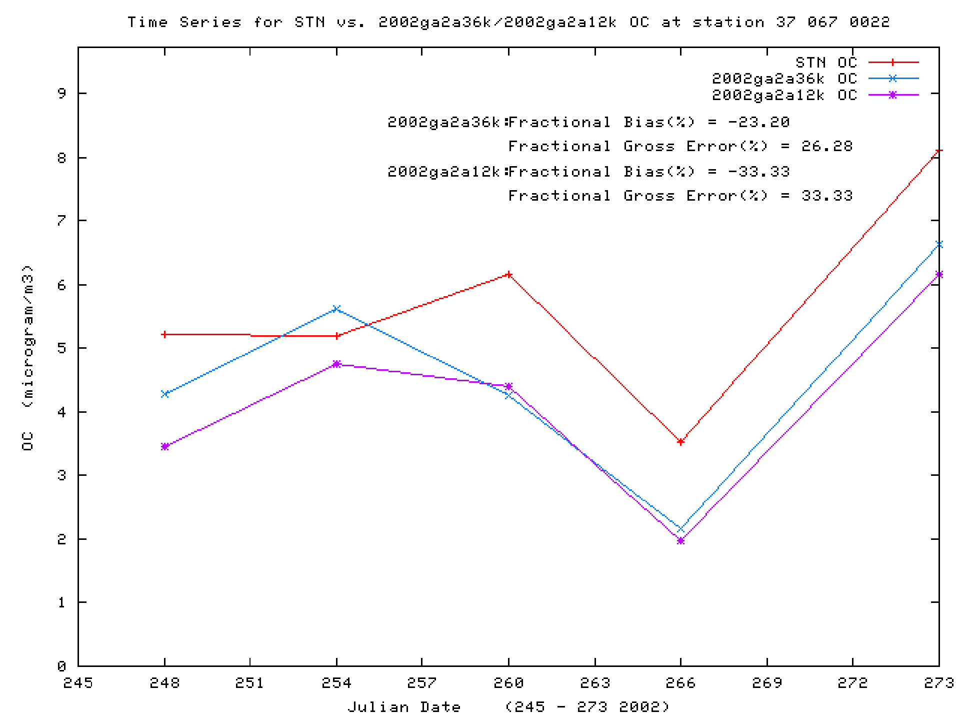


Figure 5-90: September 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.10 October

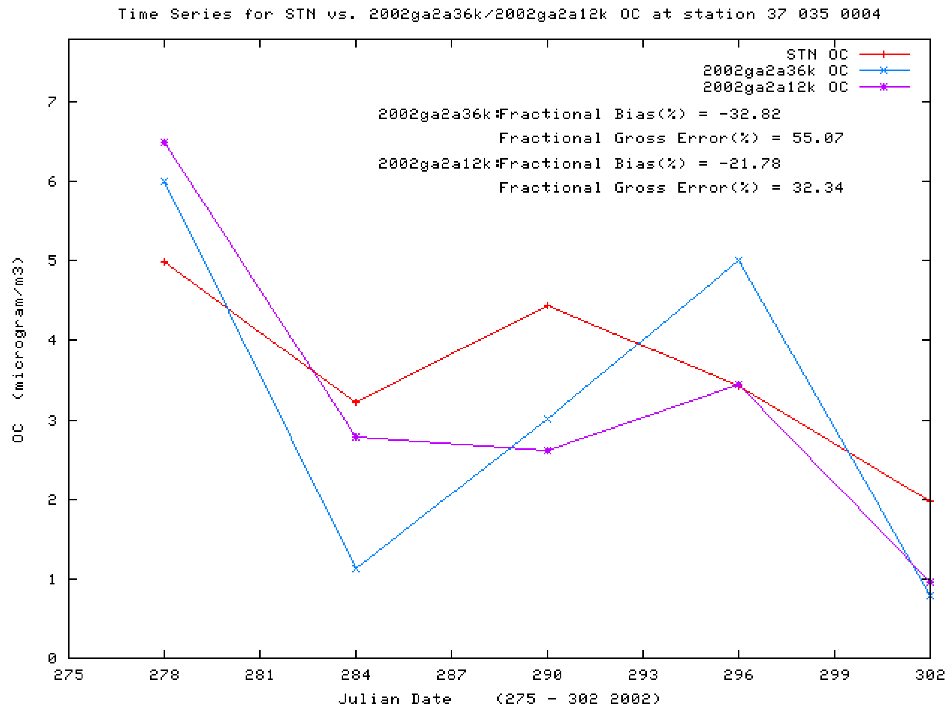


Figure 5-91: October 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

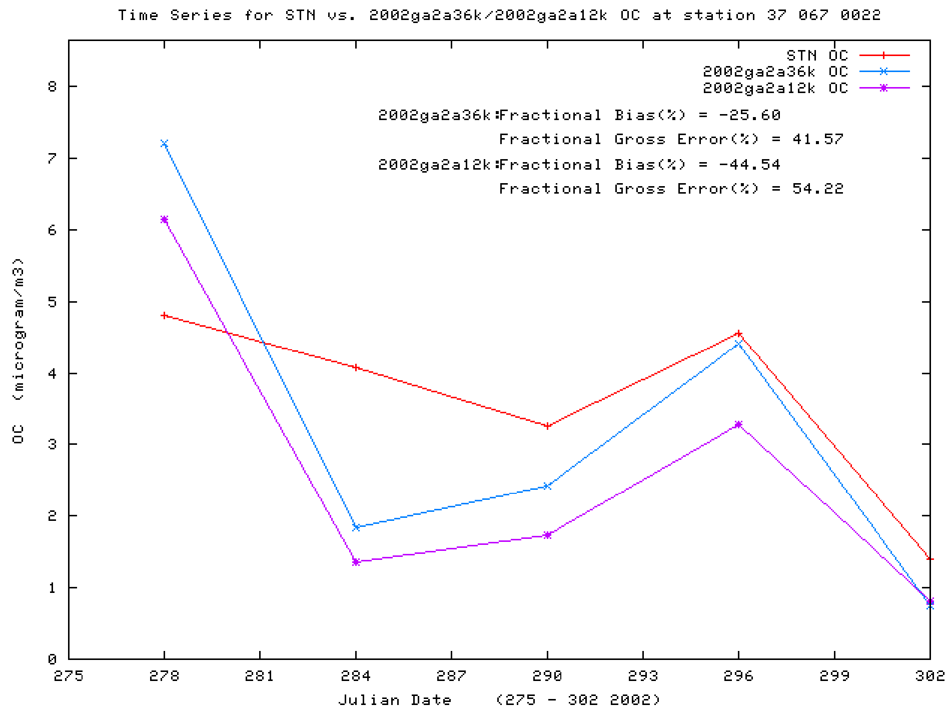


Figure 5-92: October 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.11 November

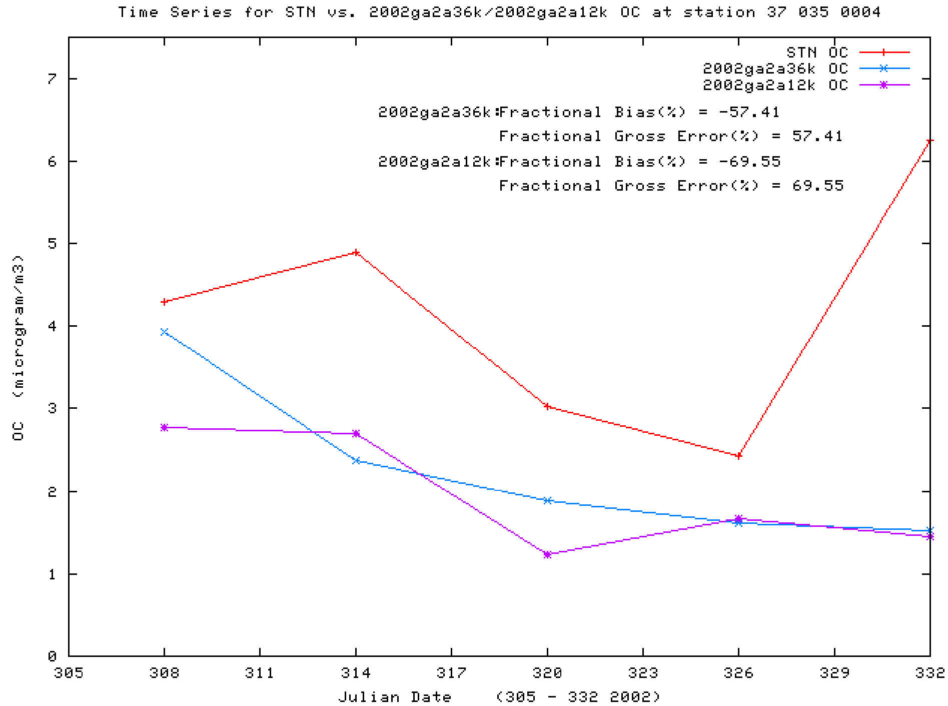


Figure 5-93: November 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

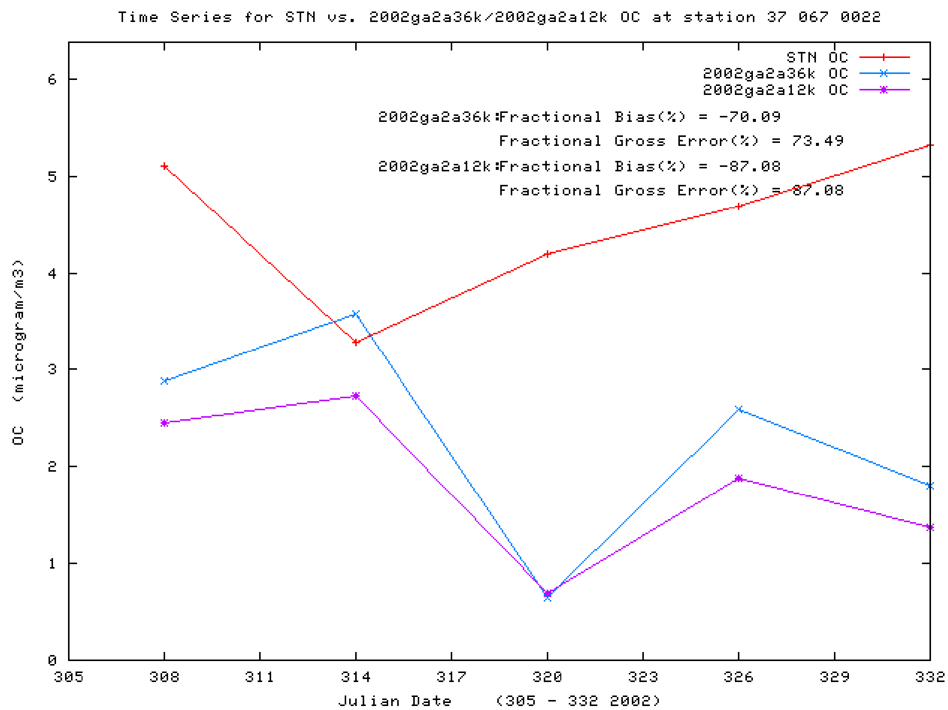


Figure 5-94: November 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.4.12 December

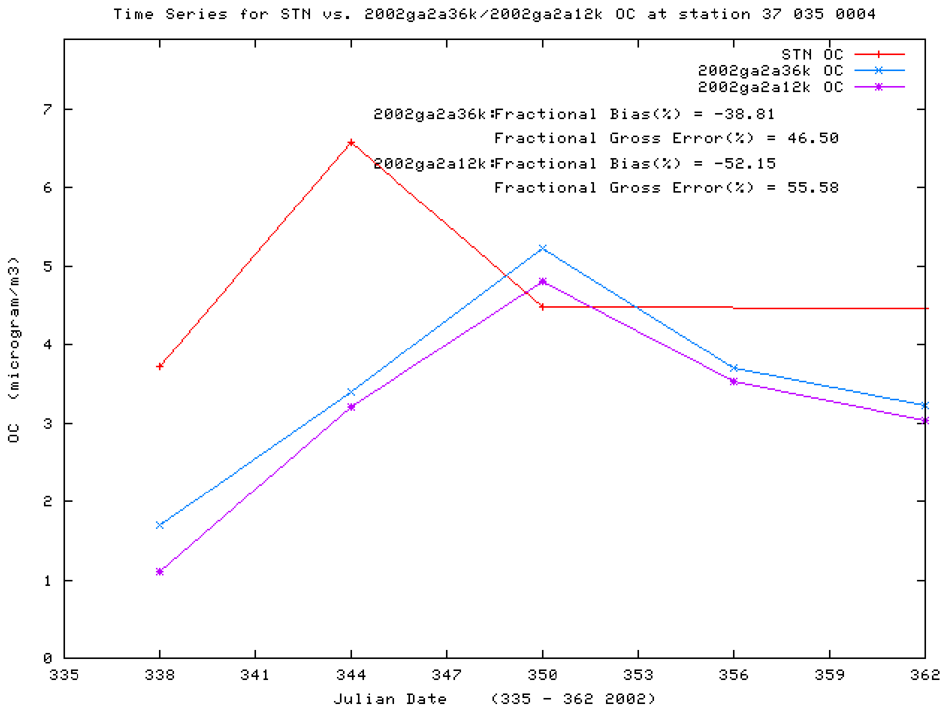


Figure 5-95: December 2002Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

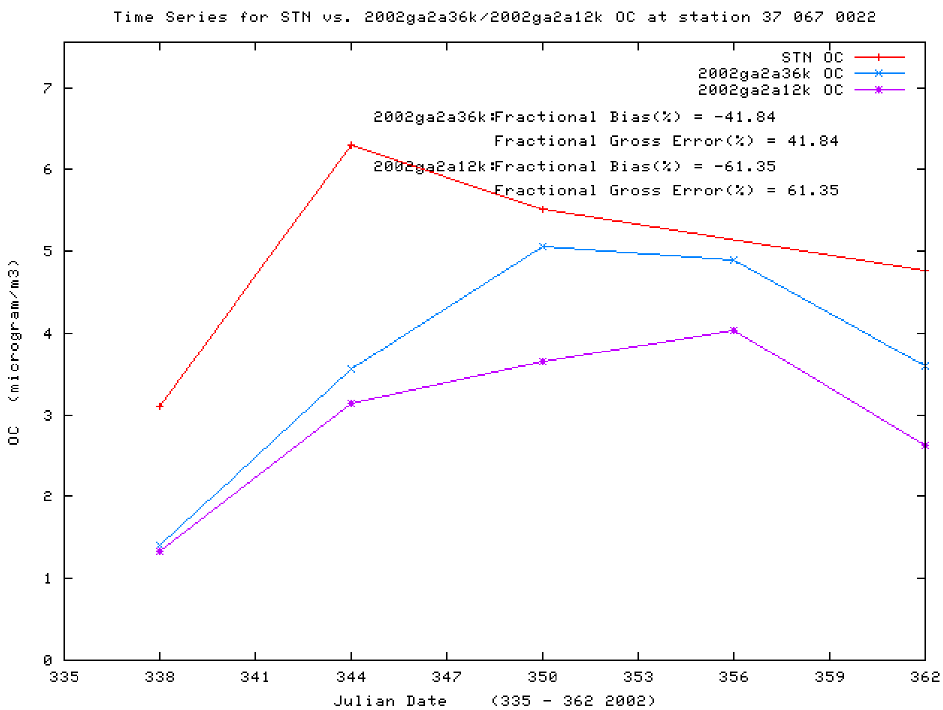


Figure 5-96: December 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5 Elemental Carbon

5.1.5.1 January

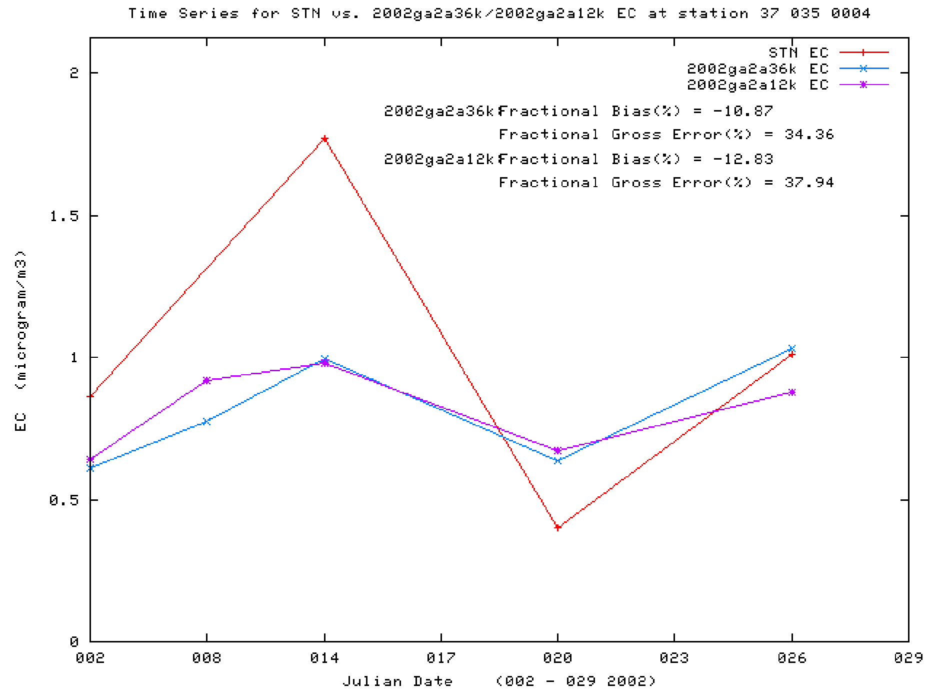


Figure 5-97: January 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

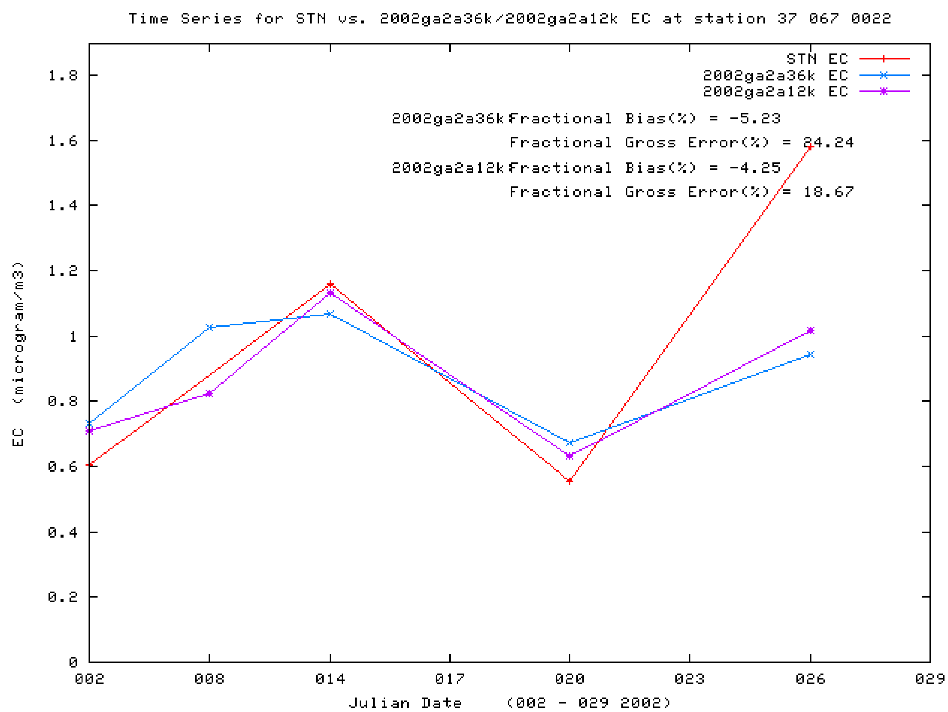


Figure 5-98: January 2002 Time Series of Observed Organic Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.2 February

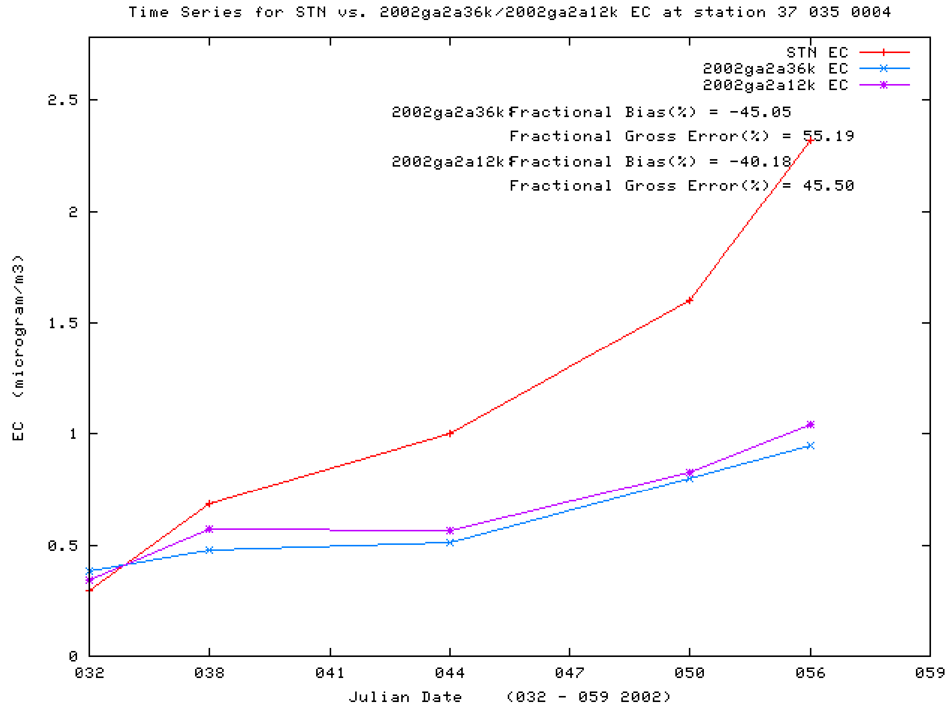


Figure 5-99: February 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

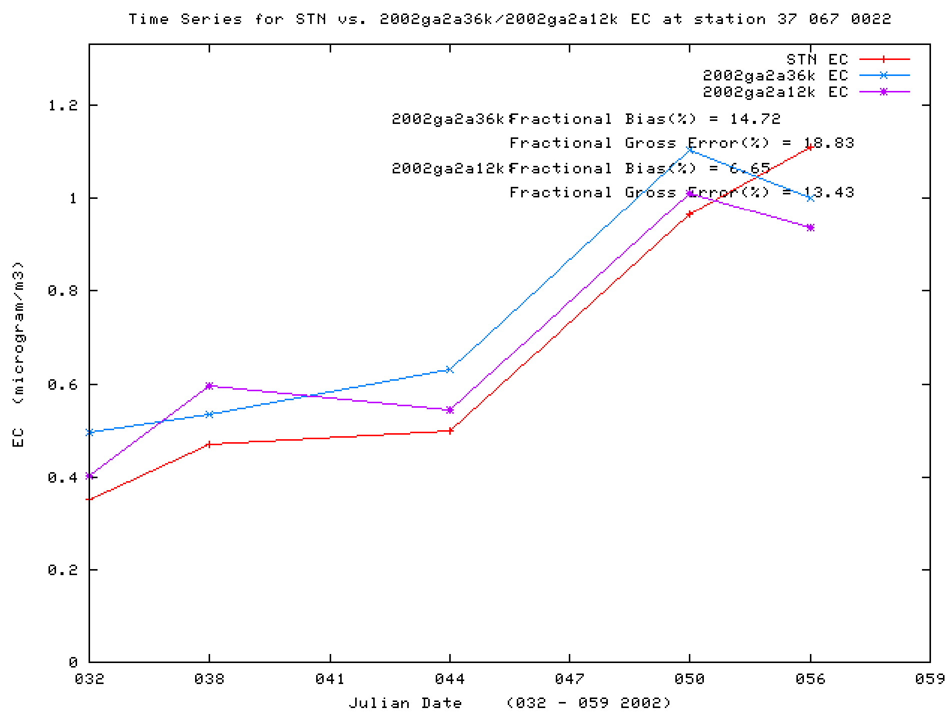


Figure 5-100: February 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.3 March

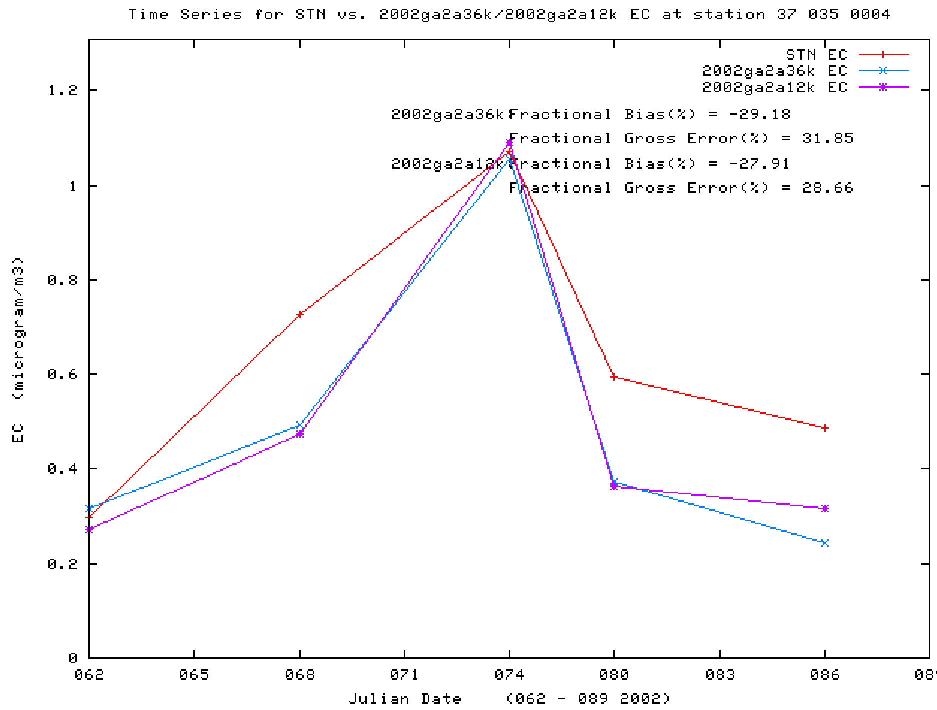


Figure 5-101: March 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

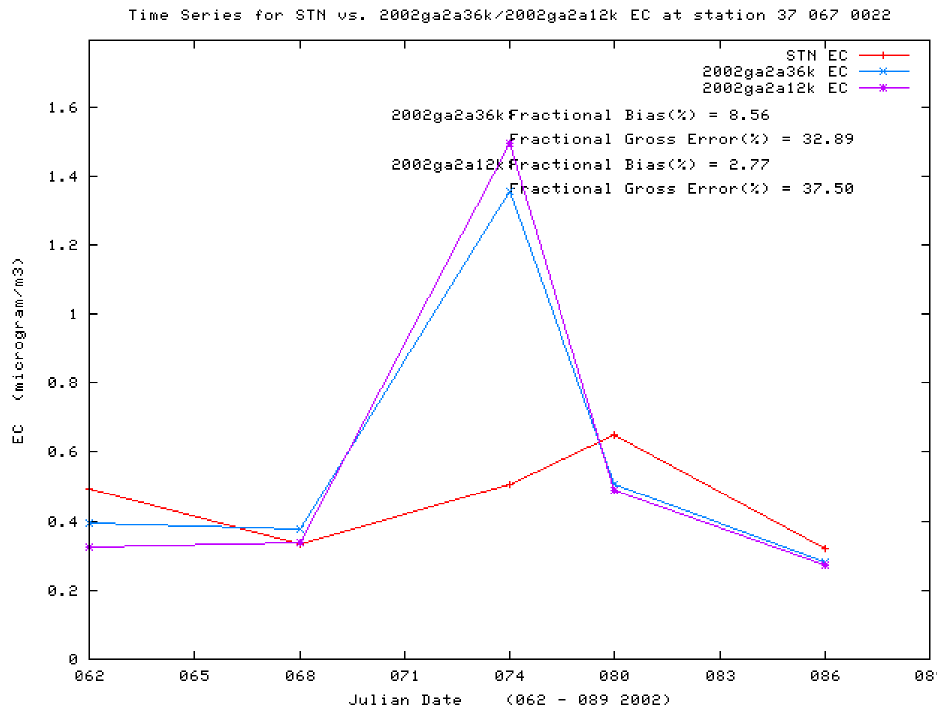


Figure 5-102: March 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.4 April

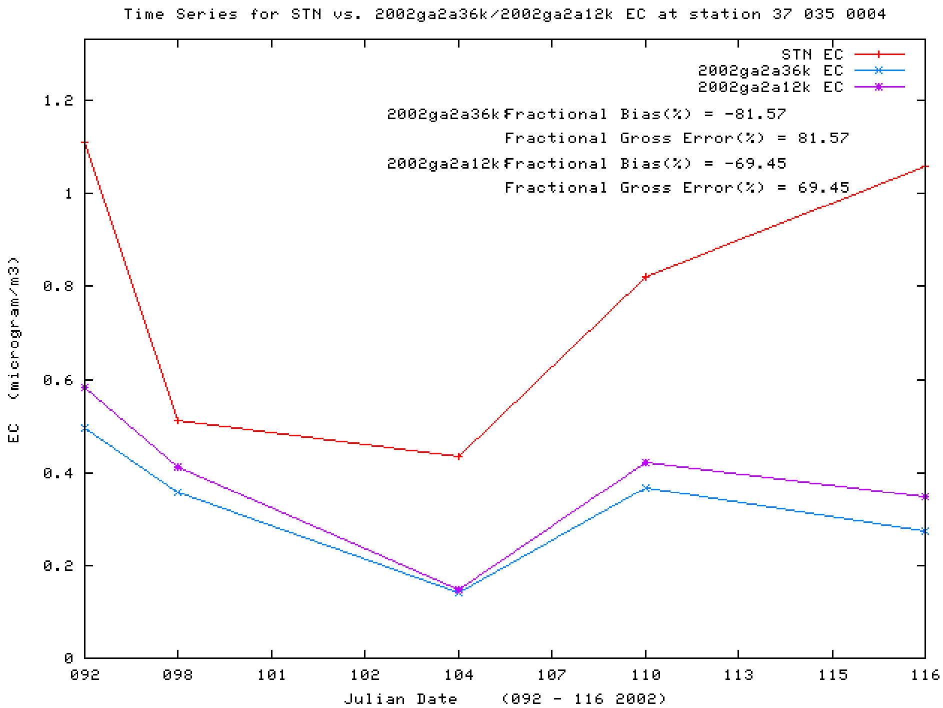


Figure 5-103: April 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

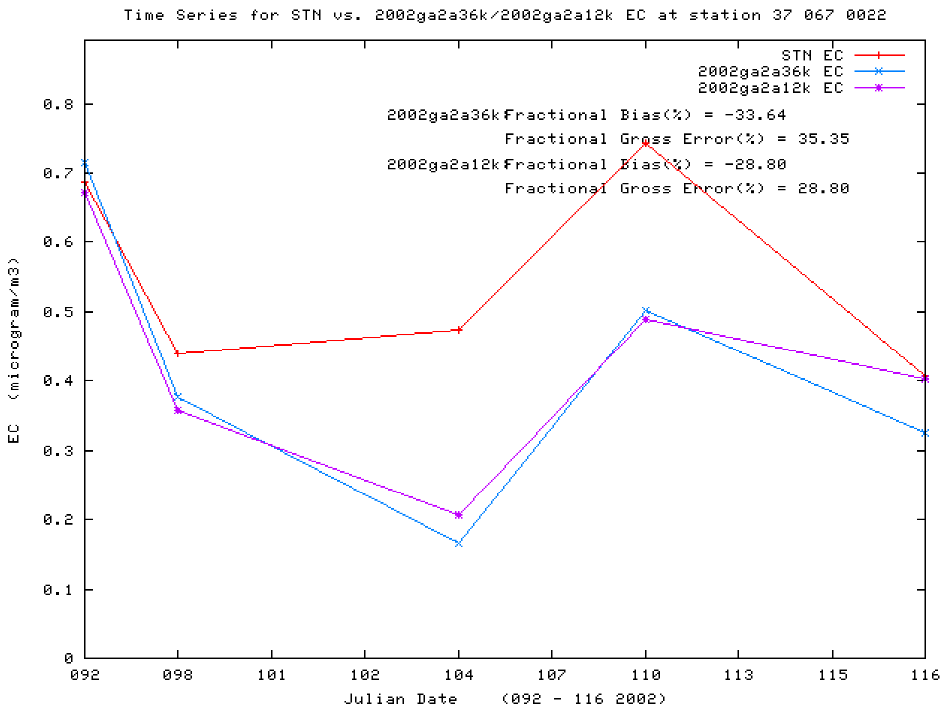


Figure 5-104: April 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.5 May

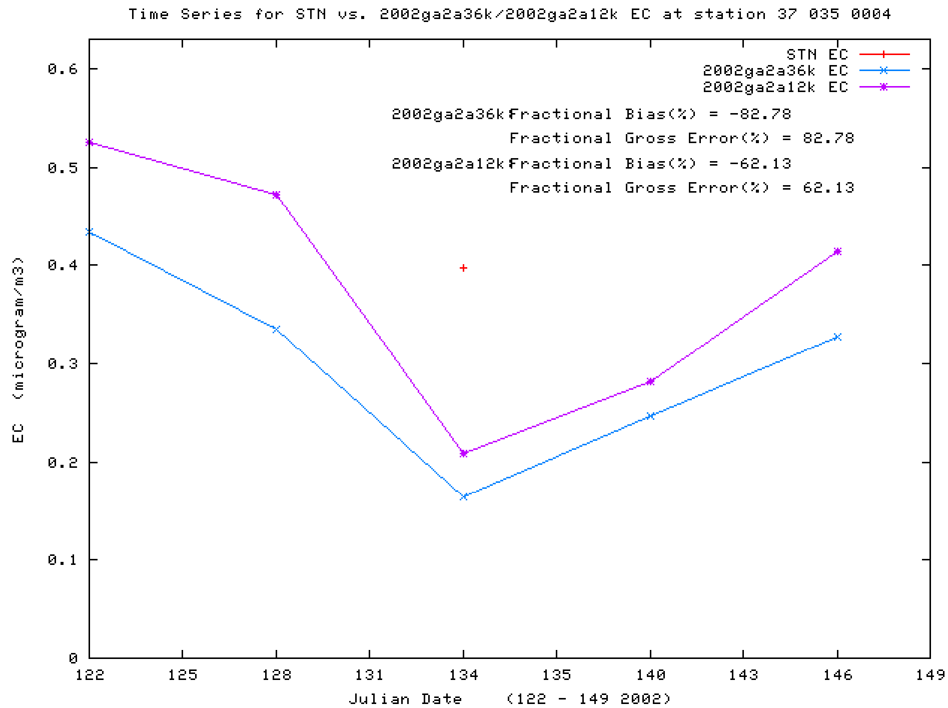


Figure 5-105: May 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

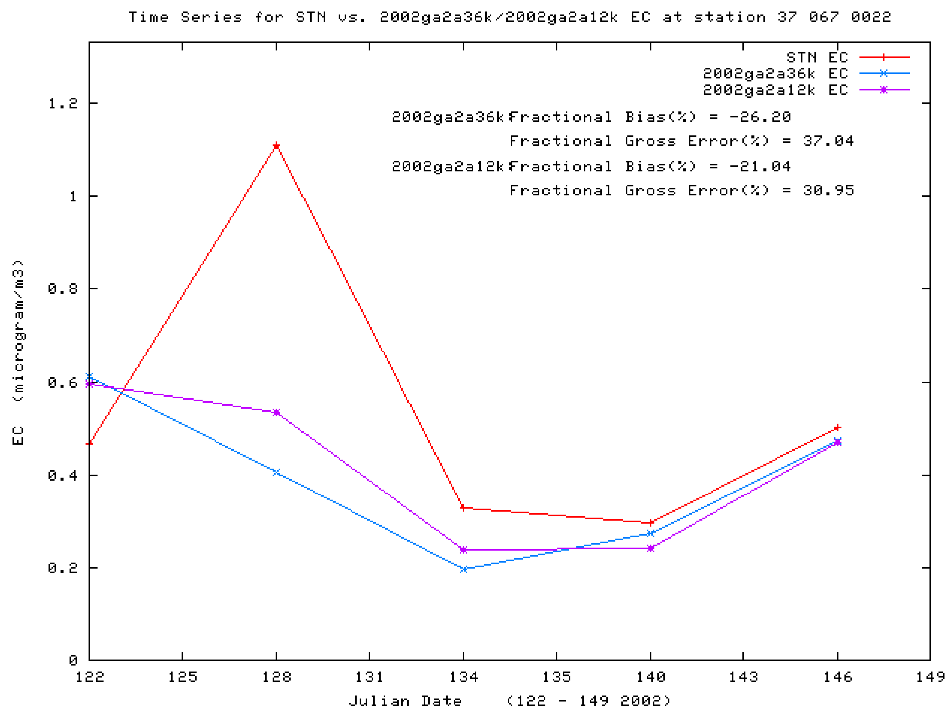


Figure 5-106: May 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.6 June

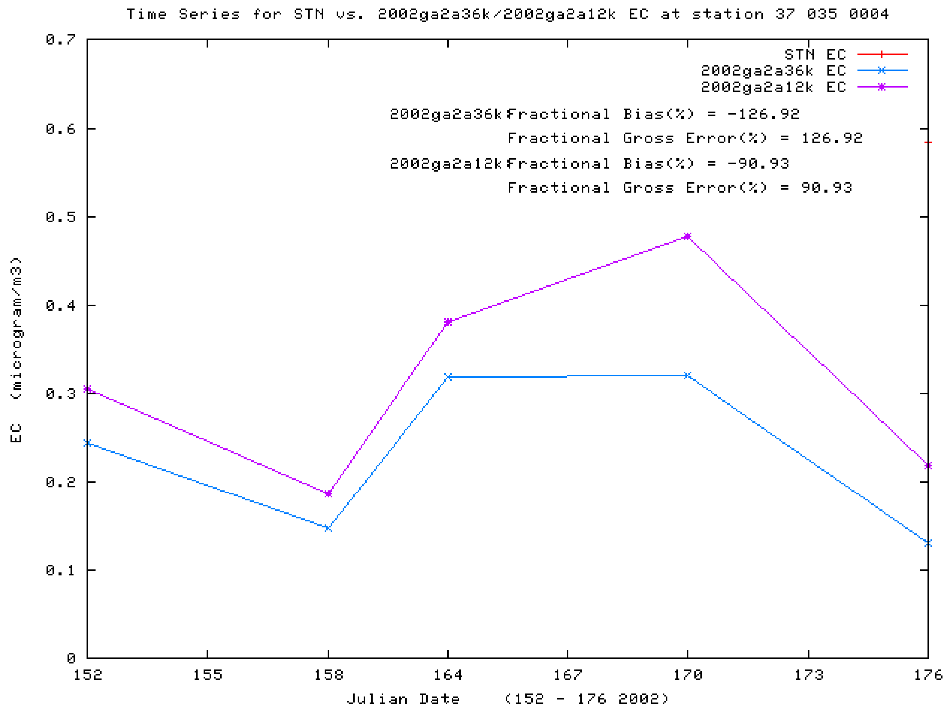


Figure 5-107: June 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

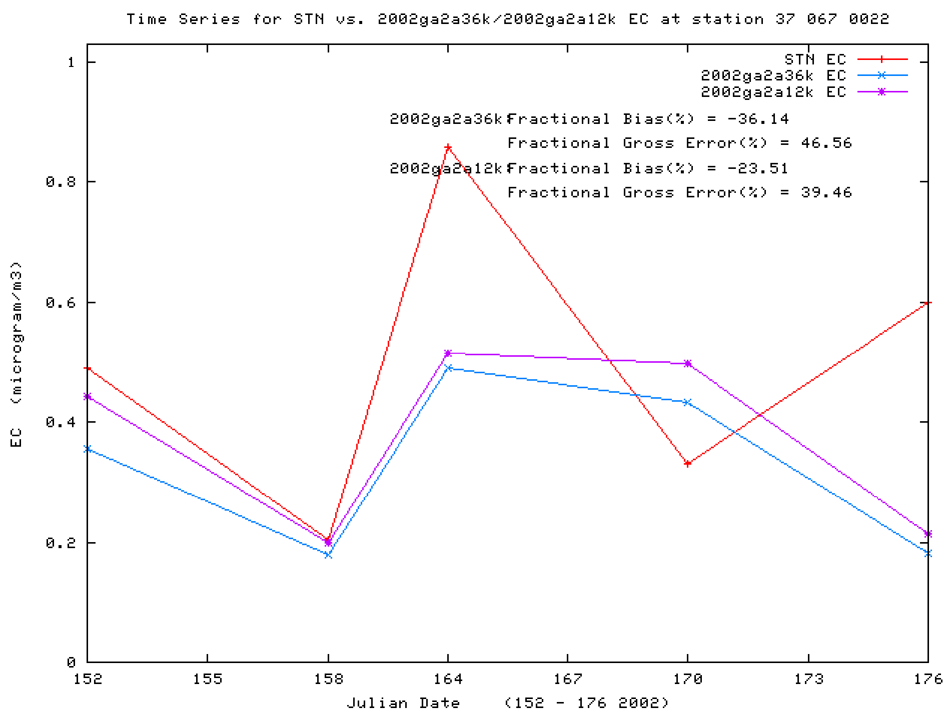


Figure 5-108: June 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.7 July

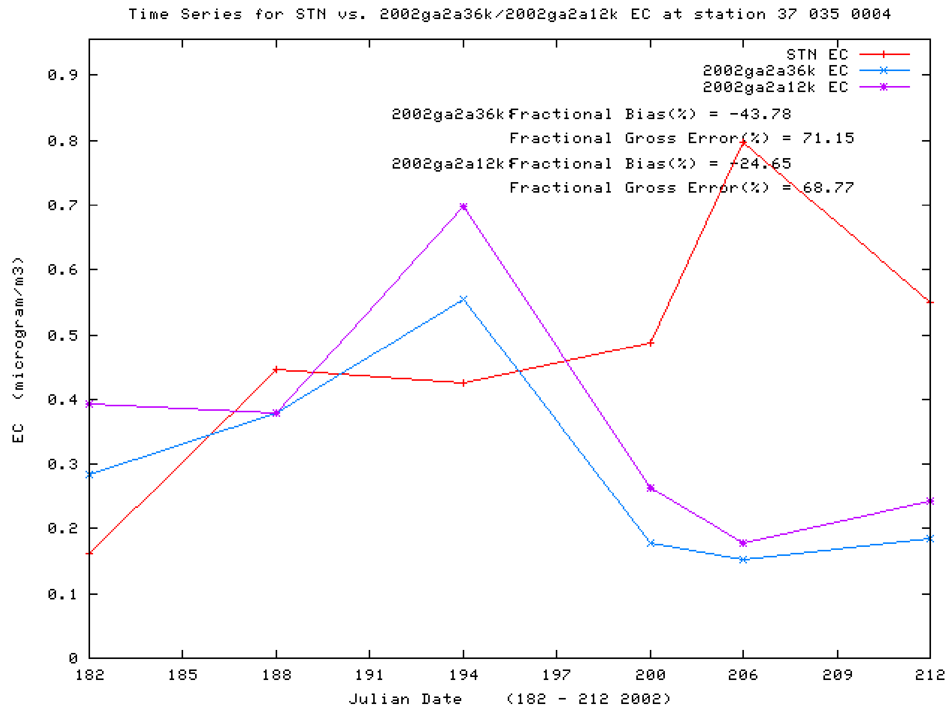


Figure 5-109: July 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

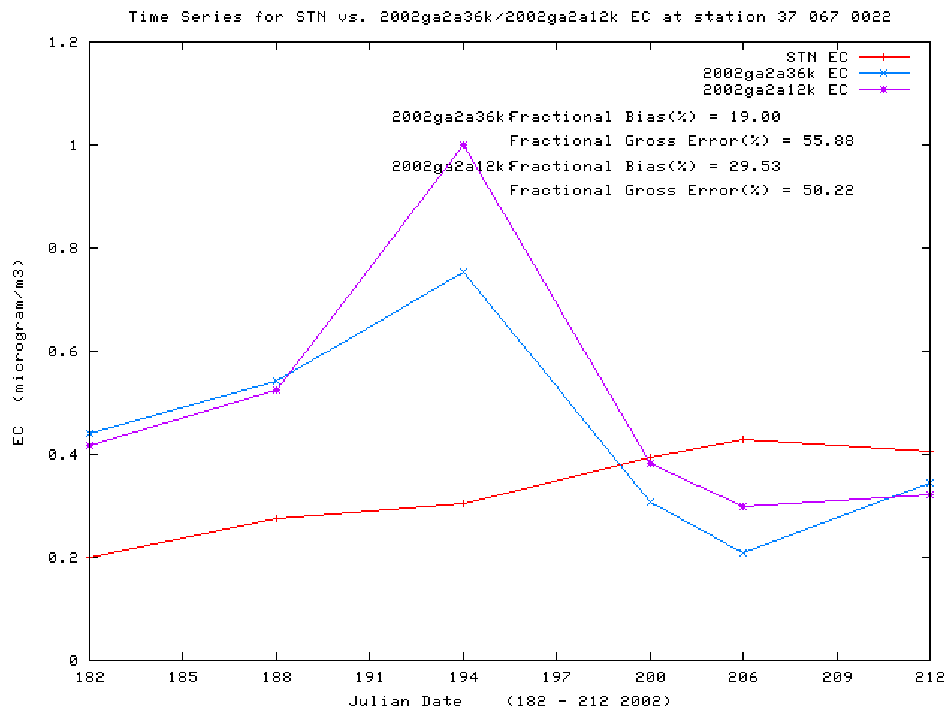


Figure 5-110: July 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.8 August

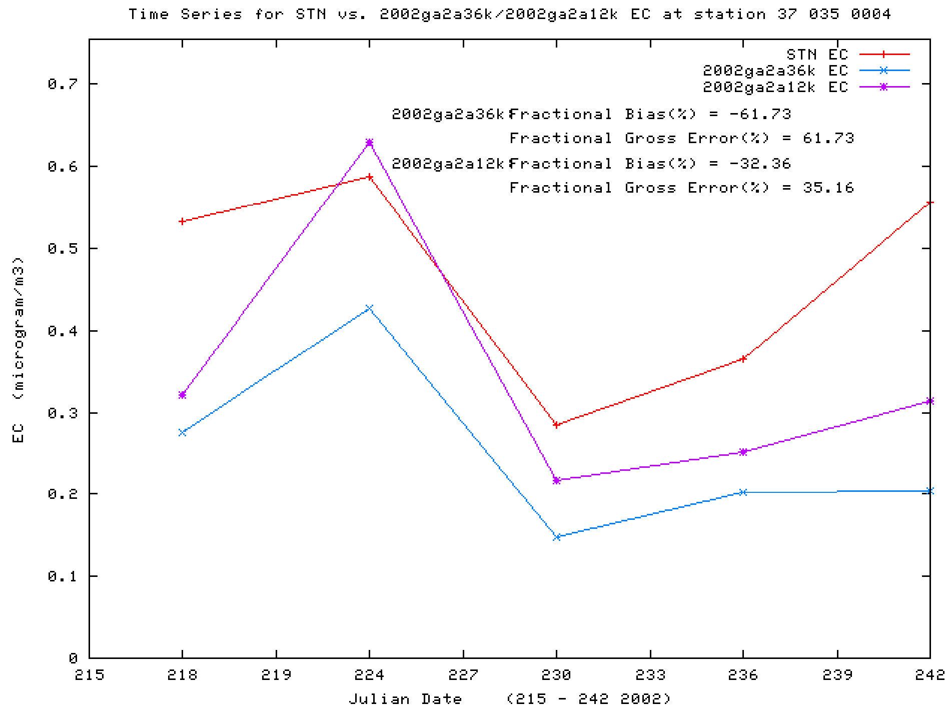


Figure 5-111: August 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

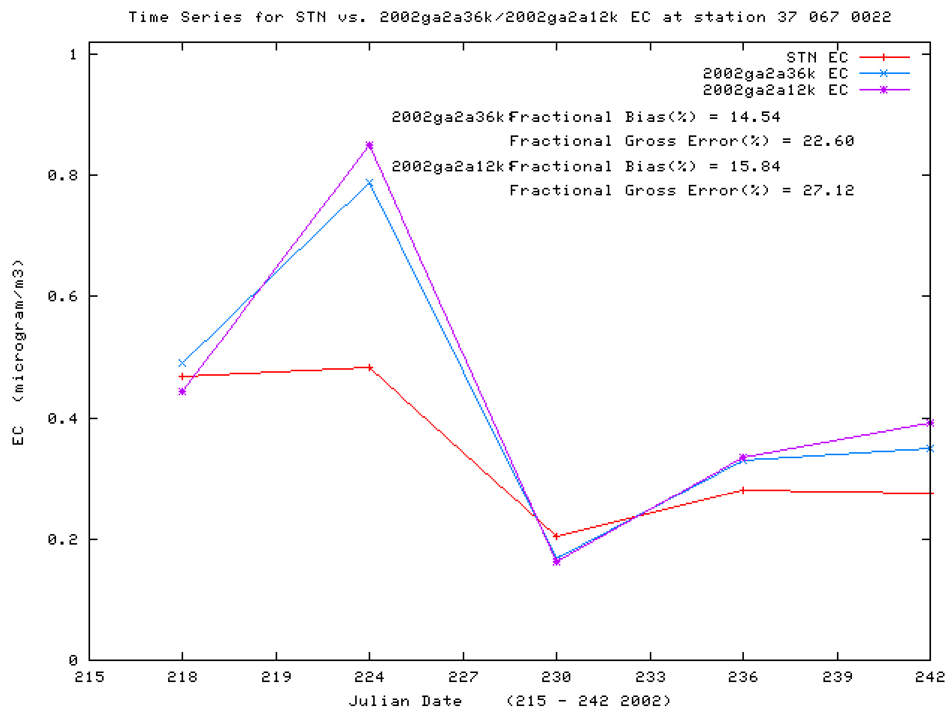


Figure 5-112: August 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.9 September

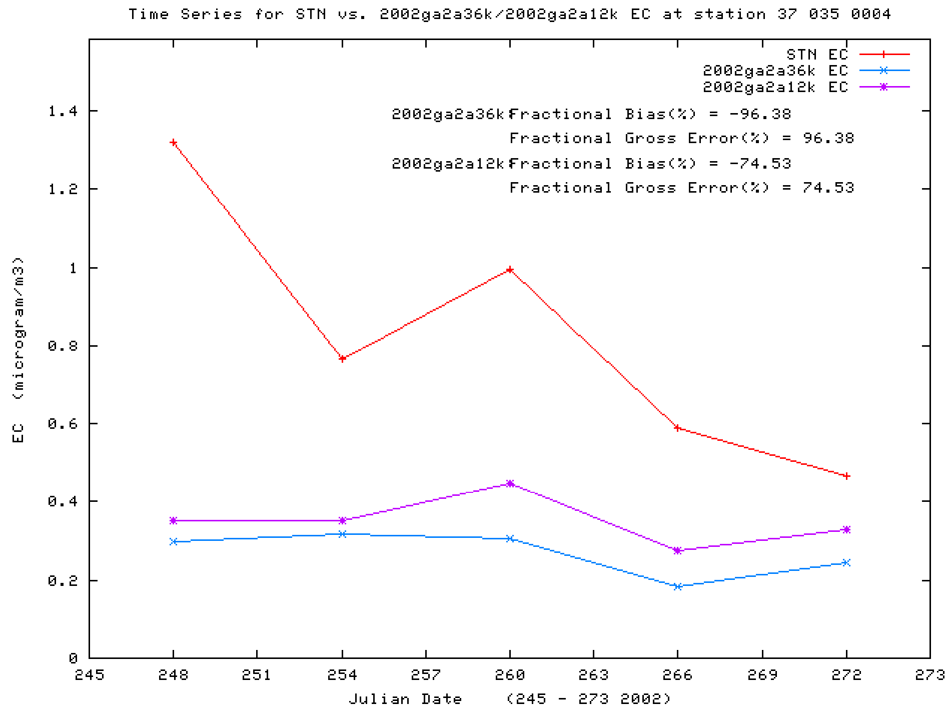


Figure 5-113: September 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

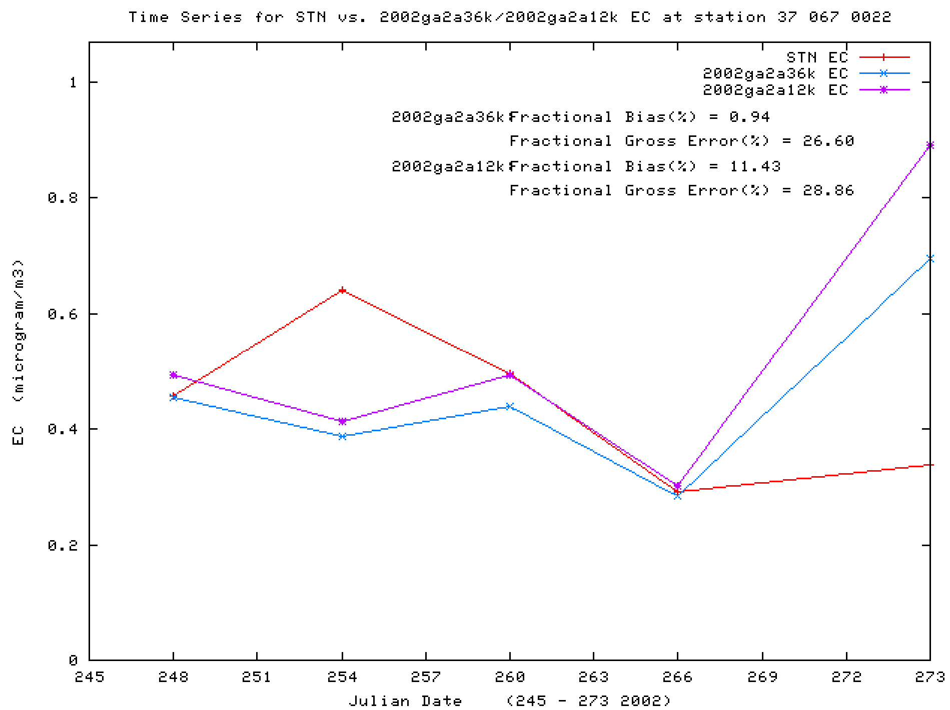


Figure 5-114: September 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.10 October

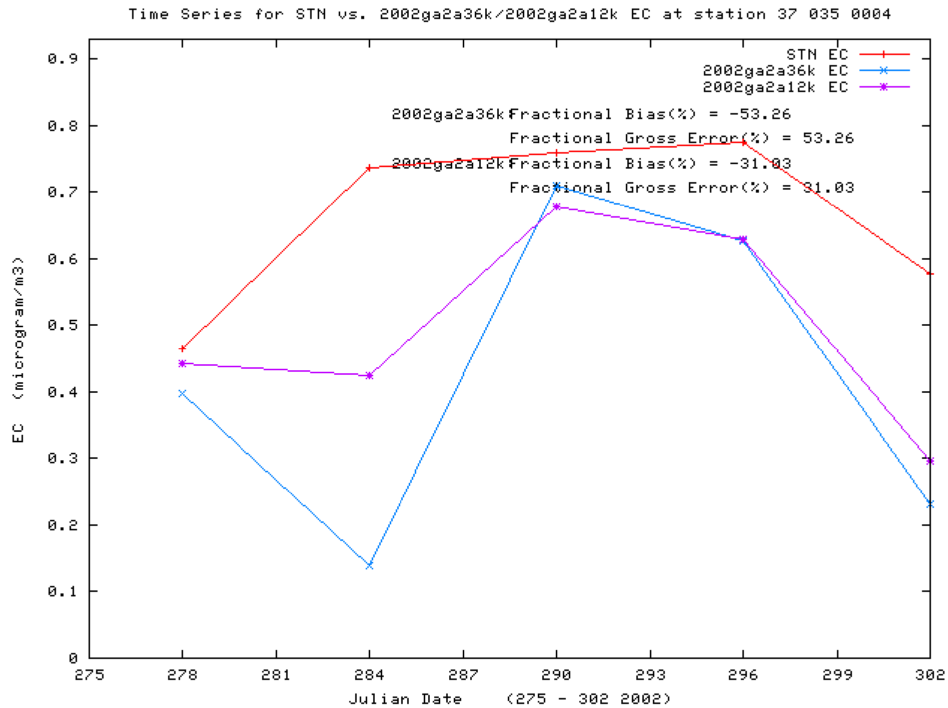


Figure 5-115: October 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

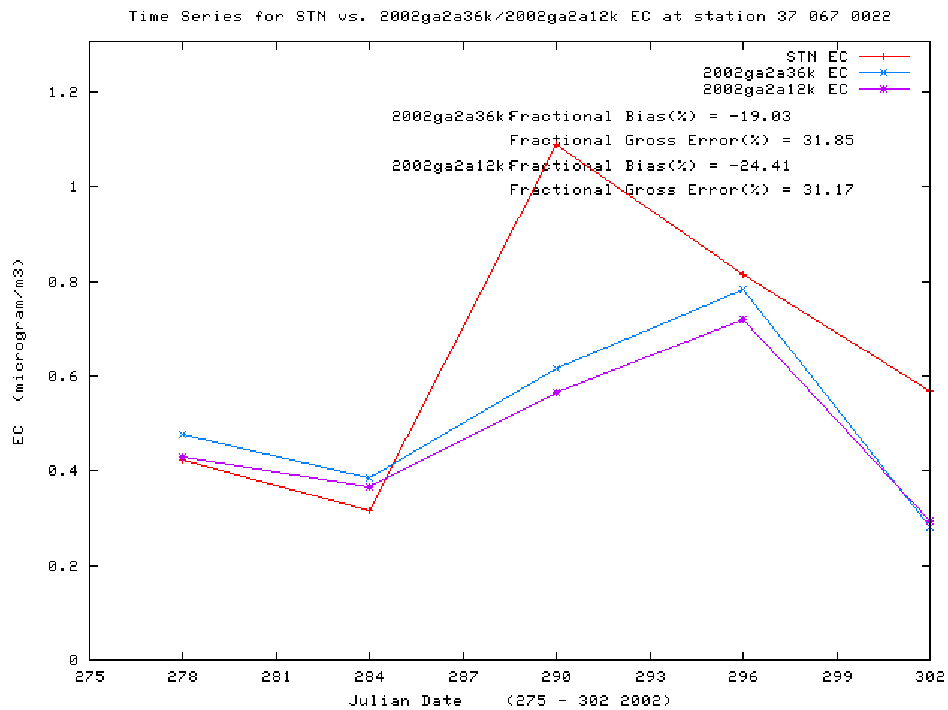


Figure 5-116: October 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.11 November

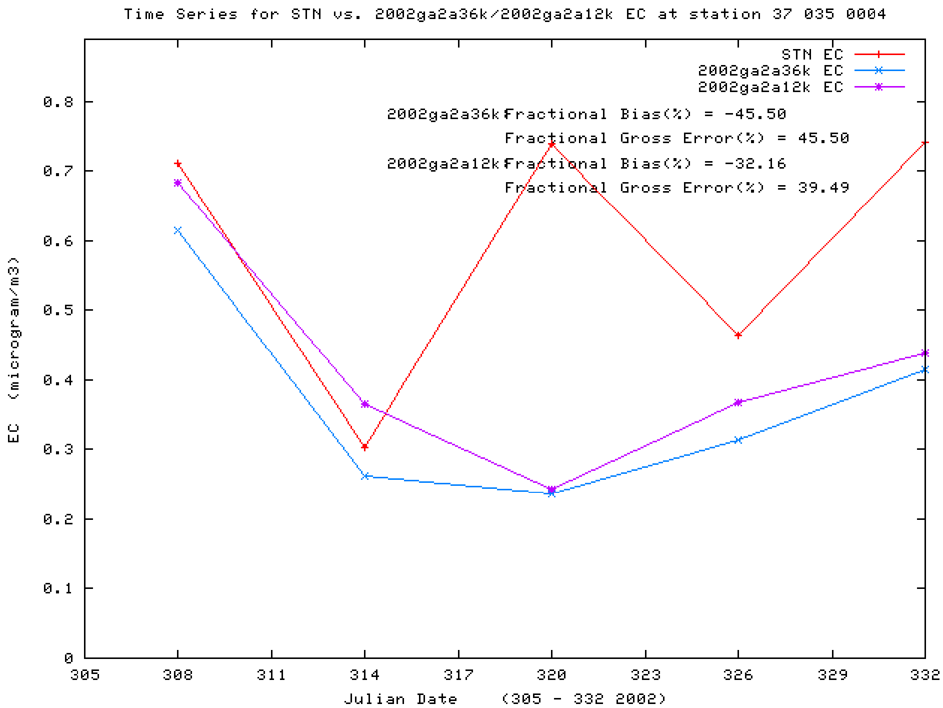


Figure 5-117: November 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

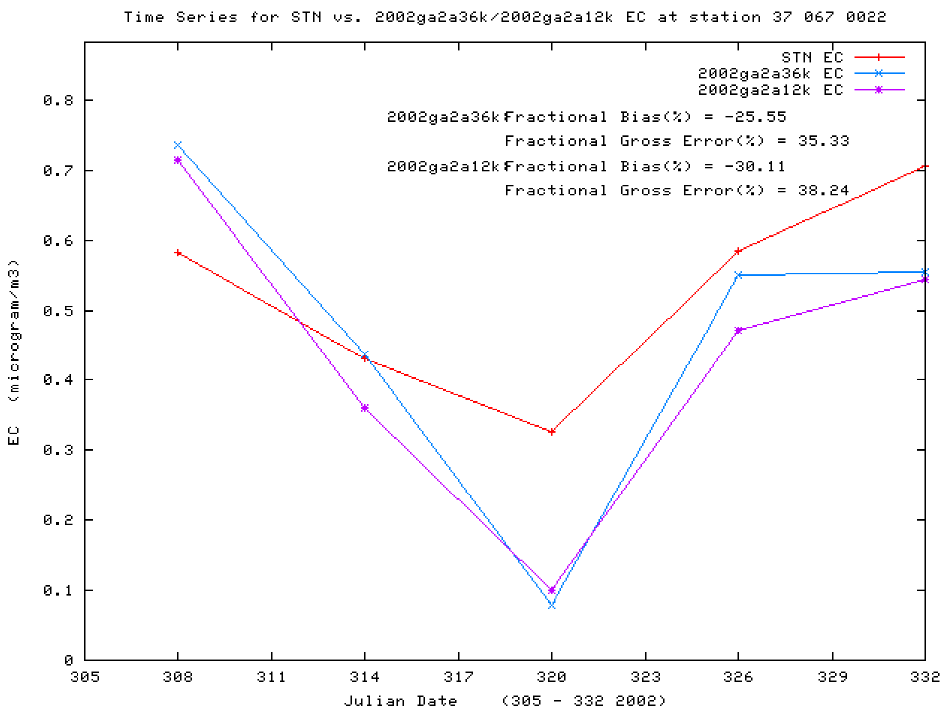


Figure 5-118: November 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.5.12 December

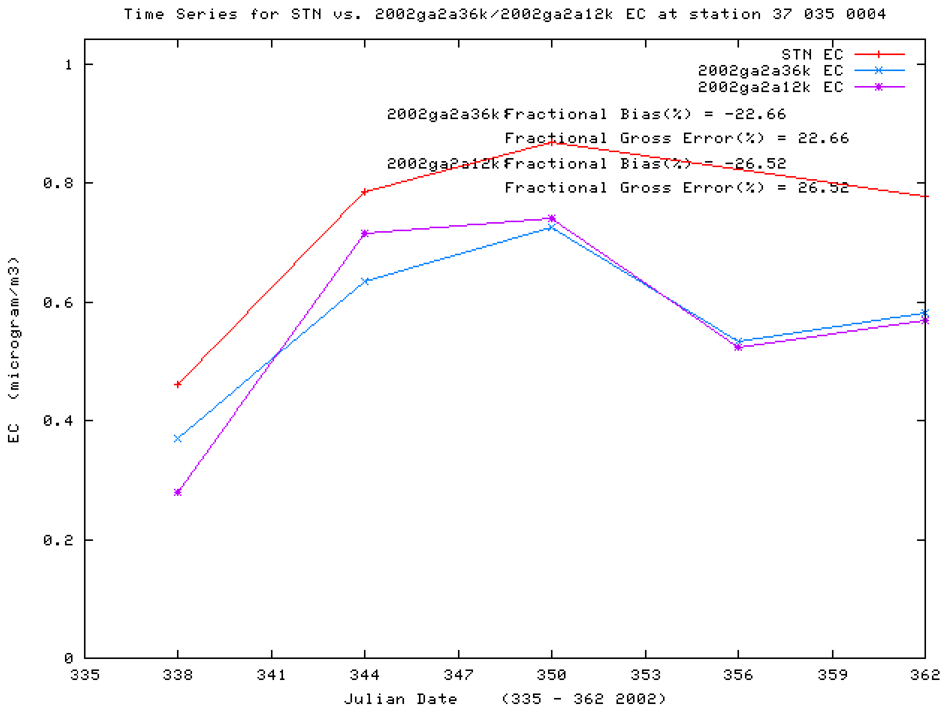


Figure 5-119: December 2002Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

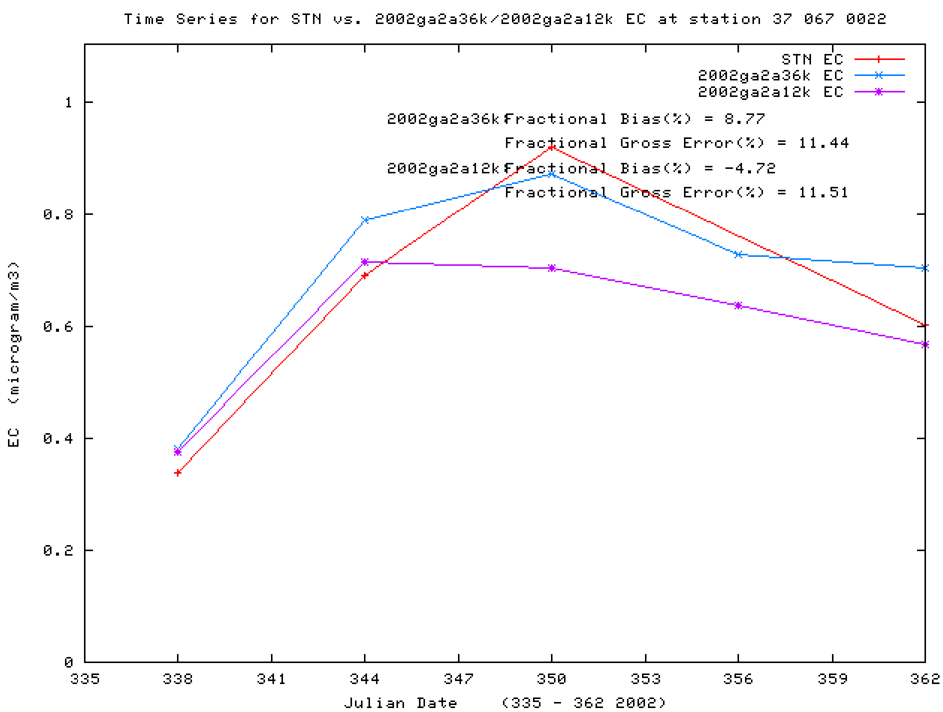


Figure 5-120: December 2002 Time Series of Observed Elemental Carbon levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6 Total $PM_{2.5}$

5.1.6.1 January

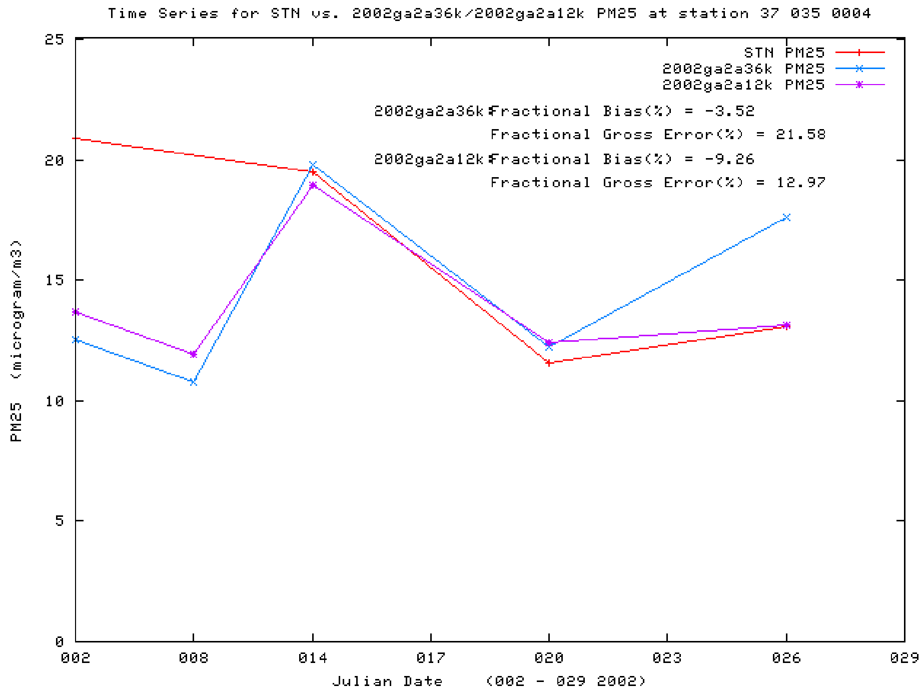


Figure 5-121: January 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

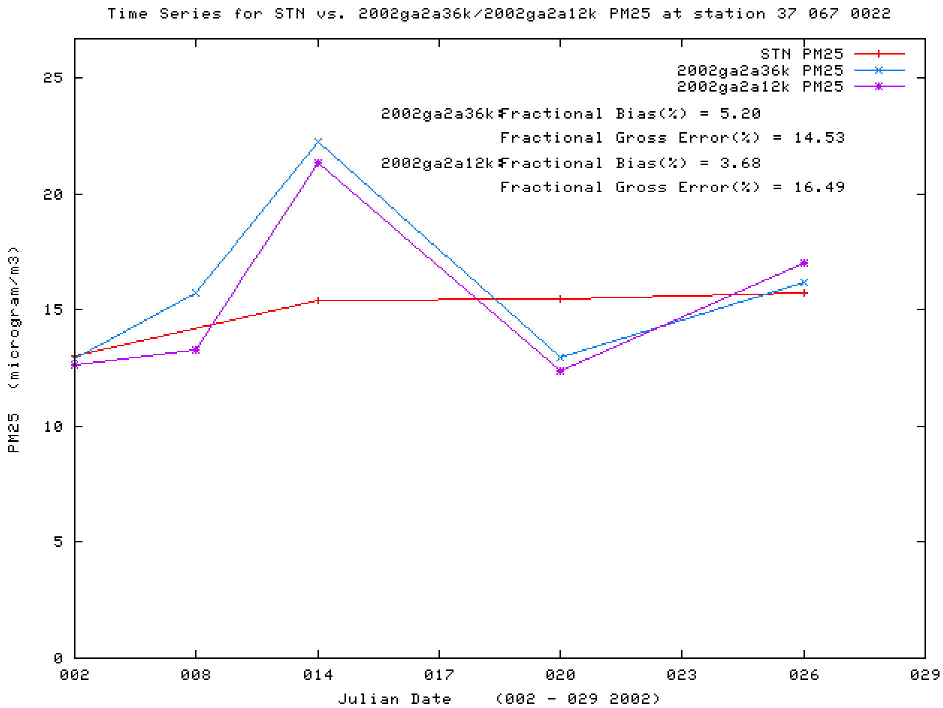


Figure 5-122: January 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.2 February

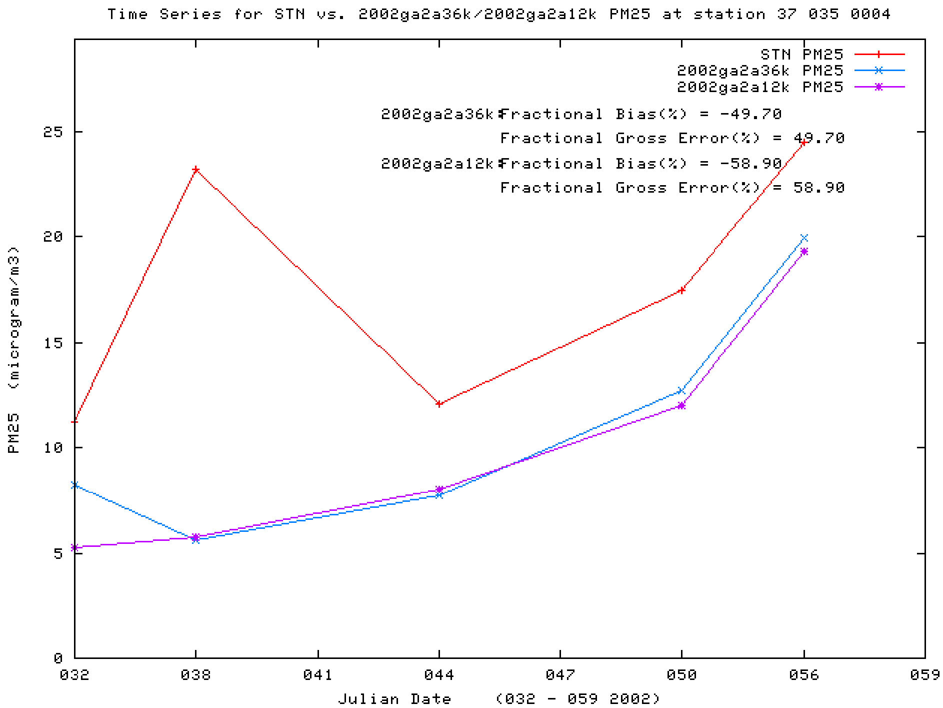


Figure 5-123: February 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

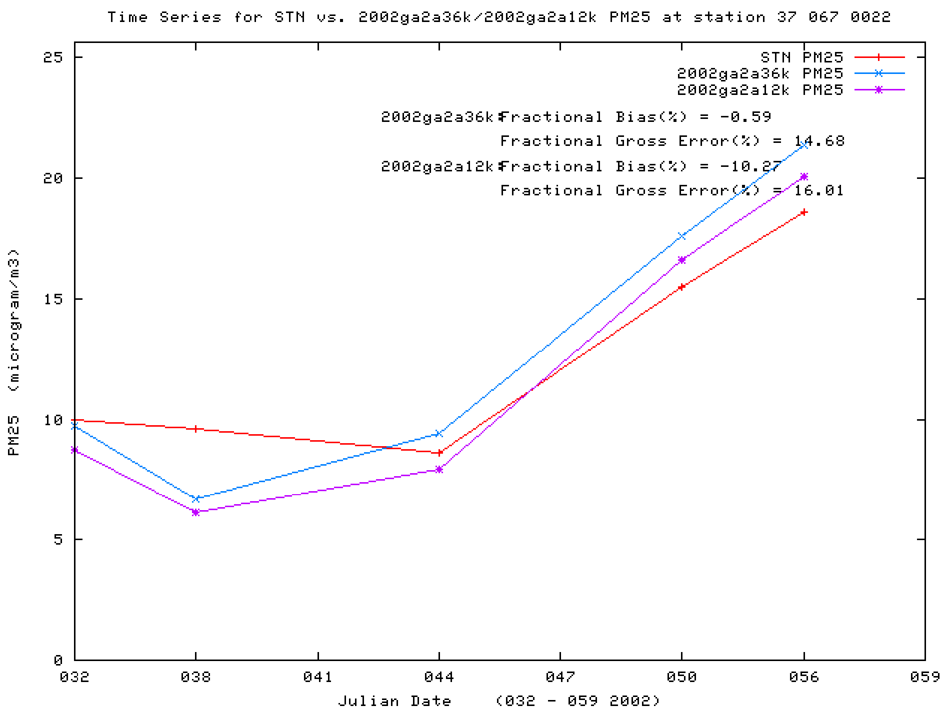


Figure 5-124: February 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.3 March

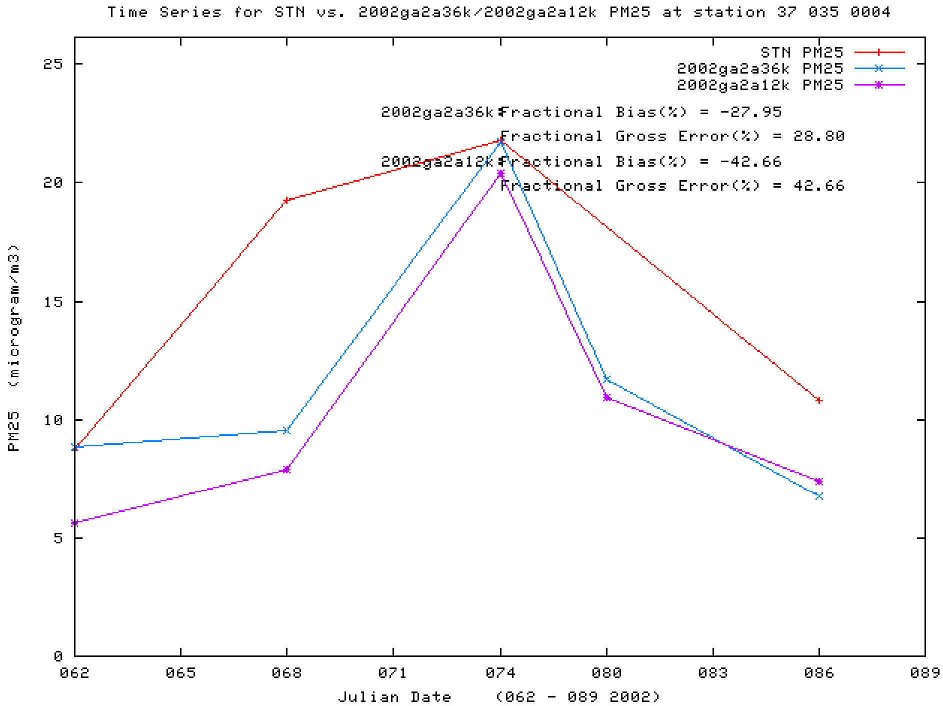


Figure 5-125: March 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

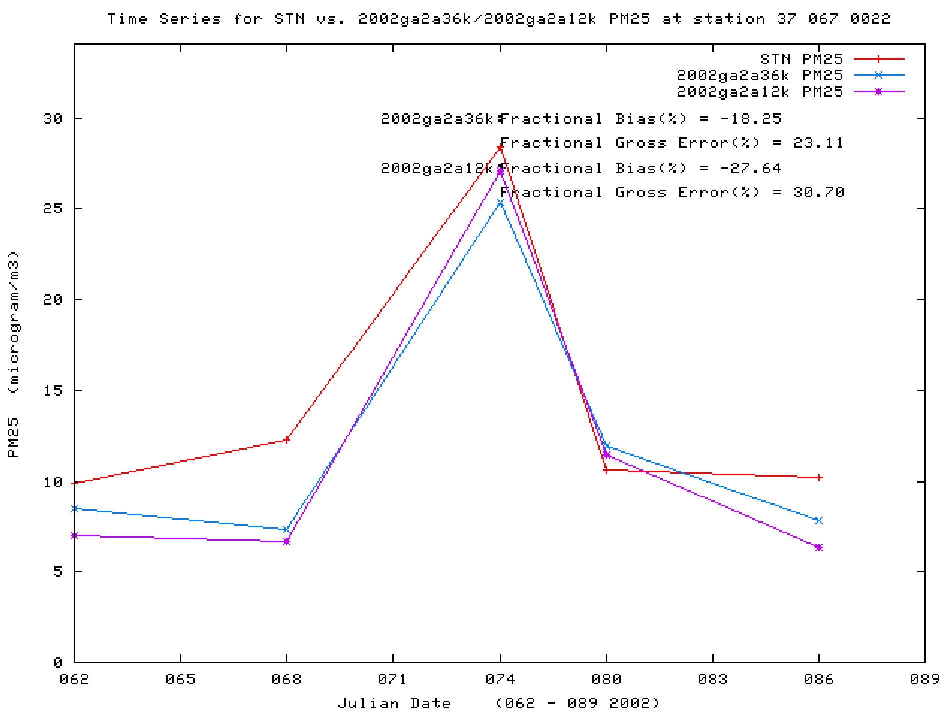


Figure 5-126: March 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.4 April

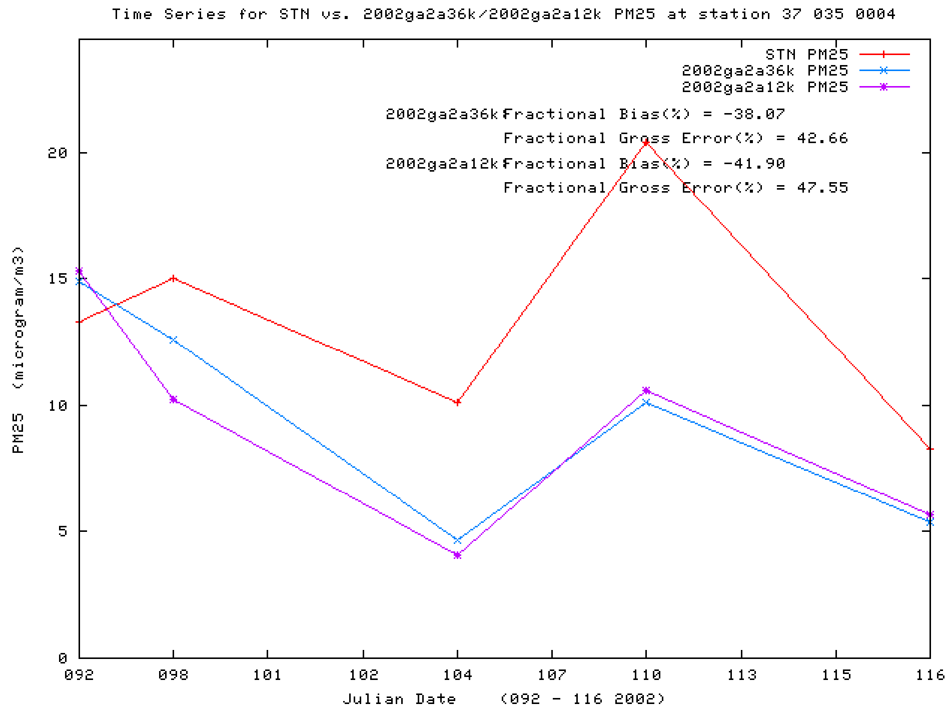


Figure 5-127: April 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

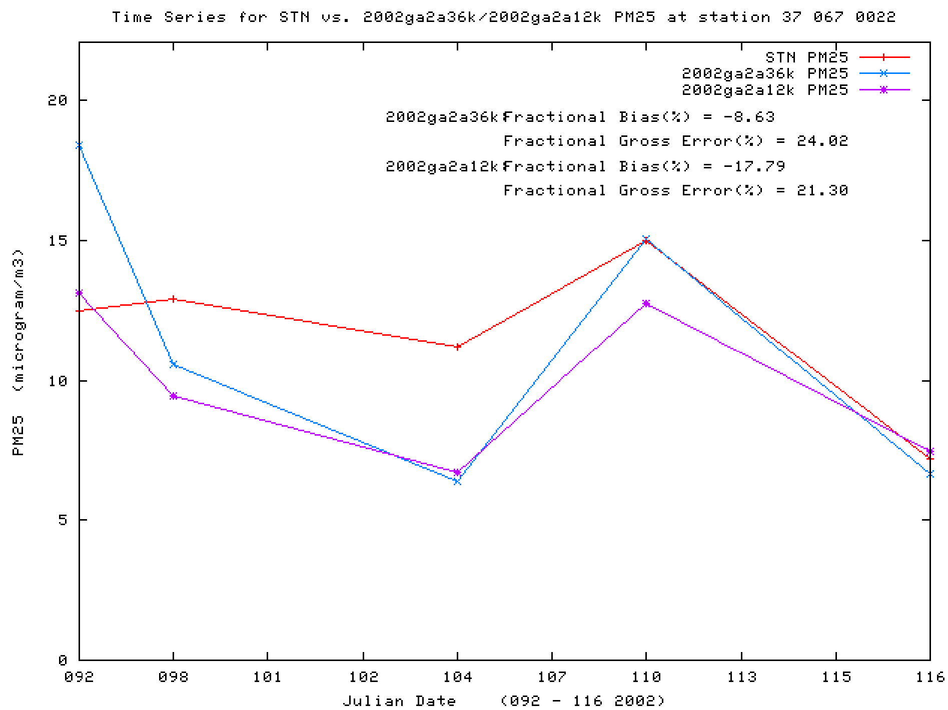


Figure 5-128: April 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.5 May

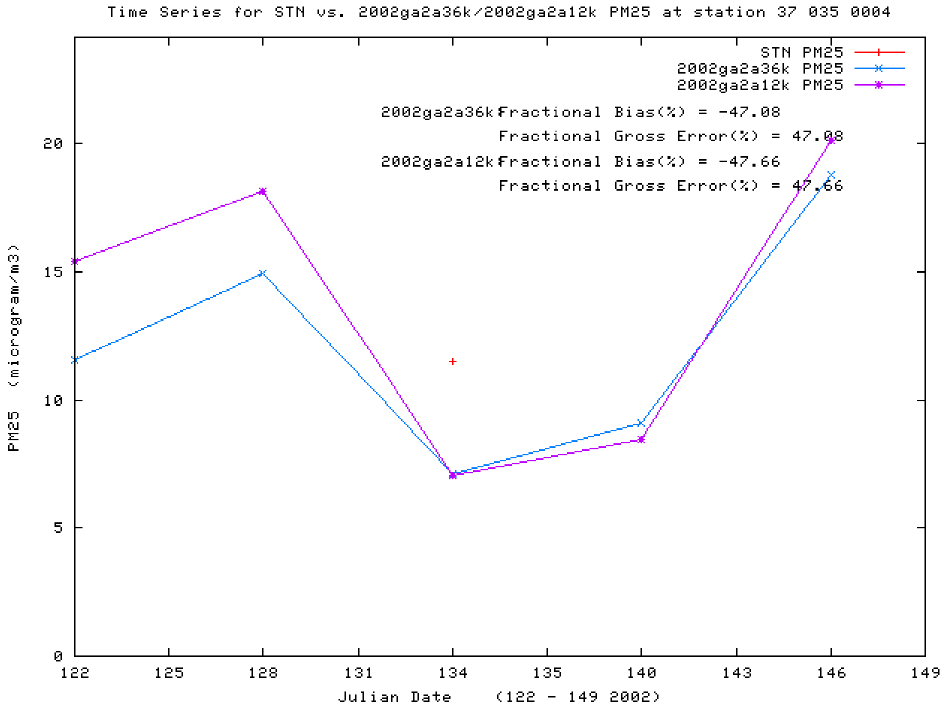


Figure 5-129: May 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

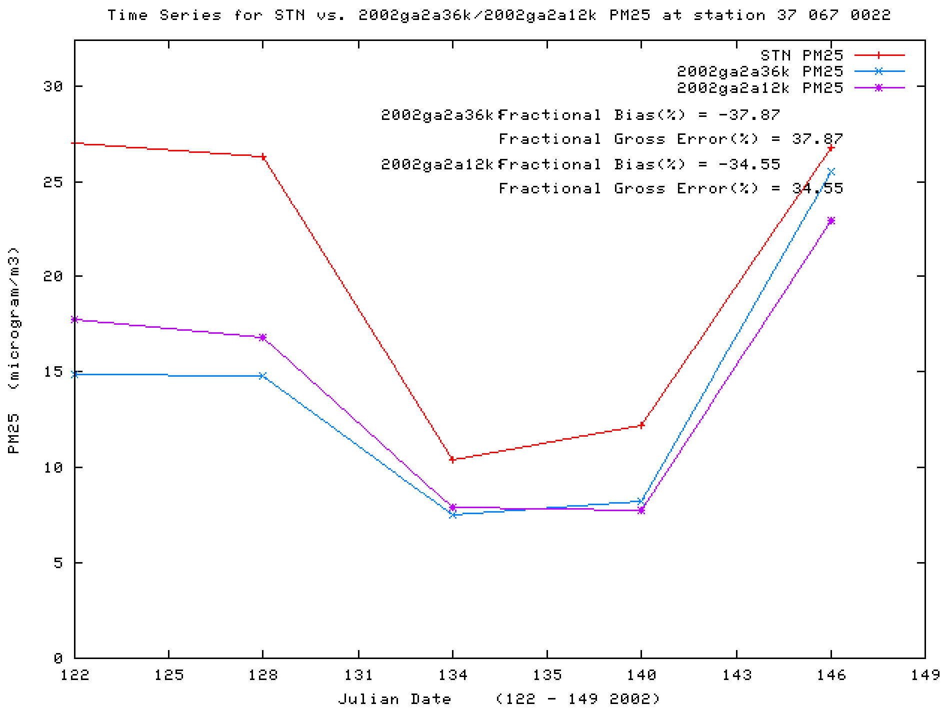


Figure 5-130: May 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.6 June

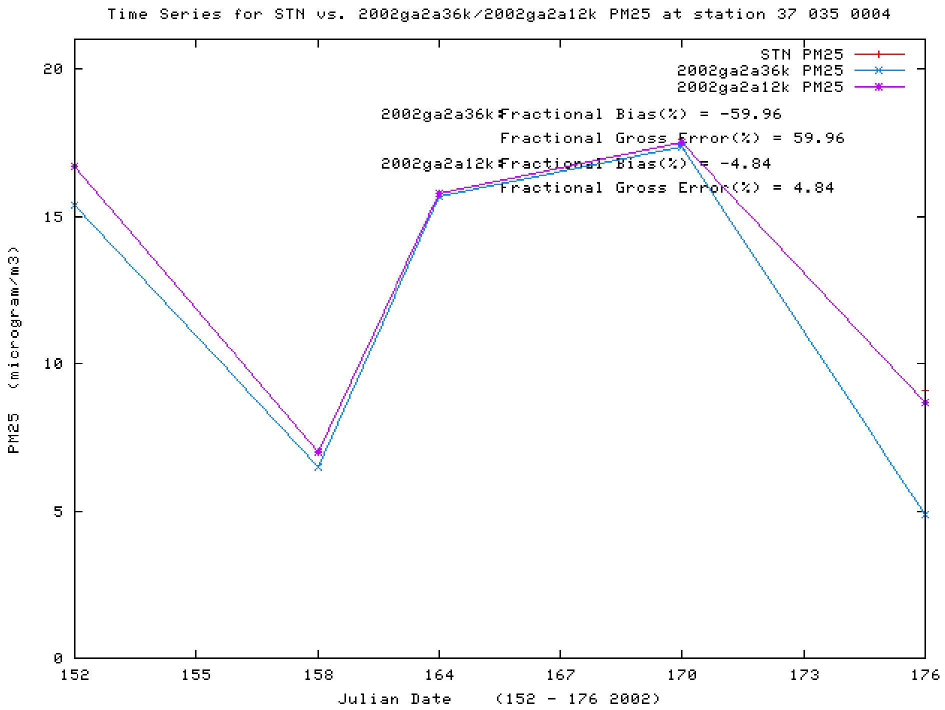


Figure 5-131: June 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

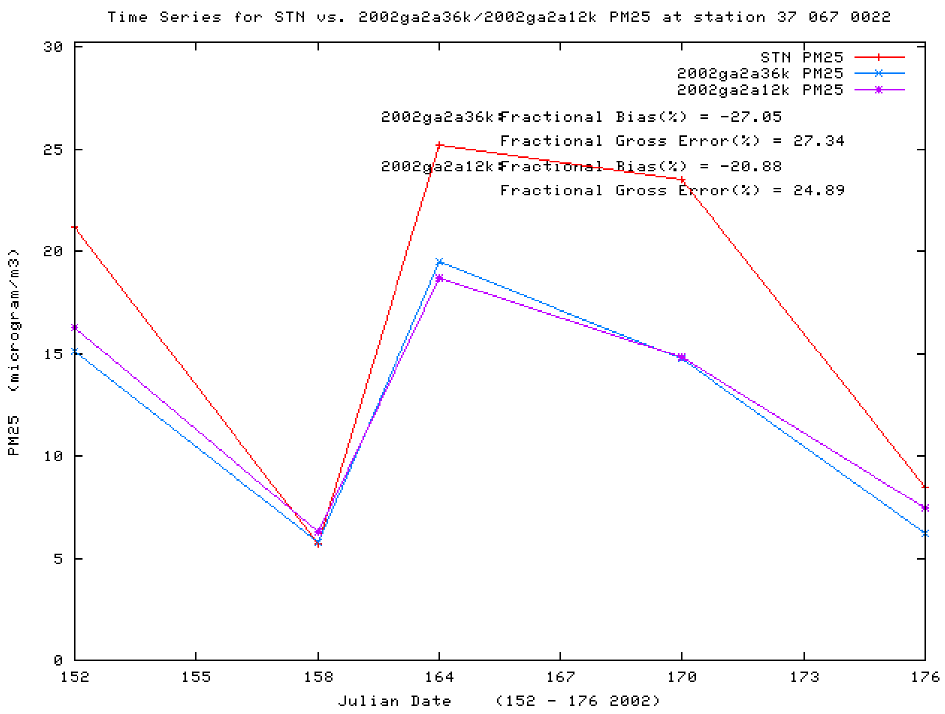


Figure 5-132: June 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.7 July

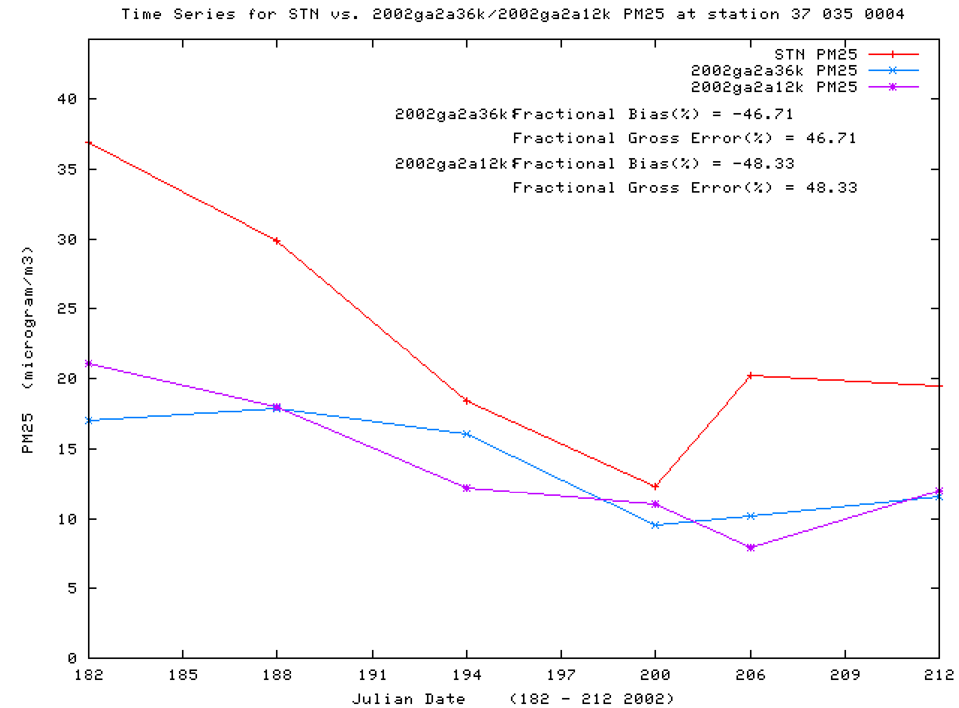


Figure 5-133: July 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

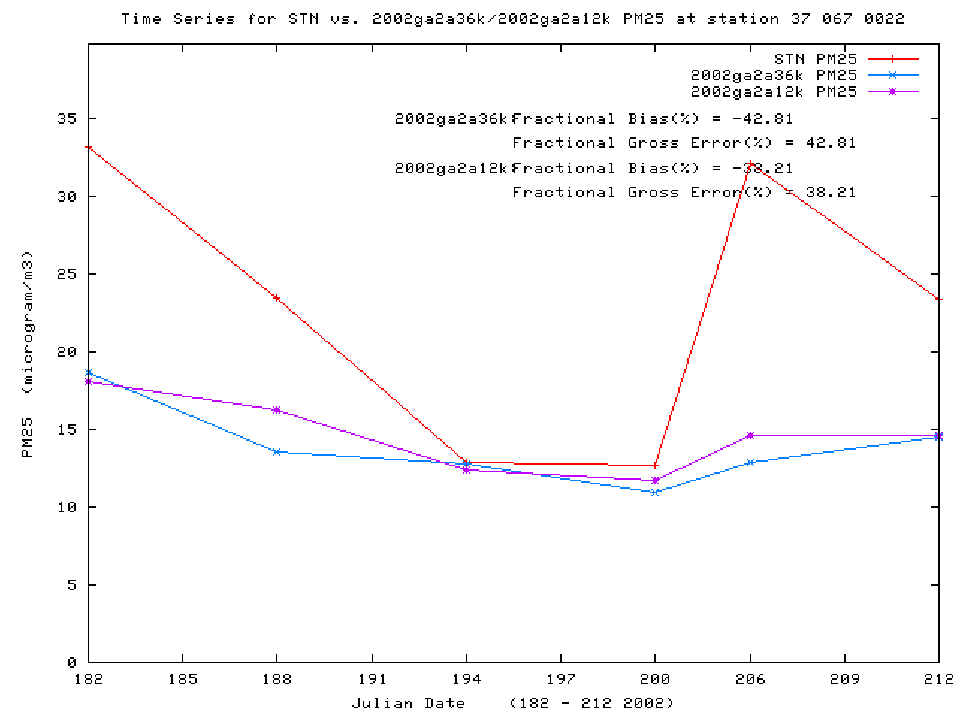


Figure 5-134: July 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.8 August

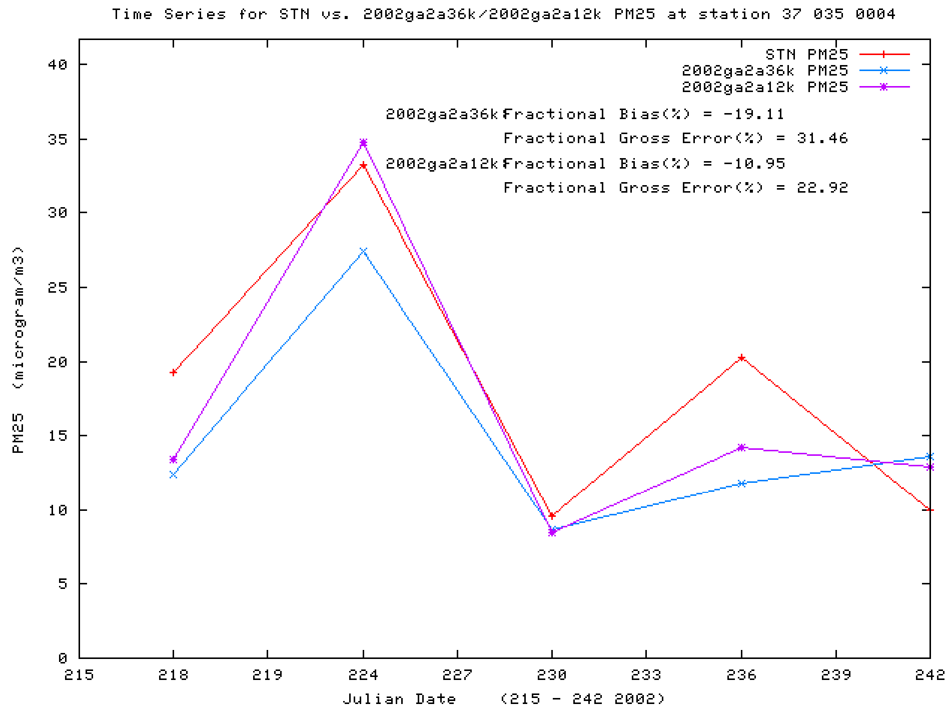


Figure 5-135: August 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

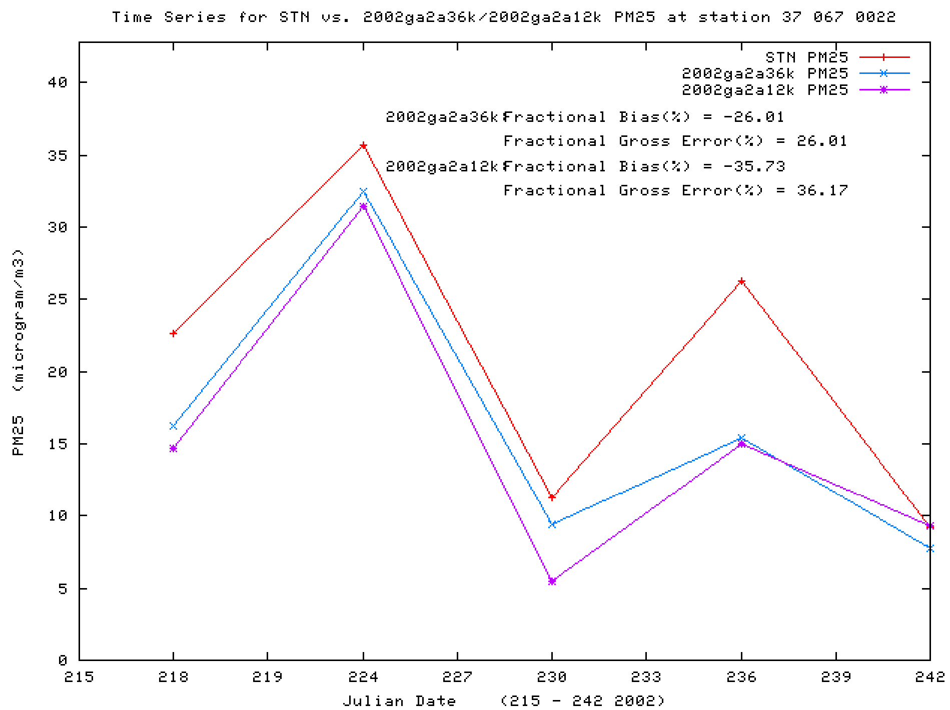


Figure 5-136: August 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.9 September

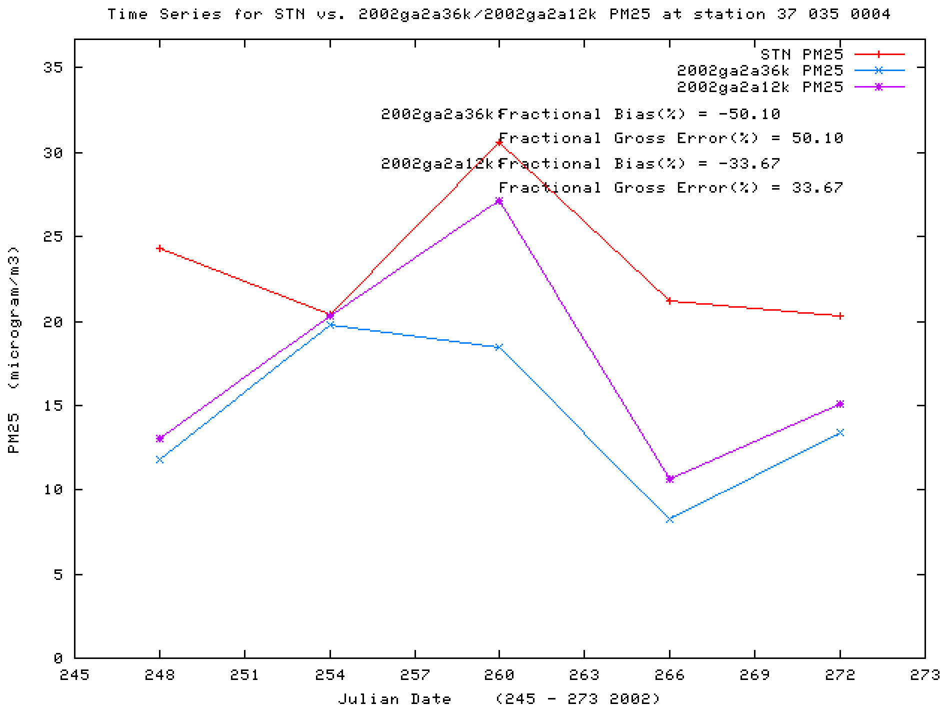


Figure 5-137: September 2002Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

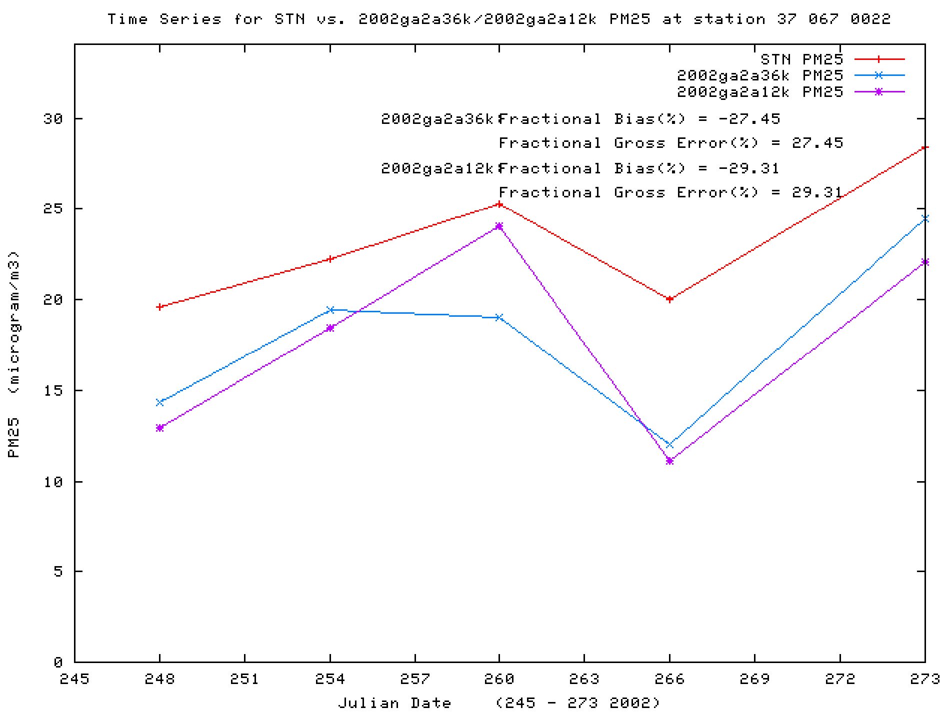


Figure 5-138: September 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.10 October

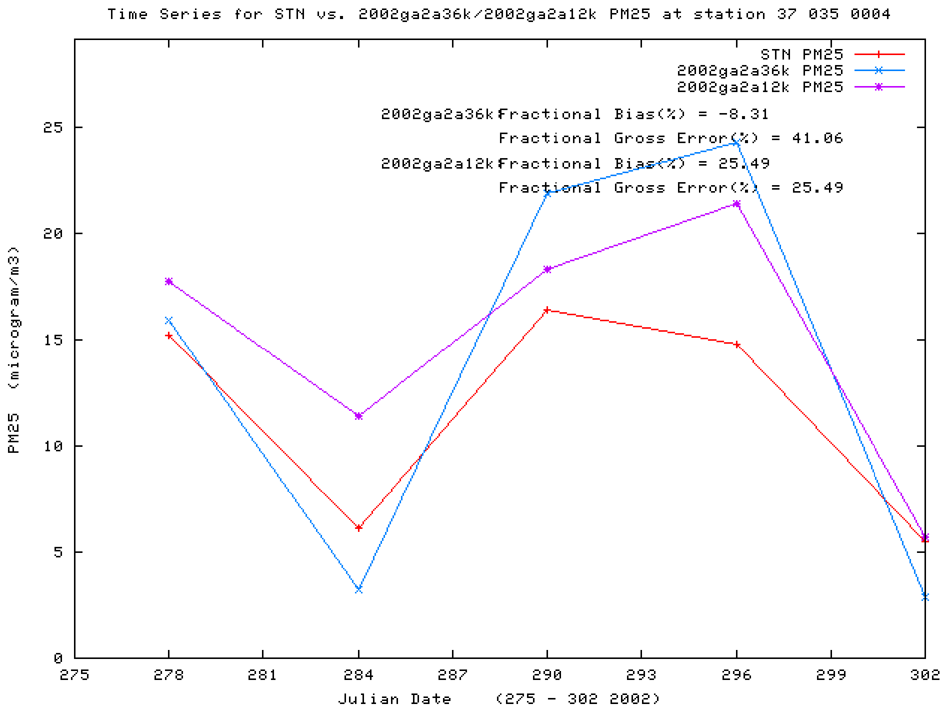


Figure 5-139: October 2002 Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

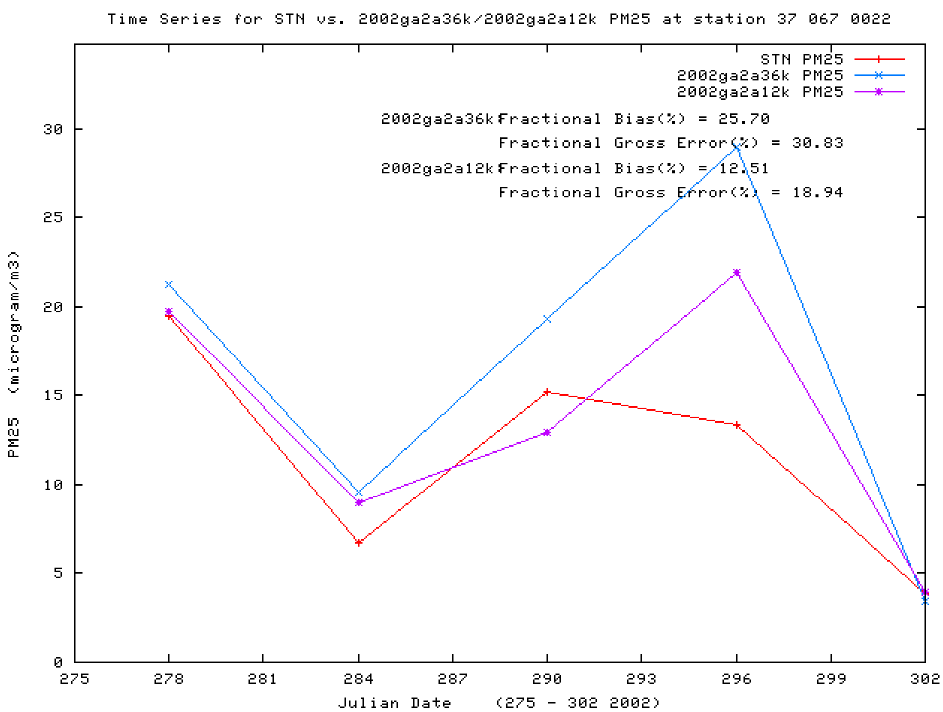


Figure 5-140: October 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.11 November

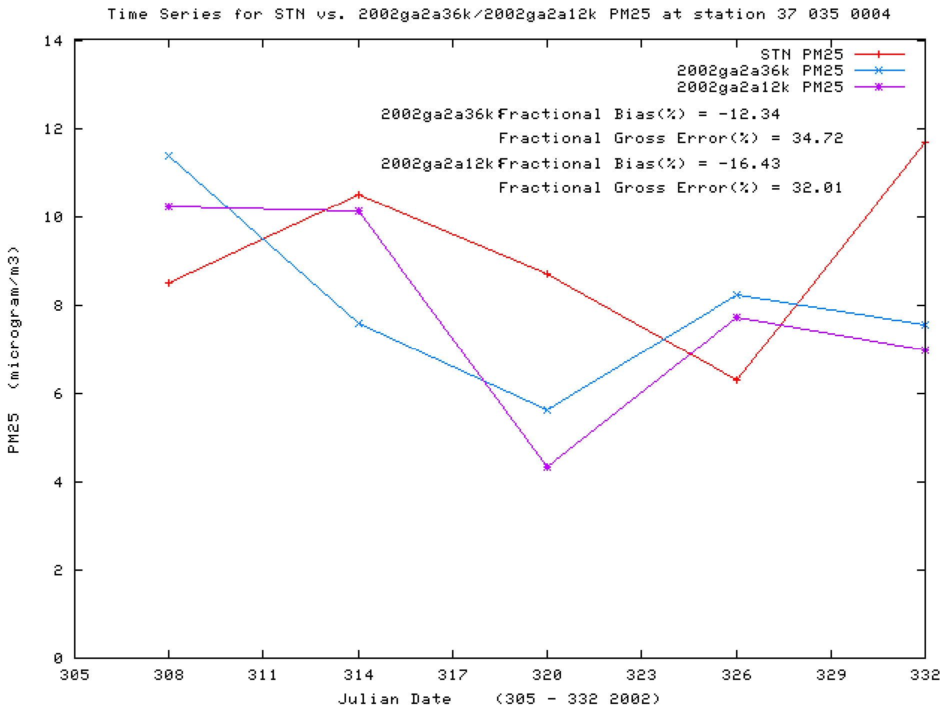


Figure 5-141: November 2002 Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

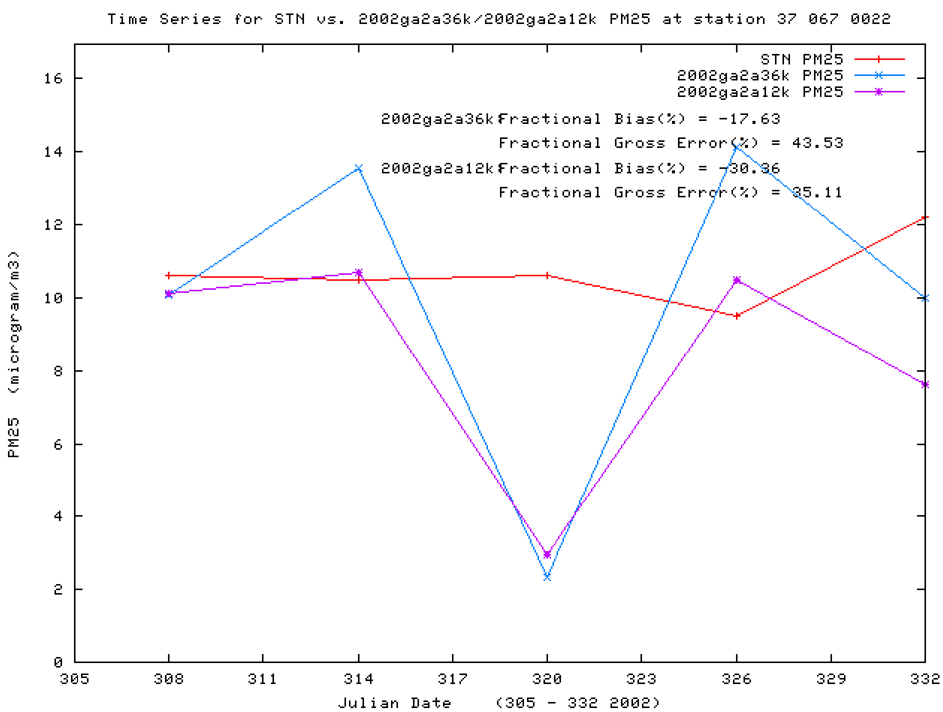


Figure 5-142: November 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.1.6.12 December

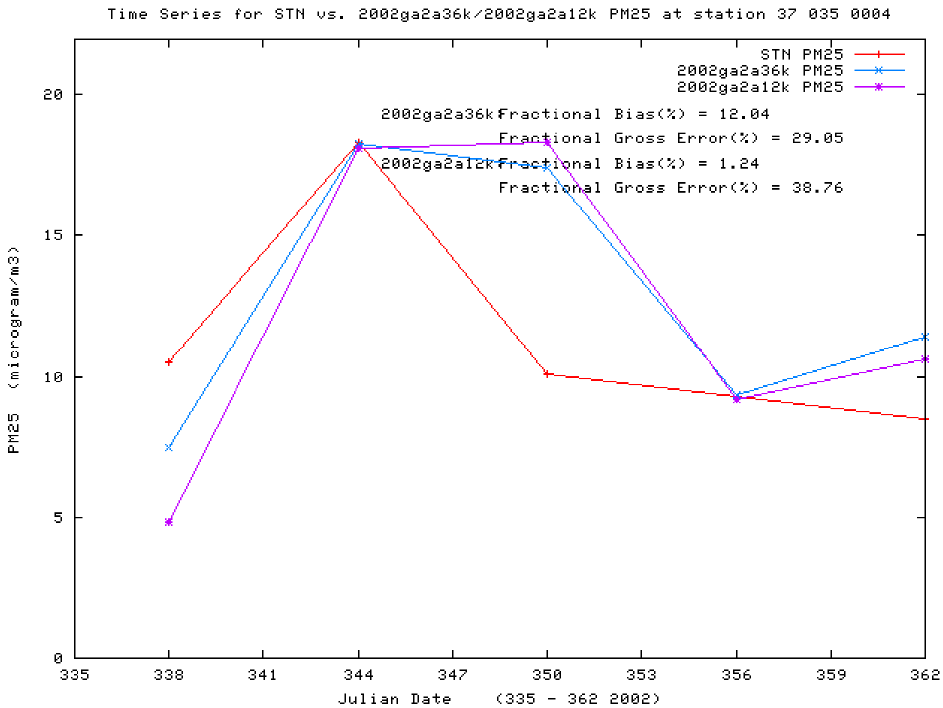


Figure 5-143: December 2002 Time Series of Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory STN monitor (37-035-0004).

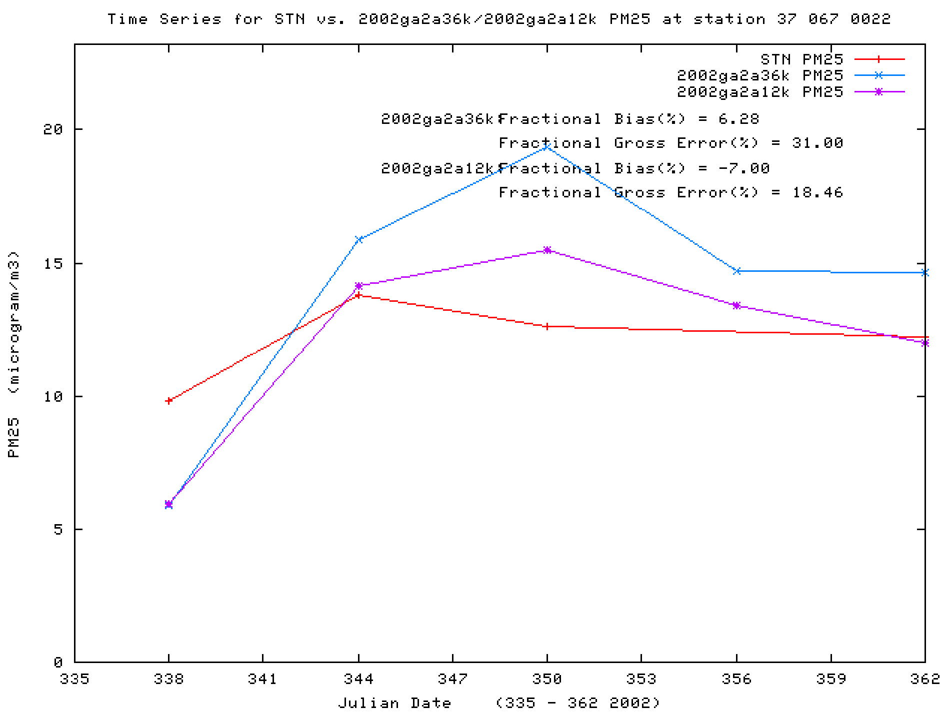


Figure 5-144: December 2002 Time Series of Observed Total Reconstructed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hattie Avenue STN monitor (37-067-0022).

5.2 FRM Scatter plots

5.2.1 January

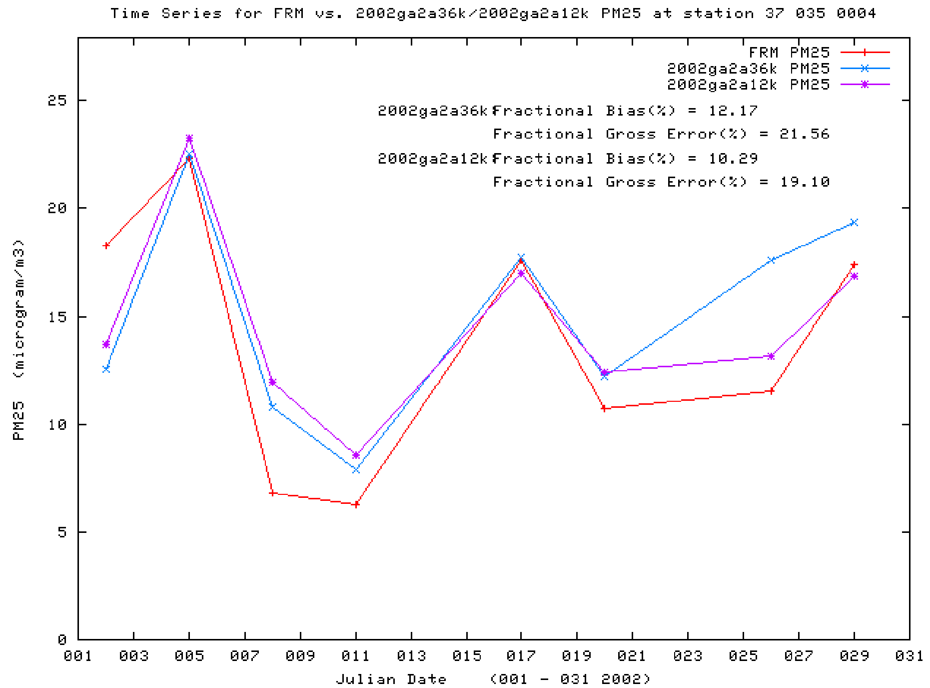


Figure 5-145: January 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

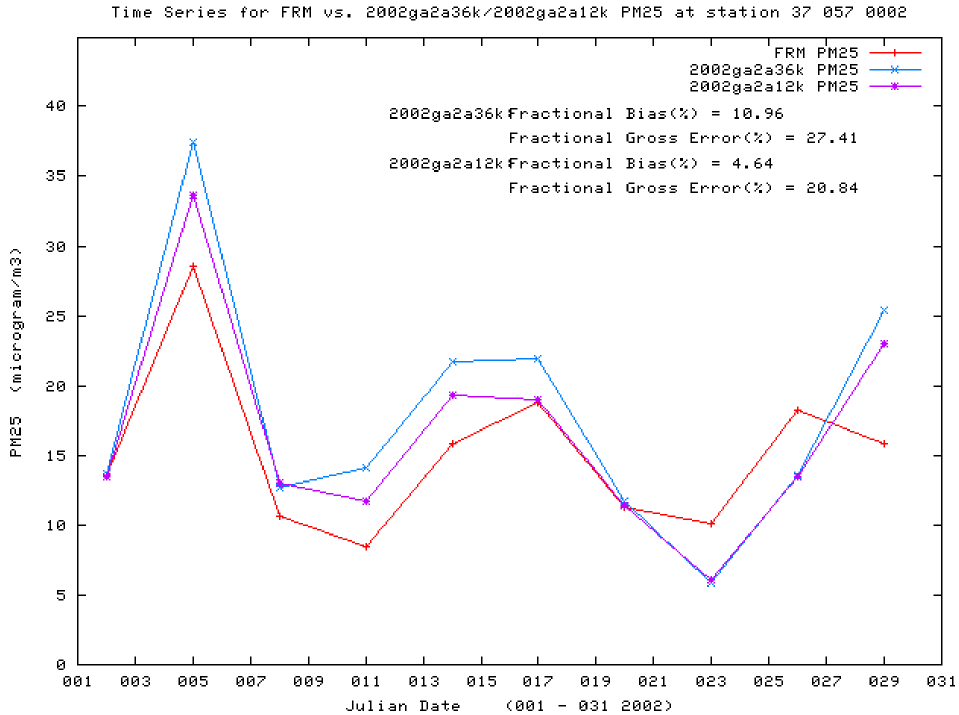


Figure 5-146: January 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

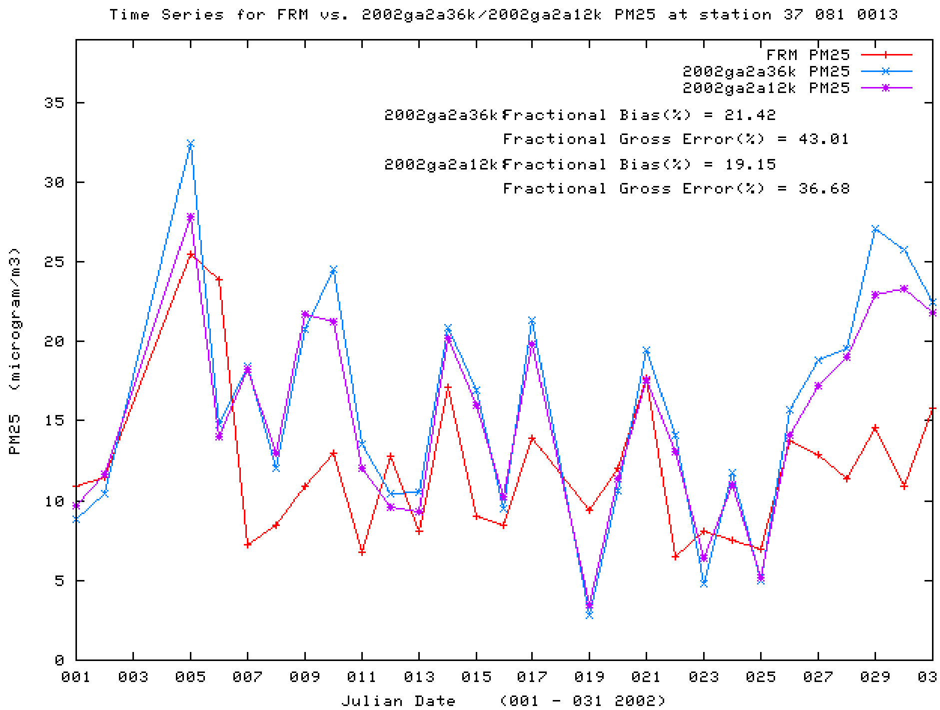


Figure 5-147: January 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.2 February

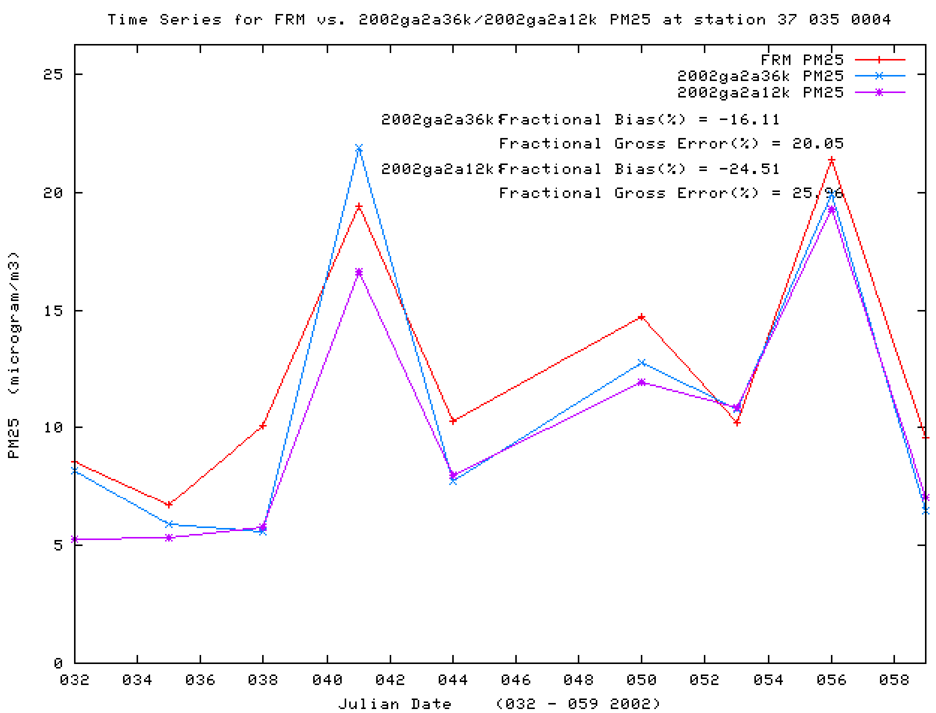


Figure 5-148: February 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

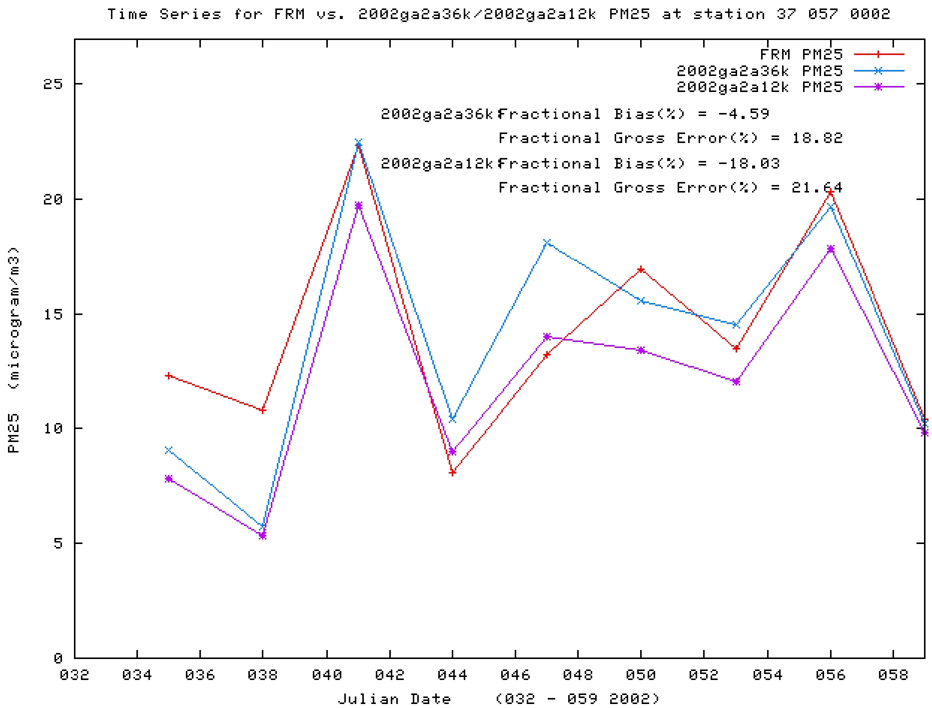


Figure 5-149: February 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

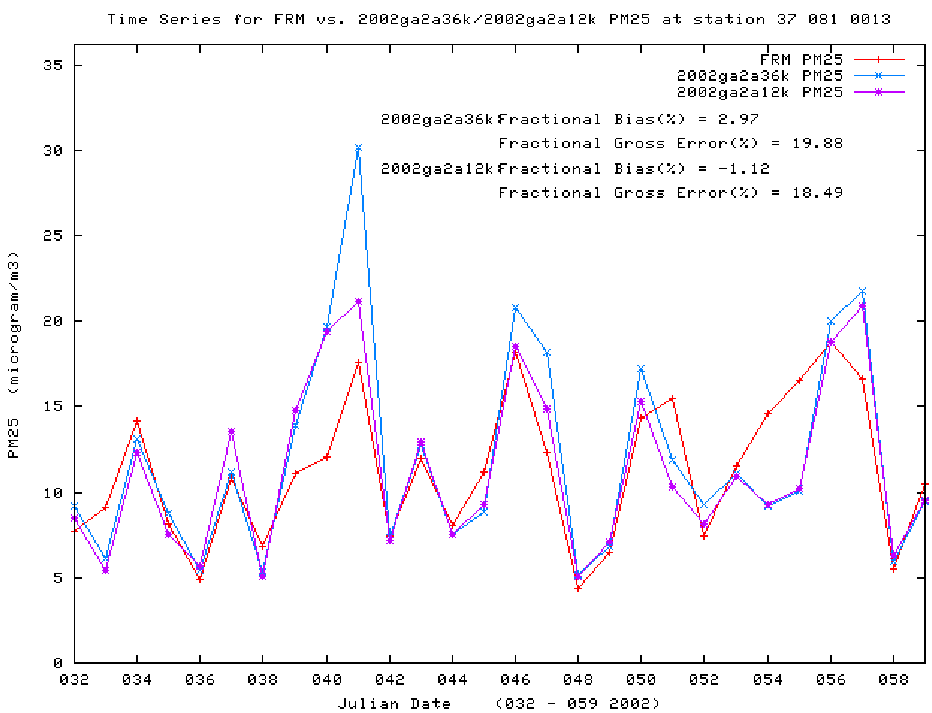


Figure 5-150: February 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.3 March

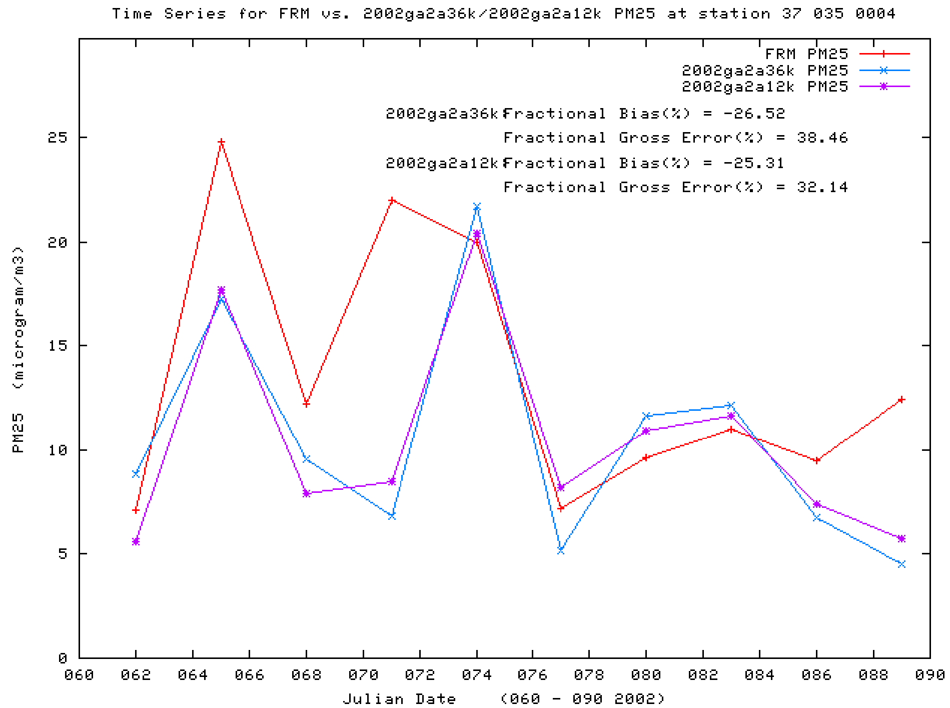


Figure 5-151: March 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004)

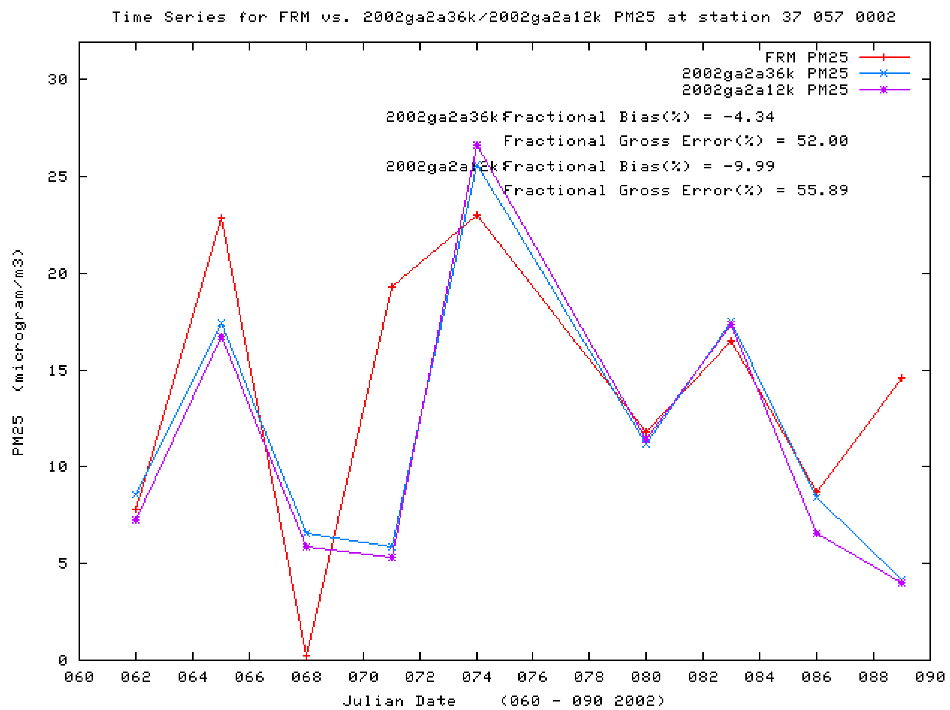


Figure 5-152: March 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

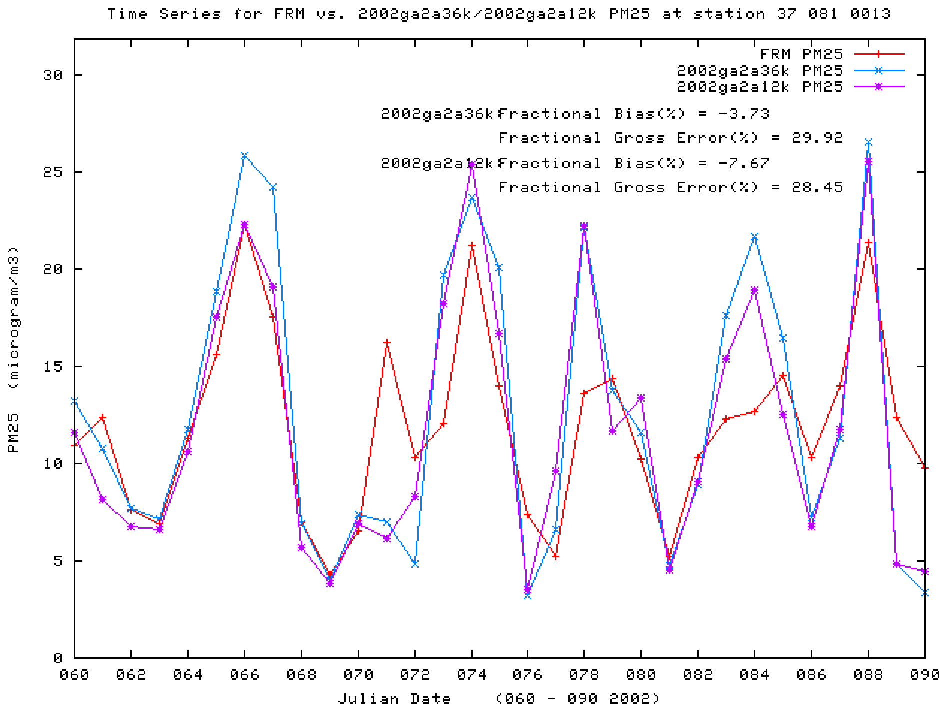


Figure 5-153: March 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.4 April

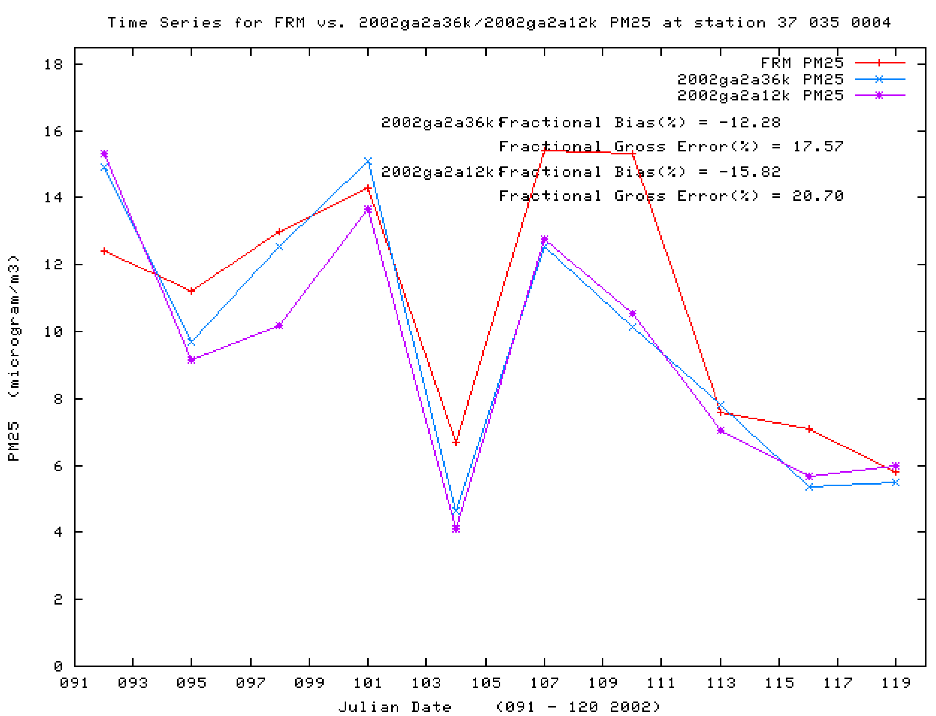


Figure 5-154: April 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

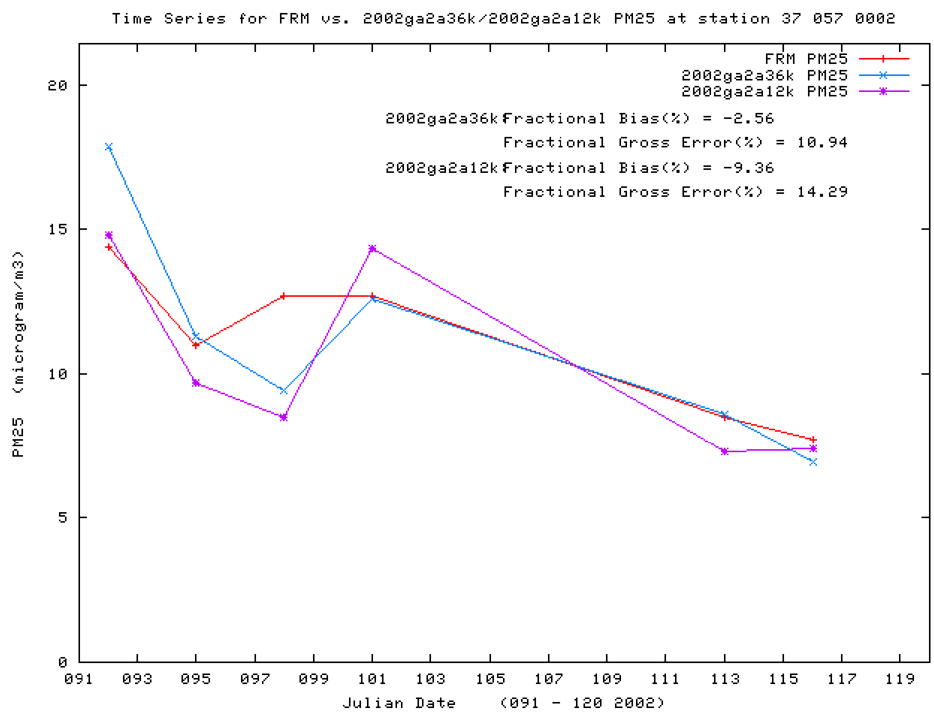


Figure 5-155: April 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

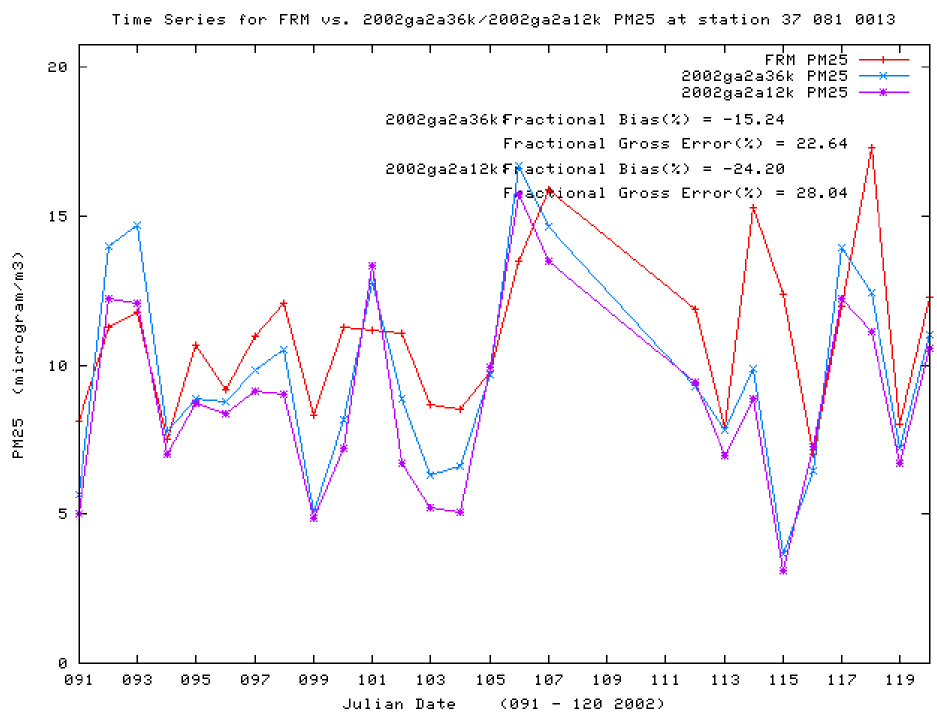


Figure 5-156: April 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.5 May

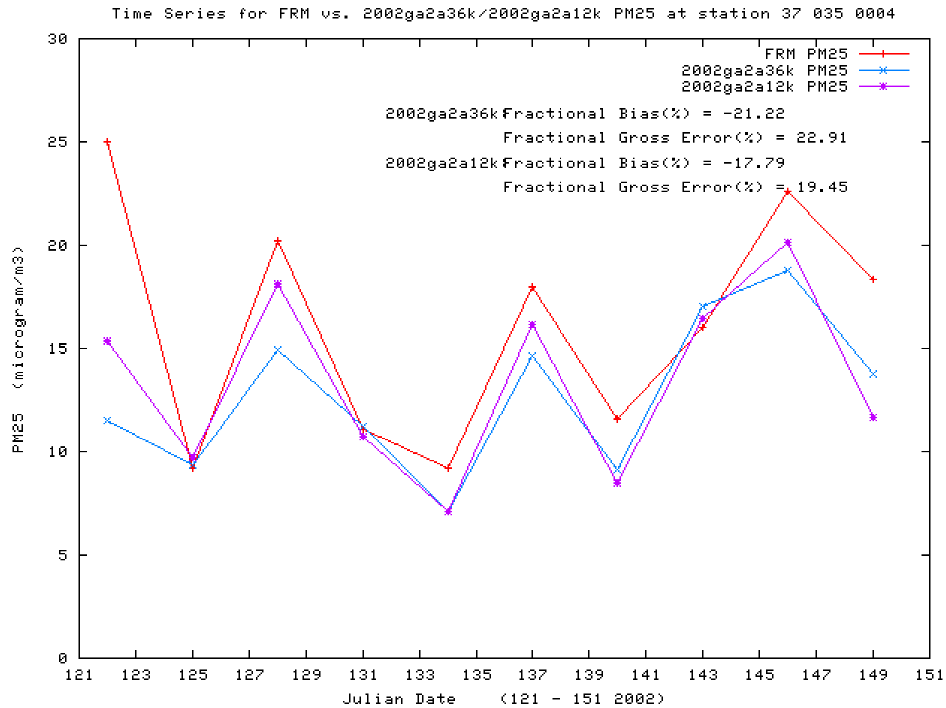


Figure 5-157: May 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

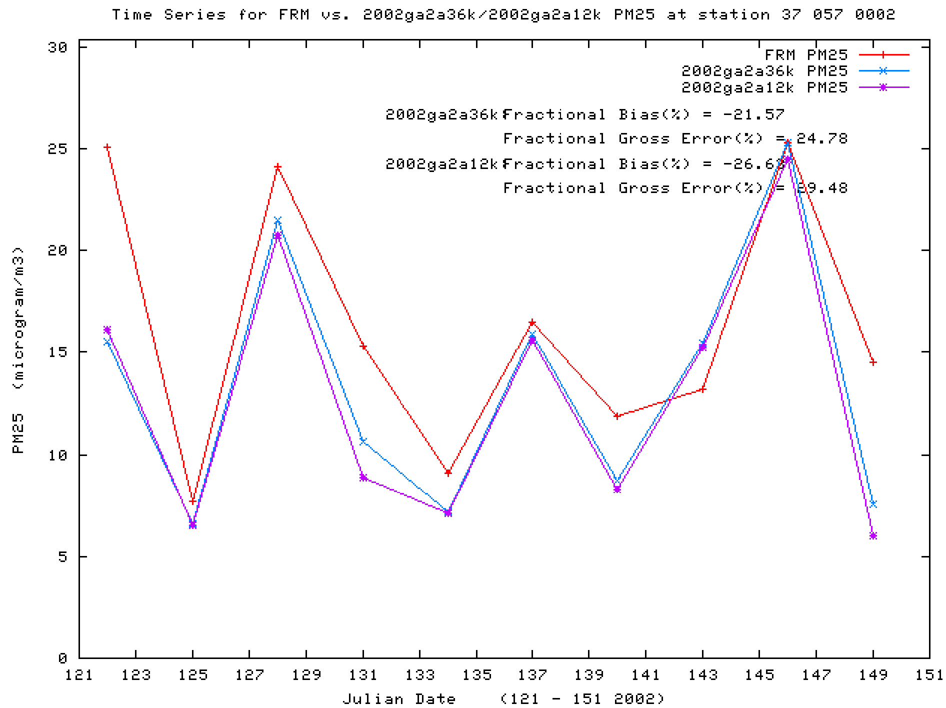


Figure 5-158: May 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

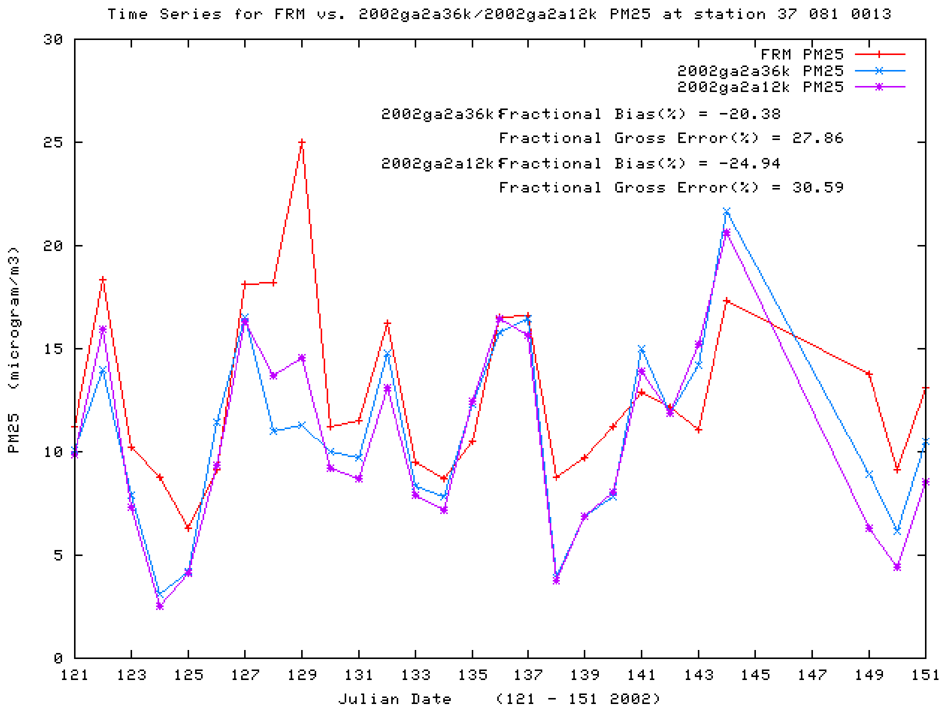


Figure 5-159: May 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.6 June

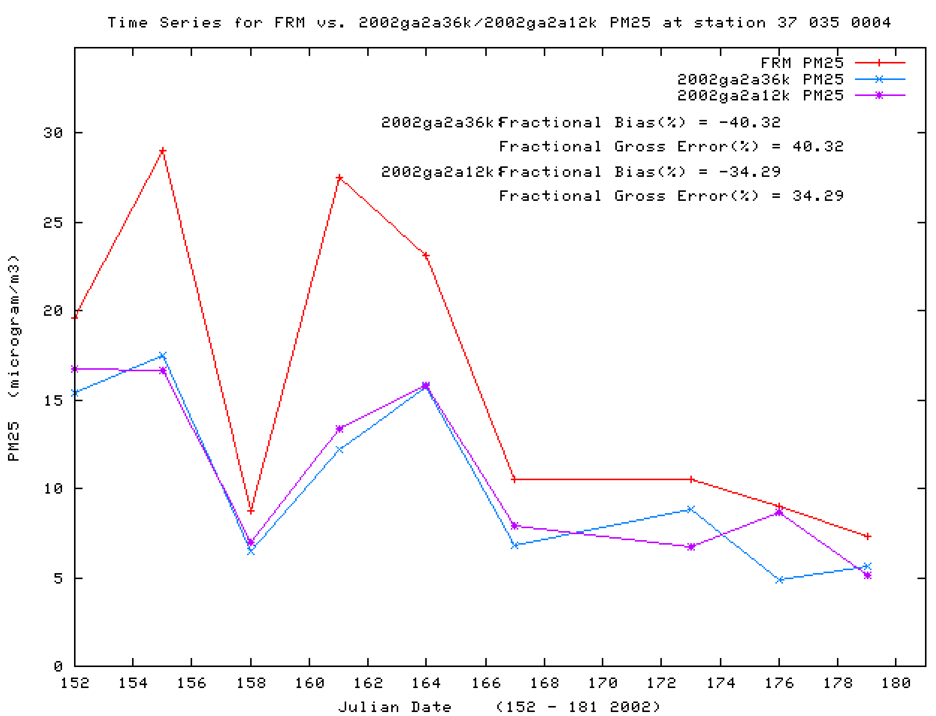


Figure 5-160: June 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

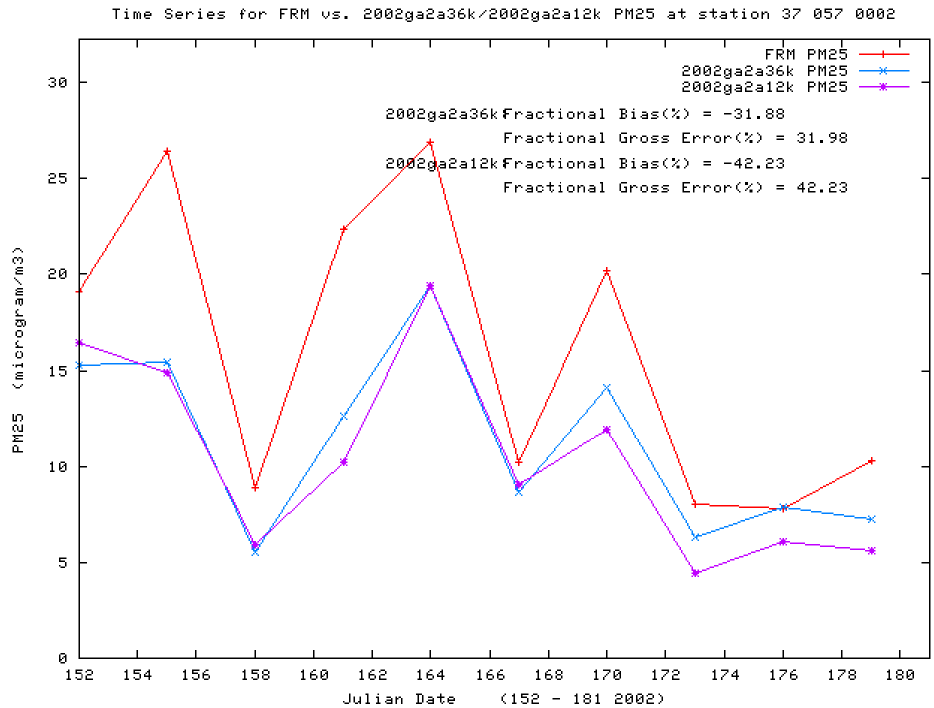


Figure 5-161: June 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

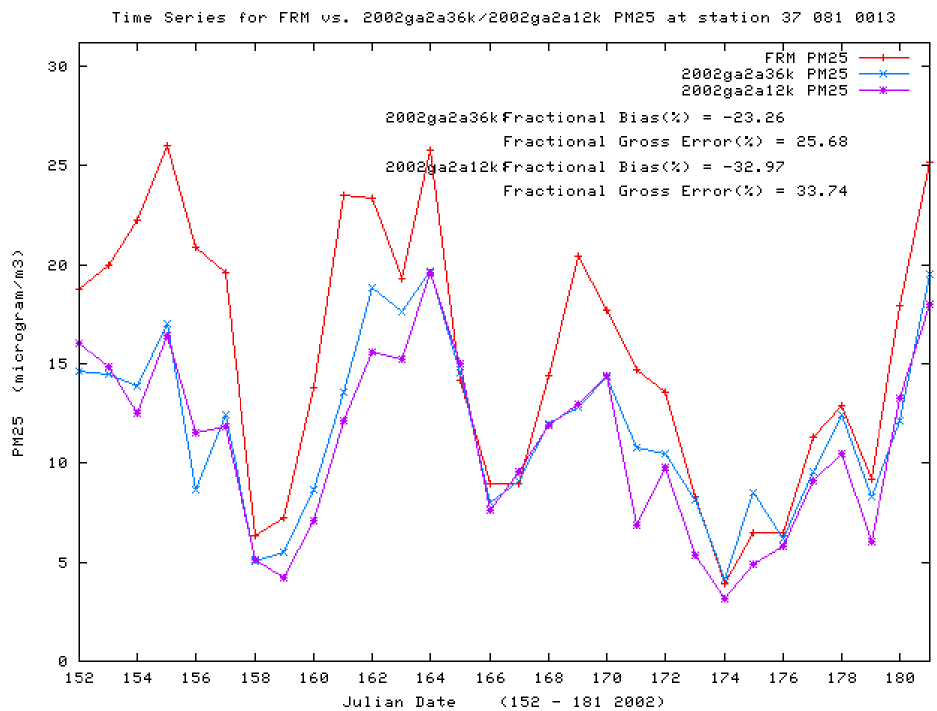


Figure 5-162: June 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.7 July

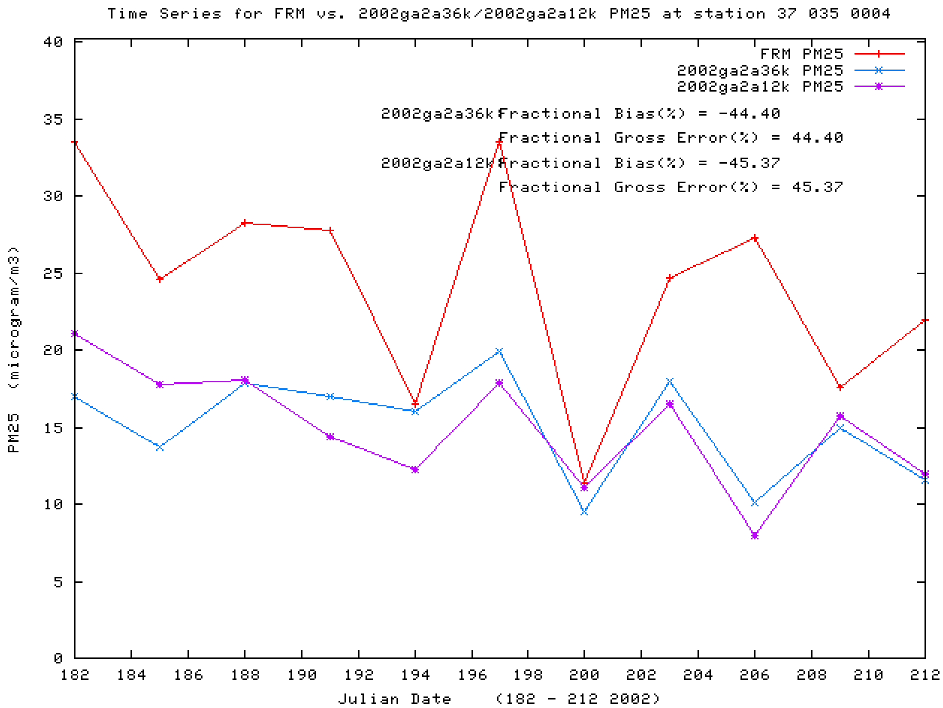


Figure 5-163: July 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

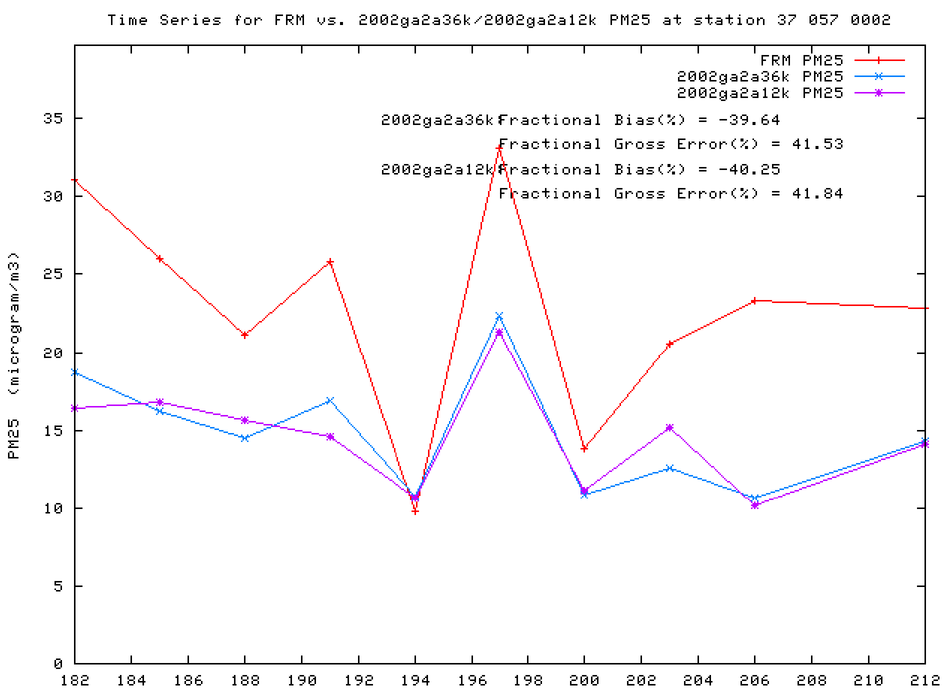


Figure 5-164: July 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

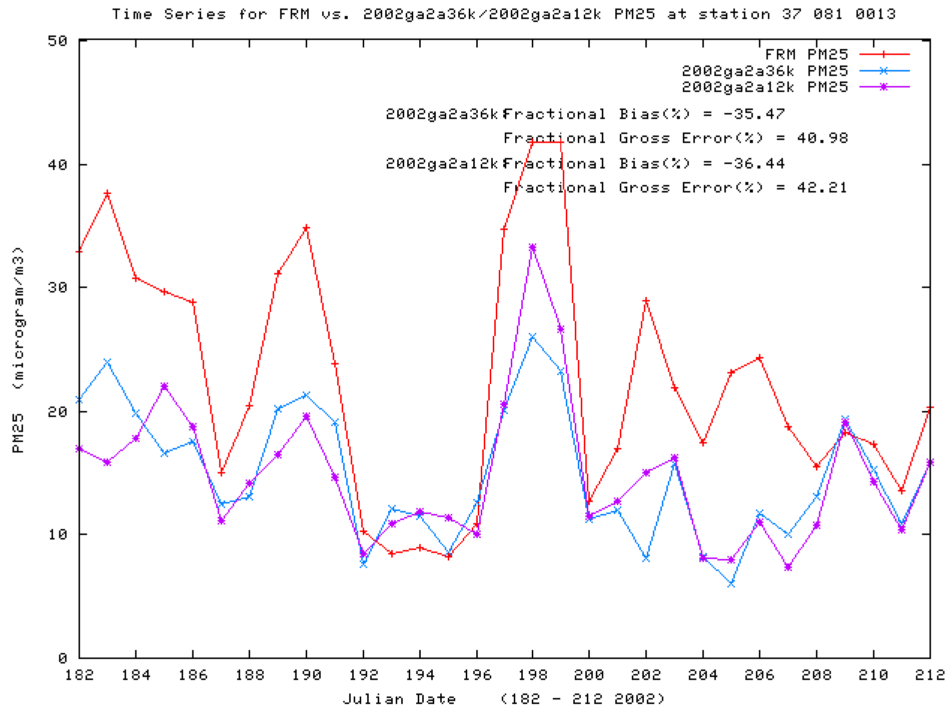


Figure 5-165: July 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.8 August

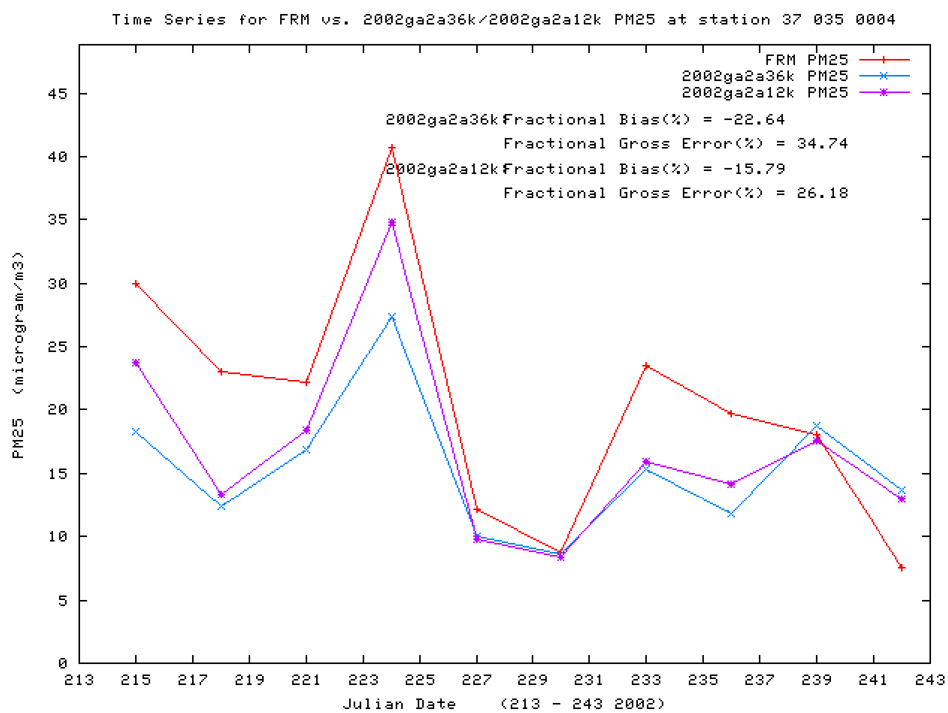


Figure 5-166: August 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

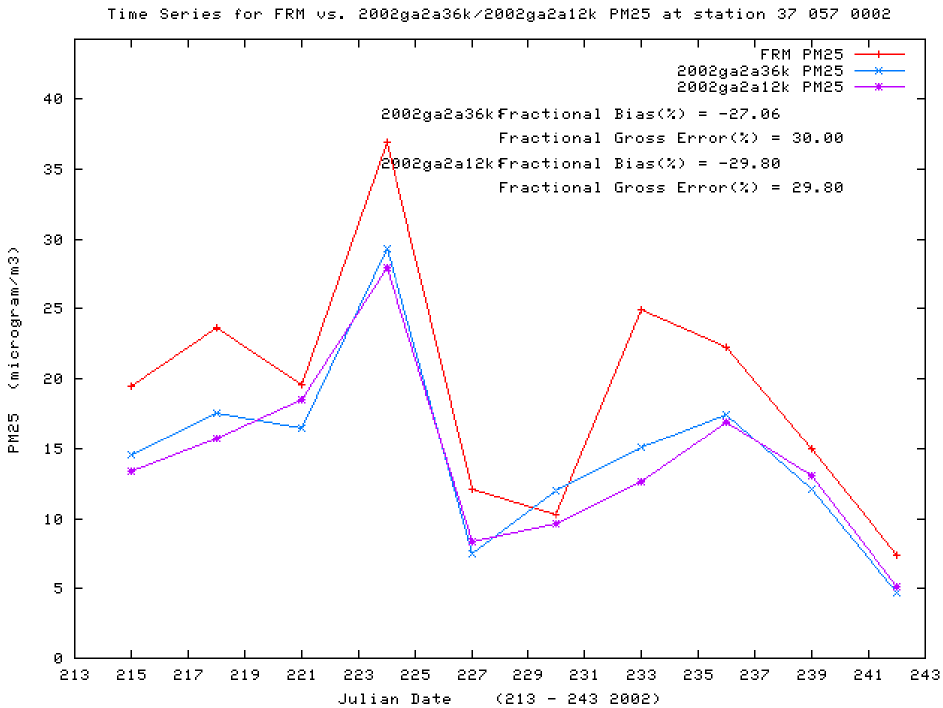


Figure 5-167: August 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

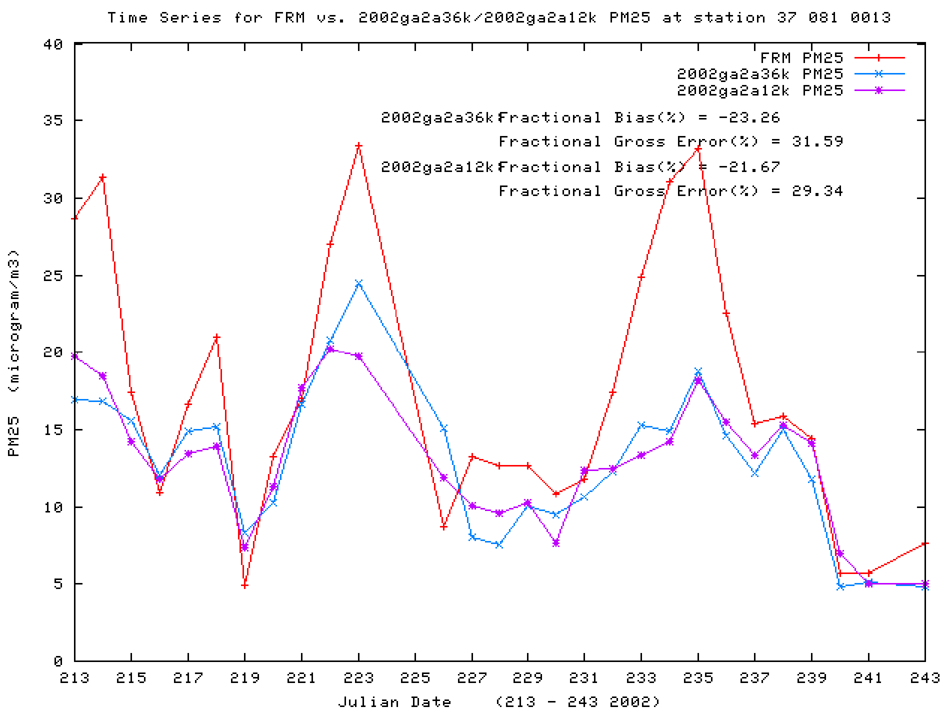


Figure 5-168: August 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.9 September

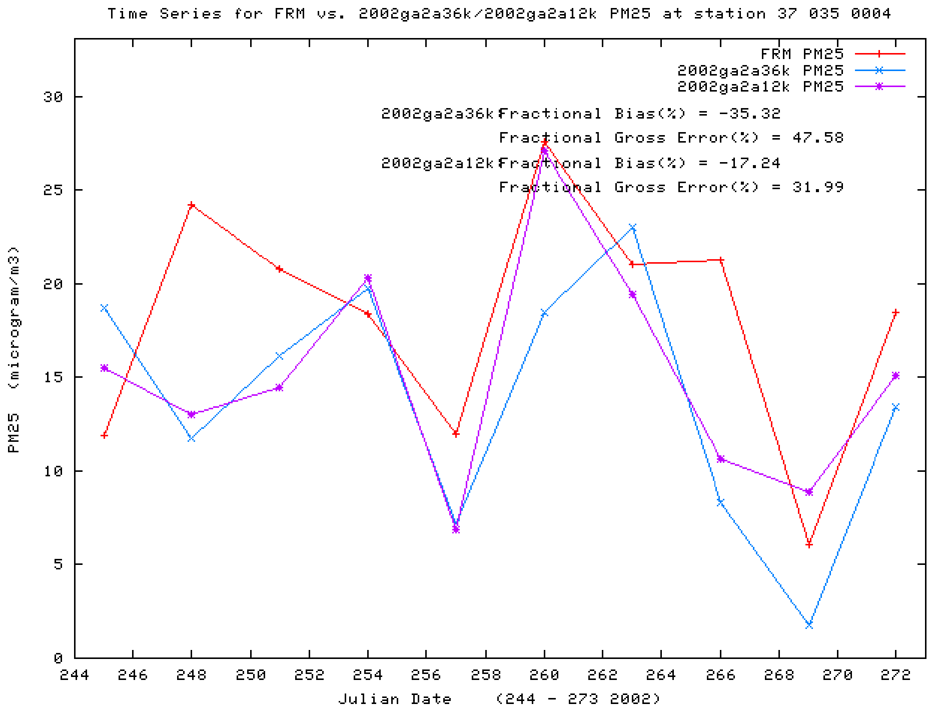


Figure 5-169: September 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

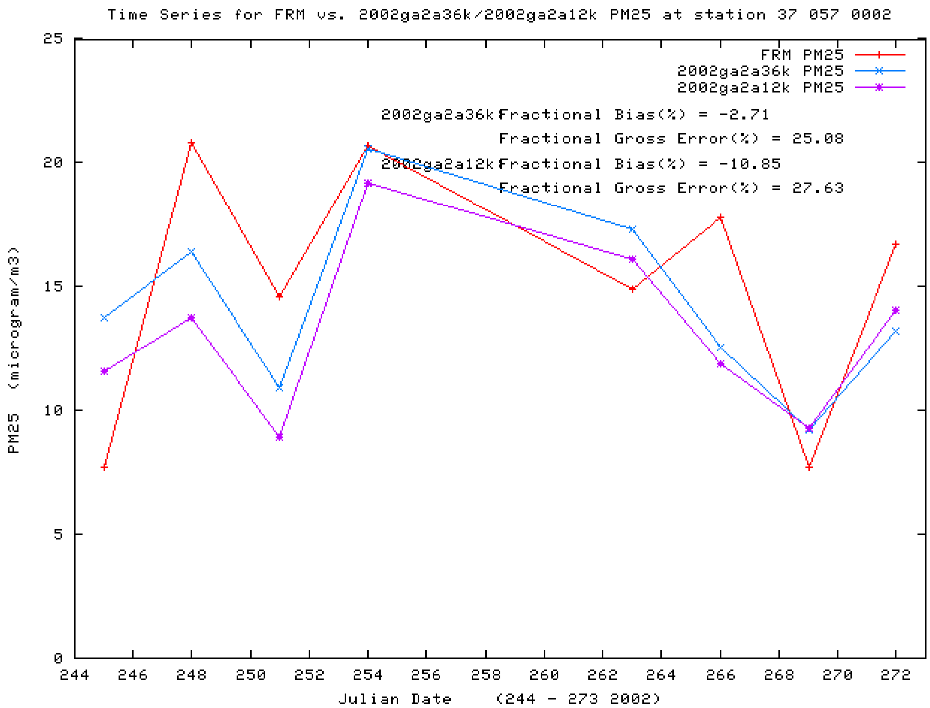


Figure 5-170: September 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

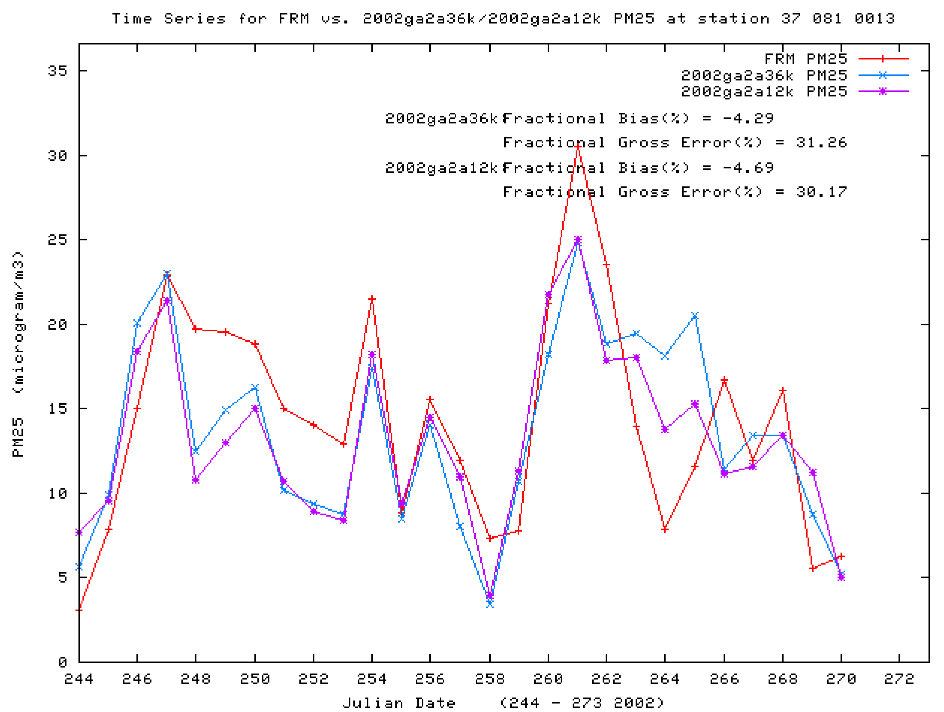


Figure 5-171: September 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.10 October

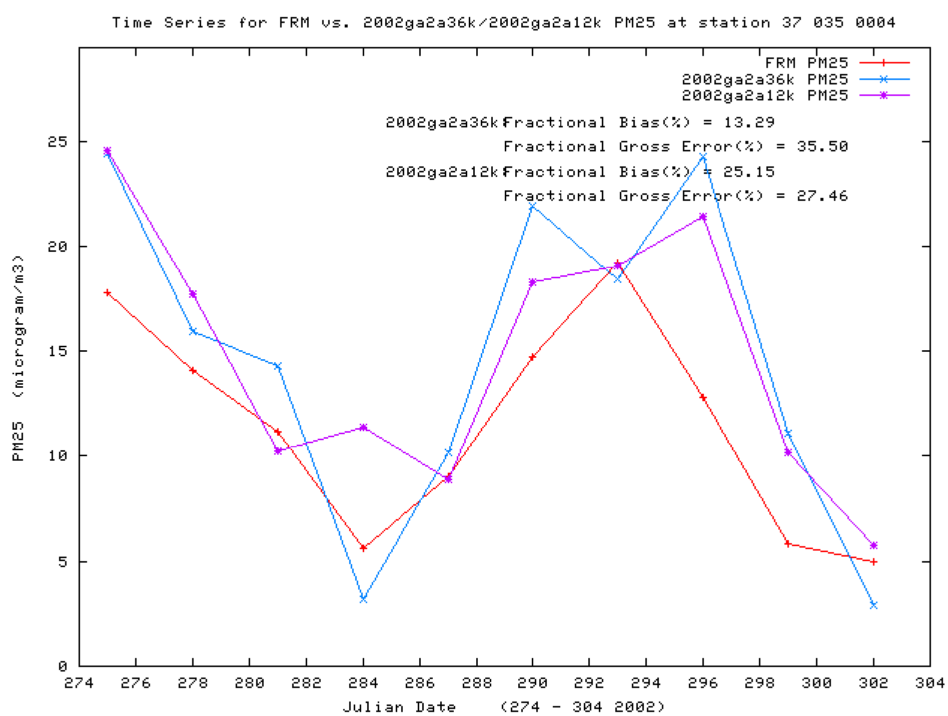


Figure 5-172: October 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

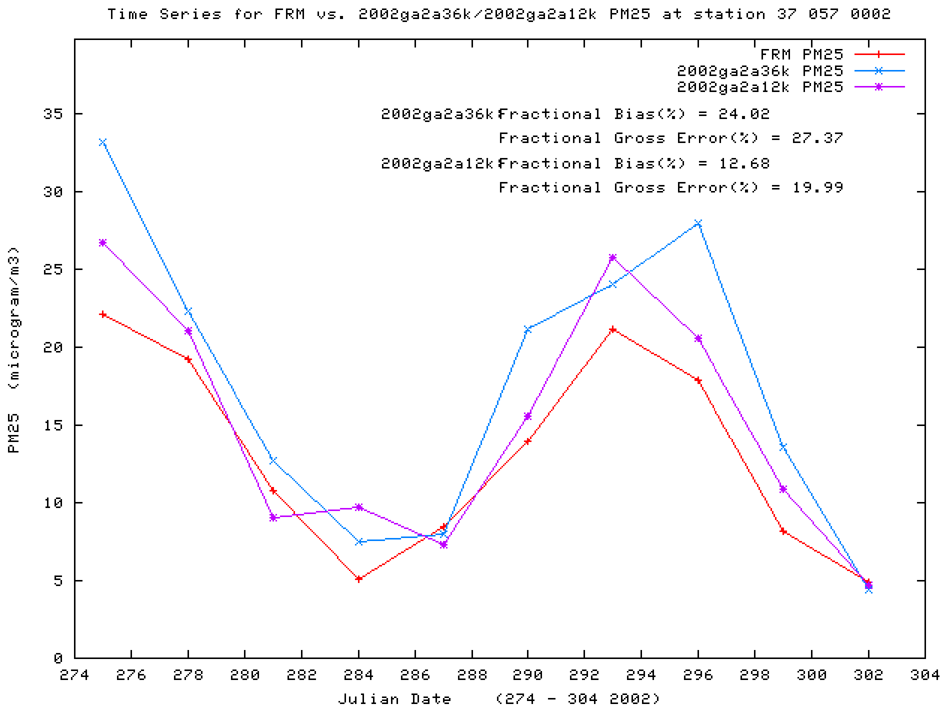


Figure 5-173: October 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

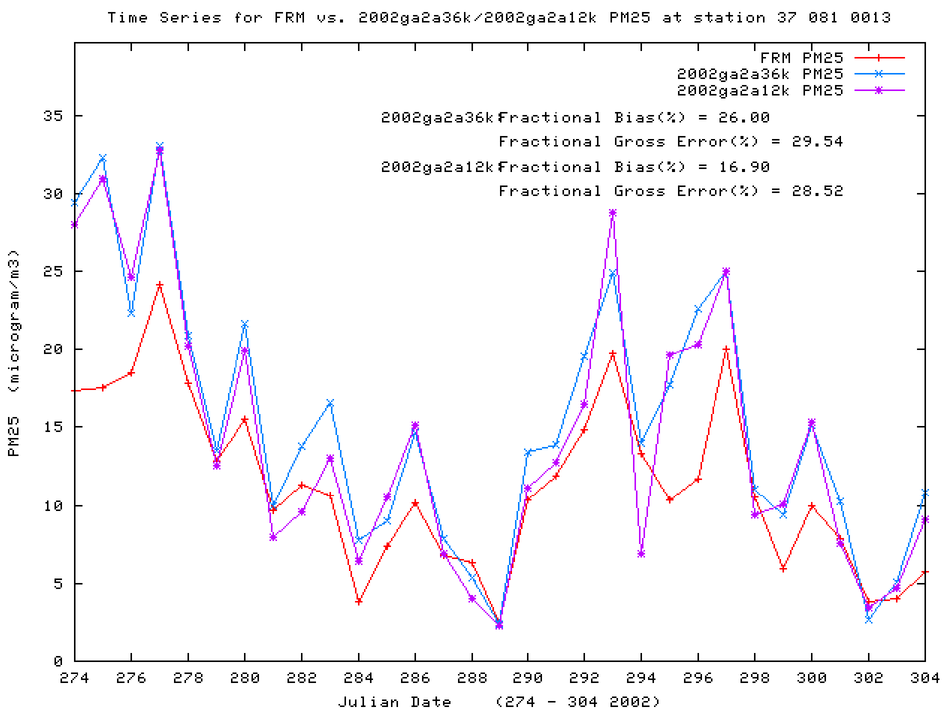


Figure 5-174: October 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.11 November

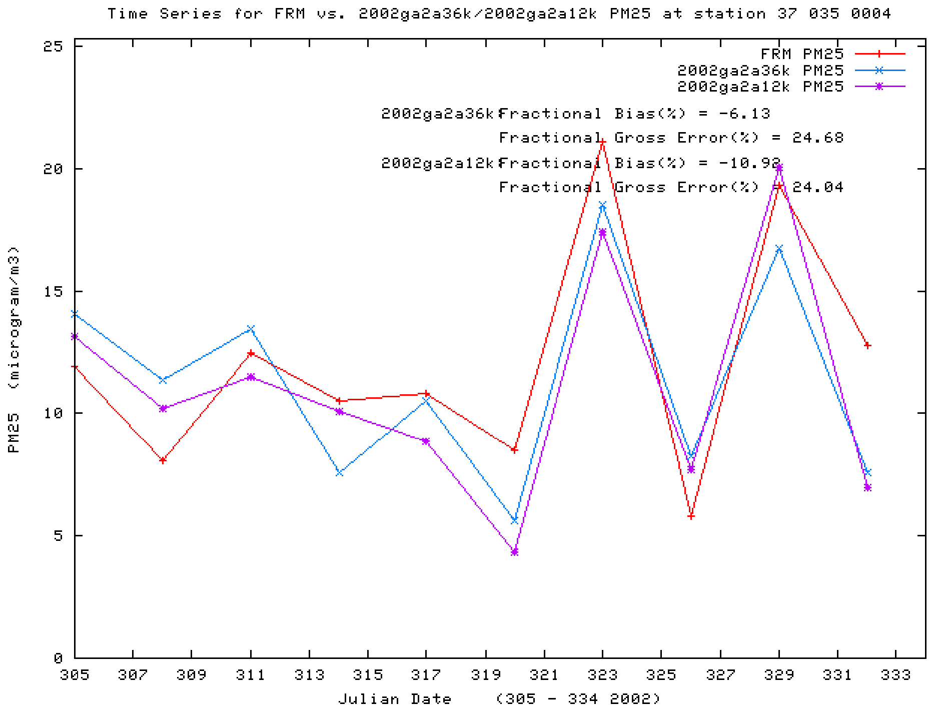


Figure 5-175: November 2002Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

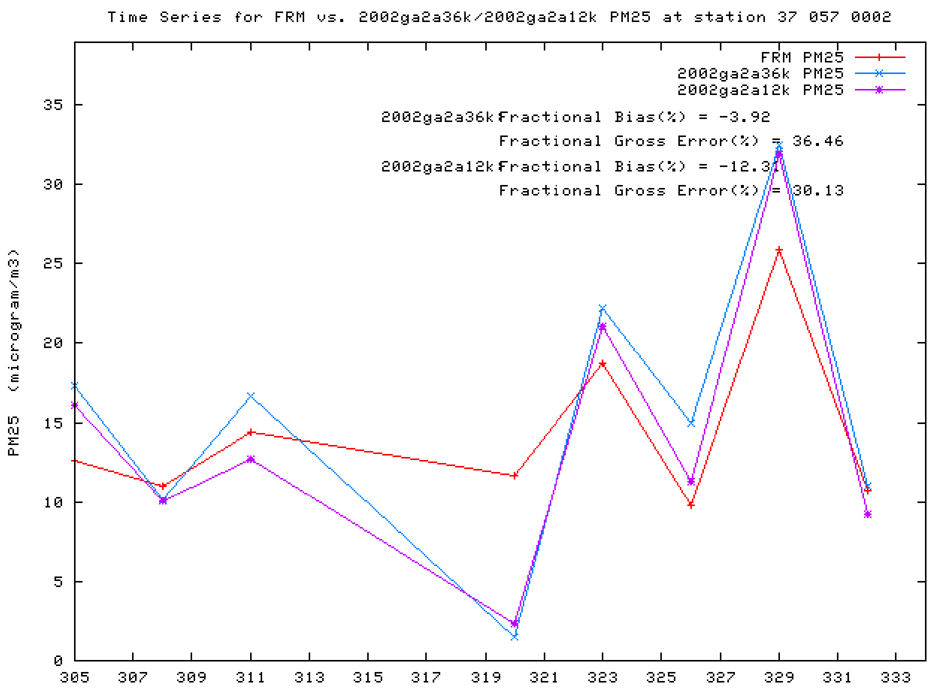


Figure 5-176: November 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

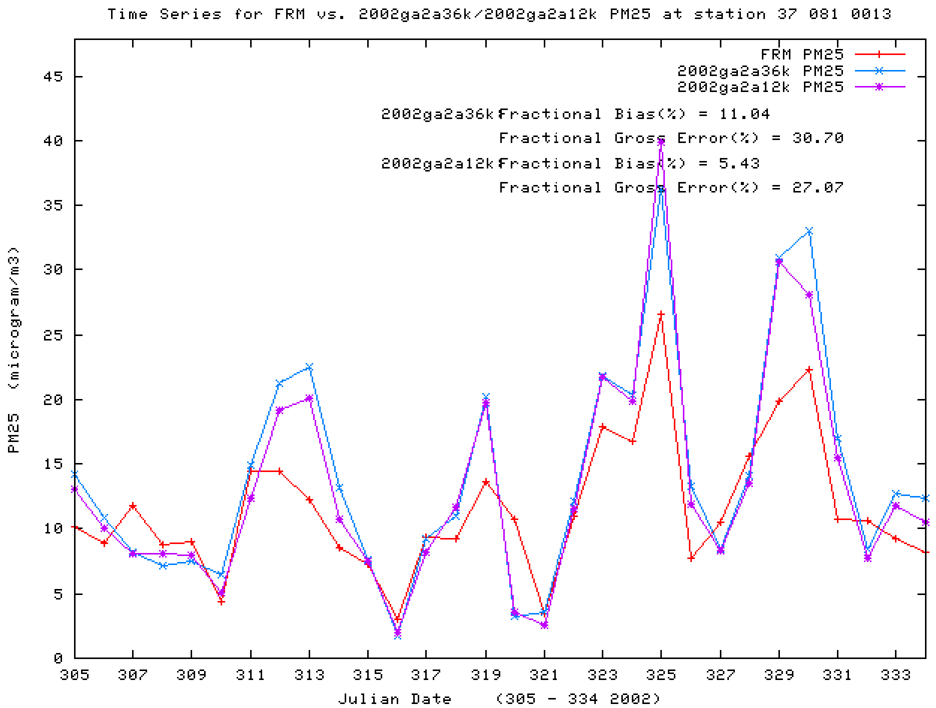


Figure 5-177: November 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

5.2.12 December

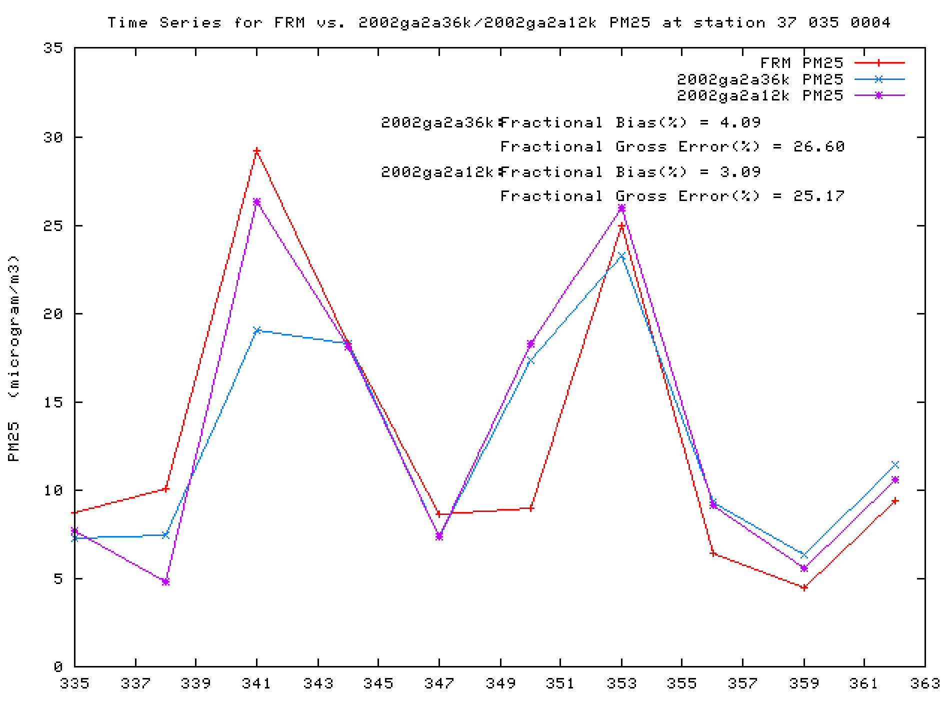


Figure 5-178: December 2002 Time Series of $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Hickory FRM monitor (37-035-0004).

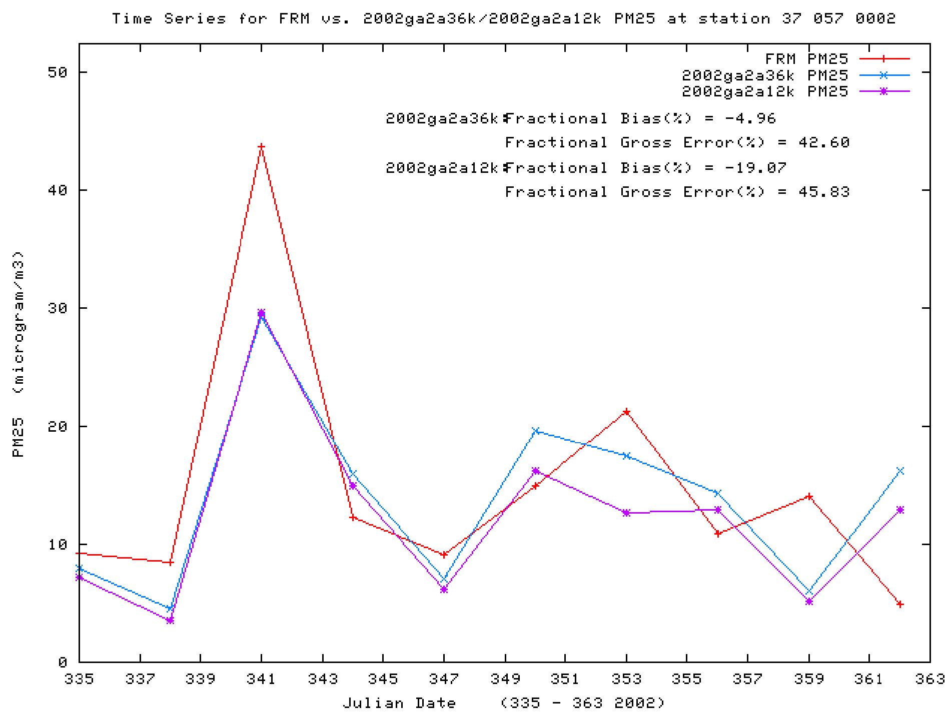


Figure 5-179: December 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Lexington FRM monitor (37-057-0002).

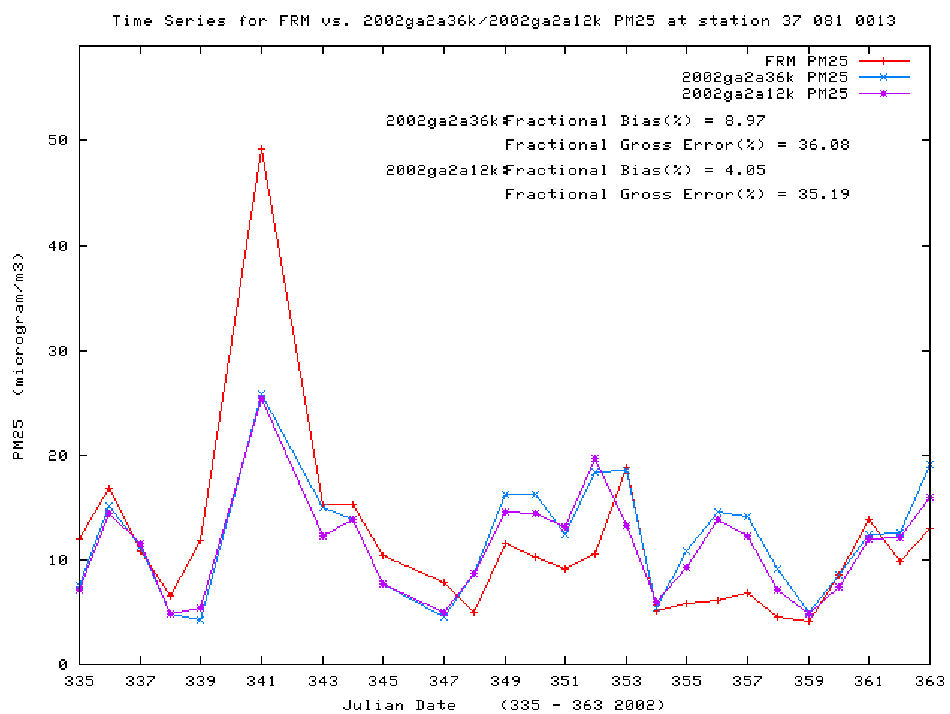


Figure 5-180: December 2002 Time Series of Observed $PM_{2.5}$ levels (red line) and Modeled Sulfate Levels at both 36km (blue line) and 12km (purple line) grind resolution for the Mendenhall FRM monitor (37-081-0013).

6. Stacked Bar Charts

The following section provides stacked bar charts comparing observed fine particulate matter composition and modeled fine particulate matter composition. Stacked bar charts have been developed for each of the STN monitoring sites in and near the North Carolina $PM_{2.5}$ nonattainment areas (Hickory and Hattie Avenue).

The stacked bar chart allows a side-by-side comparison of each day's observed and modeled compositional and total light extinction. Within each bar, the yellow portion of the bar represents the mass due to sulfates (SO4), the red portion of the bar represents the mass due to nitrates (NO3), the green portion of the bar represents the mass due to organic carbon (OC), the black the bar represents the portion of mass due to elemental (EC), and finally the grey portion of the bar represents the mass due to ammonium (NH4). The components are presented in the same order for both the observed (left hand bar) and modeled bar (right hand bar), so it is easy to identify days when the predicted mass for the component differs from the observed. The total height of the bar provides the total reconstructed mass of fine particulate matter.

Just glancing through the stacked bars charts reiterates that sulfates are a large contributor to total $PM_{2.5}$ mass in both nonattainment areas. The bar charts also suggest that organic carbon is also a large contributor to $PM_{2.5}$ mass in North Carolina. The bar charts reiterate the general under-prediction seen in previous sections. Both the Hickory and Hattie Avenue sites, the bar charts show that the sulfate mass is generally well captured, with instances of both over and under prediction. Nitrates tend to be over predicted in the early spring and late winter, when the mass is the highest. The bars also suggest that organic carbon is generally under predicted at both sites. Looking across the bars, it appears as though this under prediction of organic carbon and the slight sulfates is the largest contributor to general $PM_{2.5}$ under prediction.

6.1 Hickory (STN)

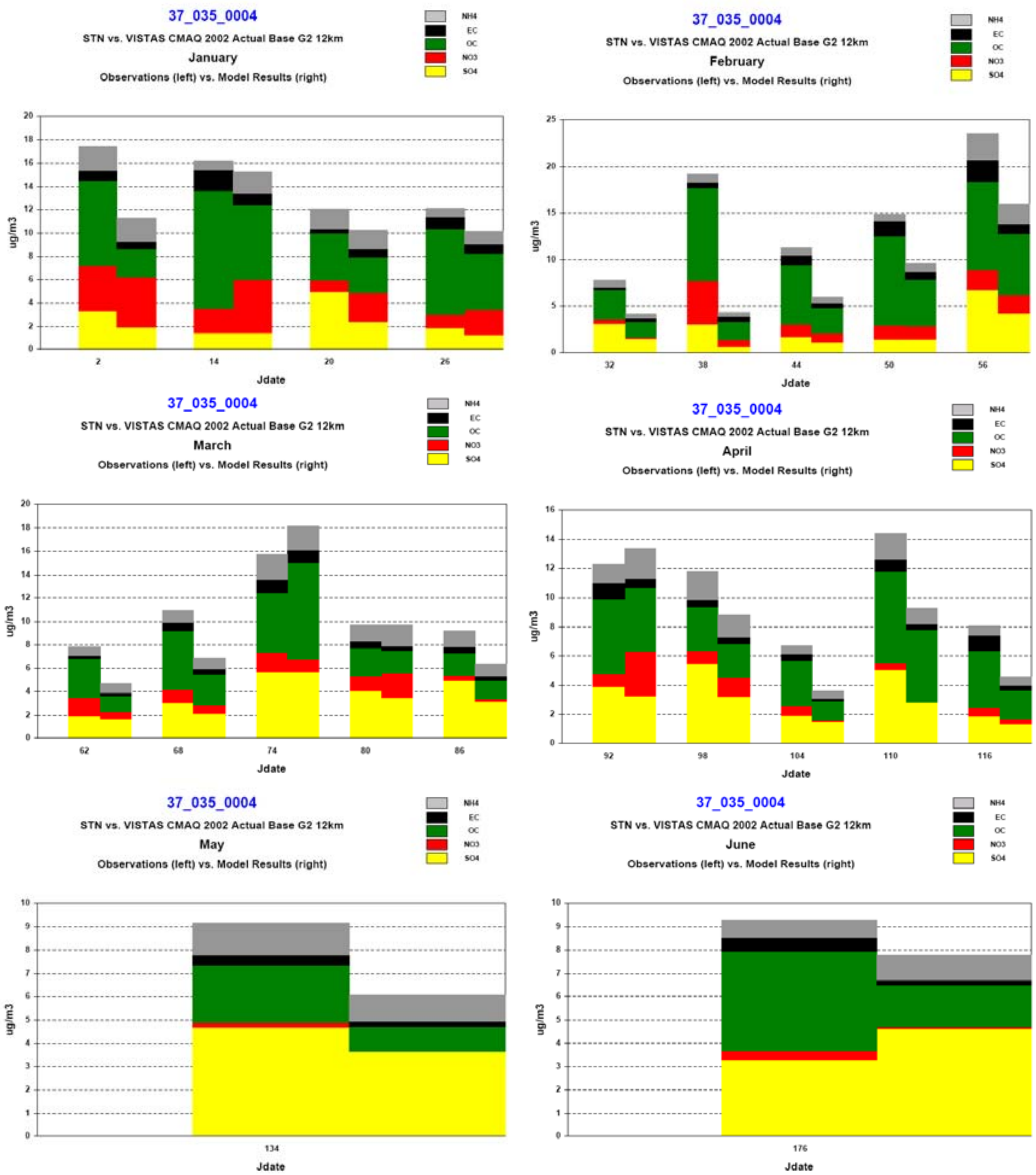


Figure 6-1: Stacked bar chart for the Hickory STN monitoring site (37-035-0004) for January (top left), February (top right), March (center left), April (center right), May (bottom left), and June (bottom right). Observed composition is presented in the left hand bar, with modeled composition represented by the right hand bar.

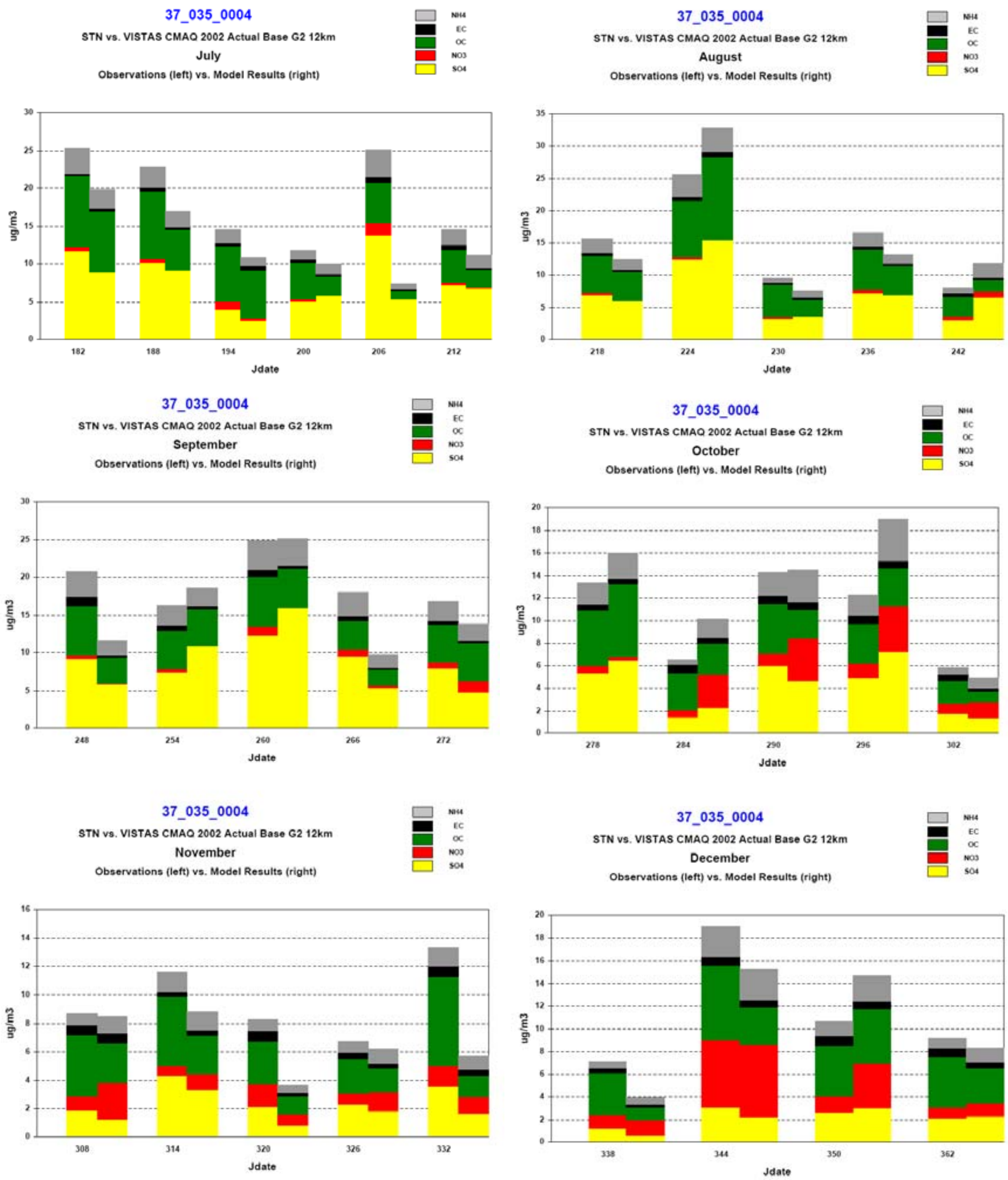


Figure 6-2: Stacked bar chart for the Hickory STN monitoring site (37-035-0004) for July (top left), August (top right), September (center left), October (center right), November (bottom left), and December (bottom right). Observed composition is presented in the left hand bar, with modeled composition represented by the right hand bar.

6.2 Hattie Avenue (STN)

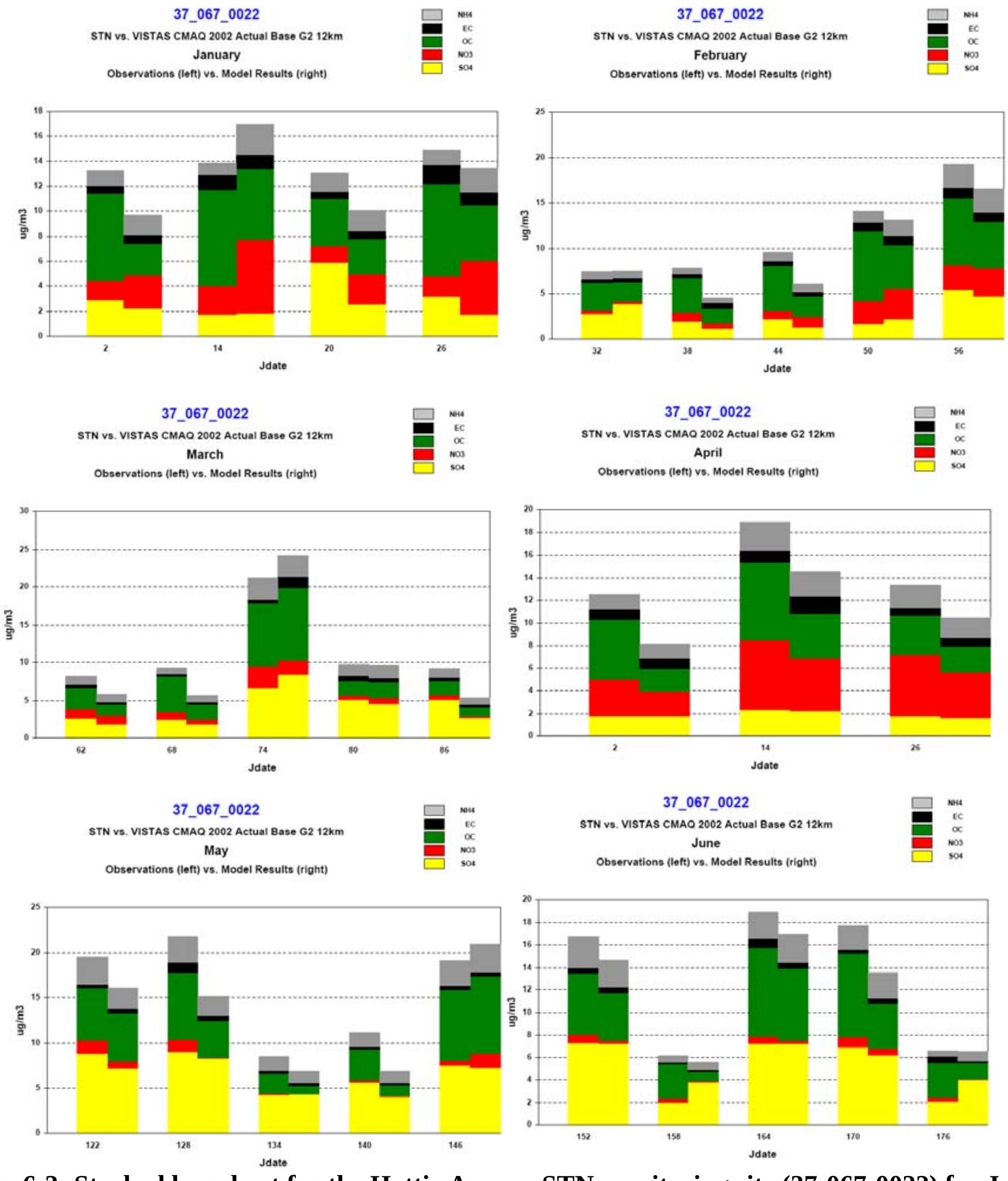


Figure 6-3: Stacked bar chart for the Hattie Avenue STN monitoring site (37-067-0022) for January (top left), February (top right), March (center left), April (center right), May (bottom left), and June (bottom right). Observed composition is presented in the left hand bar, with modeled composition represented by the right hand bar.

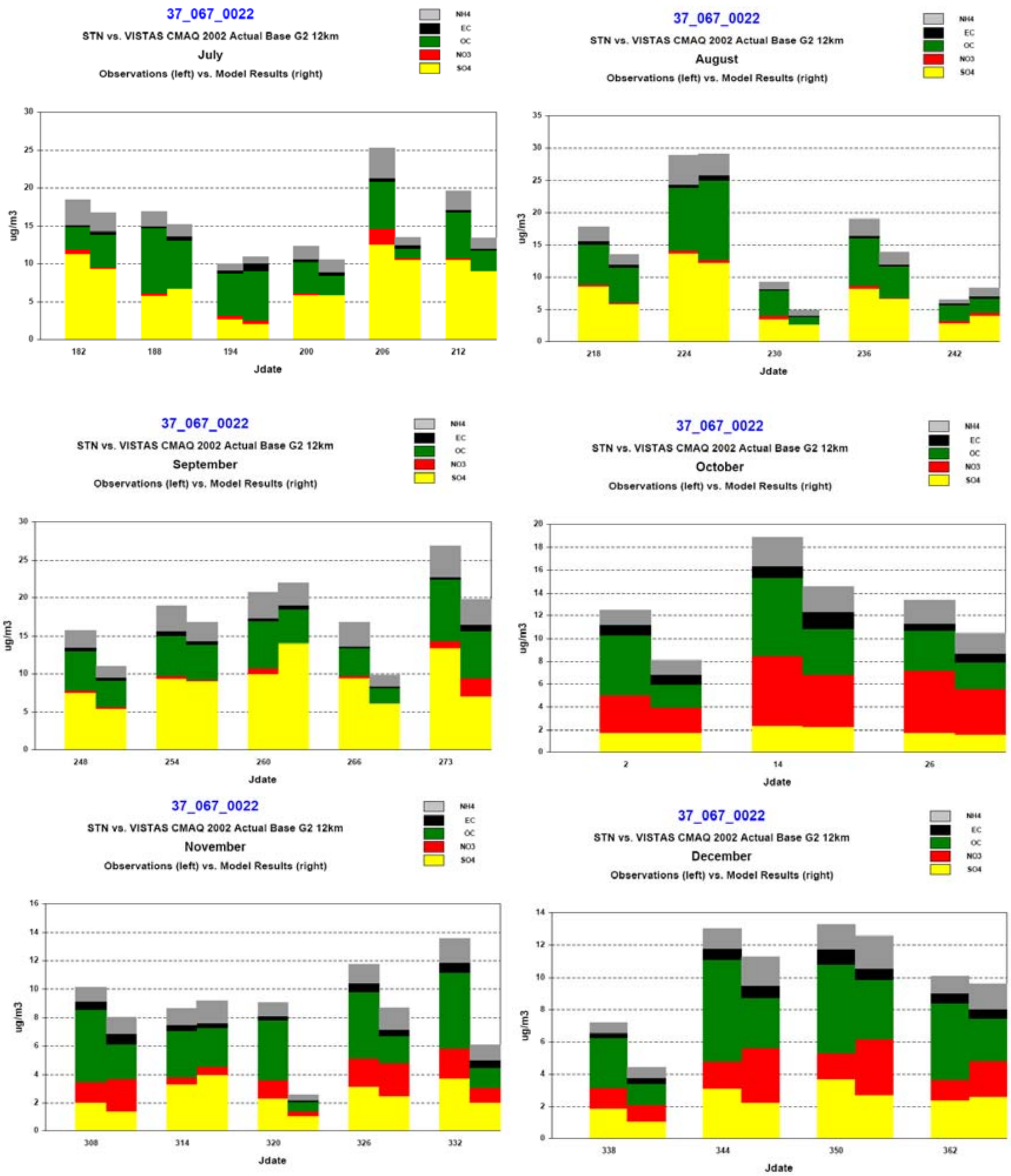


Figure 6-4: Stacked bar chart for the Hattie Avenue STN monitoring site (37-067-0022) for July (top left), August (top right), September (center left), October (center right), November (bottom left), and December (bottom right). Observed composition is presented in the left hand bar, with modeled composition represented by the right hand bar.

Appendix K

Modeling Results

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List Of Tables

Introduction

The air quality modeling results for the 12-kilometer (km) grid modeling domain are presented in this appendix for the attainment demonstration for both the Hickory and the Greensboro-Winston-Salem-High Point (referred to as the Triad area) annual fine particulate matter (PM25) nonattainment areas. These modeling results are displayed as 24-hour average plots of reconstructed PM25 for both the 2002 baseline year and the 2009 attainment year.

A subset of days from 2002 is presented in this appendix, though all days from 2002 are used in developing the relative reduction factor (RRF) and subsequently the future design value (DVF). For model performance evaluation, the USEPA's "Guidance on the Use of Models and Other Analysis for Demonstrating Attainment Goals for Ozone, PM25, and Regional Haze" suggests looking at days with an daily average PM25 concentration greater than 65 micrograms per meter cubed (μg/m^3). However, neither the Hickory nor the Triad PM25 nonattainment area has any observed values greater than or equal to 65 μg/m^3. This lead the North Carolina Division of Air Quality chose to use a cut off of 30 μg/m^3 at any of the monitoring sites in either nonattainment area, as an initial method to select days for examination in the model performance evaluation and in the results section.

To ensure at least four days from each quarter were presented, PM25 values form each quarter were ranked, and the four days with the highest average daily values in each quarter were also chosen. This selection process identified 28 days for presentation in this appendix, and examination in the model performance evaluation (Appendix J). The selected days are presented in Table 1 below.

Each of the following 28 pages presents a single modeling day. The first or top plot on each page is the daily average PM25 plot for the 2002 baseline year. The second or bottom plot is the daily average PM25 plot for the 2009 attainment year. The comparison of the of the attainment year plot to the baseline year plot determines the relative reduction for each of the RRF days in this attainment modeling exercise.

A table is presented immediately below the plots to further detail the change in number of grid cells between ranges approximating the AQI color codes for the daily PM25 standard from 2002 to 2009. The grid cell counts are only calculated for a domain mask that represents the Hickory and Triad nonattainment areas. A statewide view of this domain mask is presented in Figure 1, with a closer view presented in Figure 2.

Finally, a table is included at the bottom of each page that lists the observed monitor values from that particular day. Gray cells indicate days in which the sites had no observed value. Observations can be missing due to the sampling frequency of the site (every day versus every third day) or the monitor was off line for repairs.

Table 1: Days selected for model evaluation and the observed value at each of the monitoring sites in the Hickory and Triad PM Nonattainment areas. Gray cells indicate no monitoring data was available for that day either due to the sampling frequency or the site being off line

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
01/05/02	5	Q1		22.3	28.5	25.5
01/06/02	6	Q1				23.9
02/25/02	56	Q1	24.5	21.4	20.3	18.8
03/06/02	65	Q1		24.8	22.8	15.6
05/26/02	146	Q2		22.6	25.3	
06/04/02	155	Q2		29.0	26.4	26.0
06/10/02	161	Q2		27.5	22.4	23.5
06/13/02	164	Q2		23.1	26.9	25.8
07/01/02	182	Q3	36.9	33.5	31.1	32.9
07/02/02	183	Q3				37.7
07/03/02	184	Q3				30.8
07/08/02	189	Q3				31.1
07/09/02	190	Q3				34.9
07/16/02	197	Q3		33.5	33.1	34.8
07/17/02	198	Q3				41.8
07/18/02	199	Q3				41.8
08/02/02	214	Q3				31.4
08/03/02	215	Q3		30.0	19.5	17.4
08/11/02	223	Q3				33.4
08/12/02	224	Q3	33.3	40.7	36.9	
08/22/02	234	Q3				31.1
08/23/02	235	Q3				33.2
09/17/02	260	Q3	30.6	27.6		21.2
09/18/02	261	Q3				30.5
11/21/02	325	Q4				26.6
11/25/02	329	Q4		19.3	25.9	19.9
12/07/02	341	Q4		29.2	43.7	49.2
12/31/02	365	Q4		28.9	18.9	20.5

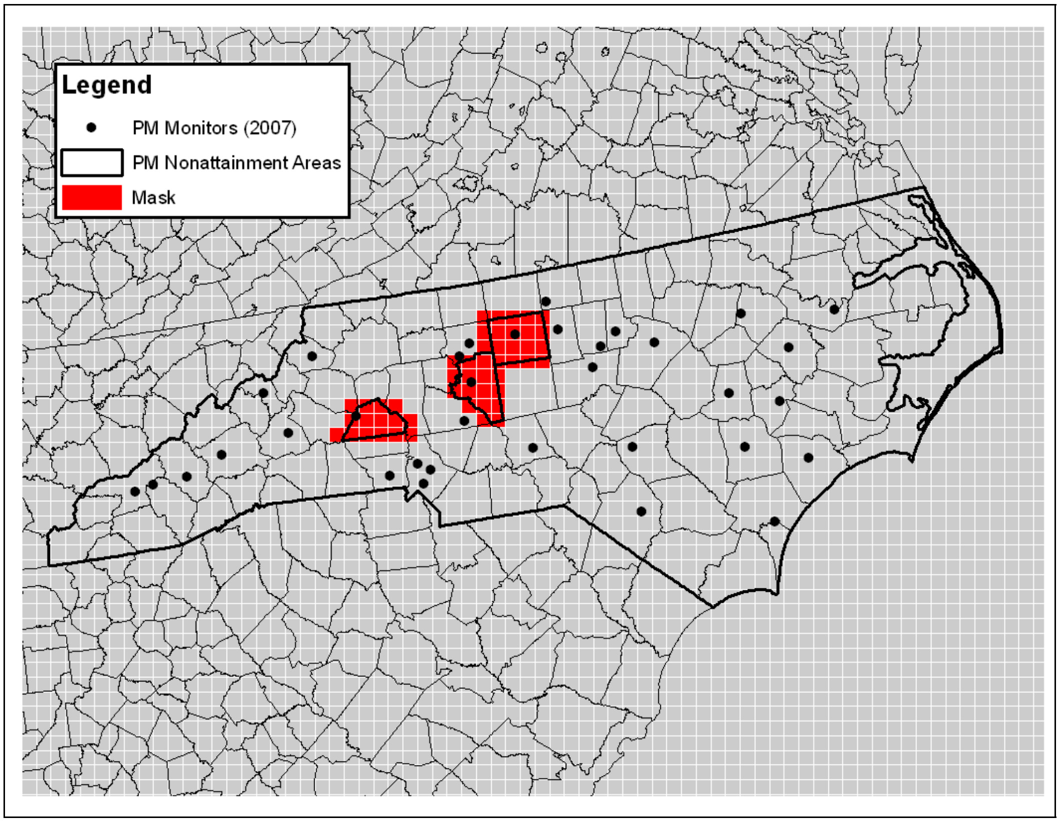


Figure 1: North Carolina PM Nonattainment Area Domain Mask

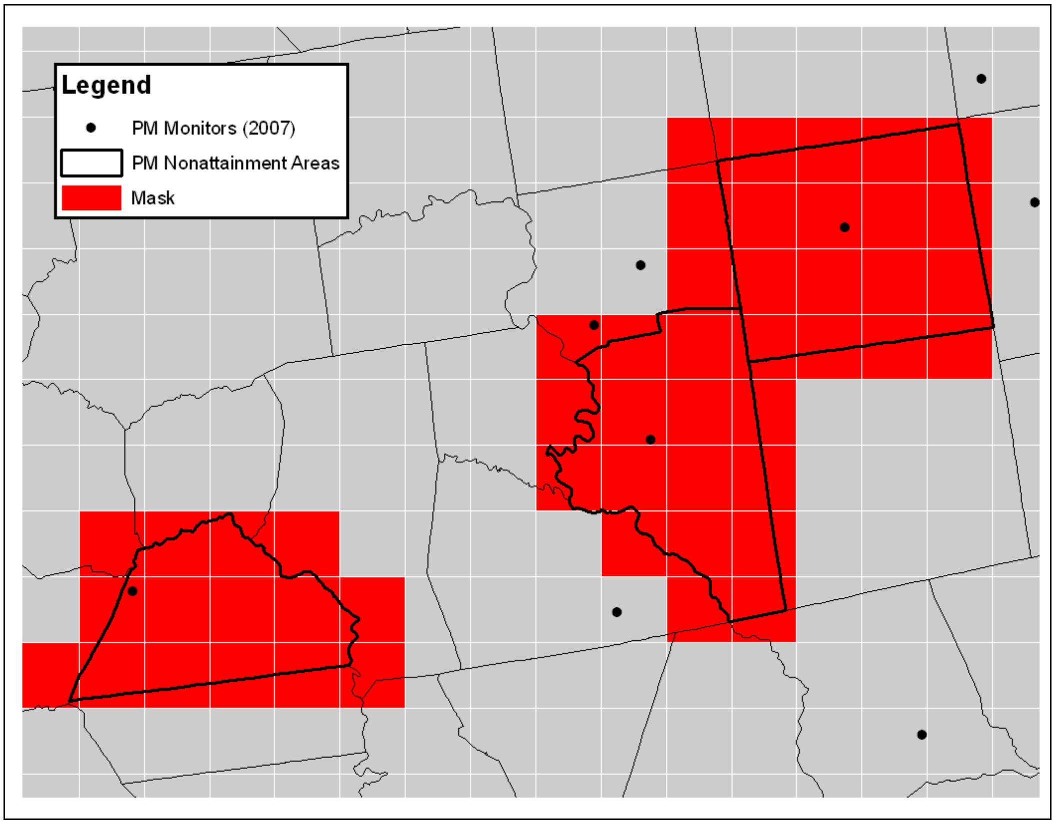
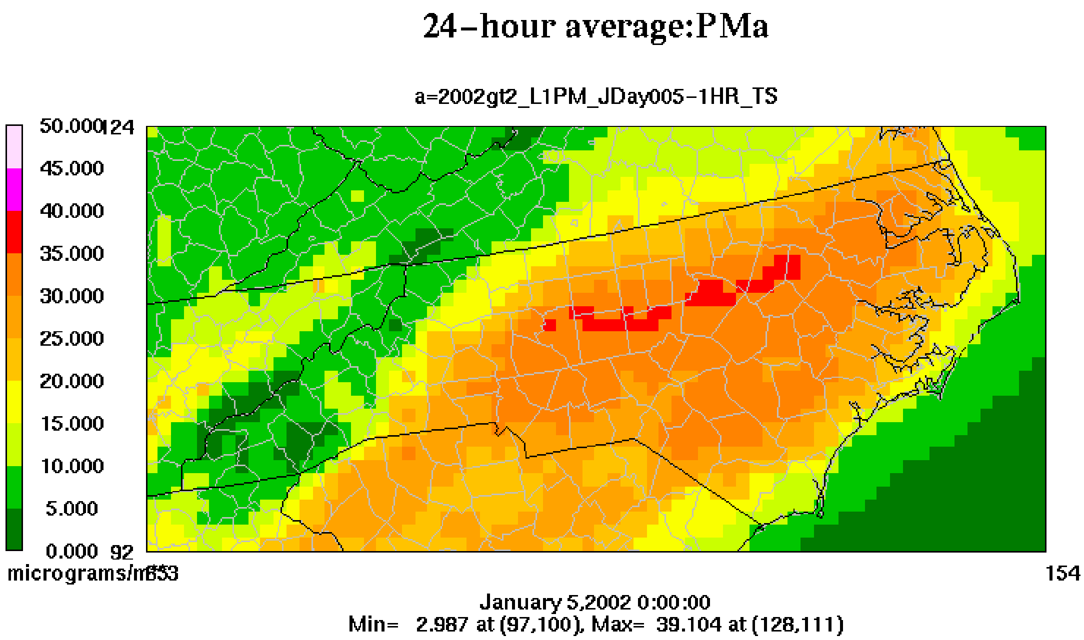


Figure 2: Zoomed View of the North Carolina PM Nonattainment Area Mask



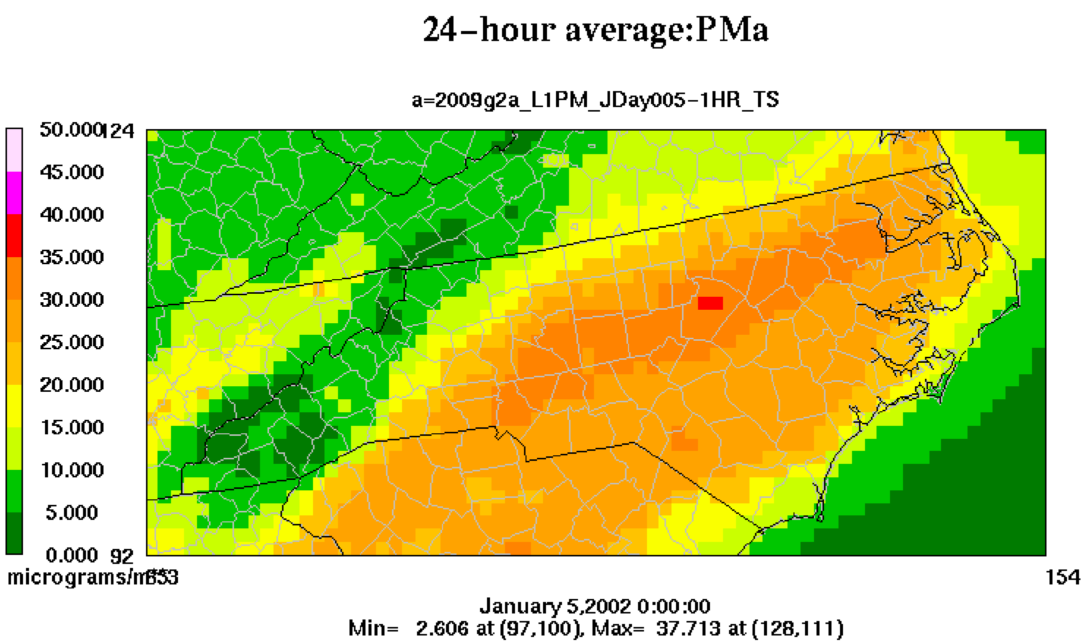


Figure 3: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for January 5th

Table3.1: Cell Count Across the PM Nonattainment Area Domain Mask For January 5th

Day 365	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	5	9
30.0 - 44.9 μg/m^3	41	34
45.0 - 60.0 μg/m^3	4	7

Table 3.2: Table of Observed Values from January 5, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
01/06/02	6	Q1				23.9

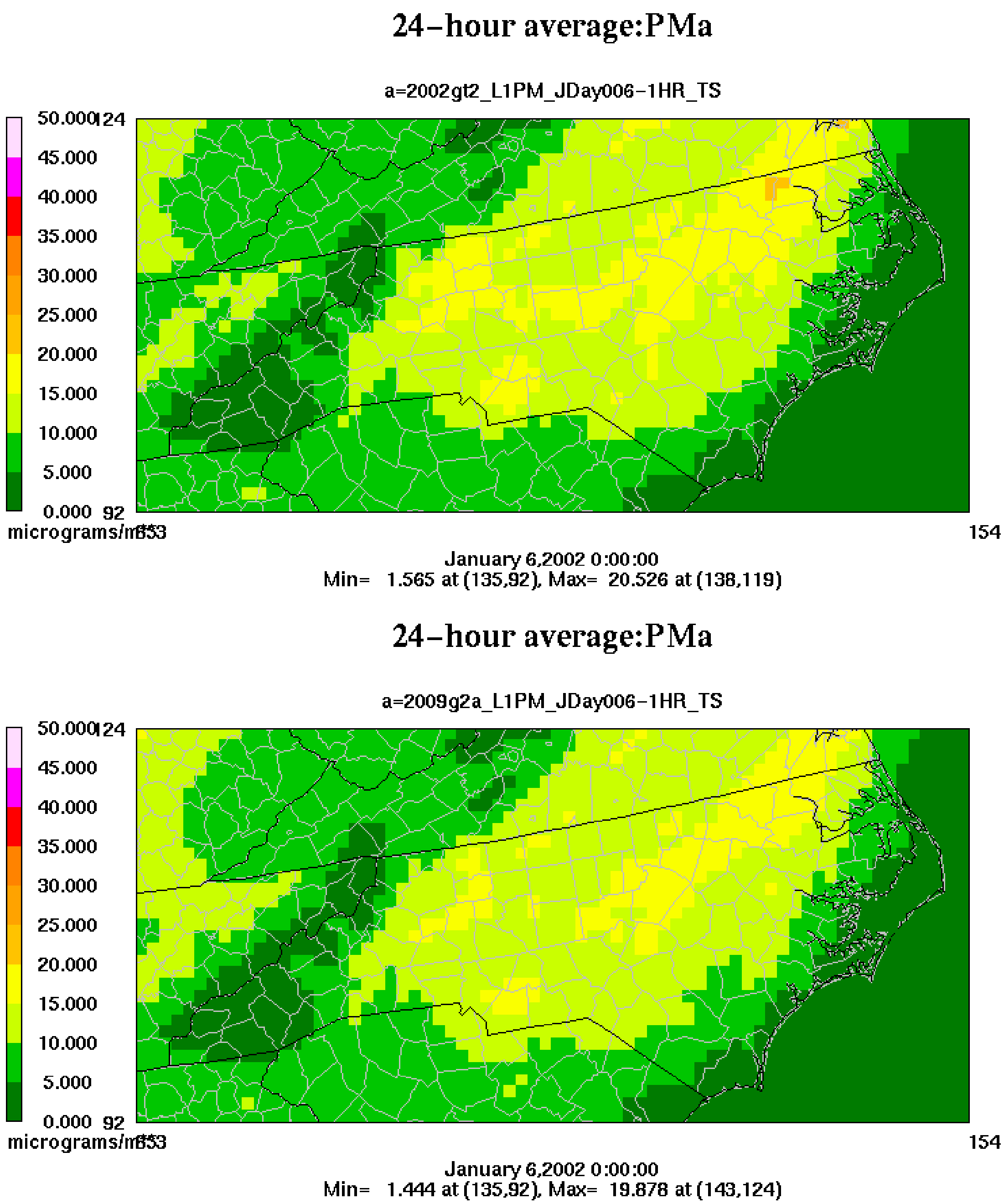


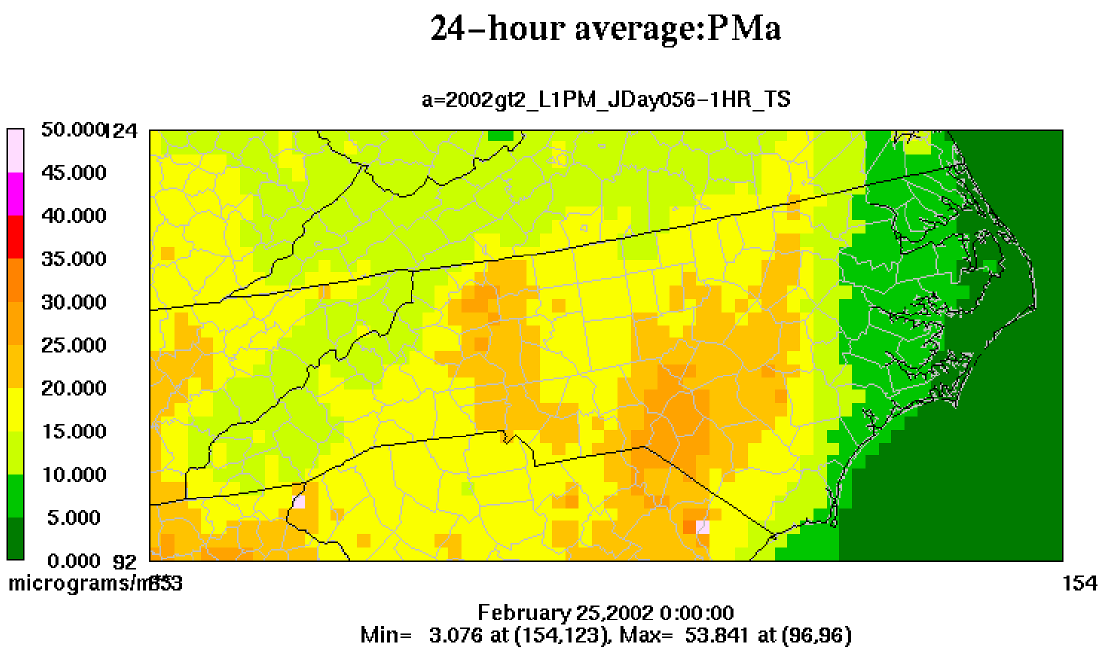
Figure 4: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for January 6th

Table 4.1: Cell Count Across the PM Nonattainment Area Domain Mask For January 6th

Day 6	2002	2009
00.0 - 14.9 µg/m^3	34	46
15.0 - 29.9 µg/m^3	16	4
30.0 - 44.9 µg/m^3	0	0
45.0 - 60.0 µg/m^3	0	0

Table 4.2: Table of Observed Values from January 6, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
01/06/02	6	Q1				23.9



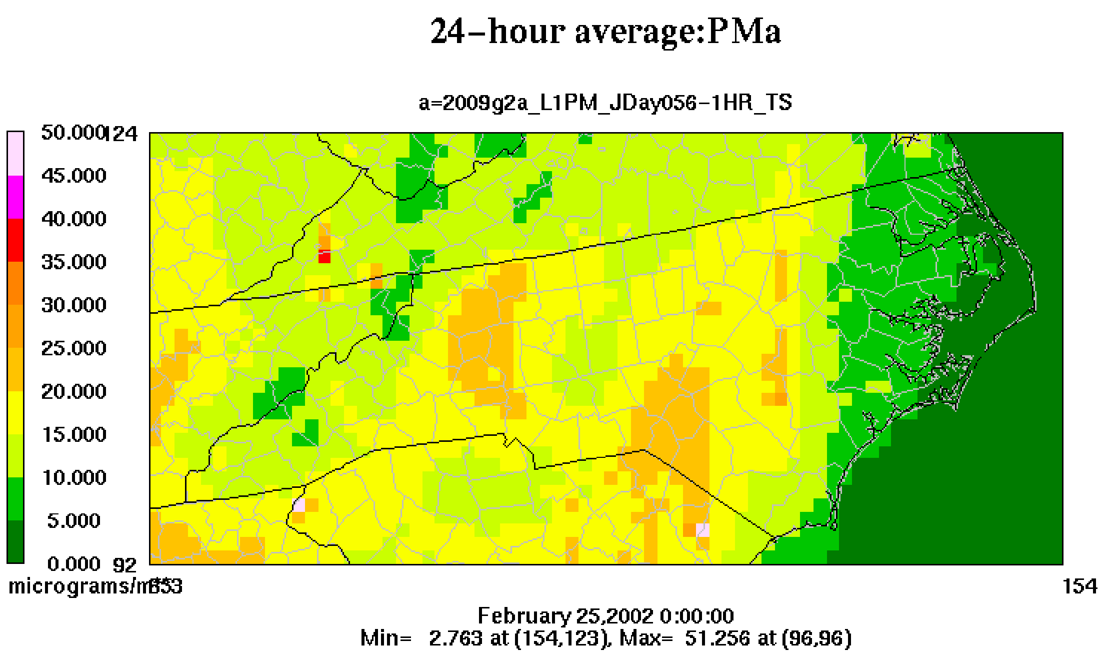


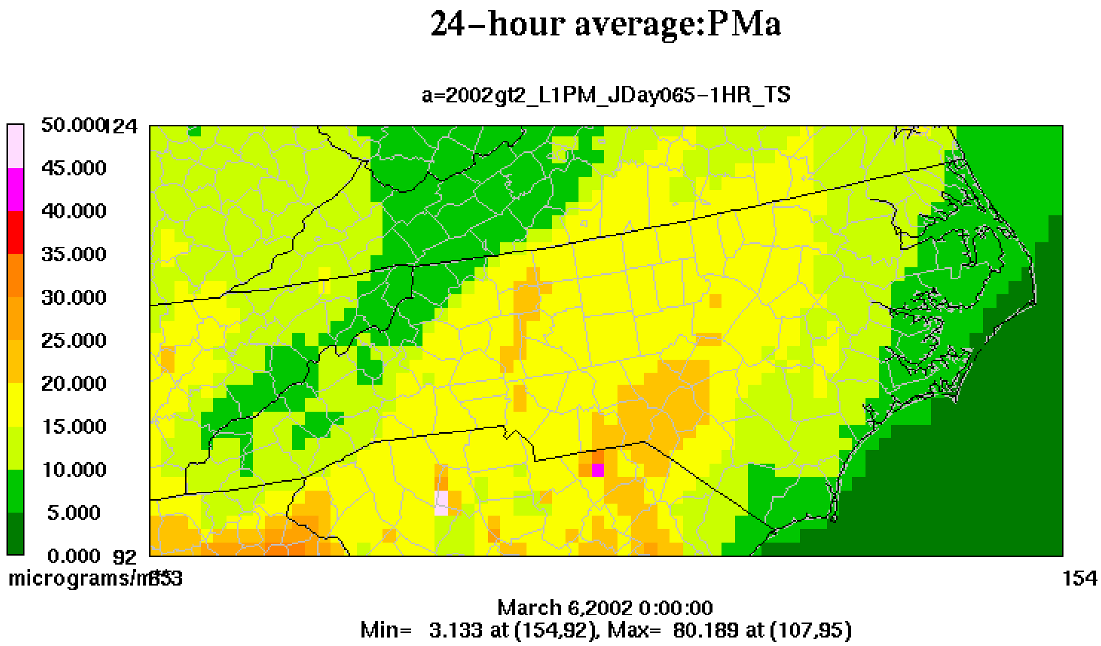
Figure 5: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for February 25th

Table 5.1: Cell Count Across the PM Nonattainment Area Domain Mask For February 25th

Day 56	2002	2009
00.0 - 14.9 μg/m^3	0	17
15.0 - 29.9 μg/m^3	50	33
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 5.2: Table of Observed Values from February 25, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
02/25/02	56	Q1	24.5	21.4	20.3	18.8



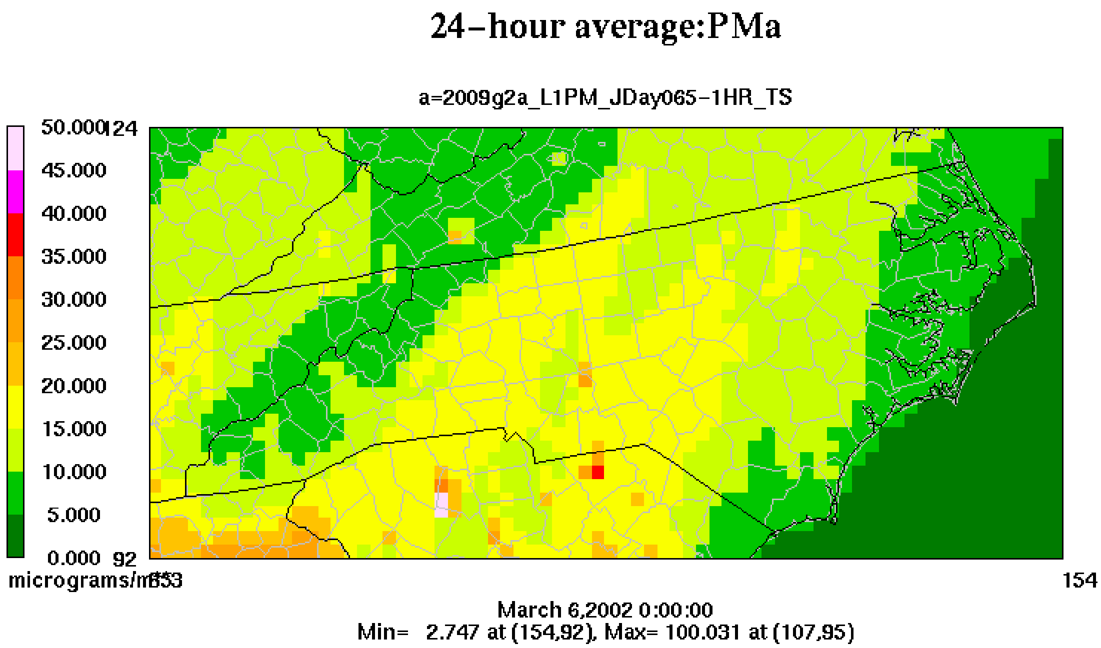


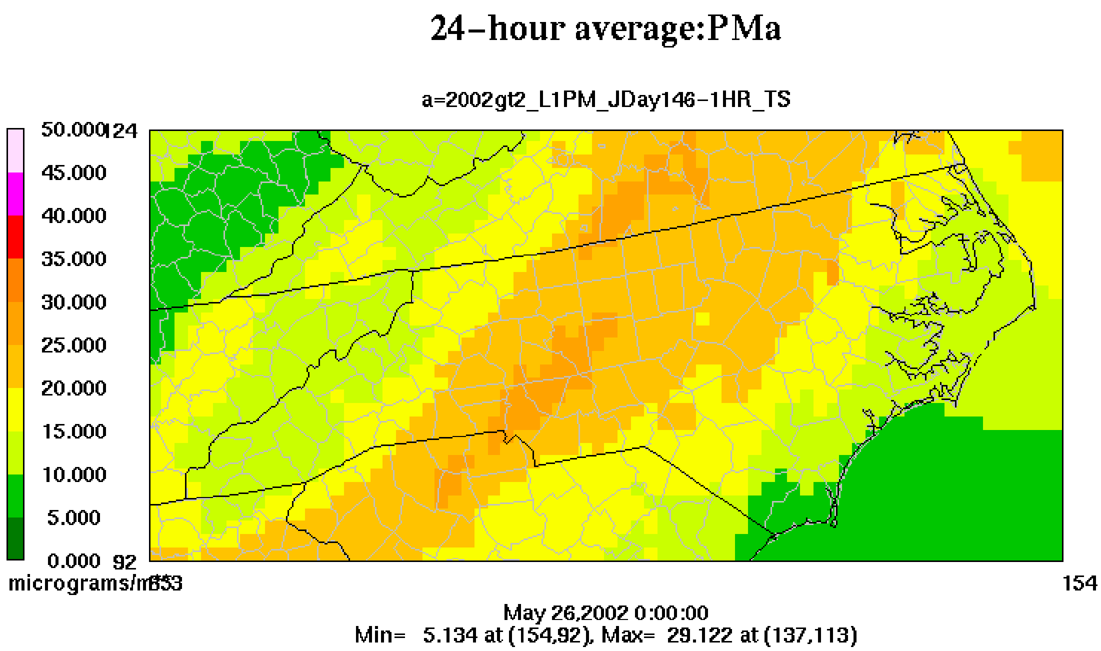
Figure 6: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for March 6th

Table 6.1: Cell Count Across the PM Nonattainment Area Domain Mask For March 6th

Day 65	2002	2009
00.0 - 14.9 μg/m^3	0	13
15.0 - 29.9 μg/m^3	50	37
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 6.2: Table of Observed Values from March 6, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
03/06/02	65	Q1		24.8	22.8	15.6



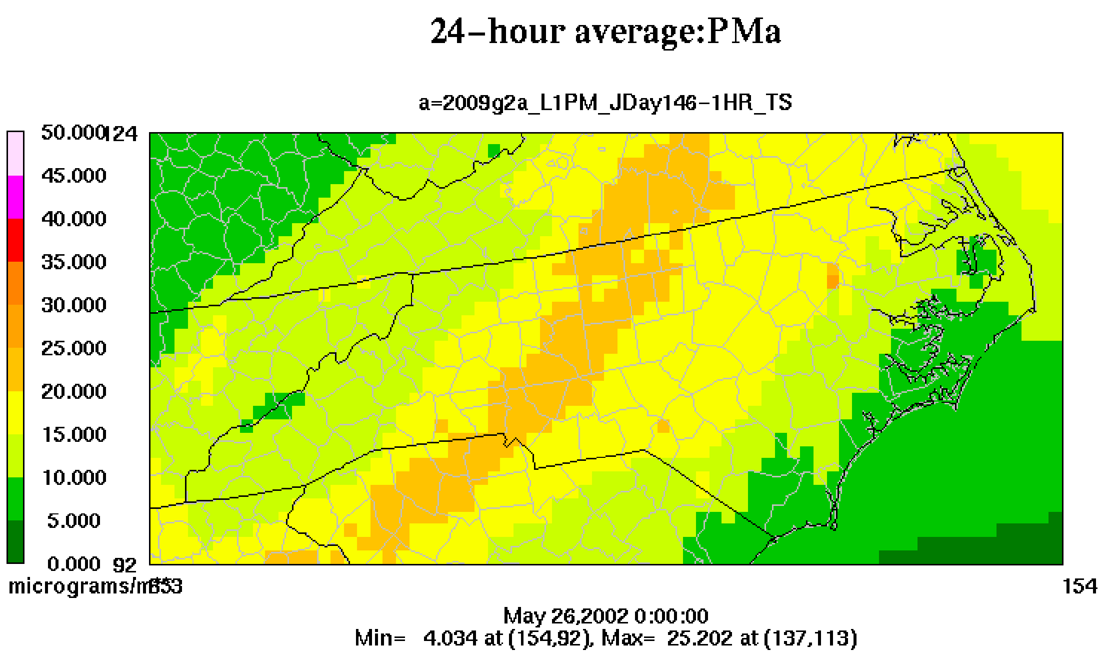


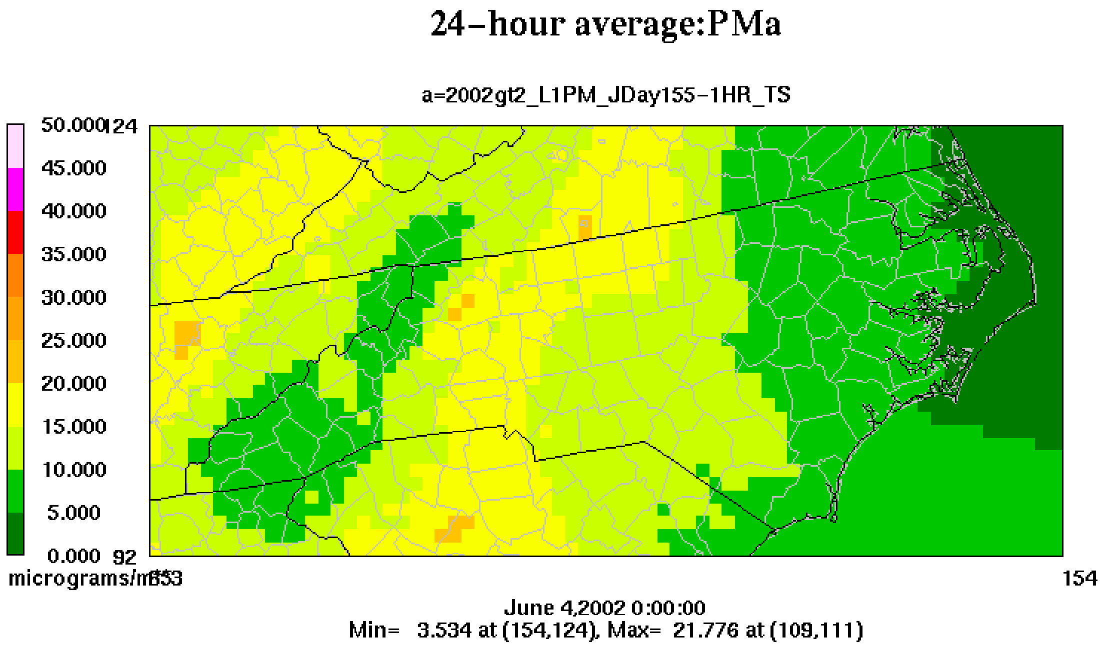
Figure 7: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for May 26th

Table 7.1: Cell Count Across the PM Nonattainment Area Domain Mask For May 26th

Day 146	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	50	50
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 7.2: Table of Observed Values from May 26, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
05/26/02	146	Q2		22.6	25.3	



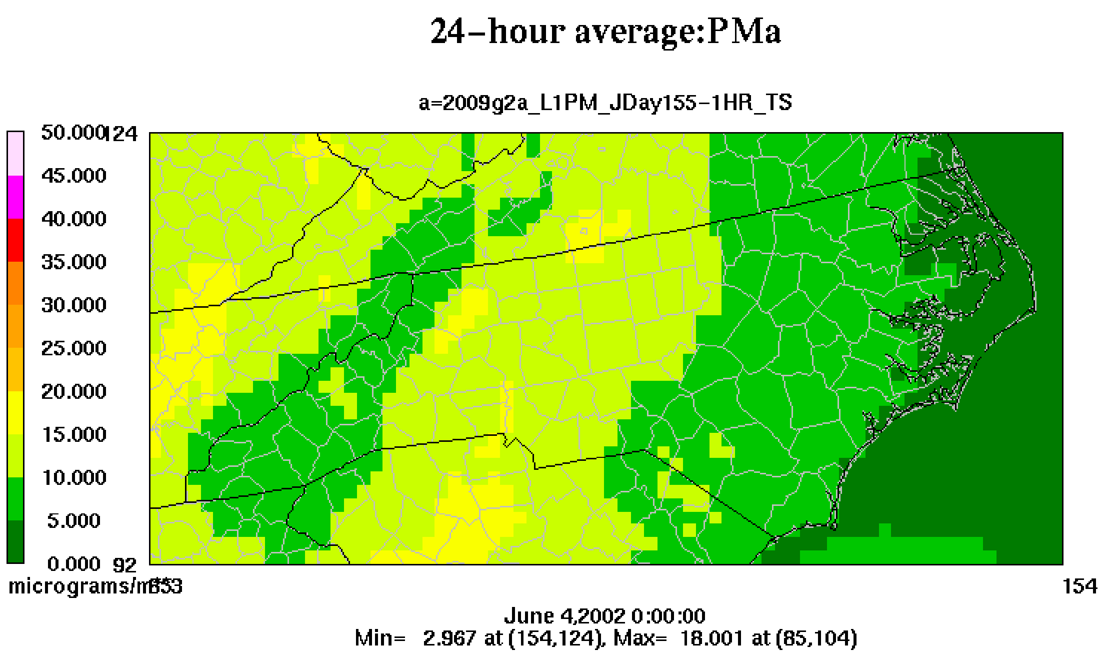


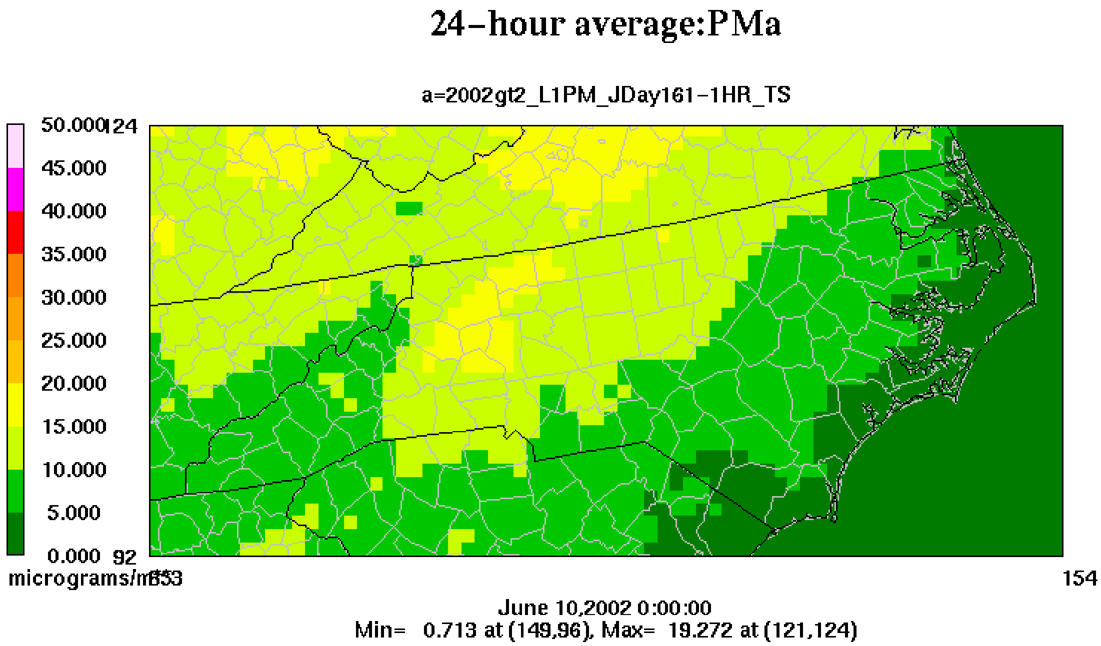
Figure 8: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for June 4th

Table 8.1: Cell Count Across the PM Nonattainment Area Domain Mask For June 4th

Day 155	2002	2009
00.0 - 14.9 μg/m^3	22	49
15.0 - 29.9 μg/m^3	28	1
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 8.2: Table of Observed Values from June 4, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
06/04/02	155	Q2		29.0	26.4	26.0



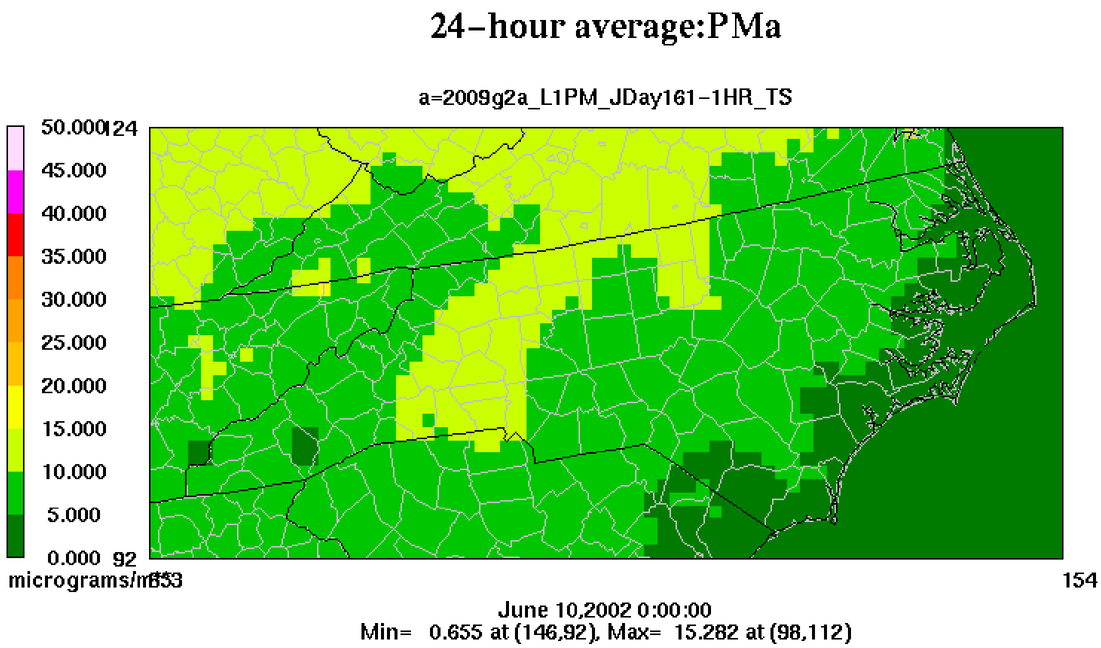


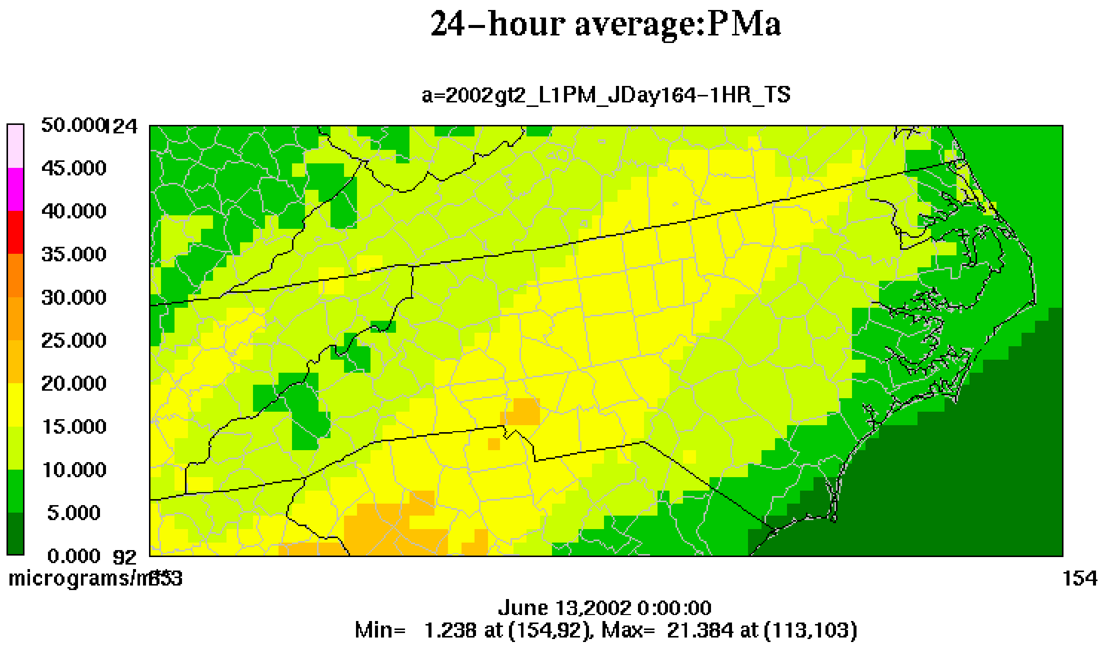
Figure 9: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for June 10th

Table 9.1: Cell Count Across the PM Nonattainment Area Domain Mask For June 10th

Day 161	2002	2009
00.0 - 14.9 μg/m^3	42	50
15.0 - 29.9 μg/m^3	8	0
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 9.2: Table of Observed Values from June 10, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
06/10/02	161	Q2		27.5	22.4	23.5



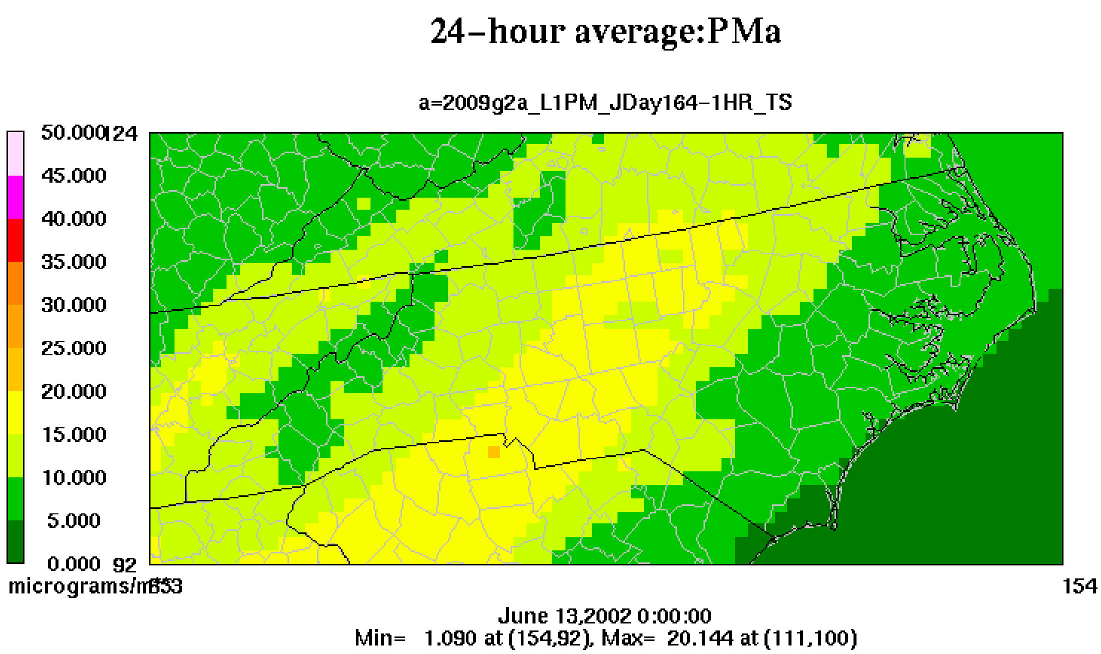


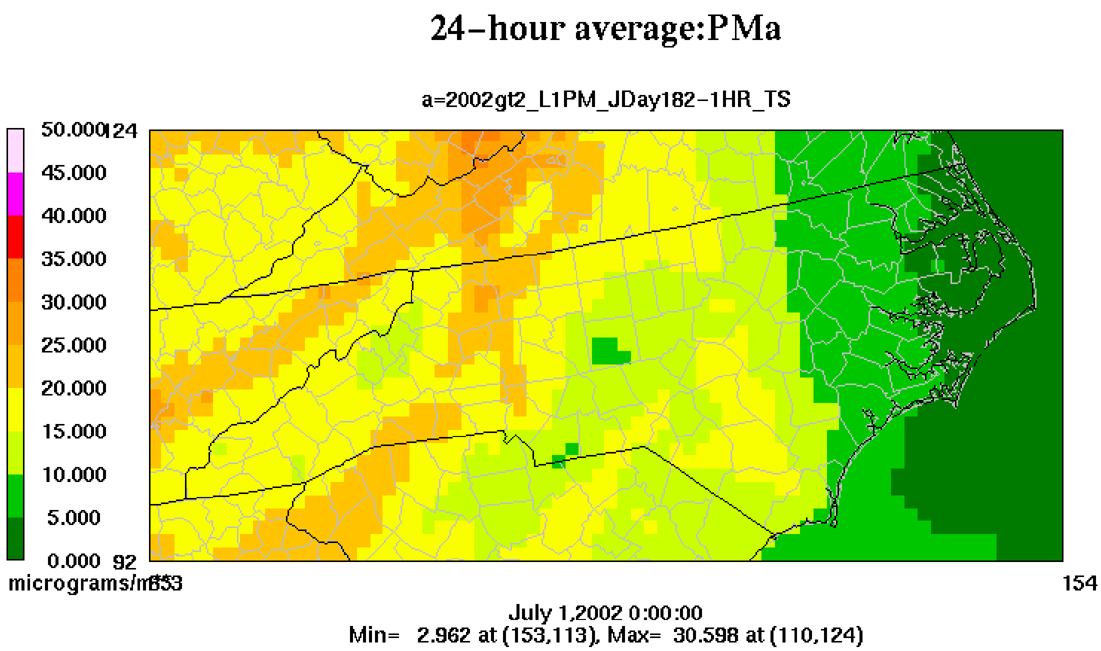
Figure 10: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for June 13th

Table 10.1: Cell Count Across the PM Nonattainment Area Domain Mask For June 13th

day 164	2002	2009
00.0 - 14.9 μg/m^3	1	16
15.0 - 29.9 μg/m^3	49	34
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 10.2: Table of Observed Values from June 13, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
06/13/02	164	Q2		23.1	26.9	25.8



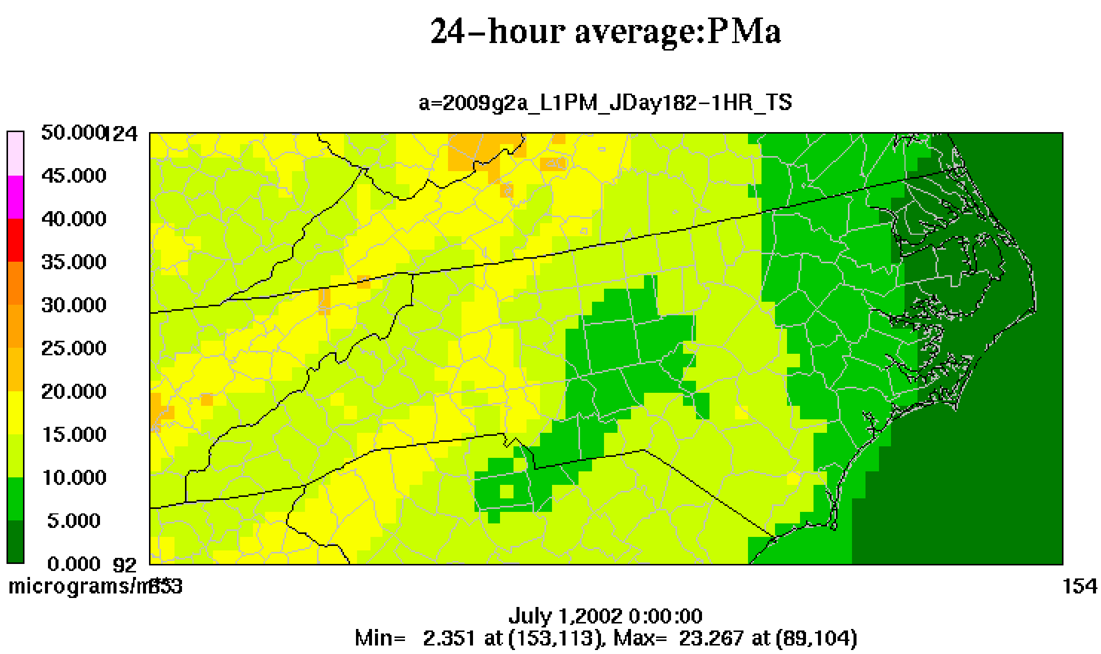


Figure 11: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 1st

Table 11.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 1st

Day 182	2002	2009
00.0 - 14.9 µg/m^3	20	37
15.0 - 29.9 µg/m^3	30	13
30.0 - 44.9 µg/m^3	0	0
45.0 - 60.0 µg/m^3	0	0

Table 11.2: Table of Observed Values from July 1, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/01/02	182	Q3	36.9	33.5	31.1	32.9

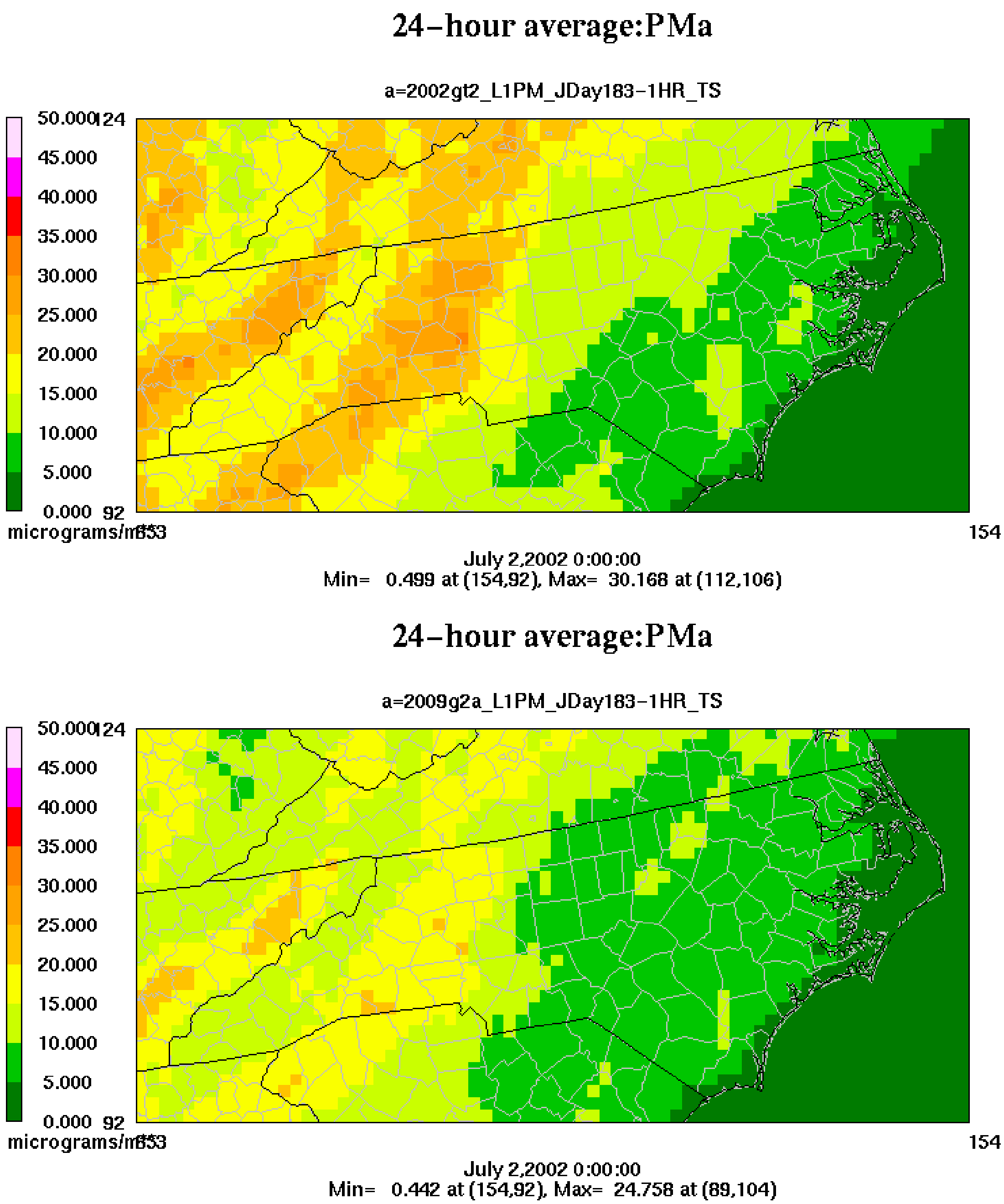


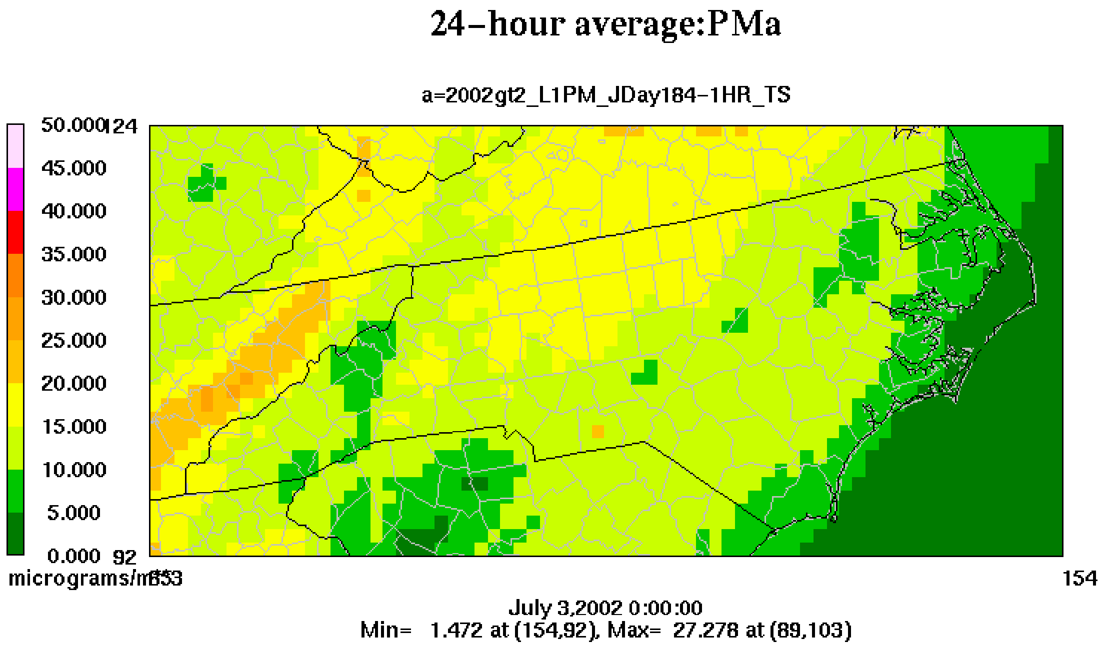
Figure 12: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 2nd

Table 12.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 2nd

Day 183	2002	2009
00.0 - 14.9 μg/m^3	25	35
15.0 - 29.9 μg/m^3	24	15
30.0 - 44.9 μg/m^3	1	0
45.0 - 60.0 μg/m^3	0	0

Table 12.2: Table of Observed Values from July 2, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/02/02	183	Q3				37.7



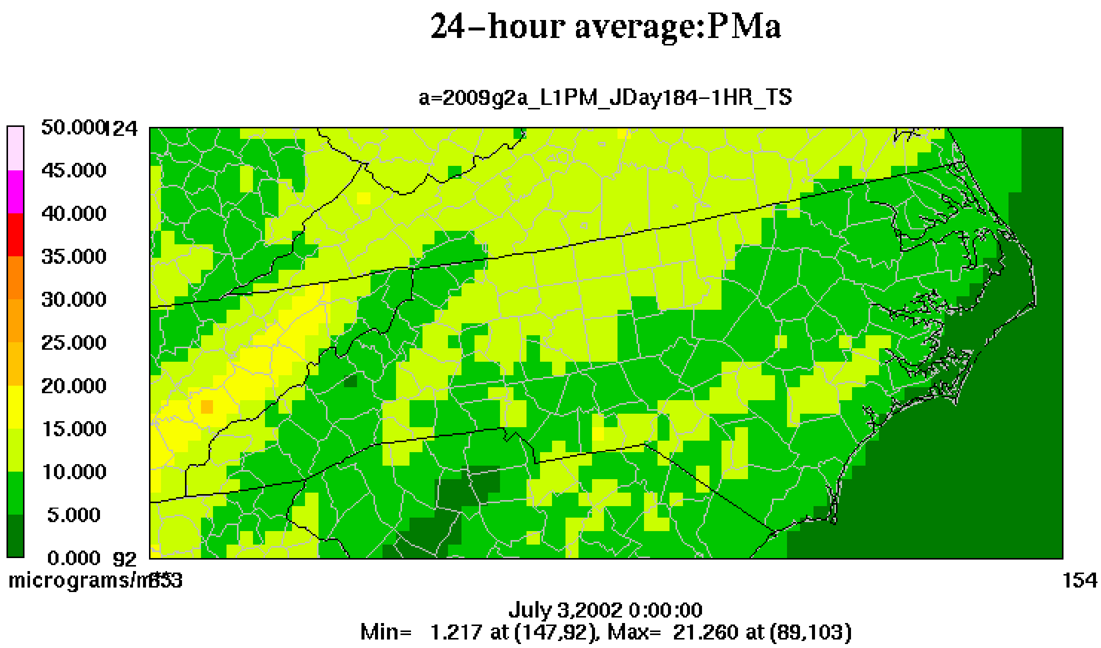


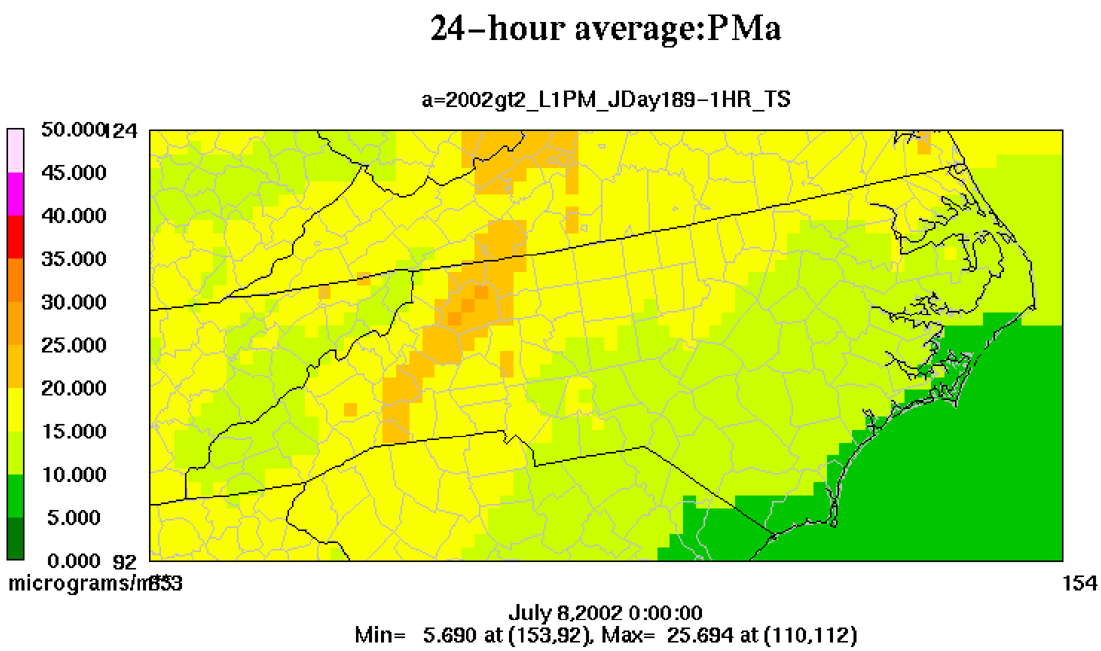
Figure 13: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 3rd

Table 13.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 3rd

Day 184	2002	2009
00.0 - 14.9 μg/m^3	13	50
15.0 - 29.9 μg/m^3	37	0
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 13.2: Table of Observed Values from July 3, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/03/02	184	Q3				30.8



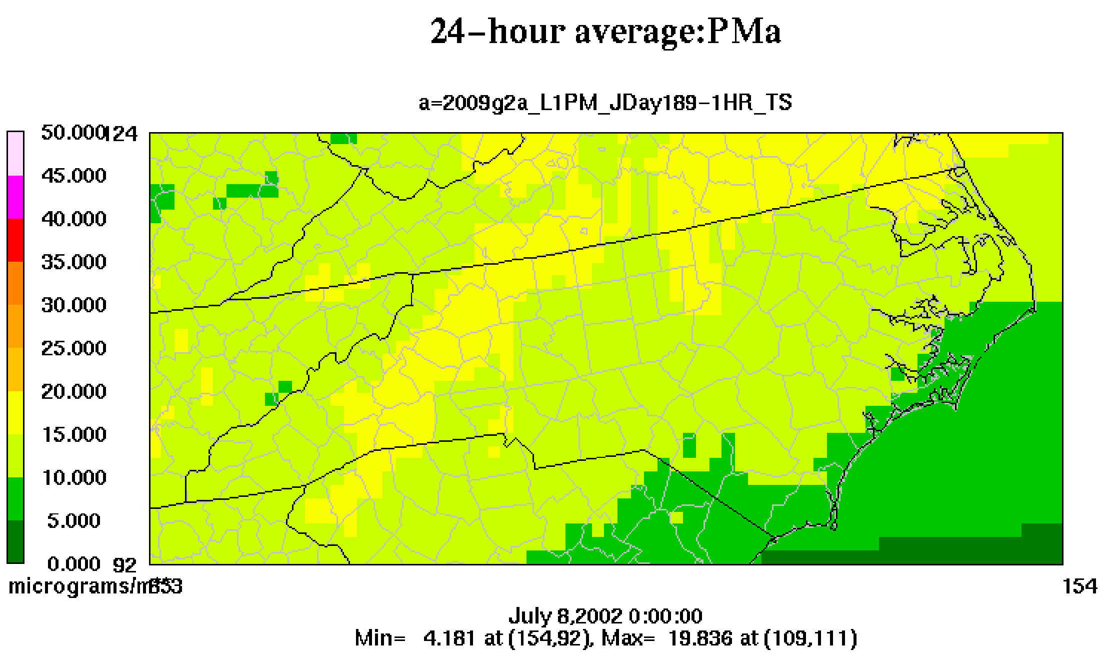


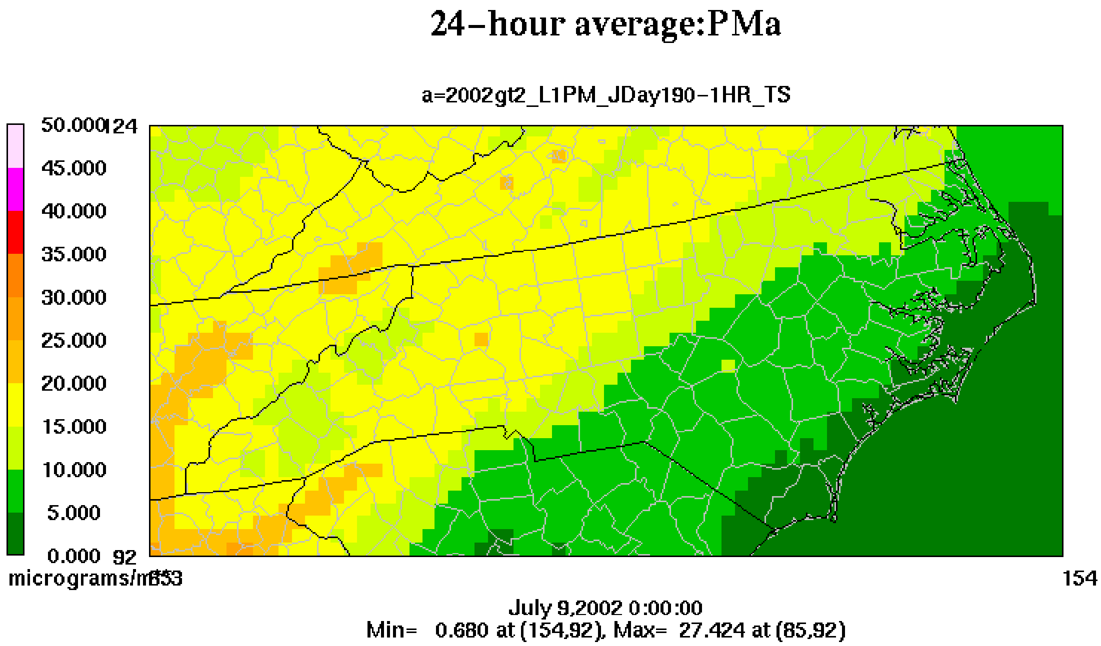
Figure 14: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 8th

Table 14.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 8th

Day 189	2002	2009
00.0 - 14.9 µg/m^3	7	42
15.0 - 29.9 µg/m^3	43	18
30.0 - 44.9 µg/m^3	0	0
45.0 - 60.0 µg/m^3	0	0

Table 14.2: Table of Observed Values from July 8, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/08/02	189	Q3				31.1



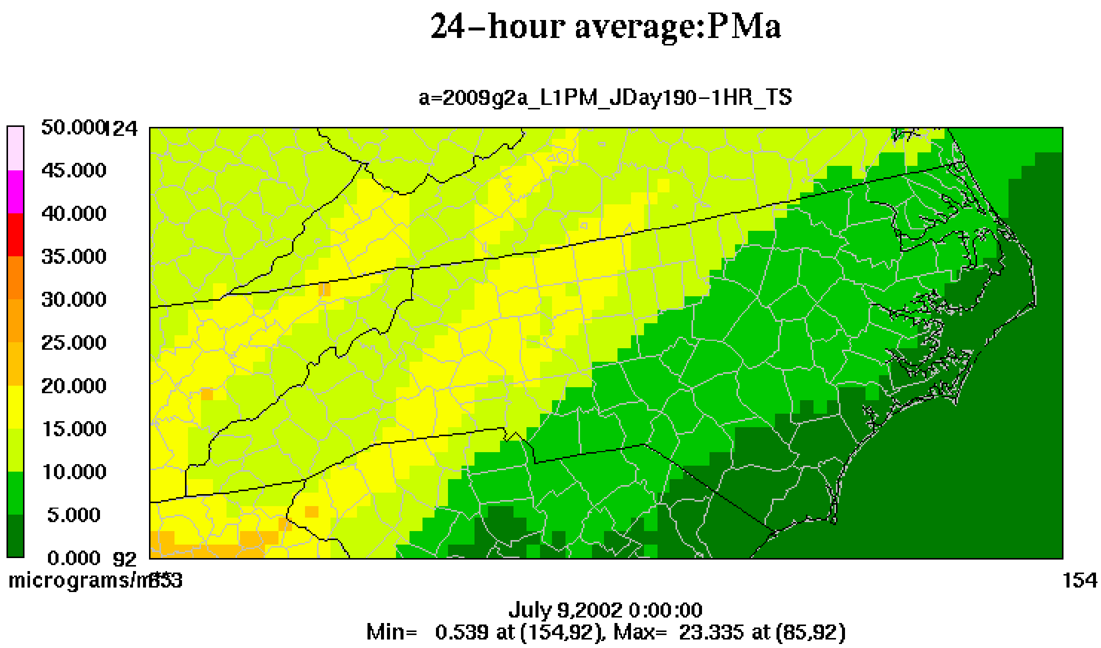


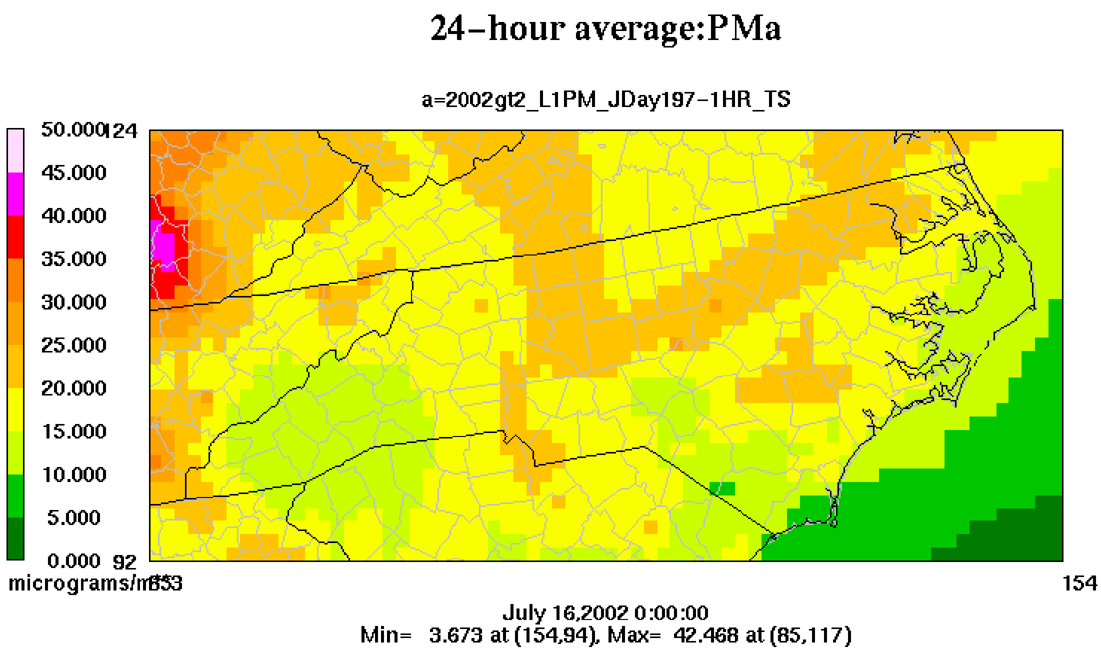
Figure 15: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 9th

Table 15.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 8th

Day 190	2002	2009
00.0 - 14.9 μg/m^3	3	20
15.0 - 29.9 μg/m^3	47	30
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 15.2: Table of Observed Values from July 8, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/09/02	190	Q3				34.9



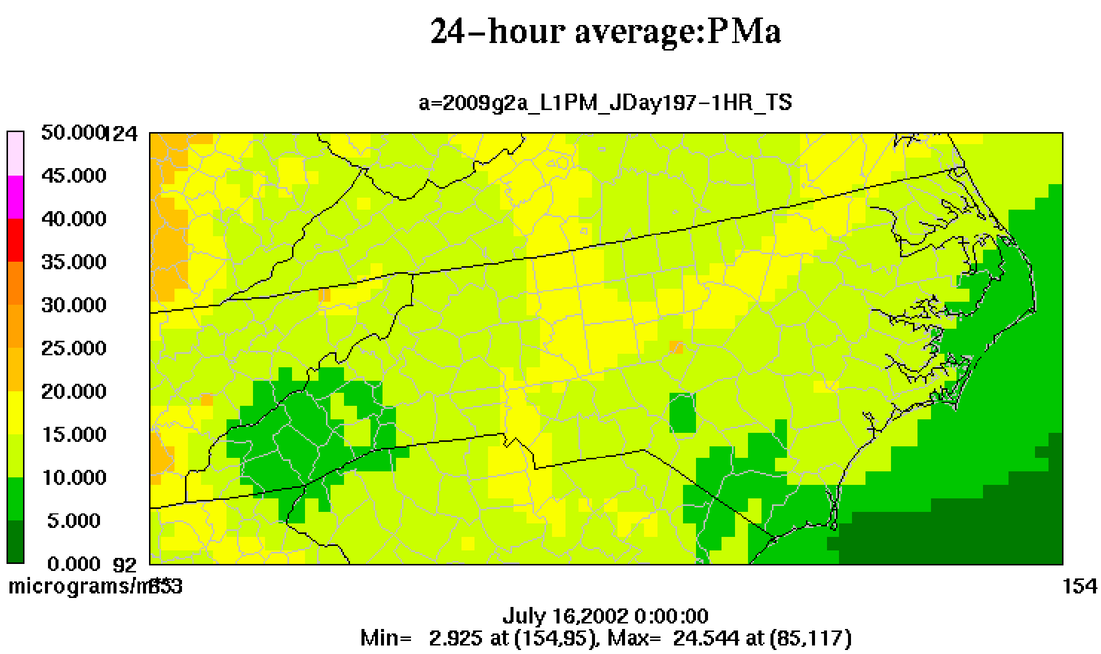


Figure 16: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 16th

Table 16.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 16th

Day 197	2002	2009
00.0 - 14.9 μg/m^3	0	16
15.0 - 29.9 μg/m^3	50	34
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 16.2: Table of Observed Values from July 16, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/16/02	197	Q3		33.5	33.1	34.8

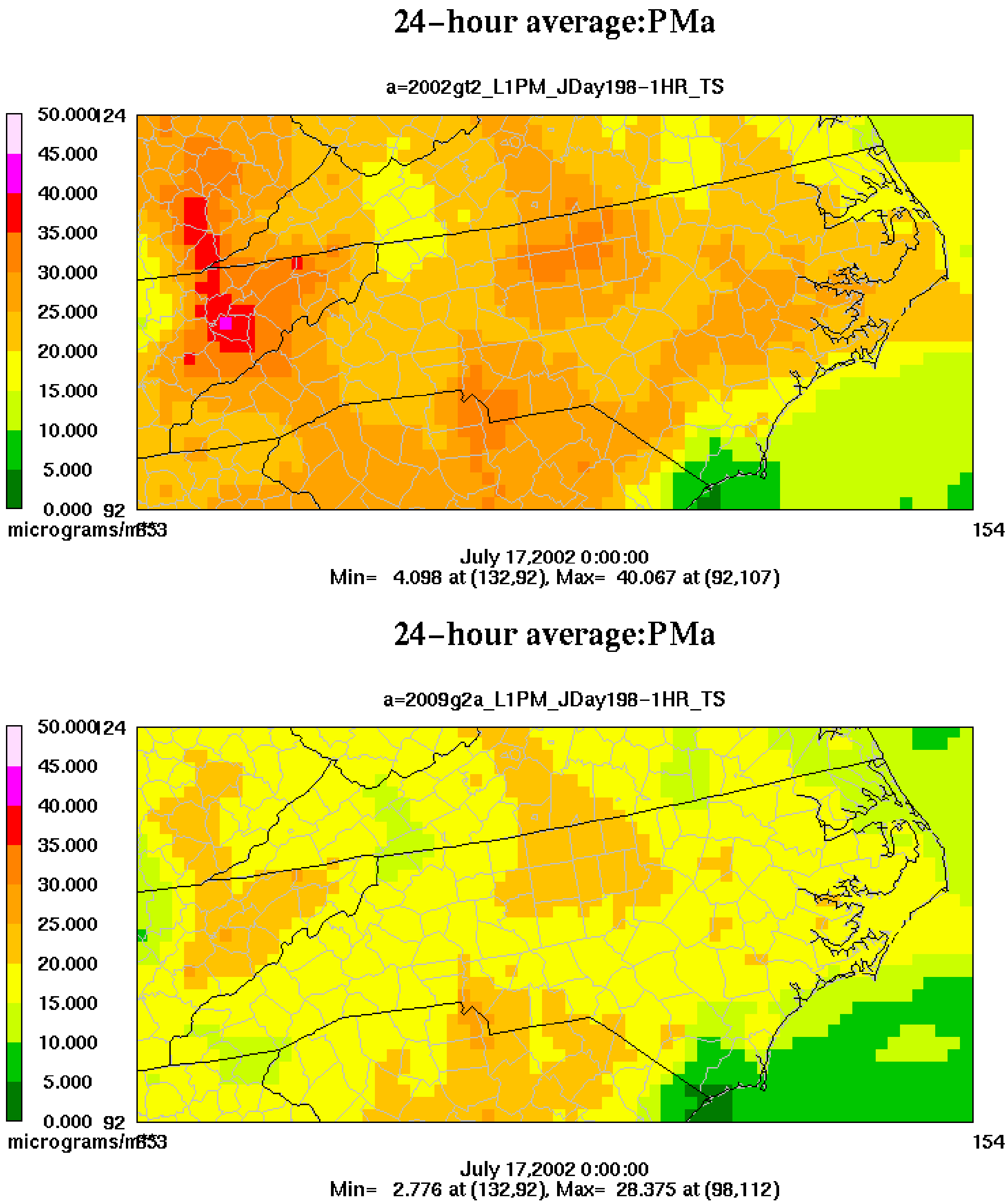


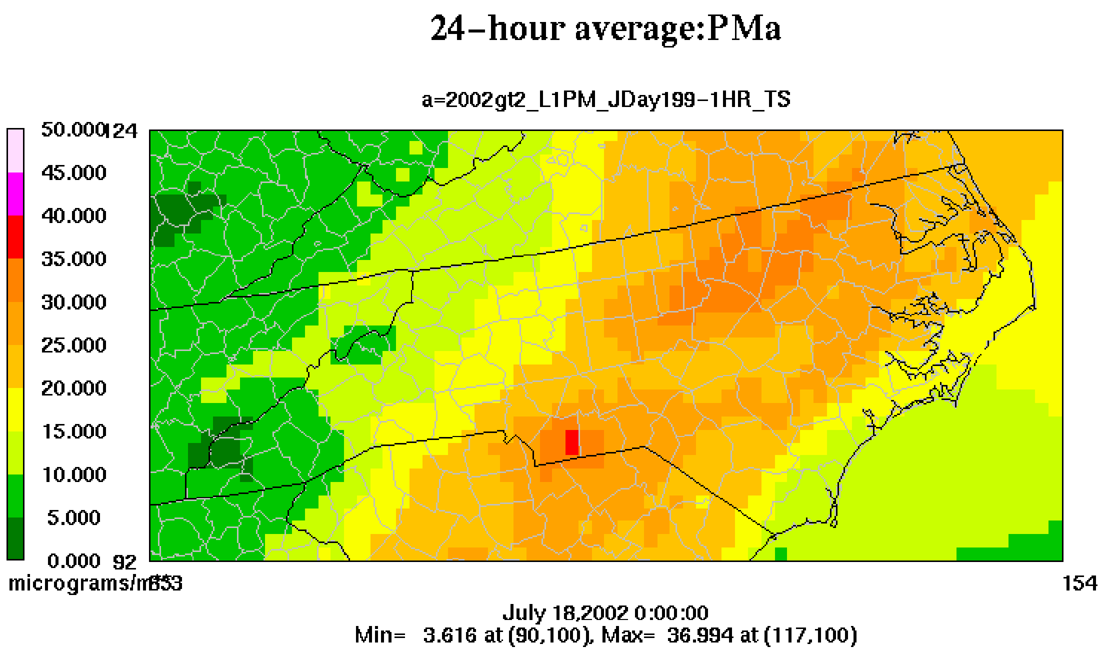
Figure 17: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 17th

Table 17.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 17th

Day 198	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	37	50
30.0 - 44.9 μg/m^3	13	0
45.0 - 60.0 μg/m^3	0	0

Table 17.2: Table of Observed Values from July 17, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/17/02	198	Q3				41.8



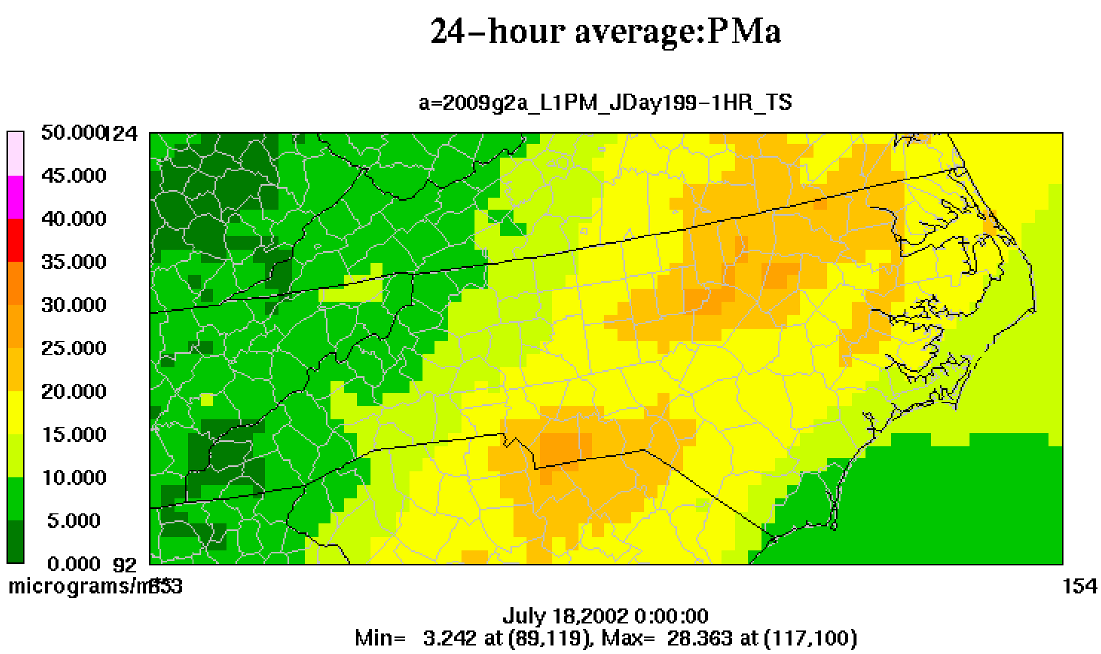


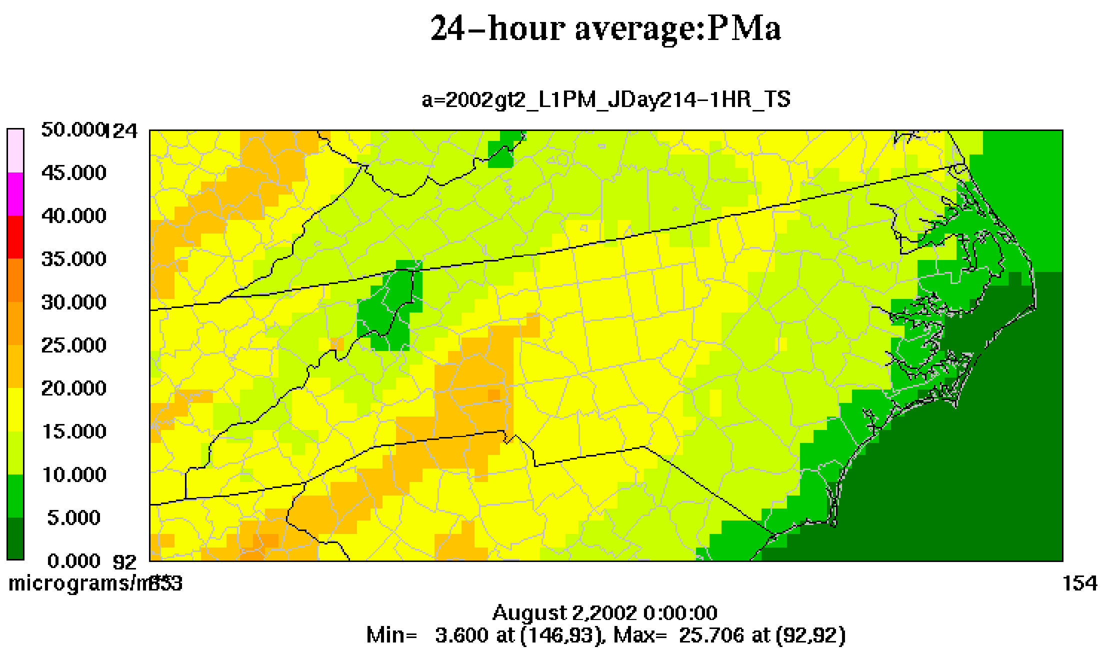
Figure 18: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for July 18th

Table 18.1: Cell Count Across the PM Nonattainment Area Domain Mask For July 18th

Day 199	2002	2009
00.0 - 14.9 μg/m^3	0	14
15.0 - 29.9 μg/m^3	50	36
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 18.2: Table of Observed Values from July 18, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
07/18/02	199	Q3				41.8



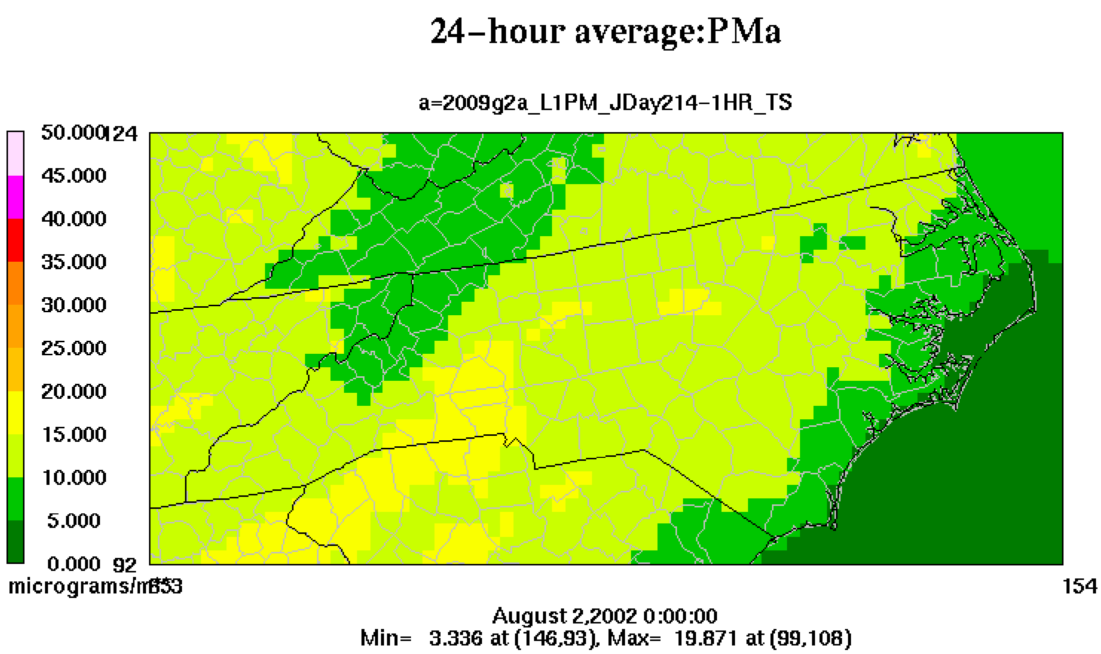


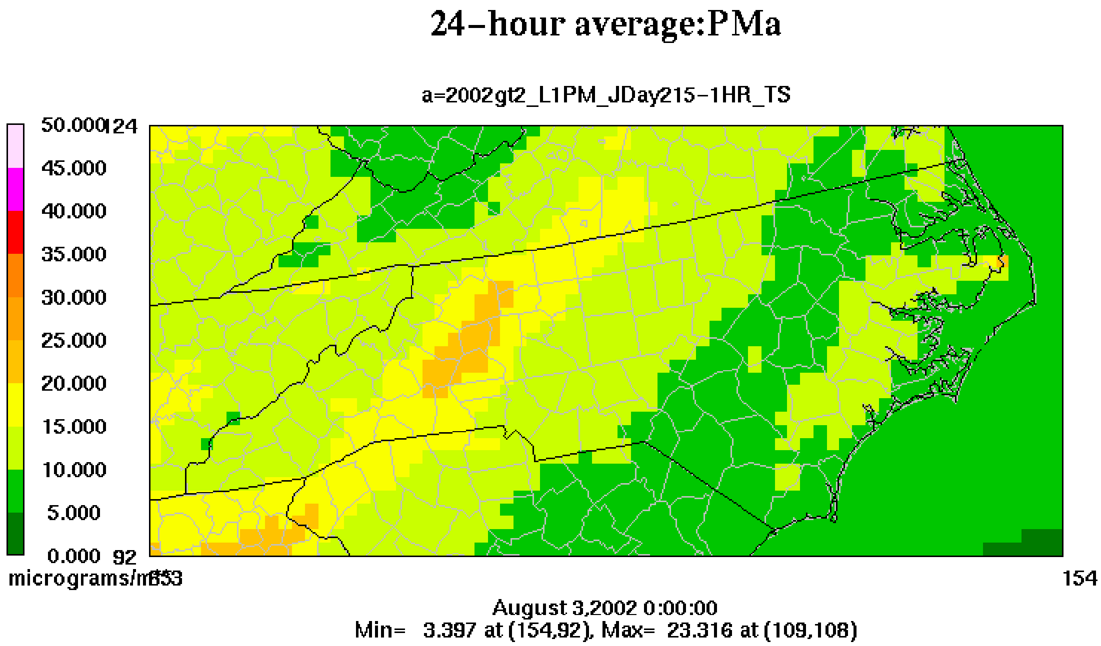
Figure 19: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for August 2nd

Table 19.1: Cell Count Across the PM Nonattainment Area Domain Mask For August 2nd

Day 214	2002	2009
00.0 - 14.9 μg/m^3	0	32
15.0 - 29.9 μg/m^3	50	18
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 19.2: Table of Observed Values from August 2, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/02/02	214	Q3				31.4



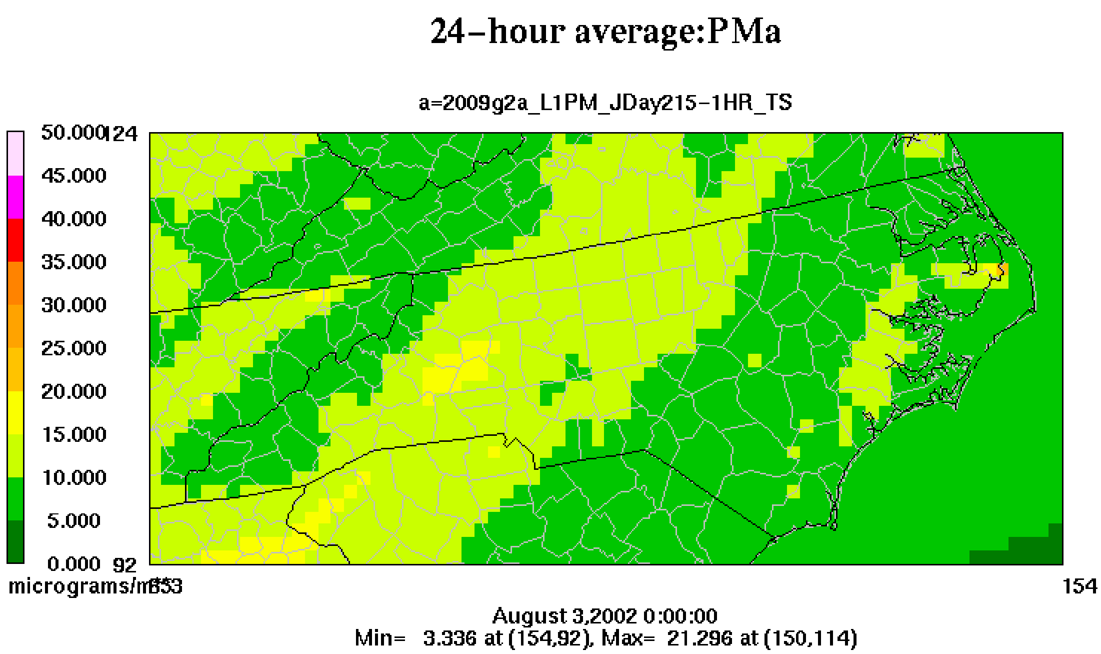


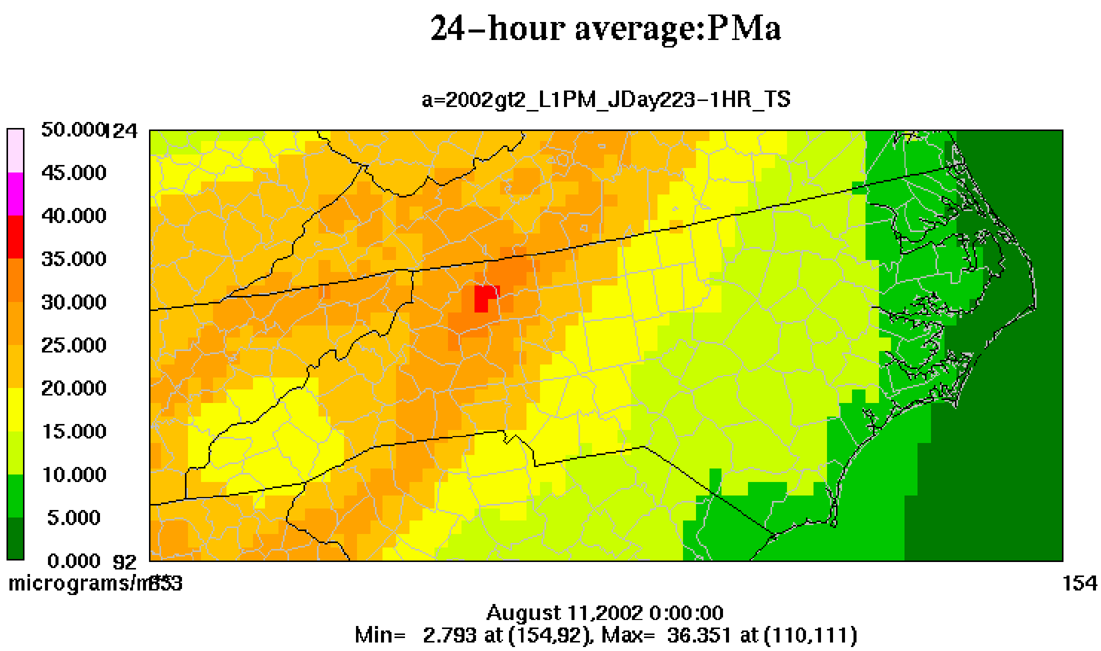
Figure 20: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for August 3rd

Table 20.1: Cell Count Across the PM Nonattainment Area Domain Mask For August 3rd

Day 215	2002	2009
00.0 - 14.9 µg/m^3	30	42
15.0 - 29.9 µg/m^3	20	8
30.0 - 44.9 µg/m^3	0	0
45.0 - 60.0 µg/m^3	0	0

Table 20.2: Table of Observed Values from August 3, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/03/02	215	Q3		30.0	19.5	17.4



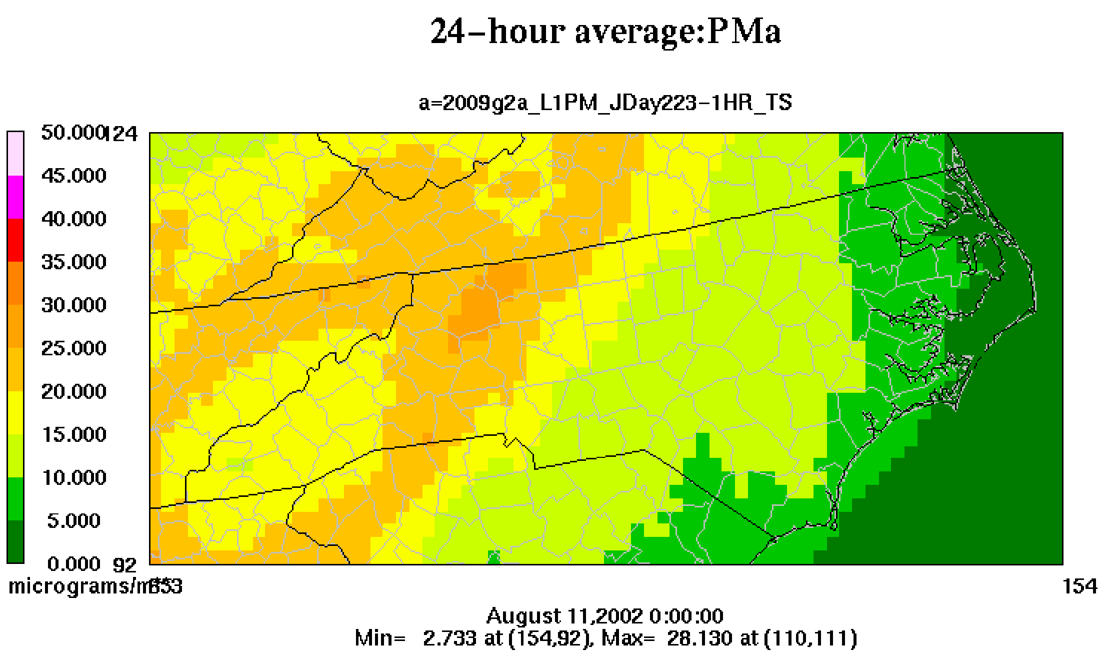


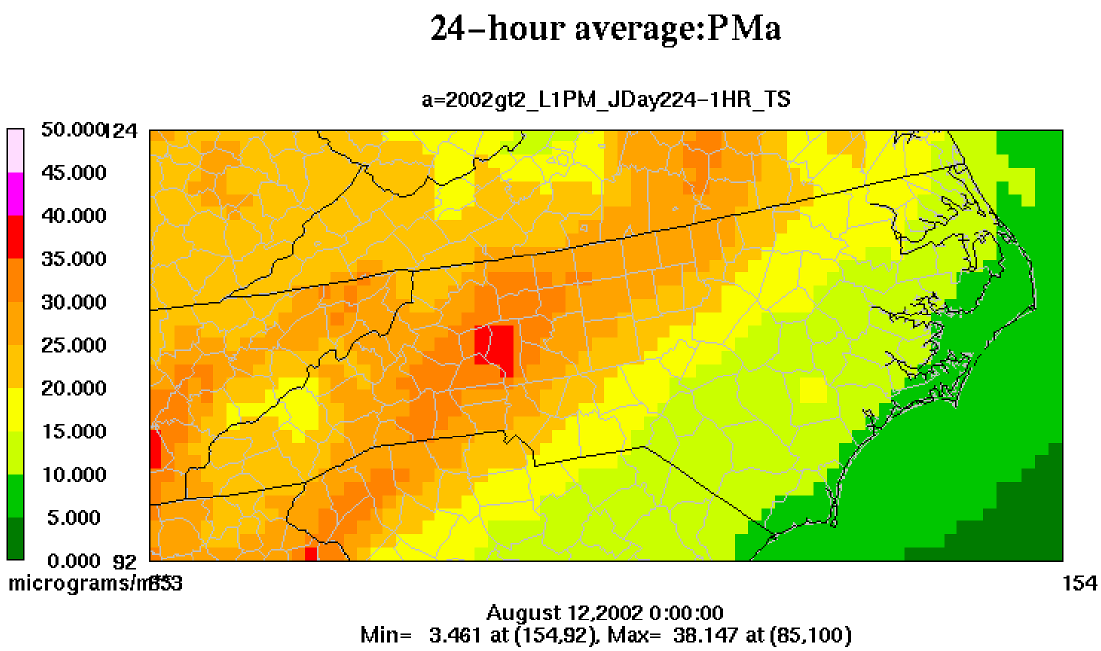
Figure 21: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for August 11th

Table 21.1: Cell Count Across the PM Nonattainment Area Domain Mask For August 11th

Day 223	2002	2009
00.0 - 14.9 μg/m^3	0	4
15.0 - 29.9 μg/m^3	50	46
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 21.2: Table of Observed Values from August 11, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/11/02	223	Q3				33.4



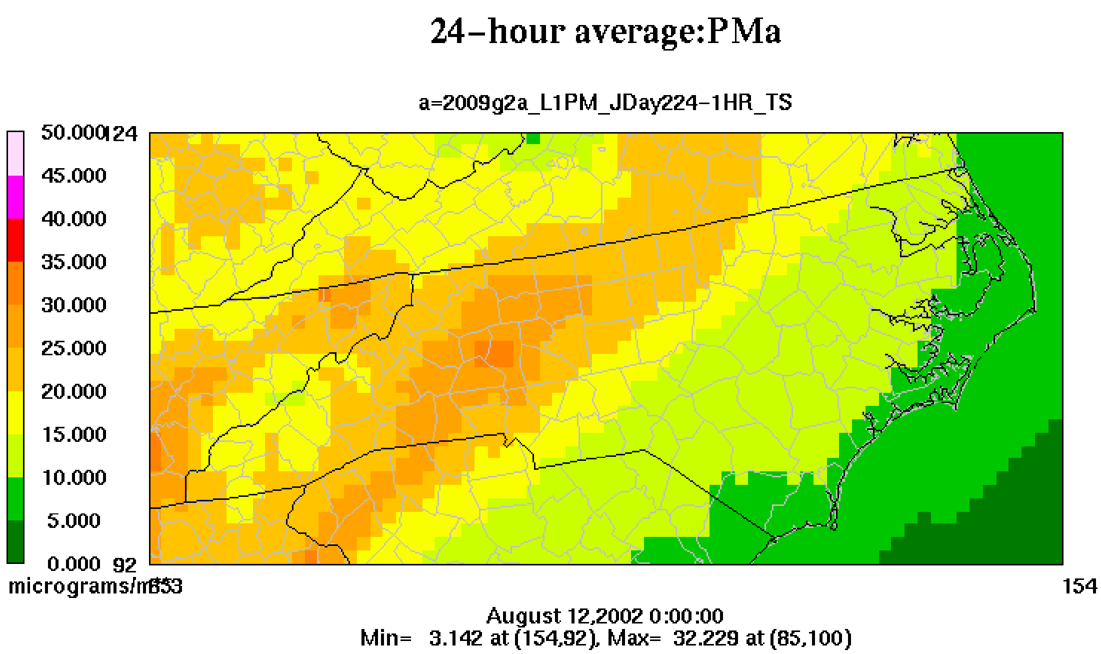


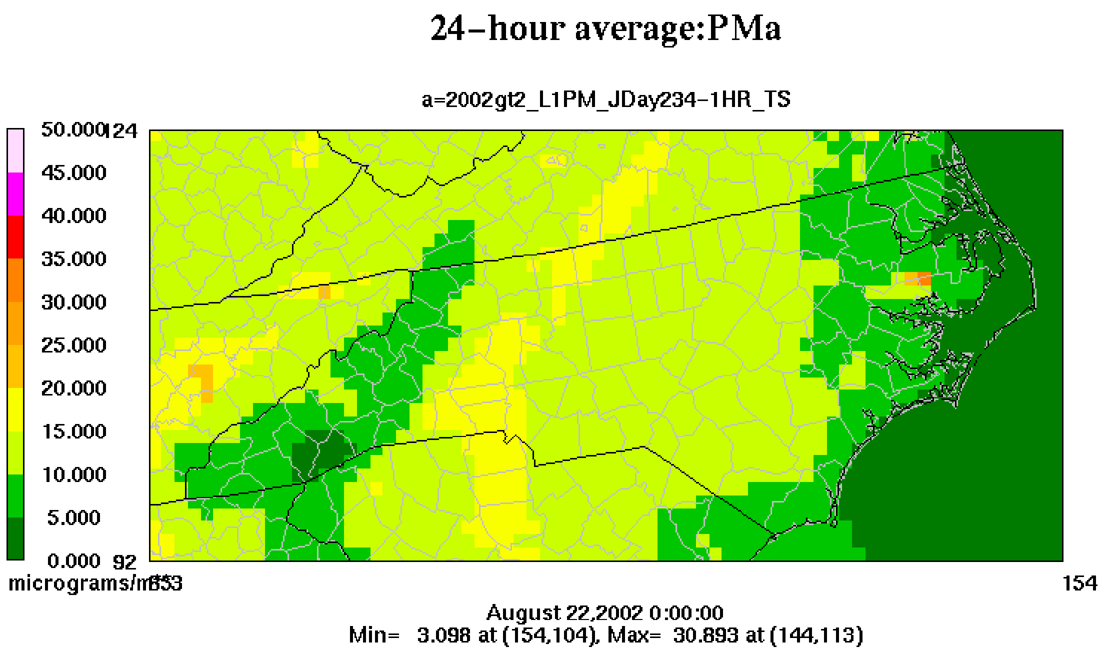
Figure 22: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for August 12th

Table 22.1: Cell Count Across the PM Nonattainment Area Domain Mask For August 12th

Day 224	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	31	48
30.0 - 44.9 μg/m^3	19	2
45.0 - 60.0 μg/m^3	0	0

Table 22.2: Table of Observed Values from August 12, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/12/02	224	Q3	33.3	40.7	36.9	



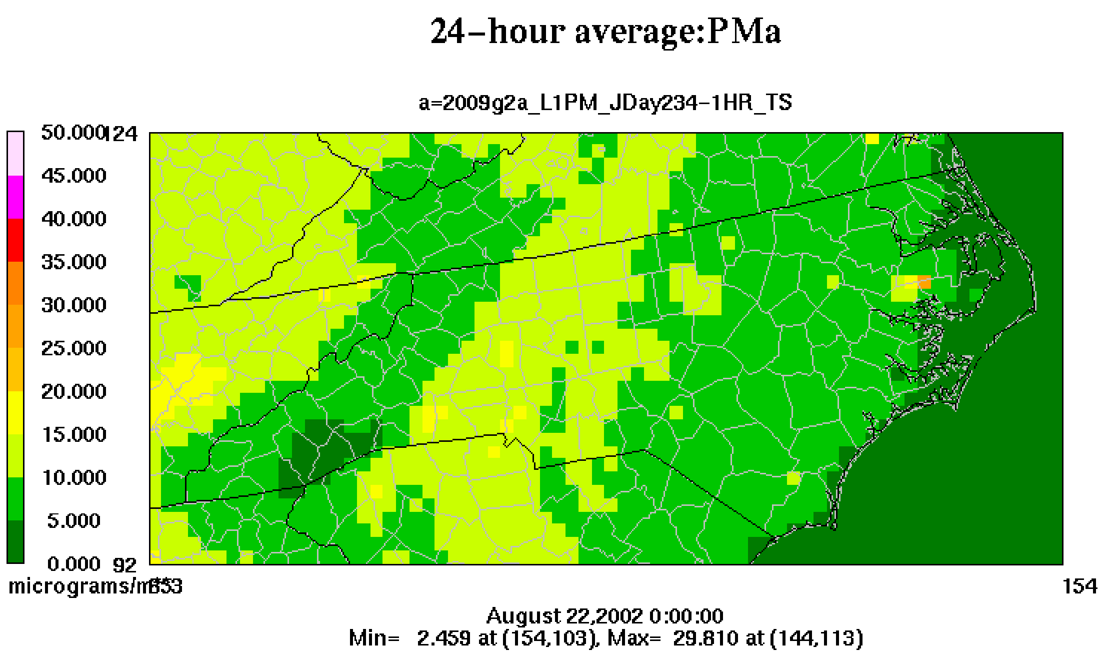


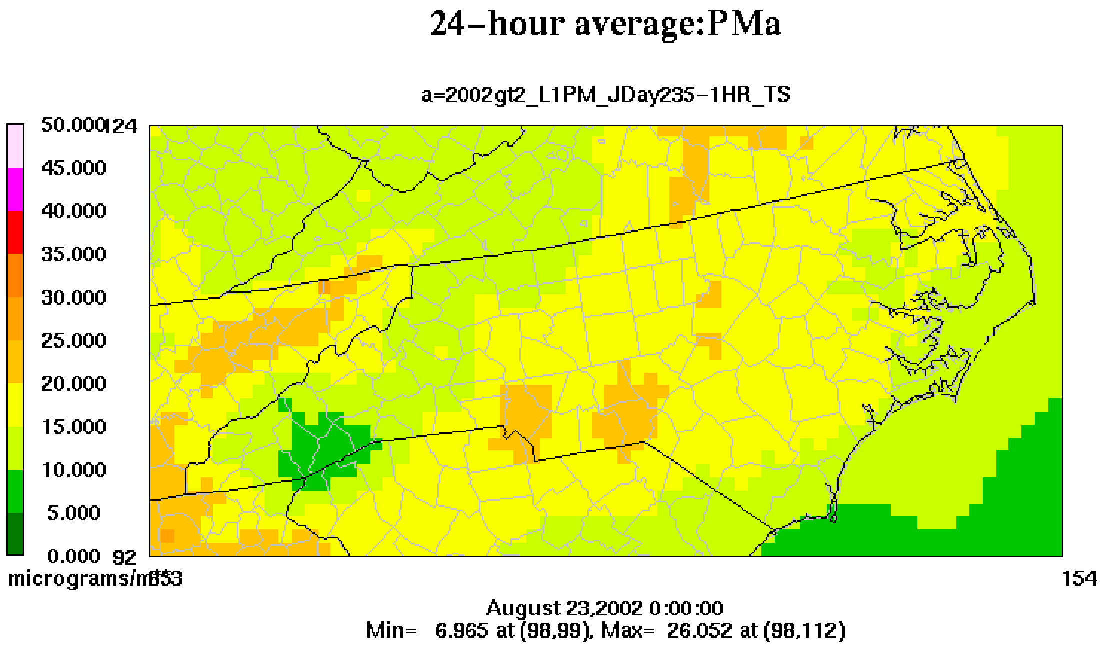
Figure 23: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for August 22nd

Table 23.1: Cell Count Across the PM Nonattainment Area Domain Mask For August 22nd

Day 234	2002	2009
00.0 - 14.9 µg/m^3	36	50
15.0 - 29.9 µg/m^3	14	0
30.0 - 44.9 µg/m^3	0	0
45.0 - 60.0 µg/m^3	0	0

Table 23.2: Table of Observed Values from August 22, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/22/02	234	Q3				31.1



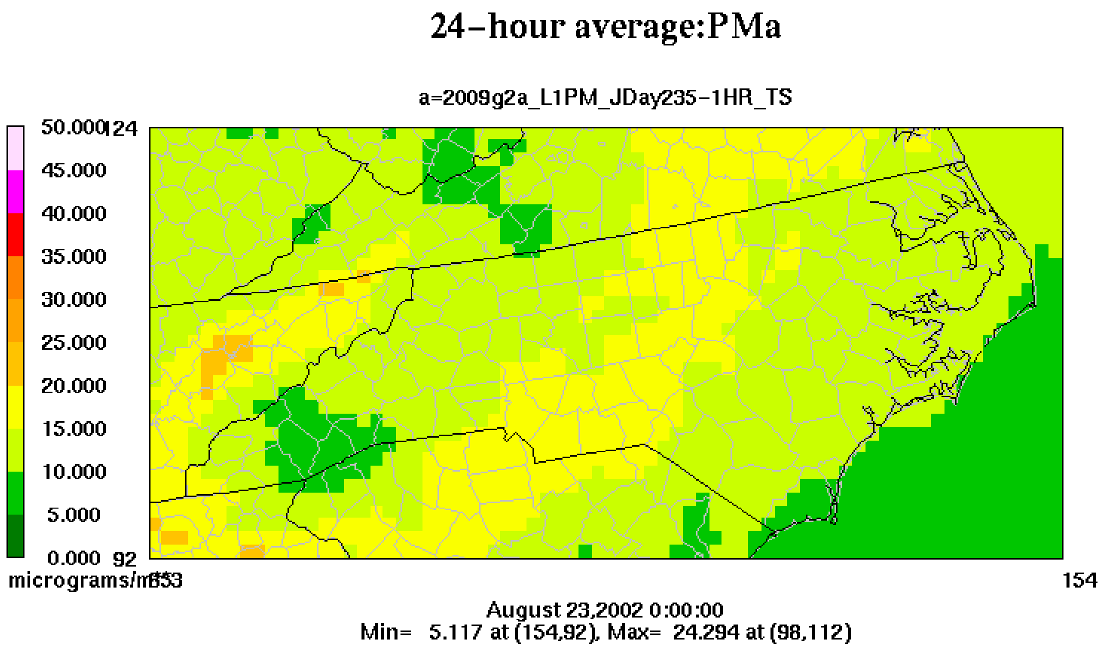


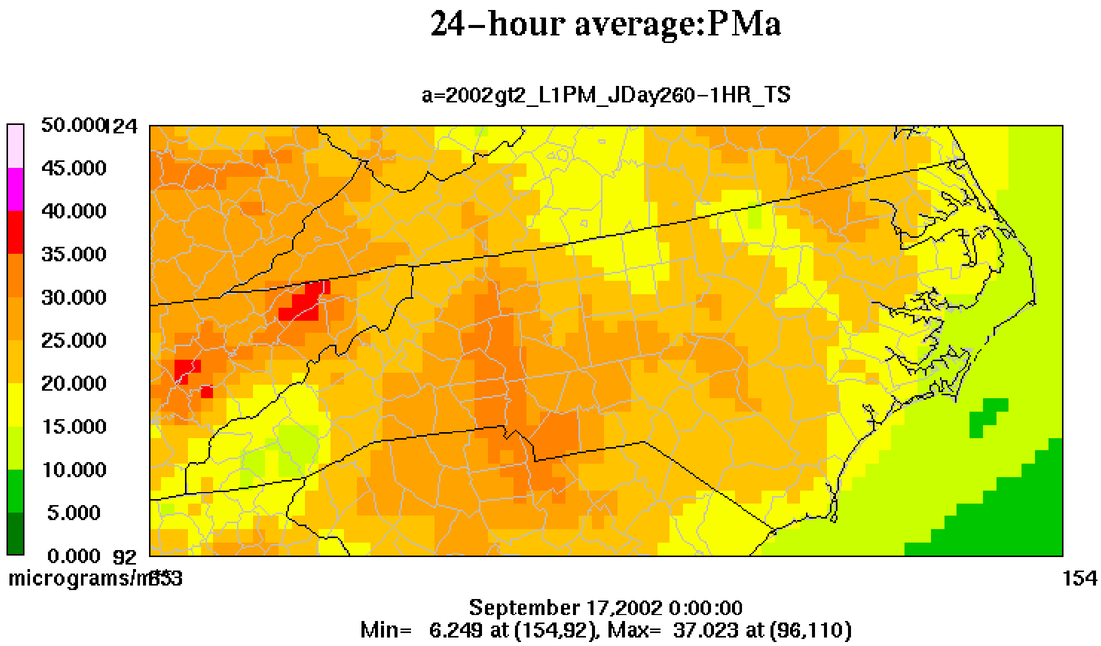
Figure 24: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for August 23rd

Table 24.1: Cell Count Across the PM Nonattainment Area Domain Mask For August 23rd

Day 235	2002	2009
00.0 - 14.9 μg/m^3	7	40
15.0 - 29.9 μg/m^3	43	10
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 24.2: Table of Observed Values from August 23, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
08/23/02	235	Q3				33.2



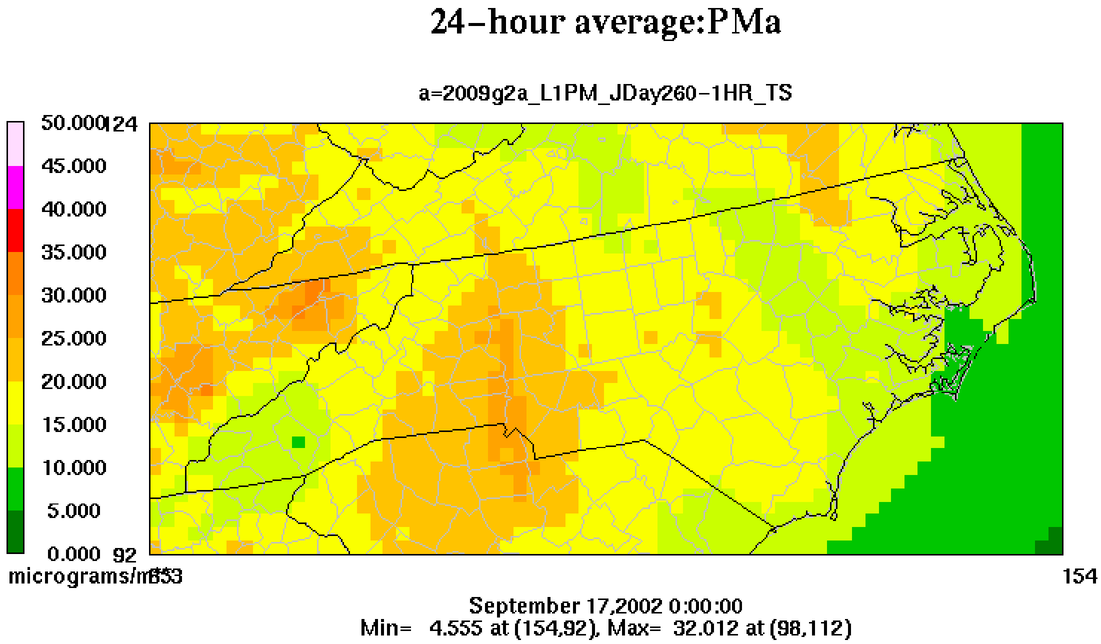


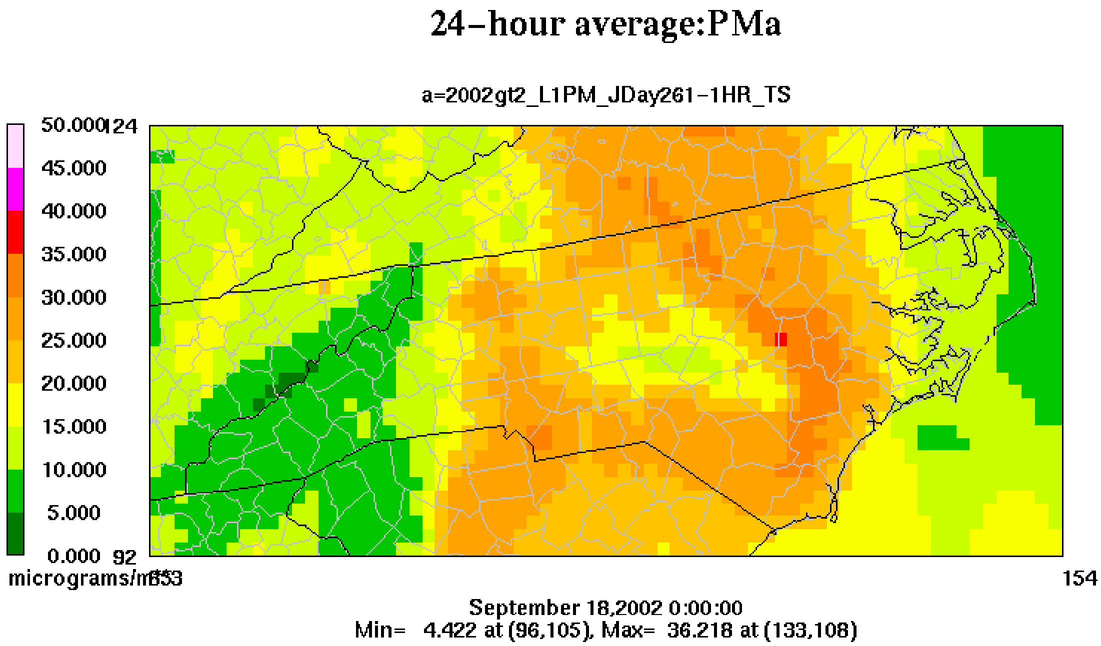
Figure 25: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for September 17th

Table 25.1: Cell Count Across the PM Nonattainment Area Domain Mask For September 17th

Day 260	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	41	50
30.0 - 44.9 μg/m^3	9	0
45.0 - 60.0 μg/m^3	0	0

Table 25.2: Table of Observed Values from September 17, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
09/17/02	260	Q3	30.6	27.6		21.2



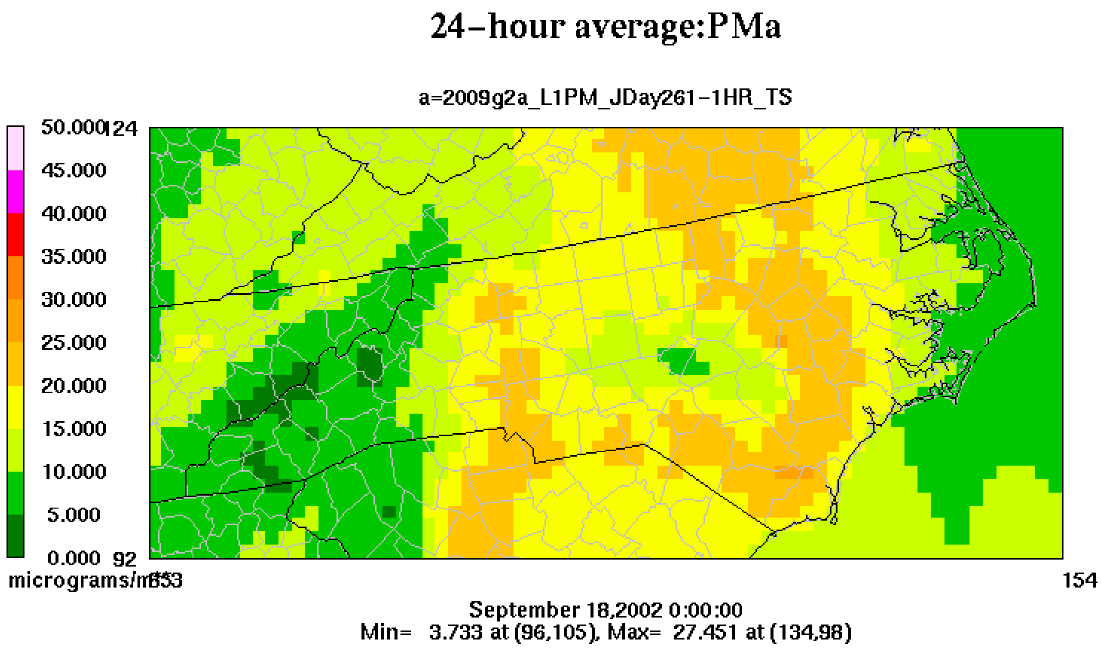


Figure 26: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for September 18th

Table 26.1: Cell Count Across the PM Nonattainment Area Domain Mask For September 18th

Day 261	2002	2009
00.0 - 14.9 μg/m^3	1	8
15.0 - 29.9 μg/m^3	49	42
30.0 - 44.9 μg/m^3	0	0
45.0 - 60.0 μg/m^3	0	0

Table 26.2: Table of Observed Values from September 18, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
09/18/02	261	Q3				30.5

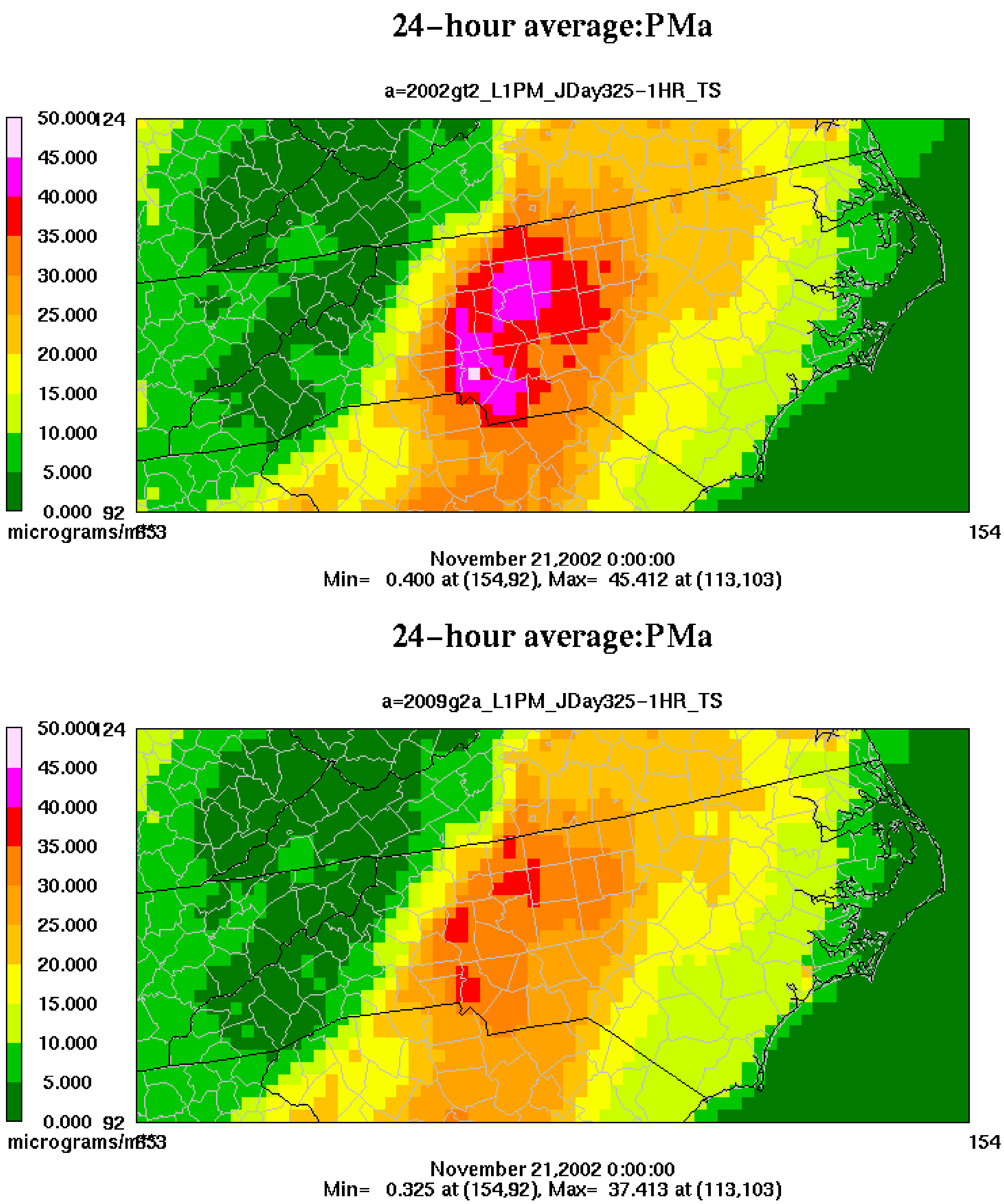


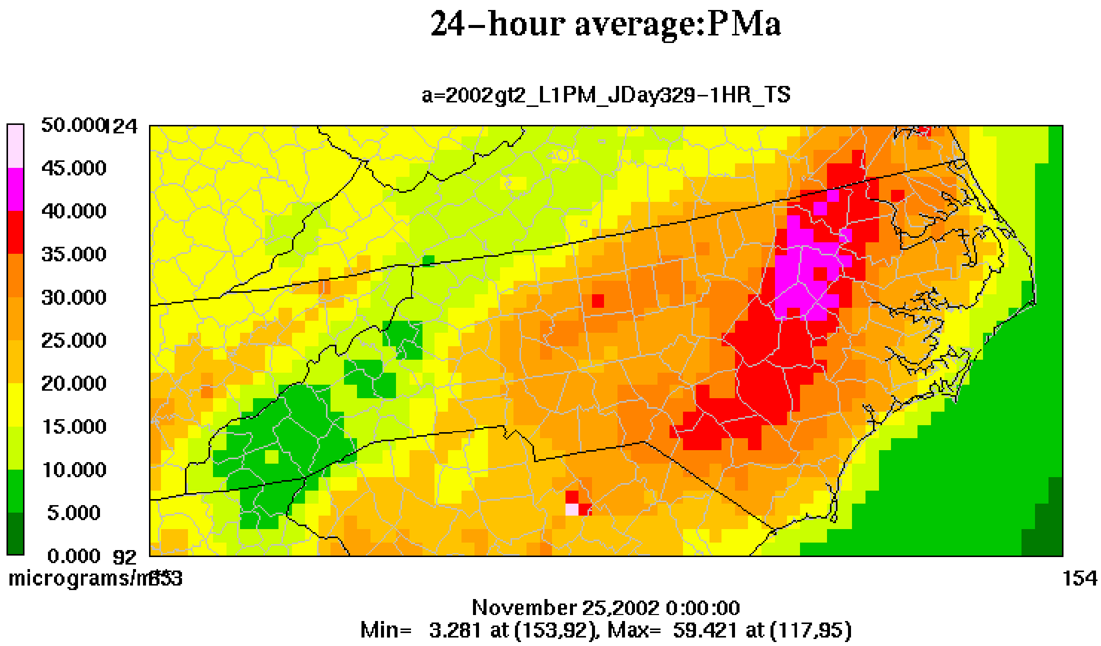
Figure 27: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for November 21st

Table 27.1: Cell Count Across the PM Nonattainment Area Domain Mask For November 21st

Day 325	2002	2009
00.0 - 14.9 µg/m^3	0	0
15.0 - 29.9 µg/m^3	6	8
30.0 - 44.9 µg/m^3	44	42
45.0 - 60.0 µg/m^3	0	0

Table 27.2: Table of Observed Values from December 31, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
11/21/02	325	Q4				26.6



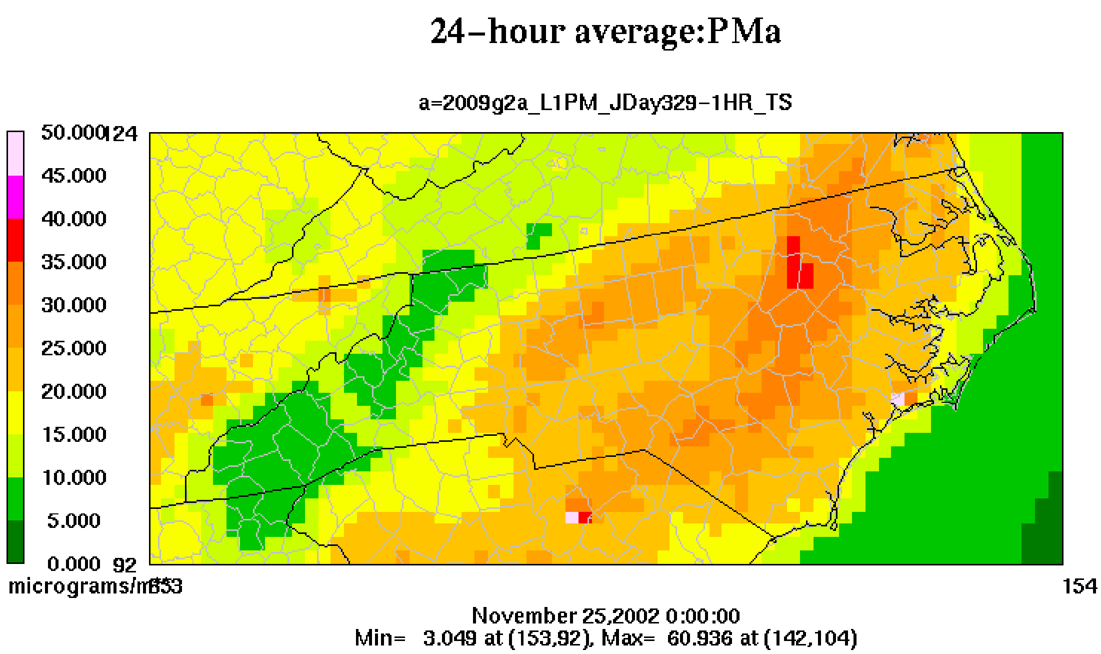


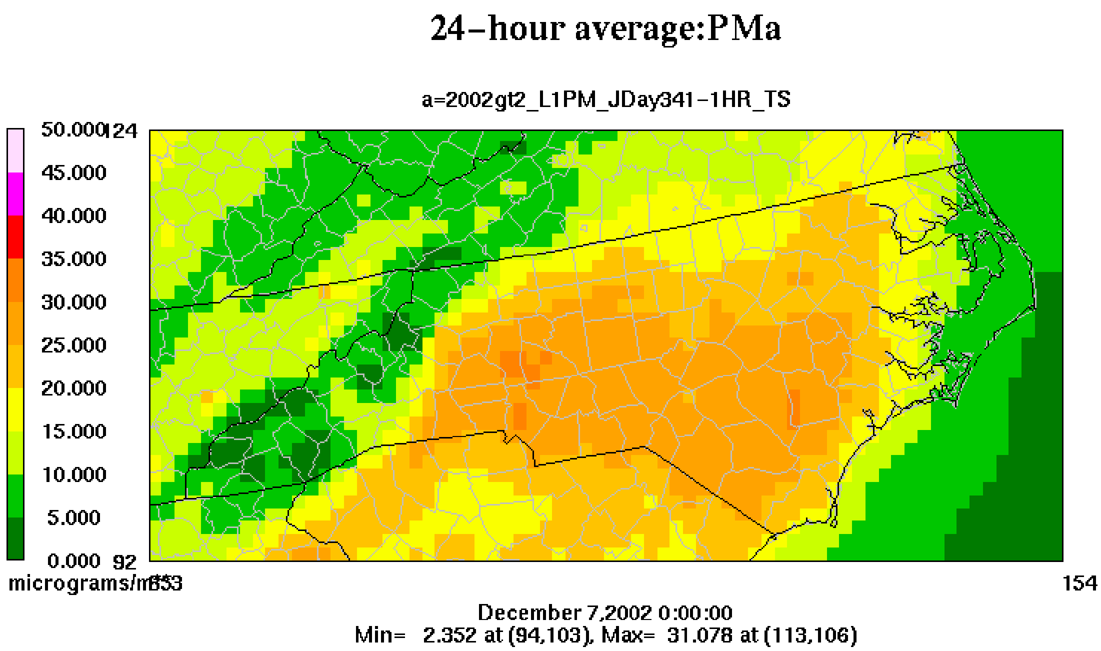
Figure 28: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for November 25th

Table 28.1: Cell Count Across the PM Nonattainment Area Domain Mask For November 25th

Day 329	2002	2009
00.0 - 14.9 µg/m^3	0	1
15.0 - 29.9 µg/m^3	32	46
30.0 - 44.9 µg/m^3	18	3
45.0 - 60.0 µg/m^3	0	0

Table 28.2: Table of Observed Values from November 25, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
11/25/02	329	Q4		19.3	25.9	19.9



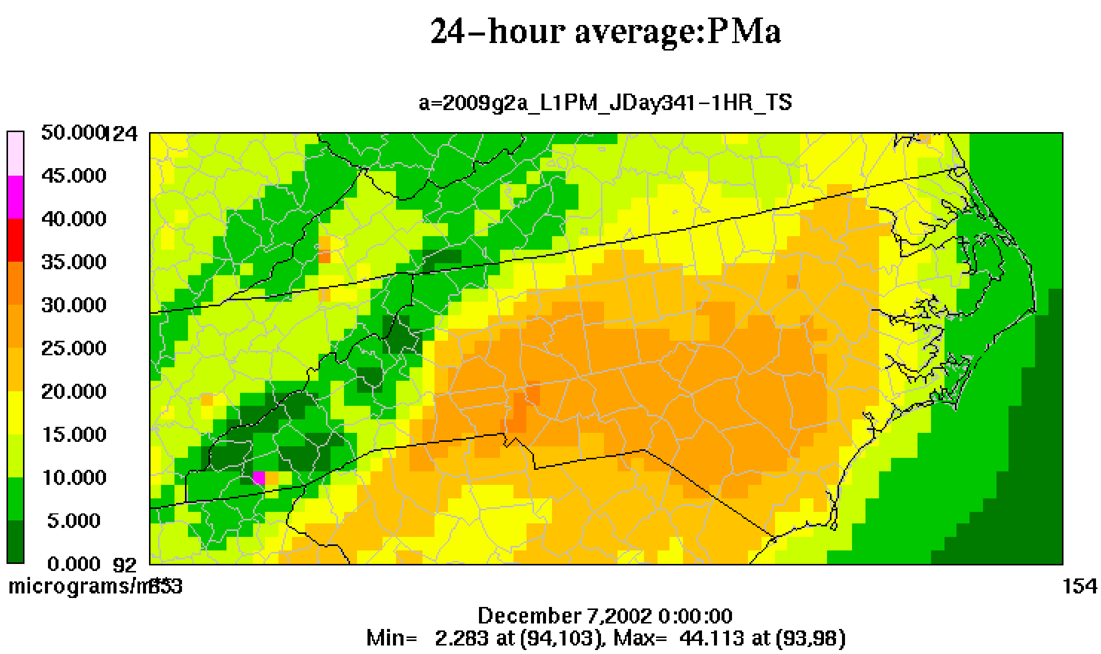


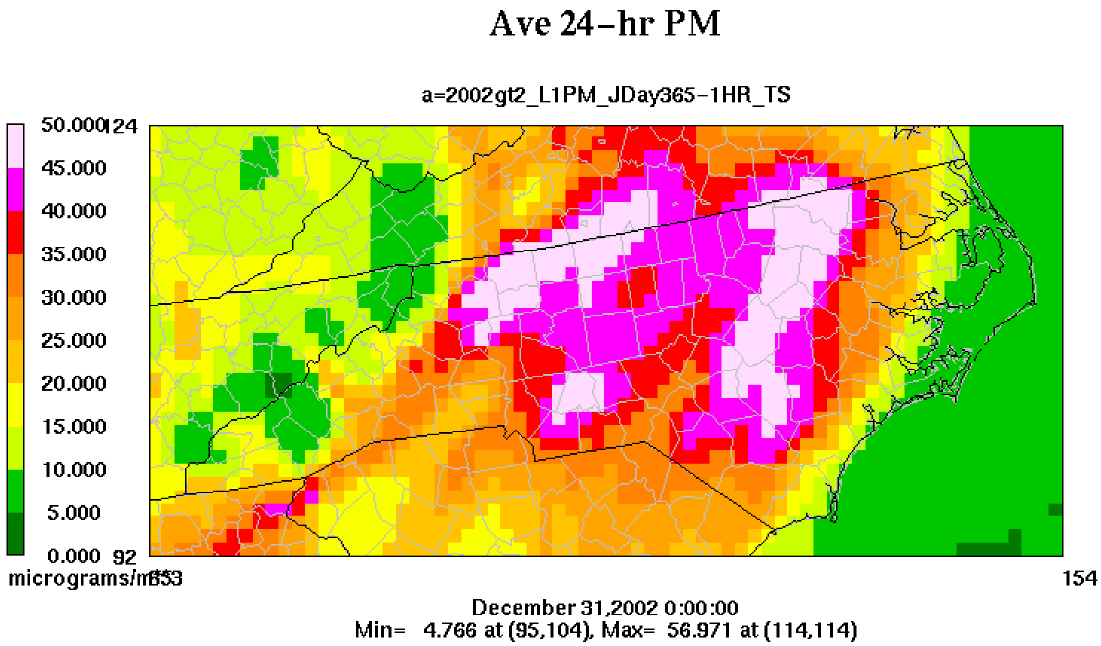
Figure 29: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for December 7th

Table 29.1: Cell Count Across the PM Nonattainment Area Domain Mask For December 7th

Day 341	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	49	50
30.0 - 44.9 μg/m^3	1	0
45.0 - 60.0 μg/m^3	0	0

Table 29.2: Table of Observed Values from December 7, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
12/07/02	341	Q4		29.2	43.7	49.2



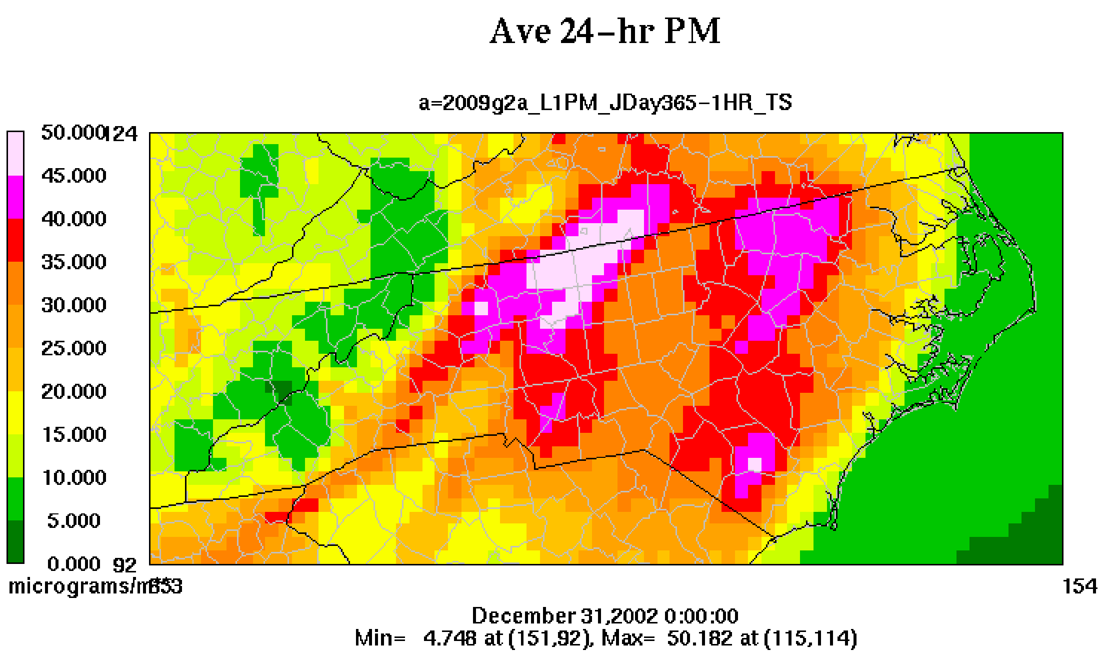


Figure 30: 2002 (top) 2009 (bottom) Reconstructed 24-hour Average Fine Particulate Matter for December 31st

Table 30.1: Cell Count Across PM Nonattainment Area Domain Mask For December 31st

Day 365	2002	2009
00.0 - 14.9 μg/m^3	0	0
15.0 - 29.9 μg/m^3	5	9
30.0 - 44.9 μg/m^3	41	34
45.0 - 60.0 μg/m^3	4	7

Table 30.2: Table of Observed Values from December 31, 2002

			37-035-004	37-035-004	37-057-0002	37-081-0013
Date	Jday	Quarter	Hickory (STN)	Hickory (FRM)	Lexington (FRM)	Mendenhall (FRM)
12/31/02	365	Q4		28.9	18.9	20.5

Appendix L
Attainment Test

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1 Attainment Demonstration

This Appendix summarizes the procedures that were used to demonstrate attainment of the annual fine particulate matter (PM2.5) National Ambient Air Quality Standard (NAAQS) in this State Implementation Plan (SIP) package. As described in the US Environmental Protection Agency's (USEPA's) Guidance On The Use Of Models And Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze ("*Attainment Guidance*"), an attainment demonstration consists of (a) analyses which estimate whether selected emissions reductions will result in ambient concentrations that meet the NAAQS, and (b) an identified set of control measures which will result in the required emissions reductions. The necessary emission reductions for both of these attainment demonstration components may be determined by relying on results obtained with air quality models.

Section 3.0 of the *Attainment Guidance* recommends applying both a modeled attainment test and a subsequent screening test to the air quality modeling results to determine if the annual PM2.5 NAAQS will be met. Additional technical or corroboratory analyses may also be used as part of a "supplemental analysis" or a more stringent "weight of evidence" determination to supplement the modeled attainment test and to further support a demonstration of attainment of the NAAQS.

The modeled attainment test, additional corroborative analyses and weight of evidence, and unmonitored area analysis are described in further detail in the remaining portions of this Appendix, detailing how the respective test or analysis was performed and applied to the attainment demonstration.

2 Model Attainment Test

The purpose of a modeling assessment is to determine if control strategies currently being implemented ("on the books") and proposed control strategies will lead to attainment of the NAAQS for PM2.5 by the attainment year of 2009. The modeling is applied in a relative sense, similar to the 8-hour ozone attainment test. However, the PM2.5 attainment test is more complicated and reflects the fact that PM2.5 has many components. In the test, ambient PM2.5 is divided into major components, with a separate relative response factor (RRF) and future design value (DVF) calculated for each of the PM2.5 components. Since the attainment test is calculated on a per species basis, the attainment test for PM2.5 is referred to as the Speciated Modeled Attainment Test (SMAT). The following sections outline the process to determine 2009 projections of PM2.5 will meet the NAAQS from regional modeling, as suggested in the US EPA's Attainment Guidance.

2.1 Determine Baseline Design Values

The first step in any attainment test process is to determine the baseline design value (DVB). In the Attainment Guidance, the US EPA recommends using a DVB that is the average of the three design value periods that straddle the baseline inventory year (e.g., the average of the 2000-2002, 2001-2003, and 2002-2004 design value periods for a 2002 baseline inventory year). This works out to a 5-year weighted average, with the baseline year having the heaviest weight (e.g. {[2000] + 2*[2001] + 3*[2002] + 2*[2003] + [2004]}/9).

For the SMAT process, a mean PM2.5 DVB is determined, as well as component specific DVB for each quarter. The following section will detail the calculation of baseline design values needed for the PM2.5 attainment test.

2.1.1 Mean PM2.5 Baseline Design Values

To begin the SMAT process, a mean PM2.5 DVB is calculated on a quarterly basis for each Federal Reference Method (FRM) monitor in the PM2.5 nonattainment areas. Concentrations are calculated based on calendar quarters (Q1: January - March; Q2: April - June; etc.) as the NAAQS is calculated for a calendar year, and the quarters need to fit evenly within a year. Also, calculating the attainment test on a quarterly basis allows states to examine the differences in PM2.5 composition that occur during the different seasons.

Table 2-1 contains the quarterly average PM2.5 concentration for the FRM monitors in the nonattainment areas. This quarterly data was then averaged, using the weighted scheme suggested by the US EPA, to produce a 5-year weighted DVB. In the case of the Guilford County FRM site (Mendenhall, 37-081-0013), there is less than 5 years of data available, as the site came online late third quarter 2001. Per the Attainment Guidance, when only 3 years of data are available at a site, the baseline design value is then based on a single three-year design value. This is the case for quarters 1 through 3 at the Mendenhall site. Since there are four years of data for fourth quarter, then the baseline design value is based on an average of two design value periods (2001-2003 and 2002-2004). Table 2-2 presents the final mean PM2.5 DVBs for the nonattainment areas.

Table 2-1: Quarterly Average PM2.5 Mass for the FRM Monitors in the North Carolina Nonattainment Areas

AIRS ID	County	Site Name	Year	Q1	Q2	Q3	Q4	Annual
37-035-0004	Catawba	Hickory	2000	16.14	16.58	18.9	18.89	17.63
			2001	15.3	16.61	18.83	13.16	15.98
			2002	13.25	14.32	21.12	12.73	15.36
			2003	12.94	16.08	19.34	11.81	15.04
			2004	13.1	14.92	19.6	12.39	15.00
37-057-0002	Davidson	Lexington	2000	17.05	17.8	18.43	18.88	18.04
			2001	14.79	18.62	18.84	13.56	16.45
			2002	14.94	15	19.28	14.29	15.88
			2003	12.56	16.07	19.12	12.91	15.17
			2004	13.9	15.69	17.96	13.15	15.18
37-081-0013	Guilford	Mendenhall	2000					
			2001				10.31	
			2002	11.71	13.14	18.29	11.72	13.72
			2003	11.55	13.57	16.47	11.69	13.32
			2004	11.76	14.4	16.54	13.19	13.97

Table 2-2: Observed Quarterly Mean PM2.5 Concentrations for Monitors in the North Carolina Nonattainment Areas

AIRS ID	County	Site Name	2000-2004 Q1	2000-2004 Q2	2000-2004 Q3	2000-2004 Q4
37-035-0004	Catawba	Hickory	13.9	15.5	19.8	13.3
37-057-0002	Davidson	Lexington	14.5	16.4	18.9	14.2
37-081-0013	Guilford	Mendenhall	11.7	13.4	17.6	11.7

2.1.2 Speciated Baseline Conditions

The monitored attainment test for PM2.5 utilizes both PM2.5 and individual PM2.5 component species. A separate RRF is calculated for each PM2.5 species. In order to perform the recommended modeled attainment test, States should divide observed mass concentrations of PM2.5 into 7 components (plus passive mass):

1. Mass associated with sulfates (SO4)
2. Mass associated with nitrates (NO3)
3. Mass associated with ammonium (NH4)
4. Mass associated with organic carbon (OC)
5. Mass associated with elemental carbon (EC)
6. Mass associated with particle bound water (PBW)
7. Mass associated with “other” primary inorganic particulate matter (Crustal)
8. And passively collected mass or the mass of the blank filter (0.5 $\mu g/m^3$)

The second part of the process is to use the quarterly mean PM2.5 DVBs (as calculated in Section 2.1.1) with speciated data to calculate the quarterly mean concentrations of these 7 components at the FRM sites. This need to speciate the FRM data presents two issues:

1. FRM measurements and speciated PM2.5 measurements do not always measure the same mass
2. Not all FRM monitoring sites have co-located STN speciation monitors.

The following sections will explain how these issues were overcome to produce the speciated values needed for this attainment demonstration.

2.1.2.1 SANDWICH

As the Attainment Guidance notes, recent data analyses (Frank, 2006) have noted that the FRM monitors do not measure the same components and do not retain all of the PM2.5 that is measured by routine speciation samplers and therefore cannot be directly compared to speciation measurements from the Speciation Trends Network (STN). By design, the FRM mass measurement does not retain all ammonium nitrate and other semi-volatile materials (negative sampling artifacts) and includes particle bound water associated with sulfates, nitrates and other hygroscopic species (positive sampling artifacts). This results in concentrations (and percent contributions to PM2.5 mass), which may be different than the ambient levels of some PM2.5 chemical constituents.

To resolve the differences between FRM and STN total mass, the US EPA has recommended using the "sulfate, adjusted nitrate, derived water, inferred carbonaceous material balance approach" or SANDWICH approach. With the SANDWHICH approach, nitrate mass is adjusted to account for volatilization based on hourly meteorology parameters. Subsequently, quarterly average nitrate, sulfate, elemental carbon, and crustal mass can be calculated, as well as the Degree of Neutralization (DON) of sulfates. Quarterly average NH4 can then be calculated from adjusted the adjusted nitrate mass, sulfate mass, and DON of sulfate. Next the mass of particle bound water can be calculated from the previously obtained DON, sulfate, nitrate, and ammonium values. Finally, organic carbon is calculated by taking the difference between the total PM2.5 mass as measured at the FRM monitor, and the calculated component mass (i.e. OC from mass balance ([OCMmb]) = $PM2.5_{FRM}$ - {[EC] + [SO4] + [NO3] + [NH4] + [water] + [crustal material] + [passive mass]}).

2.1.2.2 Speciated Profiles

While the SANDWICH method reconciles the differences between FRM and STN, a lingering issue is not all FRM monitoring sites have co-located STN monitors to provide speciated data. The US EPA Attainment Guidance suggests four measures that can be taken to resolve the lack of speciated data:

1. Use of concurrent data from a nearby speciated monitor
2. Use of representative data (from a different time period)
3. Use of interpolation techniques to create a spatial field using ambient speciation data
4. Use of interpolation techniques to create spatial fields, and gridded modeling outputs to adjust the species concentrations

Of the four methodologies, the US EPA recommends using one of the spatial interpolation techniques to estimate species concentrations at FRM sites that do not have speciation data (numbers 3 and 4 above). To assist in this task, the EPA is developing software tool called "Modeled Attainment Test Software" (or MATS) that will perform the spatial analysis of described options number 3 and 4. However, the PM2.5 portion of the MATS tool has not been released at this time. In trying to pursue the US EPA recommended course, we have used the speciated profiles from the Clean Air Interstate Rule (CAIR) SMAT tool, which is the predecessor for the MATS program, as an alternative.

The CAIR SMAT tool uses data from both the Interagency Monitoring of Protected Visual Environments (IMPROVE) and the US EPA's Speciation Network (ESPN) to derive mean concentrations for six PM2.5 components. Quarterly average concentrations between Jan 2002 to December 2002 were retained for sites that had at least 11 monitored values per quarter for each of the major PM2.5 species. Major species for ESPN include EC, OC, NH4, SO4, NO3, and crustal material (which includes the five trace elements aluminum, calcium, iron, silicon, and titanium). The major species for IMPROVE are the same except for NH4, which is not routinely measured in the IMPROVE protocol.

The quarterly averaged species concentrations at the IMPROVE and ESPN monitors were used to interpolate concentrations at the PM2.5 FRM monitoring sites using a technique called

Voronoi Neighbor Averaging (VNA). Attachment L1 to this appendix contains the document "Procedures for Estimating Future PM2.5 Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT) Updated- 11/8/04", which describes the interpolation process, and the data speciation process in detail.

As a result of the CAIR SMAT process, quarterly species fraction were generated for the FRM site, which are presented in Table 2-3 below. These fractions were then applied to Observed Quarterly Mean PM2.5 values calculated in Section 2.1.1 to determine quarterly component specific concentrations. Table 2-4 shows the quarterly concentrations for crustal, EC, OC, SO4, NO3, NH4 and PBW assuming a constant passive mass of 0.5 μg/m^3.

Table 2-3: Quarterly Species Fractions from the CAIR SMAT Tool

AIRS ID	County	Site Name	Blank Mass	qtr	DON	Frac. Crustal	Frac. EC	Frac. OC	Frac. SO4	Frac. NO3	Frac. NH4	Frac. H2O
37-035-0004	Catawba	Hickory	0.5	1	0.279900	0.024317	0.059617	0.468778	0.249448	0.047850	0.083697	0.066293
				2	0.295620	0.041253	0.036910	0.367295	0.348840	0.000724	0.103334	0.101645
				3	0.287220	0.028618	0.025223	0.330820	0.392896	0.000485	0.112988	0.108969
				4	0.315780	0.020443	0.048246	0.486327	0.241229	0.041704	0.088270	0.073781
37-057-0002	Davidson	Lexington	0.5	1	0.295120	0.021555	0.050295	0.503129	0.242853	0.032333	0.081047	0.068788
				2	0.299230	0.063465	0.034492	0.342787	0.349748	0.000690	0.104855	0.103963
				3	0.277630	0.048469	0.020772	0.279547	0.423435	0.000533	0.117713	0.109531
				4	0.295110	0.033367	0.044972	0.487990	0.250975	0.029015	0.082480	0.071201
37-081-0013	Guilford	Mendenhall	0.5	1	0.288580	0.027600	0.060542	0.390746	0.308053	0.030271	0.097677	0.085110
				2	0.283430	0.185936	0.033508	0.249273	0.340993	0.000657	0.096838	0.092795
				3	0.253500	0.103581	0.016630	0.274061	0.414322	0.000475	0.105169	0.085762
				4	0.255190	0.095325	0.053453	0.382647	0.284194	0.034745	0.082599	0.067036

Table 2-4: Quarterly PM2.5 Component-Specific Concentrations for Monitors in the North Carolina Nonattainment Areas

AIRS ID	County	Site Name	Quarter	FRM Mass	Blank Mass	Non-Blank Mass	Crustal	EC	OC	SO4	NO3	NH4	PBW
37-035-0004	Catawba	Hickory	1	13.94	0.50	13.44	0.33	0.80	6.30	3.35	0.64	1.12	0.89
			2	15.54	0.50	15.04	0.62	0.56	5.52	5.25	0.01	1.55	1.53
			3	19.80	0.50	19.30	0.55	0.49	6.38	7.58	0.01	2.18	2.10
			4	13.27	0.50	12.77	0.26	0.62	6.21	3.08	0.53	1.13	0.94
37-057-0002	Davidson	Lexington	1	14.50	0.50	14.00	0.30	0.70	7.04	3.40	0.45	1.13	0.96
			2	16.43	0.50	15.93	1.01	0.55	5.46	5.57	0.01	1.67	1.66
			3	18.91	0.50	18.41	0.89	0.38	5.15	7.79	0.01	2.17	2.02
			4	14.20	0.50	13.70	0.46	0.62	6.69	3.44	0.40	1.13	0.98
37-081-0013	Guilford	Mendenhall	1	11.67	0.50	11.17	0.31	0.68	4.37	3.44	0.34	1.09	0.95
			2	13.40	0.50	12.90	2.40	0.43	3.22	4.40	0.01	1.25	1.20
			3	17.59	0.50	17.09	1.77	0.28	4.68	7.08	0.01	1.80	1.47
			4	11.72	0.50	11.22	1.07	0.60	4.29	3.19	0.39	0.93	0.75

2.2 Relative Response Factor Calculation

The next step in the SMAT process is to use base year and future year modeling results to estimate a relative response factor (RRF) for each component of PM2.5 for each quarter. Simply put, the RRF is the quarterly average future year concentration near a monitor divided by the quarterly average base year concentration near the same monitor, or:

$$RRF = \frac{\text{Quarterly Mean Modeled Future Year Concentration "Near" Monitor "X"}}{\text{Quarterly Mean Modeled Base Year Concentration "Near" Monitor "X"}}$$

Instead of focusing on the individual cell containing the monitor, an array of cells that are "near" a monitor are considered in the attainment test. By sampling an array of cells from the modeling, the attainment test allows for variations in the model performance, as the peak concentrations may not occur in the grid cell that contains the monitor, but rather nearby the monitor. Table 2-5 provides the USEPA's recommendations for defining "nearby" cells for grid systems having cells of various sizes. Since the modeling for the North Carolina attainment demonstration was preformed at a 12km grid resolution, a 3x3 grid array was used.

Table 2-5: USEPA's Recommendation for Defining "Near" Cells

Size of Cell (km)	Size of the Array of "Nearby" Cells
<u><</u>5	7 x 7
>5-8	5 x 5
>8-15	3 x 3
>15	1 x 1

For the PM2.5 SMAT, the RRF is calculated for each component, for each quarter. To accomplish this step, daily concentration for each component of PM2.5 is extracted from the base year and future year modeling output near the FRM monitoring sites for each day. The daily component concentrations from the 3x3 array are then averaged to develop a mean daily component mass for each day in both the base and future years. These mean daily component concentrations are then averaged for each quarter to develop base and future year quarterly mean component concentration. The future year quarterly mean component concentrations are then divided by their respective base year quarterly mean component concentrations to develop quarterly RRFs for each component of PM2.5. The quarterly RRFs for the FRM monitors in the North Carolina PM2.5 nonattainment areas are presented below in Table 2-6. In lieu of using RRFs, the estimated future mass of NH4 and PBW will be determined by the estimated future mass of SO4 and NO3, as was done in the CAIR SMAT tool, per the following equations:

NH4 = DON * SO4 + 0.29*NO3

PBW =(-0.002618) + (0.980314*NH4) + (-0.260011* NO3) + (-0.000784* SO4) + (-0.159452* (NH4^2)) + (-0.356957* NO3* NH4) + (0.153894* (NO3^2)) + (0.212891* SO4* NH4) + 0.0444366* SO4* NO3) + (-0.048352* (SO4^2))

Table 2-6: Quarterly Component RRFs for Monitors in the North Carolina Nonattainment Areas

AIRS ID	County	Site Name	Quarter	RRF Crustal	EC	OC	SO4	NO3
37-035-0004	Catawba	Hickory	1	0.999	0.775	0.881	0.886	0.942
			2	1.150	0.789	0.952	0.761	0.704
			3	1.218	0.815	0.963	0.633	0.605
			4	1.037	0.744	0.897	0.810	0.867
37-057-0002	Davidson	Lexington	1	1.014	0.782	0.899	0.836	0.938
			2	1.146	0.788	0.961	0.749	0.690
			3	1.193	0.819	0.971	0.632	0.712
			4	1.061	0.746	0.911	0.782	0.877
37-081-0013	Guilford	Mendenhall	1	1.037	0.785	0.901	0.831	0.932
			2	1.169	0.789	0.958	0.727	0.721
			3	1.221	0.818	0.967	0.618	0.748
			4	1.076	0.753	0.914	0.778	0.889

2.3. Future Year Quarterly Concentration Calculation

The next step in the SMAT process is to calculate future quarterly mean concentration estimates for each component of PM2.5. To accomplish this, the current quarterly mean component concentration (Step 1, Section 2.1.3) is multiplied by the component-specific RRFs obtained in Step 2 (Section 2.2). The quarterly component concentration estimates for the monitors in the North Carolina PM2.5 nonattainment areas are provided below in Table 2-7.

Table 2-7: Blank Corrected Quarterly Component Future Concentrations Estimates for Monitors in the North Carolina Nonattainment Areas

AIRS ID	County	Site Name	Quarter	Crustal	EC	OC	SO4	NO3	NH4	PBW
37-035-0004	Catawba	Hickory	1	0.326	0.621	5.553	2.969	0.606	1.007	0.792
			2	0.714	0.438	5.256	3.994	0.008	1.183	1.161
			3	0.673	0.397	6.148	4.797	0.006	1.379	1.335
			4	0.271	0.458	5.567	2.493	0.462	0.921	0.764
37-057-0002	Davidson	Lexington	1	0.306	0.551	6.330	2.842	0.425	0.962	0.807
			2	1.159	0.433	5.245	4.171	0.008	1.250	1.235
			3	1.064	0.313	4.995	4.927	0.007	1.370	1.297
			4	0.485	0.460	6.090	2.691	0.349	0.895	0.766
37-081-0013	Guilford	Mendenhall	1	0.320	0.531	3.933	2.861	0.315	0.917	0.793
			2	2.804	0.341	3.079	3.200	0.006	0.909	0.875
			3	2.162	0.233	4.531	4.375	0.006	1.111	0.993
			4	1.151	0.452	3.923	2.482	0.346	0.734	0.595

2.4. Future Year Annual Average Estimate

The final step in the SMAT process is to sum the quarterly mean components (from Step 3, Section 2.3) to get annual mean PM2.5 values. Table 2-8 displays the quarterly mean PM2.5 values for the FRM sites in the North Carolina nonattainment areas.

Table 2-8: Quarterly Mean PM2.5 Mass Estimates for 2009

AIRS ID	County	Site Name	Non-Blank Mass Q1	Non-Blank Mass Q2	Non-Blank Mass Q3	Non-Blank Mass Q4
37-035-0004	Catawba	Hickory	11.874	12.754	14.734	10.936
37-057-0002	Davidson	Lexington	12.222	13.501	13.972	11.737
37-081-0013	Guilford	Mendenhall	9.669	11.214	13.410	9.683

The quarterly mean PM2.5 values are then averaged to produce a future year annual average PM2.5 estimate for each FRM site in the nonattainment area (Table 2-9). These values estimated annual PM2.5 values are then compared to the NAAQS (15.0 $\mu g/m^3$). Since the values at the FRM site in the nonattainment areas are < 15.0 $\mu g/m^3$, the test is passed.

Table 2-9: Estimated Annual Mean 2009 PM2.5 Mass Compared to the DVB

AIRS ID	County	Site Name	2002 Annual DVB	2009 Non-Blank Mass	Blank Mass	2009 Annual DVF
37-035-0004	Catawba	Hickory	15.137	12.575	0.050	13.075
37-057-0002	Davidson	Lexington	15.509	12.858	0.050	13.358
37-081-0013	Guilford	Mendenhall	13.095	10.994	0.050	11.494

3 Supplemental Analysis

The Attainment Guidance asserts that all attainment demonstrations should be accompanied by supplemental analysis that further supports the modeling conclusions. This supplemental analysis can include additional analyses of air quality, emissions and meteorological data, and consider modeling outputs other than the results of the attainment test. If the attainment test results fall short of the standard, the results of corroboratory analyses may be used in a weight of evidence determination (WOE) to show that attainment is likely despite modeled results, which may be inconclusive.

The Attainment Guidance defines the guidelines for supplemental analysis/WOE for the annual PM2.5 standard as follows:

- Site with a DVF less than 14.5 $\mu g/m^3$ should submit basic supplemental analysis to confirm the outcome of the model attainment test.
- Sites with a DVF between 14.5 and 15.5 $\mu g/m^3$ should submit a weight of evidence demonstration to aggregate supplemental analysis to support the model attainment demonstration
- Sites with a DVF greater than or equal to 15.5 $\mu g/m^3$ should consider additional control measure to ensure attainment, as more qualitative analysis is unlikely to attainment

All North Carolina PM2.5 nonattainment areas have DVFs lower than 14.5μg/m^3, making the following section an examination of supplemental analysis to corroborate modeling results, rather than a WOE analysis to show attainment. In the following sections we explore refinements to the attainment test, additional modeling studies, and air quality and emissions trend as part of a supplemental analysis for the North Carolina PM2.5 nonattainment areas.

3.1 Additional Air Quality Modeling

The Attainment Guidance suggests several additional modeling exercises that can be performed as part of supplemental/WOE analysis. Suggestions include completing additional analysis on the air quality modeling preformed, or modeling alternative set ups and emissions as part of sensitivity. Each of theses items will be discussed in the following sections.

3.1.1 Air Quality Modeling Metrics

In Section 7.0 of the *Attainment Guidance,* various aspects of air quality models, modeled performance, and uncertainties associated with the length of modeled episodes and limited observational datasets are described. Section 7.1 suggests that some types of "absolute" modeling results may be used to assess general progress towards attainment from the baseline inventory to the projected future inventory. The Attainment Guidance goes on to describe several metrics that can be considered as part of this type of additional analysis, which include:

1. Percent change in total amount of PM2.5 >= 15 μg/m^3 within the nonattainment area
2. Percent change in number of grid cells >= 15 μg/m^3 within the nonattainment area
3. Percent change in grid cell-hours (days) >= 15 μg/m^3 within the nonattainment area
4. Percent change in maximum modeled 24-hour PM2.5 concentrations within the nonattainment area

As the US EPA notes in the Attainment Guidance, care should be taken in interpreting absolute metrics if the model evaluation shows a large under prediction or over prediction of ozone or PM2.5 concentrations, because under (over) prediction of observed concentrations will make it artificially easy (hard) to show progress towards absolute attainment levels. To better coincide with model performance evaluation results, the same subset of days from the modeling were used in the model performance evaluation were used to develop the air quality metrics. This subset of days included all days with an 24-hour PM2.5 concentration greater than 30 μg/m^3 at any of the monitoring sites in either nonattainment area, as well as the four days with the highest average daily values from each quarter. This selection process identified 28 days for presentation in this appendix, and coincides with the days used in the model performance evaluation (Appendix J) and in the model results section (Appendix K). A full listing of the days and the observed 24-hour PM2.5 concentrations from the monitors in the nonattainment areas can be found in either Appendix J or Appendix K.

Because of the complexity of the model extraction for PM2.5, only the second metric is presented for supplemental analysis. The cell counts of modeling data was tallied from both the 2002 baseline and the 2009 attainment year modeling run for the identified days. Data was extracted for only the grid cells that contained portions of the either of the nonattainment areas. Figure 3-1 highlights the 50 cells that encompass the North Carolina nonattainment areas.

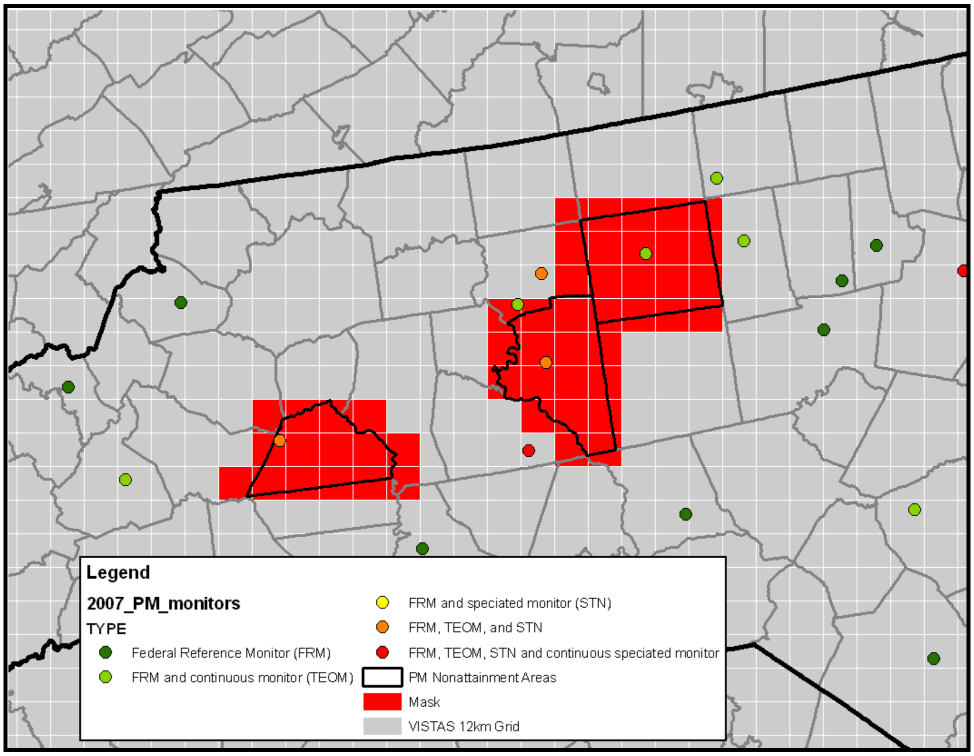
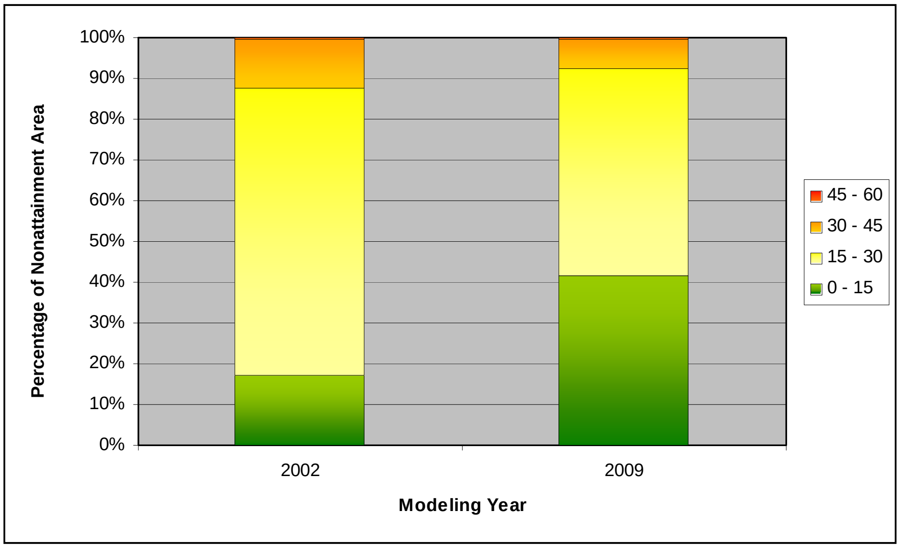


Figure 3-1: Area for which the air quality metrics were applied.

The cell counts were binned based on concentration ranges of 15 μg/m^3 intervals to help illuminate the change in severity on the days in North Carolina with the highest PM2.5 concentrations. Figure 3-2 presents the cell count results both graphically and in tabular form. The graph clearly shows a striking increase in the number of days below 15 μg/m^3. By 2009 only 41.57% of cells fall in the 0 –15 range, a substantial increase from the 17.21% in 2002. Raw cell counts shows a total of 341 cells shifted to the 0 – 15 μg/m^3 range between 2002 and 2009 (Table 3-1).

Figure 3-2 also shows a decrease in the number of cell in the 15 – 30 μg/m^3 bin (269 cell decrease) and the 30 - 45μg/m^3 bin (75 cell decrease). The number of cells in the 45 –60 range remains relatively constant from 2002 to 2009. A closer examination of the daily cell counts shows that all of the cells in the highest concentration category occur on the same day in both the 2002 and 2009 modeling and are likely associated with a fire. Overall, the results from the air quality modeling metric are encouraging. The metric shows a substantial increase in the number of cells below 15 μg/m^3, and an increase in cells below 30μg/m^3.



Concentration	2002	2009
0 - 15	17.21%	41.57%
15 - 30	70.21%	51.00%
30 - 45	12.29%	6.93%
45 - 60	0.29%	0.50%

Figure 3-2: Percentage of Cell in Nonattainment Areas within Concentration Categories for 2002 and 2009. Table of actual values is presented on the right.

Table 3-1: Number of Cells within Concentration Bins. Increases (decreases) in the number of cells within the bins are noted by red (blue) coloration in the last column.

Concentration	2002	2009	Difference
0 - 15	241	582	**341**
15 - 30	983	714	**-269**
30 - 45	172	97	**-75**
45 - 60	4	7	**3**

3.1.2 Other Modeling Results

One way to acquire modeling sensitivity runs is to examine the modeling results from other Regional Planning Organizations or from EPA modeling studies. Other modeling studies may use different physical and chemical modeling options for their meteorological and air quality modeling runs, which would provide a comparison or sensitivity based on these different options.

An air quality modeling exercise that contained results for North Carolina PM2.5 nonattainment area is the USEPA's modeling for the Clean Air Interstate Rule (CAIR). The Technical Support Document for the final CAIR, March 2005, provided modeling results with and without the implementation for the CAIR. Differences between the USEPA's modeling and the attainment demonstration are: 1) the meteorology was for 2001, 2) the DVB was the weighted design values for the 1999-2003 period and 3) the modeling results were for 2010. The DVF was calculated using the CAIR SMAT tool, so methodologies between the CAIR DVF and the values presented in Section 2.4 are the same. These modeling results are listed in Table 3-2 below.

Table 3-2: US EPA CAIR Modeling Results

Future Year	Catawba County	Davidson County
2010	14.07	14.36
2015	13.45	13.61

The USEPA's results were for the highest monitor in a county where more than one monitor is located. The USEPA's modeling results predicts that both the North Carolina nonattainment areas should be below the annual PM2.5 standard by 2010. Although this is one year later than the attainment year for these areas. The USEPA's 2010 CAIR DVFs are 1 $\mu g/m^3$ higher than what the NCDAQ is showing in the attainment demonstration, but still support that both the North Carolina nonattainment areas will attain the annual PM2.5 standard by the attainment year of 2009.

3.2 Air Quality and Emission Trends Analysis

Since the annual PM2.5 designation in 2002, annual average concentrations of PM2.5 have decreased. Values have hovered near the standard at the two nonattaining monitors for roughly the past 5 years, while the Mendenhall monitor has maintained values lower than the NAAQS. Table 3-3 provides the annual average data, with Figure 3-3 providing a graphical representation of the data, with preliminary 2007 annual average values. These preliminary 2007 values show the monitors are still trending towards the NAAQS.

With the data in Table 3-3 and Figure 3-3, please note that the Mendenhall was not in operation from 1999 to 2001, as this site replaced the McLeansville site. Data from the McLeansville site has been substituted in place of the missing data in both Figure 3-3 and Table 3-3, as the two sites are within the required distance to be considered a continuous monitoring site.

Table 3-3: Annual Average PM2.5 values for the past 10 years.

Monitoring Site	County	AIRS ID	Annual Averages									
			1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Hickory	Catawba	3703500041	17.4	17.6	16.0	15.4	15.0	15.0	15.9	15.2	14.5	12.8
Lexington	Davidson	3705700021	17.3	18.0	16.5	15.9	15.2	15.2	15.4	15.1	14.6	13.7
Mendenhall	Guilford	3708100131				13.7	13.3	14.0	14.0	*14.1*	13.0	11.4

Average of 1st-4th Quarter For Each Year. Values in colored orange are in excess of the Annual PM2.5 NAAQS.

Note: Mendenhall was not in operation from 1999 to 2001

Note: There was an extended loss of monitoring data at the Mendenhall site during the 4th quarter of 2006. The NCDAQ has performed an extensive data imputation study to estimate a 4th quarter average concentration such that an appropriate annual average concentration and design value could be calculated. This study, titled "Mendenhall PM2.5 Data Imputation for 4Q2006" can be found in Appendix C.3

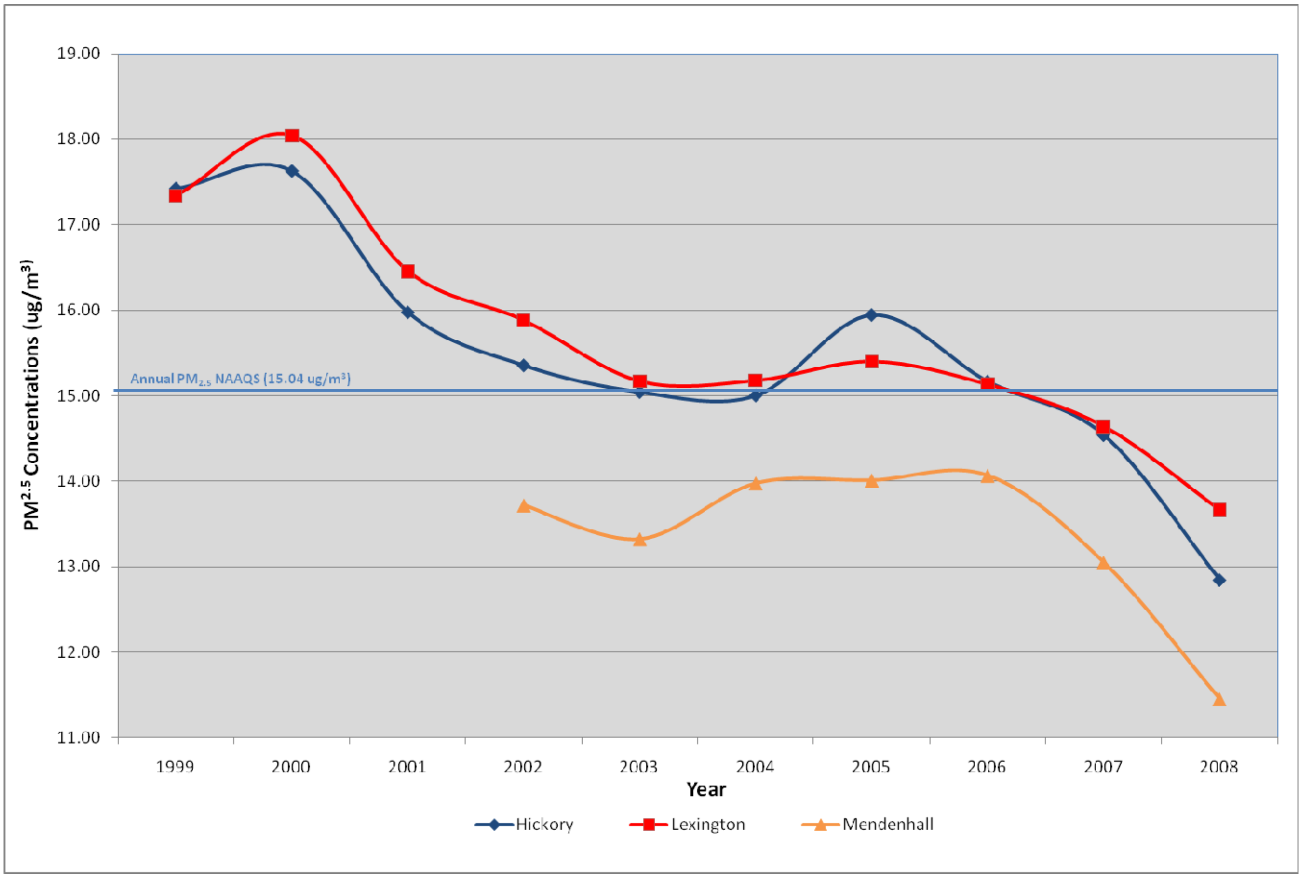


Figure 3-3: Annual PM2.5 Average Values for the Monitors in the Hickory and Triad Nonattainment Areas.

With the improvement in annual average PM2.5values, there has also been an improvement in PM2.5 design values. When one takes into account the period of record, PM2.5 design values have improved significantly over the last 6 years. Like with the annual averages, the three-year design values have also begun to hover near the level of the standard for both the Hickory and Lexington monitors in recent years. It is also important to note the Guilford County monitor (Mendenhall, 37-081-0013) monitor has also maintained design values that meet the NAAQS over the past 3 design value periods (See Table 3-4).

Table 3-4: Three Year Design values for the Monitors in North Carolina's PM2.5 Nonattainment Areas.

Monitoring Site	County	AIRS ID	Design Values							
			1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008
Hickory	Catawba	3703500041	17.0	16.3	15.5	15.1	15.3	15.4	15.2	14.2
Lexington	Davidson	3705700021	17.2	16.8	15.8	15.4	15.2	15.2	15.1	14.5
Mendenhall	Guilford	3708100131				13.7	13.8	*14.0*	*13.7*	*12.9*
			Average Over 12 Quarters. Negative & Underlined Indicate Altered Calculation							

Note: Both of the footnotes that apply to Table 3-3 are also applicable with this table.

When evaluating the trends in air quality values it is important to note that there are still significant sulfur dioxide (SO2) emission reductions that are expected between now and the attainment year in the utility sector. The Clean Smokestacks Act requires the two large North Carolina utilities to meet annual SO2 emission budgets for 2007 and a tighter budget for 2009. Units from maintained by both Duke Energy and Progress Energy units are still expected to have controls installed over the next two years. Table 3-5 lists the units that are near the PM2.5 nonattainment areas and shows the year the controls are expected to come on line and the estimated amount of yearly SO2 emissions reductions. In total, over 250,000 tons of SO2 will be reduced annually in central North Carolina alone. As sulfates are one of the larger contributors to total PM2.5 in North Carolina, this substantial reduction in SO2 should result in significant reductions of the observed PM2.5 concentrations, which are already very close to the standard.

Table 3-5: Projected emission reductions Near the North Carolina PM2.5 Nonattainment Areas.

Operator	Facility	Unit	Technology	2007 Plan	Total 2006 Emissions	2009 Projected Emissions '07 Plan SO_2 (Tons)	2009 Projected Total Emissions '07 Plan SO_2 (Tons)	2009 Projected Reductions SO_2 (Tons)
Duke Energy Carolinas, LLC	Allen	1	Scrubber	2009	45,442	1,585	32,128	-13,314
	Allen	2	Scrubber	2009		1,215		
	Allen	3	Scrubber	2009		11,543		
	Allen	4	Scrubber	2009		11,789		
	Allen	5	Scrubber	2009		5,996		
Duke Energy Carolinas, LLC	Belews Creek	1	Scrubber	2008	95,364	5,632	10,017	-85,347
	Belews Creek	2	Scrubber	2008		4,385		
Duke Energy Carolinas, LLC	Marshall	1	Scrubber	2007	85,094	1,909	10,561	-74,533
	Marshall	2	Scrubber	2007		1,916		
	Marshall	3	Scrubber	2007		3,495		
	Marshall	4	Scrubber	2006		3,241		
Progress Energy Carolinas, Inc.	Mayo	1	Scrubber	2009	24,499	9,406	9,406	-15,093
Progress Energy Carolinas, Inc.	Roxboro	1	Scrubber	2008	94,627	742	4,198	-90,429
	Roxboro	2	Scrubber	2007		978		
	Roxboro	3	Scrubber	2008		1,102		
	Roxboro	4	Scrubber	2007		1,376		

3.3 Supplemental Analysis Conclusions

After examining the totality of the modeling evidence, the North Carolina Division of Air Quality (NC DAQ) is confident the Hickory and Triad PM2.5 nonattainment areas should reach attainment status by the 2009 deadline. US EPA CAIR modeling corroborates NC DAQ modeling results suggesting both nonattainment areas should be below at least 14.5$\mu g/m^3$. In addition, current PM2.5 design values are near NAAQS, with substantial sulfate reductions anticipated in the vicinity of the nonattainment area over the next two years. NC DAQ feels these reductions will more than allow the PM2.5 nonattainment areas to achieve the NAAQS by 2009.

4 Unmonitored Area Analysis

The modeled attainment test does not address future air quality at locations where there is not a $PM_{2.5}$ monitor nearby. To guard against the possibility that air quality levels could exceed the standard in areas with limited monitoring, Section 3.4 of the Attainment Modeling Guidance suggests that additional review is necessary, particularly in nonattainment areas where the $PM_{2.5}$ monitoring network just meets or minimally exceeds the size of the network required. This review is intended to ensure that a control strategy leads to reductions in $PM_{2.5}$ and its constituent pollutants at other locations that could have baseline (and future) design values exceeding the NAAQS, were a monitor deployed there. The test is called an "unmonitored area analysis". The purpose of the analysis is to use a combination of model output and ambient data to identify areas that might exceed the NAAQS if monitors were located there.

The NCDAQ, along with Local and Tribal Programs, currently operates a network of 34 $PM_{2.5}$ monitors. Twenty-nine of these monitors were established as State and Local Air Monitoring Stations (SLAMS). These SLAMS monitors were selected based on specific monitoring objectives (background concentration, area of highest concentration, high population, source impact, transport, and rural impact) as required by the USEPA and siting scales (micro, middle, neighborhood, urban, and regional) established by the USEPA. Of the remaining 8 monitors, 7 are categorized as "Other" or "Special Purpose Monitors" that were established by NCDAQ to evaluate models, study $PM_{2.5}$ formation and transport, and obtain a better understanding of $PM_{2.5}$ in North Carolina. The remaining monitor is a Tribal monitor operated by the Eastern Band of Cherokee Nation.

The NCDAQ believes that the density of its monitoring network more than adequately captures the full extent of the $PM_{2.5}$ air quality concerns in North Carolina. With an average of one monitor per 3711 km^2, this is one of the densest statewide $PM_{2.5}$ monitoring networks in the southeast. A map of each $PM_{2.5}$ monitor and its position relative to the NCDAQ/ASIP 12-km modeling grid is provided in Figure 4-1. As can been seen by the figure, the spatial coverage of the monitors, and their resulting "nearby" 3x3 arrays, covers the majority of the urban areas where $PM_{2.5}$ tends to be higher.

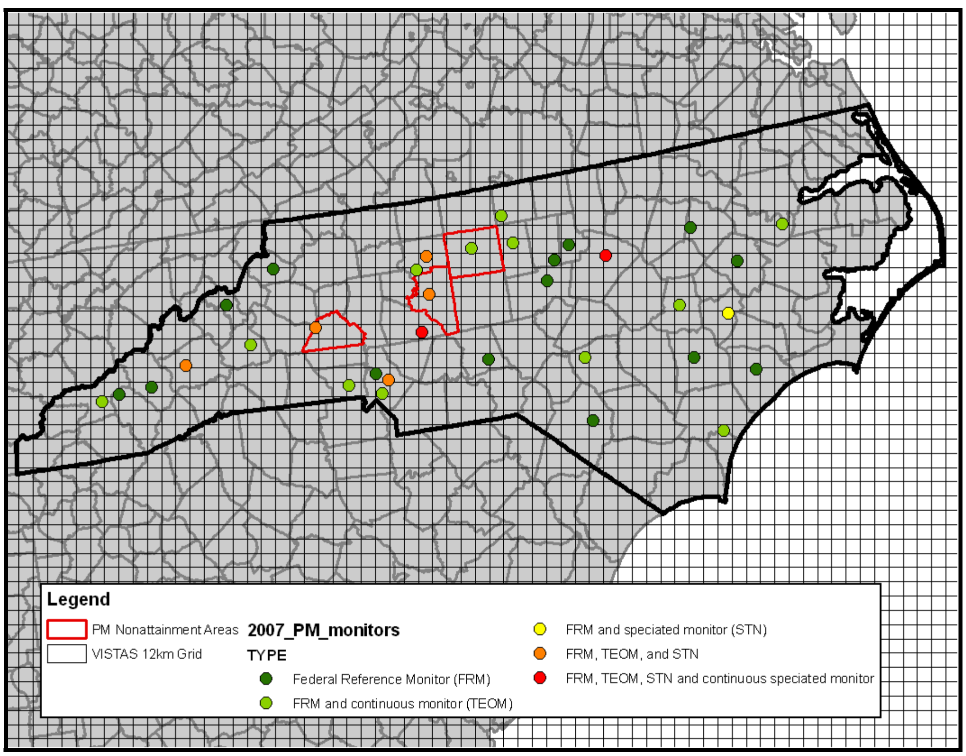


Figure 4-1: PM2.5 Monitors and with Respect to the VISTAS 12km Grid

The adequacy of the NCDAQ $PM_{2.5}$ monitoring network is further demonstrated when plotted against a projected spatial field of annual $PM_{2.5}$ design values. Figure 4-2 presents the 2009 future year $PM_{2.5}$ design value modeling output from this attainment demonstration and the location of each $PM_{2.5}$ monitor in and around North Carolina. This 2009 $PM_{2.5}$ design value spatial field was created by the USEPA's Modeled Attainment Test Software (MATS). It is clear from the MATS analysis that all of the regions of higher, yet attaining, $PM_{2.5}$ design values have numerous representative $PM_{2.5}$ monitors. There are not any identified $PM_{2.5}$ hotspots that would require any additional monitoring considerations in North Carolina.

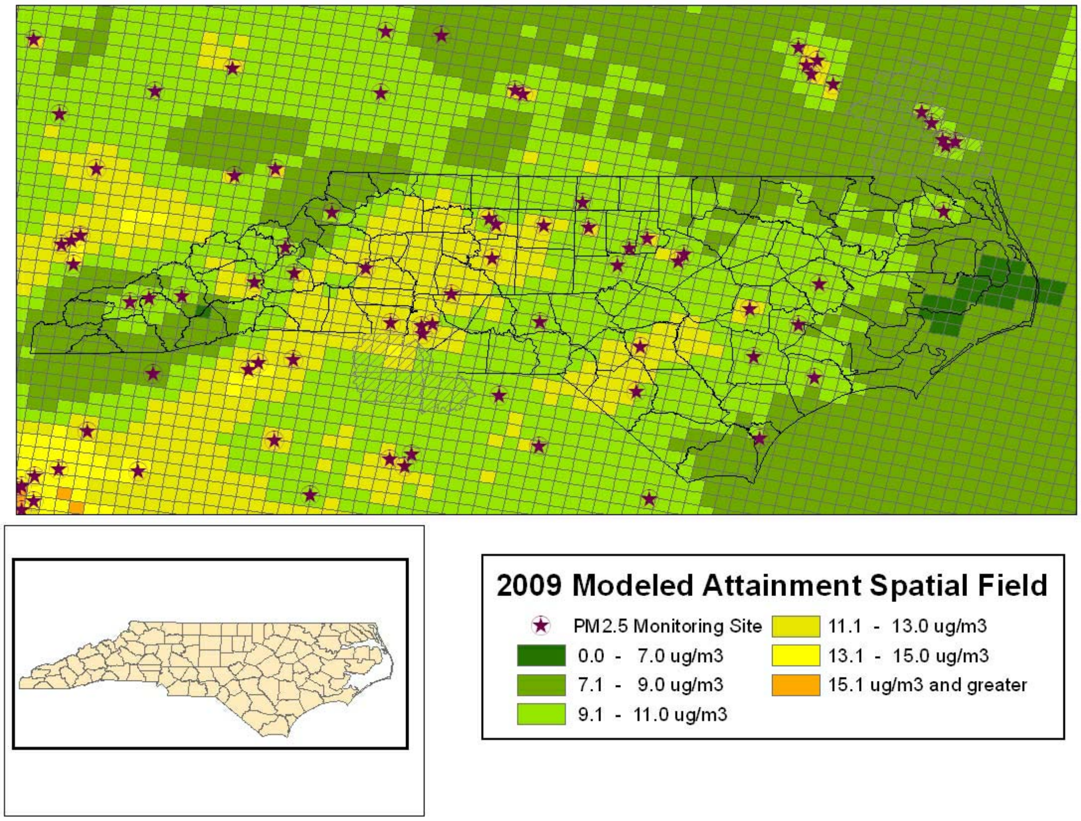


Figure 4-2: PM2.5 Monitors and 2009 Modeled Attainment Spatial Field

5 Attachments to Appendix L

Attached to this Appendix is the following supporting documentation for Section 2.1:

"Procedures for Estimating Future PM2.5 Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT) Updated- 11/8/04"

6 Reference

Frank, N., 2006: "Retained Nitrate, Hydrated Sulfates, and Carbonaceous Mass in Federal Reference Method Fine Particulate Matter for Six Eastern U.S. Cities" *J. Air Waste Mange. Assoc.*, 56, 500-511.

Attachment L1
Procedures for Estimating Future PM2.5 Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT)- Updated- 11/8/04

Procedures for Estimating Future $PM_{2.5}$ Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT) Updated- 11/8/04

I. Introduction

EPA has issued draft modeling guidance *(EPA, 2001)* that describes a procedure for combining monitoring data with outputs from simulation models to estimate future concentrations of $PM_{2.5}$ mass. The guidance recommends that model predictions be used in a relative sense to estimate changes expected to occur in each major $PM_{2.5}$ species. The procedure is referred to as the Speciated Modeled Attainment Test (SMAT). A preliminary version of SMAT was applied in the Clean Air Interstate Rule (CAIR) proposal modeling *(EPA, 2004)* to estimate future $PM_{2.5}$ nonattainment in the Eastern United States. A revised version of the SMAT technique has been applied in support of the CAIR final rule. Based on comments received from the CAIR proposal, several improvements have been implemented. The revised SMAT procedures are described below.

A. Default SMAT Procedures

The draft modeling guidance includes a sequence of key steps that are recommended for processing $PM_{2.5}$ ambient and modeling data. The following is a brief summary of those steps:

(1) Derive current quarterly mean concentrations for each of the major components of $PM_{2.5}$. This is done by multiplying the monitored quarterly mean concentration of Federal Reference Method (FRM) *(EPA, 1997)* derived $PM_{2.5}$ by the monitored fractional composition of $PM_{2.5}$ species (at speciation monitor sites) for each quarter. (e.g., 20% sulfate x 15 ug/m^3 $PM_{2.5}$ = 3 ug/m^3 sulfate).

(2) For each quarter, apply an air quality model to estimate current and future concentrations for each of the components of $PM_{2.5}$. Take the ratio of future to current predictions for each component. The result is a component-specific *relative reduction factor* (RRF). (e.g., given model predicted sulfate for base is 10 ug/m^3 and future is 8 ug/m^3 then RRF for sulfate is 0.8).

(3) For each quarter, multiply the current quarterly mean component concentration (step 1) times the component-specific RRF obtained in step 2. This leads to an estimated future quarterly mean concentration for each component. (e.g., 3 ug/m^3 sulfate x 0.8 = future sulfate of 2.4 ug/m^3).

(4) Average the four quarterly mean future concentrations to get an estimated future annual mean concentration for each component. Sum the annual mean concentrations of the $PM_{2.5}$ components to obtain an estimated future annual concentration for $PM_{2.5}$.

EPA is using the FRM data for nonattainment designations. Therefore it is critical that the speciated modeled attainment test described above uses FRM data as the base value for projecting future $PM_{2.5}$ concentrations. As can be seen from the list of steps, the modeled attainment test is critically dependent on the availability of species component mass at FRM sites. The modeling guidance recommends using ambient $PM_{2.5}$ speciation data to estimate the relative mass of $PM_{2.5}$ components at each FRM site. The guidance further recommends using the Interagency Monitoring of Protected Visual Environments (IMPROVE) procedure *(IMPROVE, 2000)* for estimating reconstructed fine mass. In this procedure, the $PM_{2.5}$ mass is assumed to be composed of 6 species: ammonium sulfate, ammonium nitrate, organic carbon mass, elemental carbon, crustal and un-attributed mass which is defined as the difference between measured PM2.5 and the sum of the five component species. The relative proportion of each of these 6 species was estimated in the CAIR proposal SMAT analysis.

B. New Species Calculations and Definitions

Recent data analyses as well as a report submited by CAIR commenters *(Glass, 2004)* have noted that the FRM monitors do not measure the same components and do not retain all of the $PM_{2.5}$ that is measured by routine speciation samplers and therefore cannot be directly compared to speciation measurements from EPA's Speciation Network (ESPN). By design, the FRM mass measurement does not retain all ammonium nitrate and other semi-volatile materials (negative sampling artifacts) and includes particle bound water associated with sulfates, nitrates and other hygroscopic species (positive sampling artifacts). This results in concentrations and percent contributions to $PM_{2.5}$ mass which may be different than the ambient levels of some $PM_{2.5}$ chemical constituents. For the purposes of predicting changes in $PM_{2.5}$ chemical components on the $PM_{2.5}$ mass, constructed $PM_{2.5}$ mass should match the composition of mass retained by the FRM. As such, we have made several revisions to the calculation and definition of $PM_{2.5}$ species used in SMAT.

The revised SMAT uses an FRM mass construction methodology which results in reduced nitrates (relative to the amount measured by routine speciation networks), higher mass associated with sulfates (reflecting water included in gravimetric FRM measurements) and a measure of organic carbonaceous mass which is derived from the difference between measured $PM_{2.5}$ and its non-carbon components. This characterization of $PM_{2.5}$ mass also reflects crustal material and other minor constituents. The resulting characterization provides a complete mass balance. It does not have any unknown mass which is sometimes presented as the difference between measured $PM_{2.5}$ mass and the characterized chemical components derived from routine speciation measurements. The net difference between retained mass and measured mass for individual $PM_{2.5}$ chemical components is relatively small when expressed as ug/m3, but can be a large percent for individual constituents.

Below we describe an application of the revised SMAT procedures for a study domain that extends over a large portion of eastern US. The study domain is defined for grids of dimension 36 km X 36 km covering the area enclosed within -100 to -67 longitude and 25 to 49 latitude. Base case and future year model predictions are available for each FRM monitor (and grid cell) that is contained within the domain.

II. $PM_{2.5}$ Mass and Species Data Handling

Speciated $PM_{2.5}$ data from both the IMPROVE and ESPN were used to derive mean concentrations of each of six $PM_{2.5}$ components. No attempt was made to resolve differences in measurement and analysis methodology between the two networks. Since three (or more) years of urban speciation data were not available, calendar year 2002 was used to best correspond[1] to the available 5 years of FRM $PM_{2.5}$ mass data (1999-2003). Quarterly average concentrations between Jan 2002 to December 2002 were retained for sites that had at least 11 monitored values per quarter for each of the major $PM_{2.5}$ species. The quarters were defined as follows: Q1 = January - March 2002; Q2 = April - June 2002; Q3 = July - September 2002; and Q4 = October - December 2002. Major species for ESPN include elemental carbon (EC), organic carbon (OC), ammonium (NH4), sulfate (SO4), nitrate (NO3), and crustal material (which includes the five trace elements aluminum, calcium, iron, silicon, and titanium). The major species for IMPROVE are the same except for ammonium (NH4), which is not routinely measured in the IMPROVE protocol.

All species were used as extracted directly from the Air Quality Subsystem (AQS) with the exception of organic carbon in ESPN. Organic carbon in the ESPN was blank corrected based on measurements from field blanks which indicate a positive bias. The blank corrections were based on a draft report which examined the blank carbon data in the STN network *(Flanagan, 2003)*. The carbon corrections are shown below in Table 1.

Table 1: Organic Carbon Blank Corrections

Sampler Type	**Organic Carbon Correction (ugC/m3)**
URG MASS	**0.29**
R and P 2300	**0.90**
Anderson RAAS	**1.19**
R&P 2025	**0.77**
MetOne SASS	**1.42**

These sampler-specific, network-wide corrections were subtracted from daily measurements of organic carbon and the results multiplied by 1.40 (to convert to organic carbon mass) before aggregating to quarterly and annual levels.

[1]The CAIR proposal SMAT was based on 2001-2002 data (the last 3 quarters of 2001 and the 1st quarter of 2002). There are 2 complete years of speciation data at a some sites, but we used only the latest complete year of data (2002) for this analysis. There were many more speciation sites available in 2002 (compared to 2001) and we did not want to mix a single year of data at most sites with a two year average at a few sites. That may have led to a regional bias in species composition.

For both ESPN and IMPROVE data (for the year Jan 2002- Dec 2002), the following quality checks were made to screen the raw data:

1. Any observations with one or more missing values of any of the major chemical species were removed.

2. All observations on July 6-9, 2002 for the 10 states most affected by the July 2002 Quebec Fires were removed. The 10 states were: DE, CT, VA, MD, NH, MA, NJ, VT, RI, and PA.

3. Only those sites that had a minimum of 11 observations for ALL the major species were retained in the final database.

These conditions result in the following final quarter-by-quarter number of observations and sites from ESPN and IMPROVE for inclusion in the "SMAT" procedure for CAIR.

Table 2: Number of Eastern sites and observations used in the SMAT analysis for 2002

	January 2002—December 2002			
	ESPN		IMPROVE	
	Total Number of Obs.	Number of Sites	Total Number of Obs.	Number of Sites
Quarter 1	2022	98	1206	49
Quarter 2	2419	131	1131	47
Quarter 3	2844	145	1320	54
Quarter 4	2725	149	1637	58

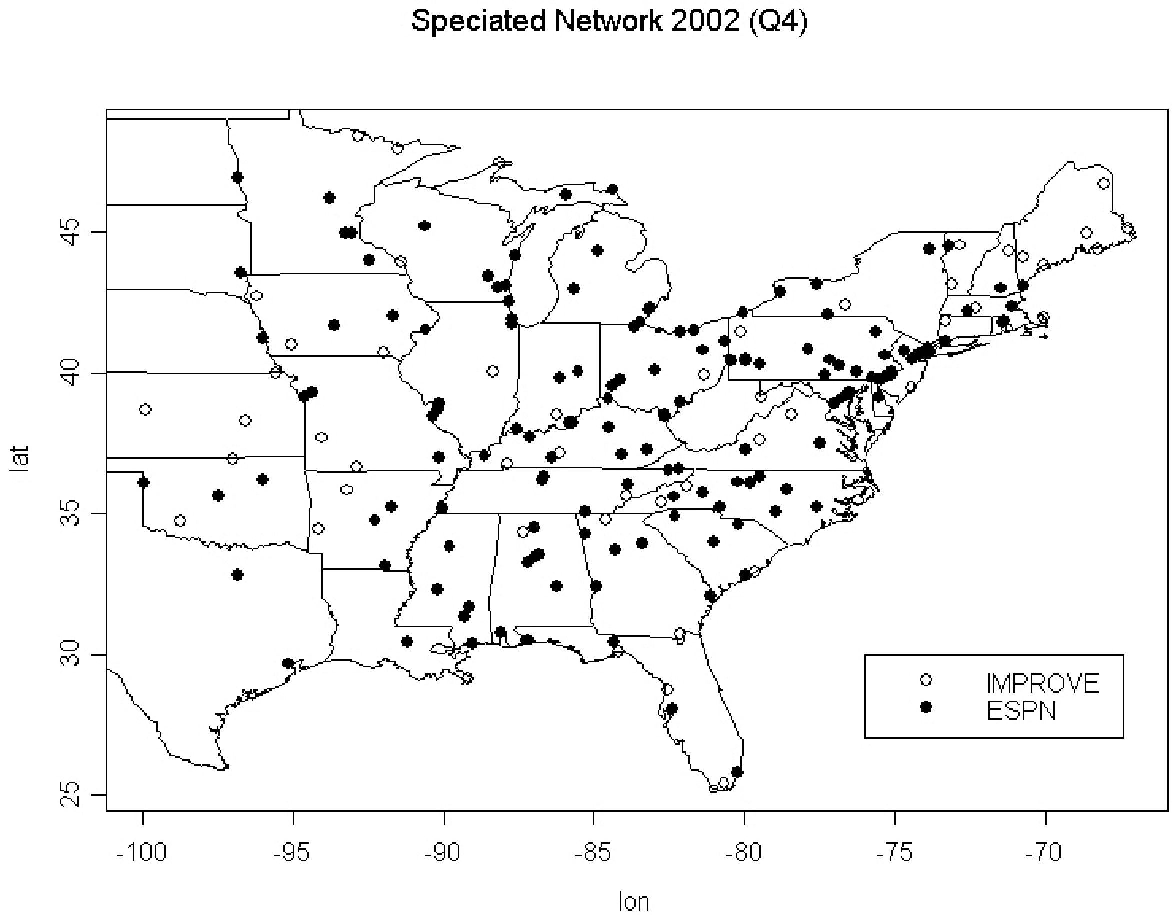


Figure 1- Speciation sites used in the revised SMAT analysis for the 4th quarter of 2002.

To further quality assure the ESPN data, the reconstructed fine mass (RCFM) was compared to measured FRM $PM_{2.5}$ on a quarterly basis[2]. To accomplish this QA check, daily RCFM was calculated for each observation using the following equation:

RCFM = Sulfate + Nitrate + OCM + EC + Crustal + Ammonium

Quarterly average RCFM was calculated using the daily RCFM. These quarterly average RCFM concentrations were then compared to quarterly average FRM $PM_{2.5}$ measurements at co-located sites.

Site-quarter combinations in the ESPN data were removed from the dataset when the quarterly average RCFM was more than 30% higher or 30% lower than the quarterly average

[2]This QA step was not done for the IMPROVE network because IMPROVE sites are not co-located with FRM sites.

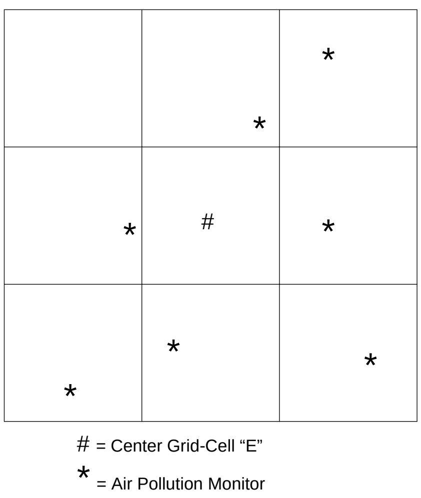
FRM $PM_{2.5}$. This comparison resulted in the removal of 30 site-quarter records from the dataset.

B. Spatial Interpolation of Data

Since roughly 80% of the FRM sites do not have co-located speciation monitors, a spatial interpolation methodology was developed to estimate component species mass at the FRM locations that do not have co-located speciation data. The quarterly average species concentrations at the IMPROVE and ESPN monitors were used to interpolate concentrations at the $PM_{2.5}$ monitoring sites[3]. We previously used a Kriging methodology for SMAT, but have now moved to a technique called Voronoi Neighbor Averaging (VNA) to produce the spatial fields. We are using the revised interpolation technique in order to remain consistent with calculations performed for the health benefits portion of the CAIR. For the benefits analysis, interpolated PM2.5 species data is needed for the entire country (not just the East). We found that VNA gave more spatially consistant results in the West compared to Kriging. We therefore decided to use VNA for the entire country and for all analyses.

All spatial interpolations were conducted using EPA's environmental Benefits Mapping and Analysis Program (BenMAP), about which information can be obtained at http://www.epa.gov/ttn/ecas/benmodels.html (*Abt, 2003*). The VNA interpolation method is contained within the BenMAP program.

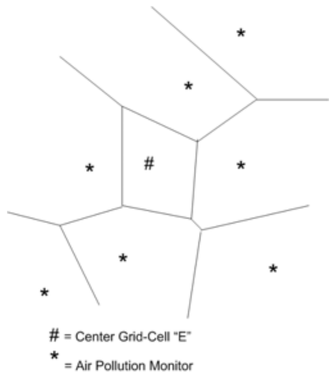
The first step in VNA is to identify the set of neighboring monitors for each of the CMAQ grid cells in the Continental United States. The figure below presents nine grid cells and seven monitors, with the focus on identifying the set of neighboring monitors for grid cell E.



In particular, BenMAP identifies the nearest monitors, or "neighbors," by drawing a polygon, or Voronoi cell, around the center of each county. The polygons have the special

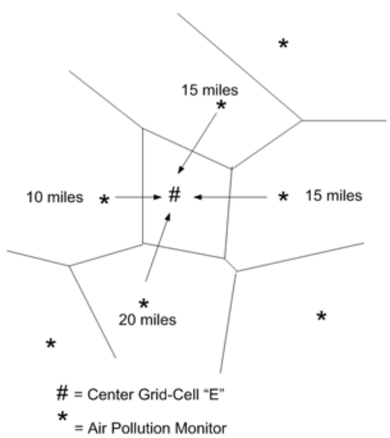
[3]The concentrations are interpolated to the CMAQ 36 km grid cells. Each grid cell has a unique set of interpolated species concentrations. The species concentrations are not interpolated to the location of each monitor within a grid cell.

property that the boundaries are the same distance from the two closest points.



We then choose those monitors that share a boundary with the center of grid cell E. These are the nearest neighbors, and we use these monitors to estimate the air pollution level for this grid cell.

To estimate the concentration of a species in each grid cell, BenMAP calculates an inverse-distance weighted average of the concentrations from each neighboring monitor. The further the monitor is from the grid cell center, the smaller the weight.



The weight for the monitor 30 kilometers from the center of grid cell E is calculated as follows:

$$weight_1 = \frac{\frac{1}{30}}{\left(\frac{1}{30}+\frac{1}{45}+\frac{1}{45}+\frac{1}{55}\right)} = 0.35$$

The weights for the other monitors would be calculated in a similar fashion.

There are several variants to the general VNA method which can be used to allow for differences in the spatial dynamics of different pollutants. These variants include distance limited VNA, inverse distance squared weighting, and nested VNA. Distance limited VNA functions the same as VNA with the exception that neighbors are constrained to be within a given distance from the center of the grid cell. Inverse distance squared weighting uses the inverse of the squared distance from the center of the grid cell in computing the weighted average of neighboring monitors. Nested VNA allows for the use of different weighting algorithms and distance limits depending on data availability. All three of these variants are used in developing the interpolated species concentrations.

Because of the spatial dynamics of different PM species, different adjustments to the generalized VNA method are applied for individual species. For the Eastern U.S., the quarterly average concentrations for nitrates, sulfates, organic carbon mass (measured organic carbon *1.4), and crustal species were interpolated using both IMPROVE and STN monitors with inverse distance squared weighting. Eastern U.S. elemental carbon quarterly concentrations were interpolated using both IMPROVE and STN monitors with inverse distance weighting[4]. Degree of neutralization of sulfate (DON) was calculated at ESPN monitors (IMPROVE does not collect ammonium data) and then interpolated using inverse distance squared weighting.

Interpolated spatial fields of quarterly average sulfate ion, “FRM” nitrate, elemental carbon, organic carbon mass, crustal mass, and the degree of neutralization of sulfate (DON) were created using VNA interpolation. Each of these fields were used in the calculation of component mass as described in the procedures below. Figure 5 is an example of the resulting interpolated surface using the first quarter data for nitrates and figure 6 shows the interpolated fields for third quarter sulfate concentrations.

[4]The elemental carbon data appeared to have stronger urban gradients compared to other species. Therefore, an inverse distance weighting scheme was used to better maintain the observed gradients.

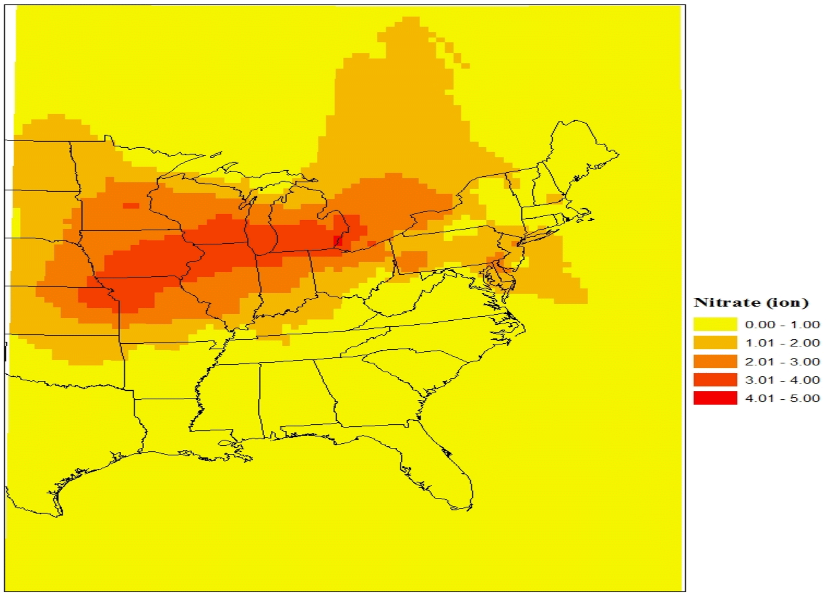


Figure 5. 1st quarter 2002 interpolated nitrate concentration.

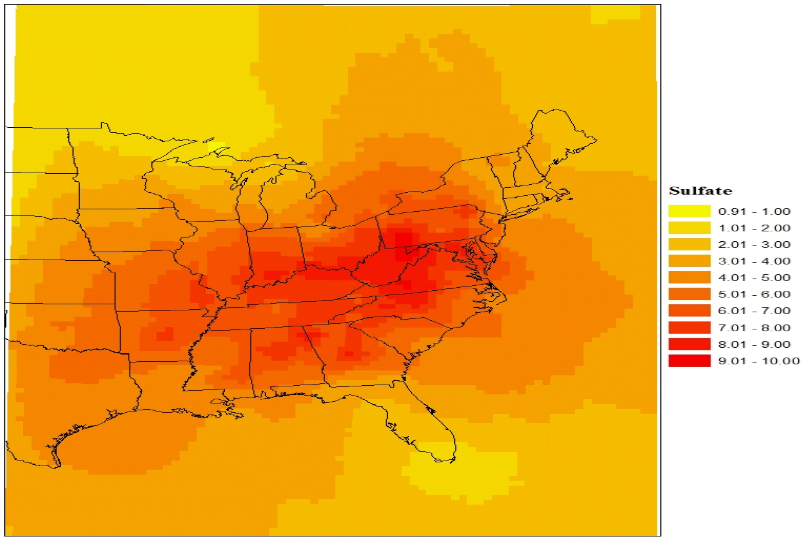


Figure 6. 3rd quarter interpolated sulfate concentration

III. Components of Measured $PM_{2.5}$ Mass

A. Introduction

As stated in the section I, one of the goals of the revised SMAT methodology is to bettter match the speciation data with the FRM $PM_{2.5}$ retained mass. A series of adjustments and calculations were performed in order to derive the estimated species compositions. Those procedures are described below.

To represent composition of measured $PM_{2.5}$ mass (for NAAQS implementation and more precise representation of regulatory $PM_{2.5}$), the following approach is used for revised SMAT:

CFM_{FRM} = [Ammoniated Sulfate Mass] + [Retained Nitrate Mass] + [Retained Carbonaceous Mass] + [Crustal] + [Other Components] [1]

In the above characterization, CFM equals constructed fine mass and all of the listed chemical components reflect those retained during sampling and equilibration on the FRM's Teflon filter. Sulfate and nitrate mass include associated ammonium but which may be different than assumed ammonium sulfate and ammonium nitrate compounds. Also, sulfates, nitrates and carbonaceous mass includes particle bound water associated with these hygroscopic aerosols. For these analyses, Crustal is intended to be a more general term that includes fine soil, and oxides that result from other PM emissions.

B. Derivation of $PM_{2.5}$ Species Used in Revised SMAT

1. Calculated adjusted nitrate by applying formula to daily average data

Retained Nitrate Mass The first step in the procedure for identifying mass components was to estimate the retained nitrate mass on the FRM filters. The FRM does not capture all of the semi-volatile components of the ambient air, such as ammonium nitrate. The retained amount of nitrate ion, however, can be accurately estimated by a simple thermodynamic model that involves 24-hr ambient nitrate speciation concentrations (as measured by a standard speciation sampler using a nylon filter preceded by a HNO3 denuder) together with hourly ambient temperature and humidity. Atmospheric nitrates are higher during the cooler months. Retention on the FRM is also higher during the cooler months and essentially all the nitrates are lost during the summer. The retention does not appear to depend on ambient NH3 or HNO3. More NO3 is retained at low temps and high humidity which varies by sampling location and time of year.

Prediction of FRM Nitrates Because nitrate retention varies by site and season, an ammonium nitrate equilibrium model is used to predict the amount of nitrates retained on the FRM teflon filter. As used by Hering *(Hering, 1999; Zhang, 1992),*

$$\text{delta NO3 (ug/m3)} = 745.7/T_R * 1/24 * \sum_{i=1}^{24} (\mathbf{K}_i^{1/2}) \quad [2]$$

where T_R is the reference temperature for the sampled air volume in degrees Kelvin and $\mathbf{K_i}$ is the dissociation constant for ammonium nitrate evaluated at the ambient temperature for hour i. This volatilization prediction characterizes depletion of some or all of the nitric acid and ammonia vapors ahead of the filter and specifies a 3-5 degree increase in the filtration temperature above ambient.

This model is used to adjust 24-hr ESPN nitrate ion concentrations to estimate FRM NO3 ($NO3_{FRM}$) as follows:

$$NO3_{FRM} = NO3_{ESPN} - \text{delta NO3 (ug/m3)} \quad [3]$$

For each hour of the day, the equilibrium dissociation constant for ammonium nitrate, K_i, was calculated from hourly ambient temperature and hourly ambient relative humidity based on Mozurkewich *(Mozurkewich, 1993)* and as applied by Chang et al.

When RH is less than deliquescence point of ammonium nitrate (61%),

$$\text{Ln } K = 118.87 - (24084/T) - 6.025 \ln T, \quad [4]$$

K in nanobars, T in Kelvins.

When RH is higher than 61%, K is replaced by

$$K' = [P_1 - P_2(1-a) + P_3(1-a)^2]\ (1-a)^{1.75} * K \quad [5]$$

where Ln P1, Ln P2, Ln P3 are specified as
$\text{Ln}(P_1) = -135.94 + 8763/T + 19.12\ln(T)$
$\text{Ln}(P_2) = -122.65 + 9969/T + 16.22\ln(T)$
$\text{Ln}(P_3) = -182.61 + 13875/T + 24.46\ln(T)$

Equation 4 assumes crystallization of ammonium nitrate when RH is less than 61%. Thus, predicted NO3 loss may be underestimated for situations where solids do not form on the filter. For supersaturated solutions and with lower RH, the estimated dissociation for the solution will be larger than K for the solid. However, there is little (or no) data that can be used to give a reliable result for how much larger.

Based on equations [2]-[5], Figure 7 illustrates the potential nitrate loss as a function of temperature and relative humidity. Temperature is presented as degrees F for more convenient interpretation. It shows that at 50 deg F and RH of 80%, approximately 1.6 ug/m3 nitrate would be lost. At RH less < 61% an additional 0.4ug/m3 could be lost. In both cases, the loss cannot exceed the amount of ambient NO3, as depicted by the ESPN NO3.

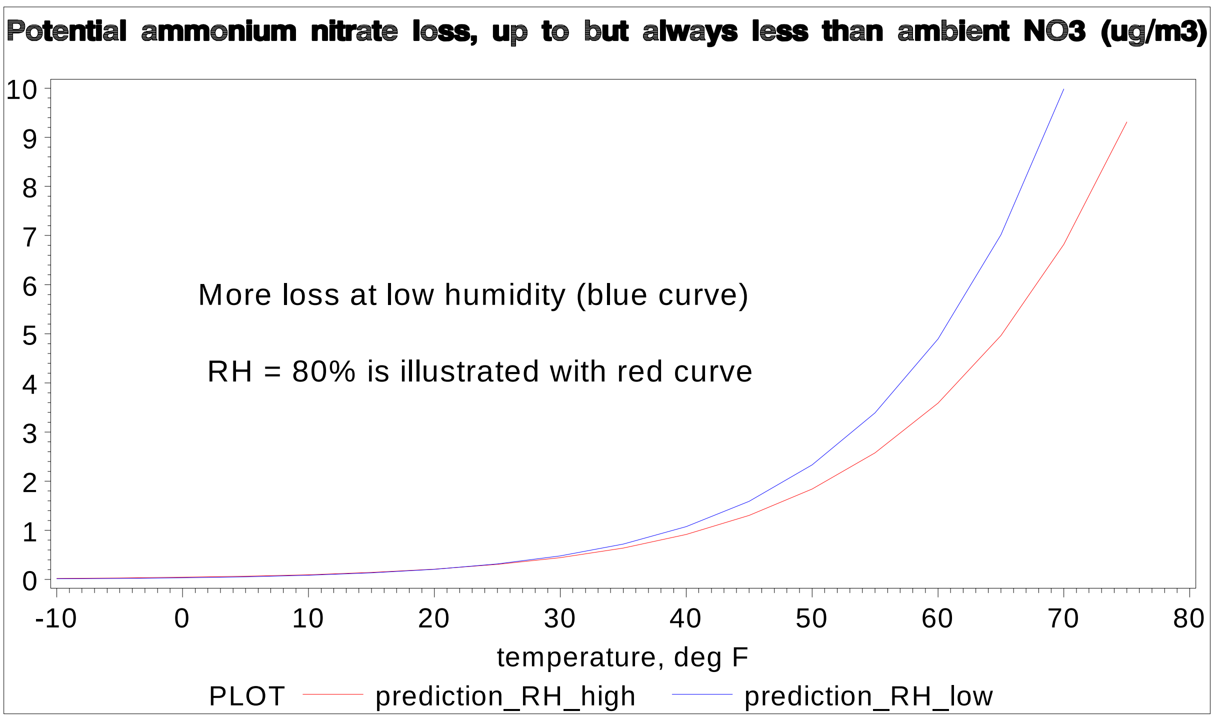


Figure 7- Potential NO3 loss as a function of temperature and relative humidity.

When these predictions are compared with measured FRM nitrates at six eastern US monitoring locations, the annual average prediction errors are <-0.3 - +0.1 ug/m3.

3. Estimated Ammonium associated with sulfates and retained nitrates and sulfates

To determine the mass associated with nitrates, we first assume retained nitrate is probably all ammonium nitrate in the Eastern US. Thus the ammonium associated with nitrates can be derived directly from the measured or predicted $NO3_{FRM}$ as

$$NH4_{NO3} = 0.29 * NO3_{FRM} \quad [6]$$

Similarly, the dry $PM_{2.5}$ mass associated with nitrates is

$$[\text{Retained dry FRM Nitrates}] = 1.29 * NO3_{FRM} \quad [7]$$

FRM nitrates retains water. Discussion of hydrated nitrates (and sulfates) are discussed in the next section.

The difference between total FRM NH4 (amount associated with nitrates and sulfates), termed $NH4_{FRM}$, and the ESPN NH4, termed $NH4_{ESPN,}$, is needed to determine the ammoniated form of sulfates as described by equation 4. Recent measurement study by Collett *(Collett, 2004)* shows that NH4 may not be completely retained during collection on nylon filters preceded by a nitric acid denuder. During sampling conditions associated with nitrate volatilization, ammonium nitrate dissociates but the HNO3 downstream of the denuder is recaptured on the basic nylon media and the result is reported as particle nitrate. On the other hand, the NH4+ volatilizes to gaseous NH3 and apparently passes thru the filter. At several FRM study sites, the ESPN NH4 which is adjusted for evaporated NH4NO3 tends to more closely corresponds to the measured NH4 from the FRM teflon filter. However, for other sites, the measured ESPN NH4 appear to agree with FRM NH4.

Because of uncertainty in retained FRM NH4, NH4adj is estimated as $NH_{4\ ESPN}$ minus ½ the amount that would have evaporated with lost NO3 as follows:

$$NH4_{adj} = NH_{4\ ESPN} - ½ * 0.29 * (NO3_{\ ESPN} - NO3_{FRM}) \quad [8]$$

This essentially assumes that 50 % of the ammonium associated with lost nitrate is also lost.

4. Ammoniated Sulfate Mass.

The mass associated with sulfates is first estimated as its dry mass. All estimated sulfates are assumed to be associated with ammonium, but the form of the sulfate compound and the amount of ammonium must be estimated. The form of the ammoniated sulfate compound(s) and the amount of associated ammonium, however, is somewhat uncertain.

Sulfates may not be fully neutralized in all geographic areas or seasons of the year. During winter-time conditions, when nitrates are prevalent in the ambient aerosol, sulfates tend to be fully neutralized and exist as ammonium sulfate. During the summer when sulfates are higher, nitrates are lower and ammonia is less available for reaction with H2SO4 , the resulting aerosol can be acidic and the form of sulfates can include bisulfate or even H2SO4.

The amount of ammonium associated with the sulfate ion can be estimated as

$$NH4_{(SO4)} = NH4_{adj} - 0.29 * NO3_{FRM}, \quad [9]$$

where 0.29 is the molar ratio of NH4 to NO3 and
$NH4_{FRM}$ and $NO3_{FRM}$ reflect the amounts retained on the FRM filter.

The amount of $NH4_{(SO4)}$ is not allowed to exceed the fully neutralized amount of 0.375 multiplied by the estimated sulfate ion concentration.

Because of uncertainties in NH4 speciation measurements, the spatially interpolated values of NH4 are calculated by deriving the degree of sulfate neutralization (DON) from the estimated $NH4_{(SO4)}$ as

$$DON = NH4_{(SO4)} / SO4. \quad [10]$$

Interpolated values of DON, sulfate and estimated FRM nitrate (adjusted nitrate) are then used to estimate the adjusted ammonium at each FRM site as follows:

$$NH4_{FRM} = DON * SO4 + 0.29*NO3_{FRM}, \quad [11]$$

where: DON, SO4 and NO3FRM are the interpolated (kriged) quarterly average values at each FRM site. $NH4_{FRM}$ is not a directly measured value, but is derived from the measurements of NH4, SO4, and NO3. The interpolated DON values were used to estimate ammonium due to the uncertainty of the ammonium measurements. The accuracy of the ammonium measurement and the amount of ammonium that is retained on the FRM filter is uncertain. Use of the smoothed, interpolated DON values allows for a relatively smooth field of ammonium concentrations.

5. Particle Bound Water

Because ammoniated sulfate and ammonium nitrate are hygroscopic, the retained sulfate and nitrate mass will include water. Particle bound water (PBW) is estimated using the Aerosol Inorganic Model (AIM) *(Clegg, 1998)*. PBW was derived from quarterly average FRM concentrations of sulfate, ammonium, nitrate as describe above. Estimated hydronium ion, H+, needed to achieve ionic balance was derived from the latter values. The model enables the distribution of water and ions to be calculated between liquid, solid and vapor phases for specific temperature and relative humidity conditions. Typical filter equilibration conditions of 35% RH and 22 deg C (295 deg K) temperature were used.

Application of AIM at the specified FRM filter equilibration conditions show that PBW is much more dependent on sulfate concentration compared to nitrate and that the relationship varies somewhat by season to differentiate the relative amounts of sulfate and nitrate aerosol. There is proportionally less estimated PBW water for wintertime aerosol which has higher NH4 and NO3 and lower SO4.

After running the AIM model, it was determined that the particle bound water concentrations are sensitive to the degree of neutralization of the sulfate particles (determined by the relative concentration of $NH4_{FRM}$). Due to the uncertainty in ammonium concentration estimates, we used a relatively smooth field of interpolated ammonium concentrations as input to AIM. This helped to smooth out some of the "bumpiness" in the water concentration predictions.

For computational convenience, a polynomial regression equation was fit to the calculated water mass from AIM and the three input values that fed into AIM (sulfate, nitrate and ammonium). The polynomial equation is then used in all SMAT analyses to estimate water.

The equation is as follows:

```
PBW =(-0.002618) + (0.980314*nh4) + (-0.260011*no3) + (-0.000784*so4)
     + (-0.159452*nh4**2) + (-0.356957*no3*nh4) + (0.153894*no3**2)
     + (0.212891*so4*nh4) + (0.044366*so4*no3) + (-0.048352*so4**2)    [12]
```

where nh4 = $NH4_{FRM}$ and no3 = $NO3_{FRM}$

6. Other Non-Carbon $PM_{2.5}$ Components (blank mass)

The other quantifiable components of $PM_{2.5}$ mass include passively collected mass, represented by the field blank concentration of 0.3-0.5ug/m3 *(EPA, 2002)*. This appears to constitute a contamination of the filter resulting from handling or contact with the FRM cassette. This value is deemed to be an important constituent of $PM_{2.5}$ mass (it is assumed to not be dependent on pollutant emissions). A nominal blank mass value of 0.5 ug/m3 will be considered in mass construction computations presented later. This value is assumed to remain constant through time.

7. Calculation of Carbonaceous Mass

Elsewhere, carbonaceous mass is estimated from blank corrected speciation data, where organic carbonaecous mass is first estimated by multiplying the organic carbon concentrations by 1.4 or alternative factors to account for the oxygen, hydrogen and other elements associated with ambient carbon particles. To that amount is added the elemental carbon concentration. An alternative approach to estimate carbon contribution to $PM_{2.5}$ mass is used for revised SMAT because of (1) many uncertainties in estimating carbonaceous mass from carbon measurements *(Turpin, 2001; Chow, 2004)* (2) differences in carbon measurement protocol between urban and rural monitoring locations, (3) a relatively “bumpy” surface of urban carbon concentrations as derived from these urban and rural organic carbon measurements and (4) lack of carbon measurements at all FRM locations. The revised SMAT approach estimates carbon by mass balance comparing precisely measured FRM $PM_{2.5}$ mass *(EPA, 2003)* with the sum of its non-carbon components. The latter are sulfates, ammonium, nitrates, estimated particle bound water, estimated crustal material plus 0.5 ug/m3 as discussed earlier.

This approach estimates retained carbonacous FRM mass and explicitly accounts for the following important and difficult to estimate carbon mass properties: (1) regional and urban-rural differences in the mix of carbonaceous aerosols, i.e. the amount of oxygen, hydrogen, etc; (2) retained water associated with hygroscopic carbon compounds *(Saxena, 1996; Yua, 2004)*; (3) volatile carbonaceous material measured by speciation samplers, but not retained in FRM mass; and (4) uncertainties associated with blank corrections of measured organic and elemental carbon.

Total Carbonaceous Mass by mass balance **(TCM_{mb})** is defined as ,

$$\mathbf{TCM_{mb}} = PM_{2.5} - \{ [SO4] + [NO3_{FRM}] + [NH4_{FRM}] + [water] + [crustal\ material] + [0.5] \} \quad [13]$$

In this expression, all of the above quarterly average components represent the mass retained on FRM teflon filters.

The mass associated with organic compounds is defined as

$$\mathbf{OCM_{mb}} = \mathbf{TCM_{mb}} - [EC] \quad [14]$$

where EC is elemental carbon.

This approach completely accounts for FRM mass and OCMmb is often greater than the amount that would be derived directly from speciation measurements. Because of uncertainties in speciation measurements and their estimates from interpolated surfaces, a lower limit (floor) for OCMmb was set so that the OCMmb was not unreasonably low. The floor was set so that OCMmb could not be more than 30% lower than measured OCM. We used the Kriged measured values of OCM to calculate the floor. The lower limit is equal to interpolated (measured) OC * 1.4 * 0.7. If the OCMmb concentration was less than the lower limit, it was set equal to the lower limit.

B. Summary of $PM_{2.5}$ Composition Calculations

Equation 15 shows the final composition of PM species as they relate to the measured FRM values for each quarter of 2002. Quarterly average FRM mass is equal to the sum of the seven species plus blank mass.

$$PM2.5_{FRM} = \{ [OCMmb] + [EC] + [SO4] + [NO3_{FRM}] + [NH4_{FRM}] + [water] + [crustal\ material] + [0.5] \} \quad [15]$$

The species data is generated in the following order:

1) Adjusted nitrate is calculated using hourly meteorology and 24-hour average nitrate measurements.

2) Quarterly averages are calculated for adjusted nitrate, sulfate, elemental carbon, degree of sulfate neutralization (DON), crustal mass , and measured OCM[5].

3) Quarterly average ammonium is calculated from the adjusted nitrate, sulfate, and DON values.

4) Calculated ammonium, sulfate, and nitrate values are input into the polynomial water equation to derive particle bound water concentrations.

5) Carbon mass by difference (OMCmb) is calculated from the $PM_{2.5}$ mass, adjusted nitrate, ammonium, sulfate, water, elemental carbon, crustal, and blank mass values.

6) The sum of the 7 species plus blank mass is equal to the FRM mass.

C. Calculation of Quarterly Species Fractions

For each quarter at each FRM site, concentrations for each of the seven species (plus blank mass) are combined with quarterly 2002 $PM_{2.5}$ FRM averages to derive composition fractions in the following manner:

First, the 0.5 ug/m3 of blank mass is subtracted from the FRM $PM_{2.5}$ concentration.

$$PM2.5_{FRM\text{-}Blank} = PM2.5_{FRM} - 0.5\ ug/m3 \qquad [16]$$

The blank mass is subtracted before species fractions are calculated because the blank mass is held constant at 0.5 ug/m3 throughout the analysis. In the example below (table 3a), the measured FRM mass for quarter 3 in 2002 is 22.5 ug/m3. The non-blank FRM mass is 22.0 ug/m3. The mass of the seven species add up to the non-blank mass.

Table 3a

FRM Mass (ug/m3)	**Blank Mass (ug/m3)**	**Non-blank Mass (ug/m3)**	**Sulfate (ug/m3)**	**Nitrate (ug/m3)**	**Organic aerosol (ug/m3)**	**Elemental Carbon (ug/m3)**	**Water (ug/m3)**	**Ammonium (ug/m3)**	**Crustal (ug/m3)**
22.5	0 .5	22.0	8.5	1.1	5.2	0.9	2.3	3.3	0.7

[5]The measured OCM is only used to calculate the "floor" for OCMmb.

Next, species fractions are calculated for each quarter for each specie. In the example below (table 3b), a fraction of non-blank mass is calculated for each of the seven species. Blank mass remains fixed at 0.5 ug/m3.

Table 3b

FRM Mass (ug/m3)	Blank Mass (ug/m3)	Non-blank Mass (ug/m3)	% Sulfate	% Nitrate	% Organic aerosol	% Elemental Carbon	% Water	% Ammonium	% Crustal
22.5	0 .5	22.0	38.6	5.0	23.6	4.1	10.5	15.0	3.2

The percentages in table 3b above are the relative composition for the 3rd quarter of 2002. For the purposes of this analysis, we are assuming that the relative specie composition for each quarter of 2002 is representive of the 1999-2003 time period.

IV. $PM_{2.5}$ Design Values for Projecting to the Future

A. Defining "Current" Year FRM $PM_{2.5}$ Values

The $PM_{2.5}$ component species fractions are applied to "current" $PM_{2.5}$ design values which are then projected to the future. The CAIR proposal SMAT procedure followed the recommendations in the current draft $PM_{2.5}$ modeling guidance. The guidance recommends projecting the highest of the three design values that straddle the base modeling emissions year. In this case the base emissions year is 2001. The three design value periods that straddle 2001 are 1999-2001, 2000-2002, and 2001-2003. The 2001-2003 data was not available when the CAIR proposal was released, so the highest design value of the 2 available years; 1999-2001 or 2000-2002 were used in the CAIR proposal.

In the revised SMAT procedure we are proposing to revise the methodology to calculate the base year design values for projections. We are proposing to use the average of the 3 design value periods that straddle the emissions year. The average of the 3 design values is not a straight five year average. It is, in effect, a weighted average of the annual averages. The design value periods range from 1999-2003. In the average of 1999-2001, 2000-2002, and 2001-2003, 2001 is "weighted" 3 times, 2000 and 2002 are weighted twice, and 1999 and 2003 are weighted once. This has the desired effect of weighting the projected $PM_{2.5}$ values towards the middle year of the five year period, which is the emissions and meteorology year (2001). The average design value methodology also takes into account the emissions and meteorological variability that occurs over the full 5 year period. The average weighted design value is thought to be more representative of the 2001 emissions and meteorology period than the previous methodology of choosing the highest single design value period. This value provides the "best estimate" current year design value for use in future year model projections. It should be noted that in most cases, the "average" design value will not be the same as the 2001-2003 design value that will be used for the purpose of $PM_{2.5}$ designations. The average design value may be higher or lower than the 2001-2003 value.

There are several steps in the derivation of the average $PM_{2.5}$ design values for projections to the future. Quarterly average values are needed for each FRM site. The following steps were used to derive the quarterly average FRM values.

1) The analysis began with quarterly average FRM data for all quarters from 1999-2003.

2) Completeness was defined as site quarters with11 valid samples per quarter. All site quarters with less than 11 samples were removed.

3) A quarterly average 3 year design value was calculated for each design value period in which a site had all 12 quarters with complete data[6] (1999-2001, 2000-2002, and 2001-2003). This results in four quarterly averages for up to three design value periods for each FRM site. Sites had to have complete data for the latest design value period (2001-2003) to be considered in the analysis. Since the $PM_{2.5}$ designation process will use the 2001-2003 data, sites were not used in the analysis if they did not have complete data (as defined in 2 above) for the 2001-2003 period.

4) The (up to) 3 quarterly design value periods were averaged together to get a single quarterly average design value for each site. All complete design value data was used, provided that the 2001-2003 period was complete. A site did not have to have all 3 complete design periods. If 2001-2003 was the only complete period, then that was used as the average design value (even though it isn't truly an average). If 2 complete design value periods were available for a site (1999-2001 and 2001-2003 **or** 2000-2002 and 2001-2003), then those 2 periods were averaged together.

The averaged quarterly average FRM design values were used as the "current" FRM value for each monitoring site. The species fractions from the 2002 speciation data were used to estimate the species concentrations for the current year FRM $PM_{2.5}$ data. The percentage compositions for 2002 are applied to the quarterly average design values as shown in table 4a.. In the example below, the average design value for the 3rd quarter for the site from table 3b is 20.3 ug/m3. This leads to the following concentrations of $PM_{2.5}$ species:

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[6]Sites were considered to have complete data for the purposes of calculating a 3 year design value if they had 12 complete quarters <u>or</u> were considered to have complete data through data substitution. If a site was complete with data substitution and had 10 or 11 complete quarters, the quarterly design values were calculated using only the complete quarters. Incomplete quarters were not used in the calculations.

Table 4a. Calculation of the "current" species concentrations

Weighted Avg. FRM Mass (ug/m3)	Blank Mass (ug/m3)	Non-blank Mass (ug/m3)	Sulfate (ug/m3)	Nitrate (ug/m3)	Organic aerosol (ug/m3)	Elemental Carbon (ug/m3)	Water (ug/m3)	Ammonium (ug/m3)	Crustal (ug/m3)
20.3	0 .5	19.8	7.64	0.99	4.67	0.81	2.08	2.97	0.63

This procedure is repeated for each $PM_{2.5}$ site and quarter to complete the calculation of current (or baseline) ambient concentrations used as the basis for future estimates of $PM_{2.5}$ mass and its components.

B. Estimating Future Year $PM_{2.5}$

Future concentrations of $PM_{2.5}$ component species are estimated by assuming that the quarterly average component concentration will change in the same proportion as the model predicted change. Model predicted changes in species concentrations (from a current year to a future year) are used to calculate "relative reduction factors". Relative reduction factors are calculated for each grid cell and species as the ratio of the quarterly average future model predictions to the current base model predictions. The relative reduction factor for each species is then multiplied by the estimated current year ambient species mass for the site to estimate future species concentrations.

In the revised SMAT methodology, relative reduction factors are calculated for 5 species; sulfate, nitrate, organic carbon mass, elemental carbon, and crustal mass. The future year concentrations of the 5 components are calculated for each site quarter. The future year ammonium concentrations are calculated from the sulfate, nitrate, and (current year) DON values. Assuming that the DON is unchanged from the current year[7], the ammonium is calculated using the following formula:

$NH4_{future} = DON * SO4_{future} + 0.29*NO3_{future}$,

The $NH4_{future}$, $SO4_{future,}$ and $NO3_{future}$ concentrations were then run through the polynomial water equation to predict a future year water concentration. The future species concentrations at

[7]The DON was assumed to stay constant through time due to the uncertainty in the ammonium measurements. The water calculation is sensitive to the ammonium (and therefore the DON value) concentrations. Keeping the DON constant allows for the future year ammonium and water values to be solely a function of the sulfate and nitrate concentrations. Otherwise, it is possible for sulfate and nitrate to be reduced and water concentrations to increase. This may occur if sulfate becomes more neutralized in the future. But it is somewhat illogical outcome (although scientifically possible) and is highly dependent on an uncertain measurement (ammonium). Therefore we did not allow the DON value to vary with time.

each FRM site were then summed over the seven species plus blank mass[8] to estimate the future quarterly average $PM_{2.5}$ concentration. The four quarterly values are then averaged to obtain the estimated future annual average $PM_{2.5}$ for each FRM site.

V. Summary

The results of the analysis at each of the FRM monitoring sites (with complete data) were used in the CAIR final rule modeling analysis. The revised SMAT technique has several improvements over the original SMAT application in the CAIR proposal. One goal of the revised SMAT methodology was to estimate the $PM_{2.5}$ mass that is retained on the FRM filters. This provides a more unbiased estimate of future $PM_{2.5}$ concentrations which are based on current year FRM measurements. Averaging of multiple design value periods provides a "best estimate" current year design value. Application of revised SMAT with interpolated spatial fields allows us to take advantage of the measurements at each FRM site. In this way, a more complete future year attainment/nonattainment picture can be derived by expanding the predictions of future year design values to all FRM monitoring sites.

Use of SMAT with Spatial Fields for SIPs

The details of this application of revised SMAT are specific to the short term use of the FRM and speciation data (ESPN and IMPROVE) in estimating future year $PM_{2.5}$ concentrations for the CAIR. The use of a single year of speciation data interpolated to a modeling grid is necessary at this time, due to the relatively sparse ambient data sets. The amount of available ambient data will increase significantly in the future. When ambient data is needed for SIP development, there will be at least 3 years of complete speciation data at hundreds of sites. In many areas, the coverage of speciation data may be adequate so that interpolation of the data through spatial fields is not necessary. It is likely that the routinely measured speciation data will never be directly comparable with the FRM data, but our understanding of the biases, artifacts, and sampling issues will continue to improve through time. This application should serve as an example that can be replicated in the short term, but the techniques and assumptions will likely evolve over the long term.

[8] The blank mass value was held constant at 0.5 ug/m3, effectively giving it a relative reduction factor of 1.0.

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Appendix M

Adopted State Measures

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INTRODUCTION

This Appendix contains the North Carolina rules and legislation that have been adopted that impact fine particulate matter pollution. Below is listed the rules and legislations, with a short description, and the corresponding page numbers where the measure can be found.

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15A NCAC 02D .0530 PREVENTION OF SIGNIFICANT DETERIORATION

(a) The purpose of the Rule is to implement a program for the prevention of significant deterioration of air quality as required by 40 CFR 51.166.

(b) For the purposes of this Rule the definitions contained in 40 CFR 51.166(b) and 40 CFR 51.301 shall apply except the definition of "baseline actual emissions."

(1) "Baseline actual emissions" means the rate of emissions, in tons per year, of a regulated new source review (NSR) pollutant, as determined in accordance with Parts (A) through (C) of this Subparagraph:

(A) For an existing emissions unit, baseline actual emissions means the average rate, in tons per year, at which the emissions unit actually emitted the pollutant during any consecutive 24-month period selected by the owner or operator within the 5-year period immediately preceding the date that a complete permit application is received by the Division for a permit required under this Rule. The Director shall allow a different time period, not to exceed 10 years immediately preceding the date that a complete permit application is received by the Division, if the owner or operator demonstrates that it is more representative of normal source operation. For the purpose of determining baseline actual emissions, the following shall apply:

(i) The average rate shall include fugitive emissions to the extent quantifiable, and emissions associated with startups, shutdowns, and malfunctions.

(ii) The average rate shall be adjusted downward to exclude any non-compliant emissions that occurred while the source was operating above any emission limitation that was legally enforceable during the consecutive 24-month period.

(iii) For an existing emission unit (other than an electric utility steam generating unit), the average rate shall be adjusted downward to exclude any emissions that would have exceeded an emission limitation with which the major stationary source must currently comply. However, if the State has taken credit in an attainment demonstration or maintenance plan consistent with the requirements of 40 CFR 51.165(a)(3)(ii)(G) for an emission limitation that is part of a maximum achievable control technology standard that the Administrator proposed or promulgated under part 63 of the Code of Federal Regulations, the baseline actual emissions shall be adjusted to account for such emission reductions.

(iv) For an electric utility steam generating unit, the average rate shall be adjusted downward to reflect any emissions reductions under G. S. 143-215.107D and for which cost recovery is sought pursuant to G. S. 62-133.6.

(v) For a regulated NSR pollutant, when a project involves multiple emissions units, only one consecutive 24-month period shall be used to determine the baseline actual emissions for all the emissions units being changed. A different consecutive 24-month period for each regulated NSR pollutant can be used for each regulated NSR pollutant.

(vi) The average rate shall not be based on any consecutive 24-month period for which there is inadequate information for determining annual emissions, in tons per year, and for adjusting this amount if required by Subparts (ii) and (iii) of this Part.

(B) For a new emissions unit, the baseline actual emissions for purposes of determining the emissions increase that will result from the initial construction and operation of such unit shall equal zero; and thereafter, for all other purposes, shall equal the unit's potential to emit.

(C) For a plantwide applicability limit (PAL) for a stationary source, the baseline actual emissions shall be calculated for existing emissions units in accordance with the procedures contained in Part (A) of this Subparagraph, and for a new emissions unit in accordance with the procedures contained in Part (B) of this Subparagraph.

(2) In the definition of "net emissions increase," the reasonable period specified in 40 CFR 51.166(b)(3)(ii) shall be seven years.

(3) The limitation specified in 40 CFR 51.166(b)(15)(ii) shall not apply.

(c) All areas of the State shall be classified as Class II except that the following areas are Class I:

(1) Great Smoky Mountains National Park;

(2) Joyce Kilmer Slickrock National Wilderness Area;

(3) Linville Gorge National Wilderness Area;

(4) Shining Rock National Wilderness Area;
(5) Swanquarter National Wilderness Area.

(d) Redesignations of areas to Class I or II may be submitted as state proposals to the Administrator of the Environmental Protection Agency (EPA), if the requirements of 40 CFR 51.166(g)(2) are met. Areas may be proposed to be redesignated as Class III, if the requirements of 40 CFR 51.166(g)(3) are met. Redesignations may not, however, be proposed which would violate the restrictions of 40 CFR 51.166(e). Lands within the boundaries of Indian Reservations may be redesignated only by the appropriate Indian Governing Body.

(e) In areas designated as Class I, II, or III, increases in pollutant concentration over the baseline concentration shall be limited to the values set forth in 40 CFR 51.166(c). However, concentration of the pollutant shall not exceed standards set forth in 40 CFR 51.166(d).

(f) Concentrations attributable to the conditions described in 40 CFR 51.166(f)(1) shall be excluded in determining compliance with a maximum allowable increase. However, the exclusions referred to in 40 CFR 51.166(f)(1)(i) or (ii) shall be limited to five years as described in 40 CFR 51.166(f)(2).

(g) Major stationary sources and major modifications shall comply with the requirements contained in 40 CFR 51.166(i) and (a)(7) and by extension in 40 CFR 51.166(j) through (o) and (w). The transition provisions allowed by 40 CFR 52.21 (i)(11)(i) and (ii) and (m)(1)(vii) and (viii) are hereby adopted under this Rule. The minimum requirements described in the portions of 40 CFR 51.166 referenced in this Paragraph are hereby adopted as the requirements to be used under this Rule, except as otherwise provided in this Rule. Wherever the language of the portions of 40 CFR 51.166 referenced in this Paragraph speaks of the "plan," the requirements described therein shall apply to the source to which they pertain, except as otherwise provided in this Rule. Whenever the portions of 40 CFR 51.166 referenced in this Paragraph provide that the State plan may exempt or not apply certain requirements in certain circumstances, those exemptions and provisions of nonapplicability are also hereby adopted under this Rule. However, this provision shall not be interpreted so as to limit information that may be requested from the owner or operator by the Director as specified in 40 CFR 51.166(n)(2).

(h) New natural gas-fired electrical utility generating units shall install best available control technology for NO_X and SO_2.

(i) 40 CFR 51.166(w)(10)(iv)(a) is changed to read: "If the emissions level calculated in accordance with Paragraph (w)(6) of this Section is equal to or greater than 80 percent of the PAL [plant wide applicability limit] level, the Director shall renew the PAL at the same level." 40 CFR 51.166(w)(10)(iv)(b) is not incorporated by reference.

(j) 15A NCAC 02Q .0102 and .0302 are not applicable to any source to which this Rule applies. The owner or operator of the sources to which this Rule applies shall apply for and receive a permit as required in 15A NCAC 02Q .0300 or .0500.

(k) When a particular source or modification becomes a major stationary source or major modification solely by virtue of a relaxation in any enforceable limitation which was established after August 7, 1980, on the capacity of the source or modification to emit a pollutant, such as a restriction on hours of operation, then the provisions of this Rule shall apply to the source or modification as though construction had not yet begun on the source or modification.

(l) The provisions of 40 CFR 52.21(r)(2) regarding the period of validity of approval to construct are incorporated by reference except that the term "Administrator" is replaced with "Director".

(m) Volatile organic compounds exempted from coverage in 40 CFR 51.100(s) shall also be exempted when calculating source applicability and control requirements under this Rule.

(n) The degree of emission limitation required for control of any air pollutant under this Rule shall not be affected in any manner by:

(1) that amount of a stack height, not in existence before December 31, 1970, that exceeds good engineering practice; or
(2) any other dispersion technique not implemented before then.

(o) A substitution or modification of a model as provided for in 40 CFR 51.166(l) shall be subject to public comment procedures in accordance with the requirements of 40 CFR 51.102.

(p) Permits may be issued on the basis of innovative control technology as set forth in 40 CFR 51.166(s)(1) if the requirements of 40 CFR 51.166(s)(2) have been met, subject to the condition of 40 CFR 51.166(s)(3), and with the allowance set forth in 40 CFR 51.166(s)(4).

(q) If a source to which this Rule applies impacts an area designated Class I by requirements of 40 CFR 51.166(e), notice to EPA will be provided as set forth in 40 CFR 51.166(p)(1). If the Federal Land Manager presents a demonstration described in 40 CFR 51.166(p)(3) during the public comment period or public hearing to the Director and if the Director concurs with this demonstration, the permit application shall be denied. Permits may be issued on the basis that the requirements for variances as set forth in 40 CFR 51.166(p)(4), (p)(5) and (p)(7), or (p)(6) and (p)(7) have been satisfied.

(r) A permit application subject to this Rule shall be processed in accordance with the procedures and requirements of 40 CFR 51.166(q). Within 30 days of receipt of the application, applicants shall be notified if the application is complete as to initial information submitted. Commencement of construction before full prevention of significant deterioration approval is obtained constitutes a violation of this Rule.

(s) Approval of an application with regard to the requirements of this Rule shall not relieve the owner or operator of the responsibility to comply fully with applicable provisions of other rules of this Subchapter or Subchapter 02Q of this Title and any other requirements under local, state, or federal law.

(t) When a source or modification subject to this Rule may affect the visibility of a Class I area named in Paragraph (c) of this Rule, the following procedures shall apply:

(1) The Director shall provide written notification to all affected Federal Land Managers within 30 days of receiving the permit application or within 30 days of receiving advance notification of an application. The notification shall be at least 30 days prior to the publication of notice for public comment on the application. The notification shall include a copy of all information relevant to the permit application including an analysis provided by the source of the potential impact of the proposed source on visibility.

(2) The Director shall consider any analysis concerning visibility impairment performed by the Federal Land Manager if the analysis is received within 30 days of notification. If the Director finds that the analysis of the Federal Land Manager fails to demonstrate to his satisfaction that an adverse impact on visibility will result in the Class I area, the Director shall provide in the notice of public hearing on the application, an explanation of his decision or notice as to where the explanation can be obtained.

(3) The Director may require monitoring of visibility in or around any Class I area by the proposed new source or modification when the visibility impact analysis indicates possible visibility impairment.

(u) If the owner or operator of a source is using projected actual emissions to avoid applicability of prevention of significant deterioration requirements, the owner or operator shall notify the Director of the modification before beginning actual construction. The notification shall include:

(1) a description of the project,

(2) identification of sources whose emissions could be affected by the project,

(3) the calculated projected actual emissions and an explanation of how the projected actual emissions were calculated, including identification of emissions excluded by 40 CFR 51.166(b)(40)(ii)(c),

(4) the calculated baseline actual emissions and an explanation of how the baseline actual emissions were calculated, and

(5) any netting calculations if applicable.

If upon reviewing the notification, the Director finds that the project will cause a prevention of significant deterioration evaluation, then the Director shall notify the owner or operator of his findings. The owner or operator shall not make the modification until it has received a permit issued pursuant to this Rule. If a permit revision is not required pursuant to this rule, the owner or operator shall maintain records of annual emissions in tons per year, on a calendar year basis related to the modifications for 10 years following resumption of regular operations after the change if the project involves increasing the emissions unit's design capacity or its potential to emit the regulated NSR pollutant; otherwise these records shall be maintained for five years following resumption of regular operations after the change. The owner or operator shall submit a report to the director within 60 days after the end of each year during which these records must be generated. The report shall contain the items listed in 40 CFR 51.166(r)(6)(v)(a) through (c). The owner or operator shall make the information documented and maintained under this Paragraph available to the Director or the general public pursuant to the requirements in 40 CFR 70.4(b)(3)(viii).

(v) The reference to the Code of Federal Regulations (CFR) in this Rule are incorporated by reference unless a specific reference states otherwise. The version of the Code of Federal Regulations incorporated in this Rule is that as of June 13, 2007 except those provisions noticed as stayed in 69 FR 40274, and does not include any subsequent amendments or editions to the referenced material.

History Note: *Authority G.S. 143-215.3(a)(1); 143-215.107(a)(3); 143-215.107(a)(5); 143-215.107(a)(7); 143-215.108(b); 150B-21.6;*
Eff. June 1, 1981;
Amended Eff. December 1, 1992; August 1, 1991;

Temporary Amendment Eff. March 8, 1994, for a period of 180 days or until the permanent rule is effective, whichever is sooner;
Amended Eff. May 1, 2008; July 28, 2006; July 1, 1997; February 1, 1995; July 1, 1994.

15A NCAC 02D .0531 SOURCES IN NONATTAINMENT AREAS

(a) For the purpose of this Rule the definitions contained in 40 CFR 51.165(a)(1) and 40 CFR 51.301 shall apply except the definition of "baseline actual emissions."

(1) "Baseline actual emissions" means the rate of emissions, in tons per year, of a regulated new source review (NSR) pollutant, as determined in accordance with Parts (A) through (C) of this Subparagraph:

(A) For an existing emissions unit, baseline actual emissions means the average rate, in tons per year, at which the emissions unit actually emitted the pollutant during any consecutive 24-month period selected by the owner or operator within the 5-year period immediately preceding the date that a complete permit application is received by the Division for a permit required under this Rule. The Director shall allow a different time period, not to exceed 10 years immediately preceding the date that a complete permit application is received by the Division, if the owner or operator demonstrates that it is more representative of normal source operation. For the purpose of determining baseline actual emissions, the following shall apply:

(i) The average rate shall include fugitive emissions to the extent quantifiable, and emissions associated with startups, shutdowns, and malfunctions.

(ii) The average rate shall be adjusted downward to exclude any non-compliant emissions that occurred while the source was operating above any emission limitation that was legally enforceable during the consecutive 24-month period.

(iii) For an existing emission unit (other than an electric utility steam generating unit), the average rate shall be adjusted downward to exclude any emissions that would have exceeded an emission limitation with which the major stationary source must currently comply. However, if the State has taken credit in an attainment demonstration or maintenance plan consistent with the requirements of 40 CFR 51.165(a)(3)(ii)(G) for an emission limitation that is part of a maximum achievable control technology standard that the Administrator proposed or promulgated under part 63 of the Code of Federal Regulations, the baseline actual emissions shall be adjusted to account for such emission reductions.

(iv) For an electric utility steam generating unit, the average rate shall be adjusted downward to reflect any emissions reductions under G.S. 143-215.107D and for which cost recovery is sought pursuant to G.S. 62-133.6.

(v) For a regulated NSR pollutant, when a project involves multiple emissions units, only one consecutive 24-month period shall be used to determine the baseline actual emissions for all the emissions units being changed. A different consecutive 24-month period for each regulated NSR pollutant.

(vi) The average rate shall not be based on any consecutive 24-month period for which there is inadequate information for determining annual emissions, in tons per year, and for adjusting this amount if required by Subparts (ii) and (iii) of this Part.

(B) For a new emissions unit, the baseline actual emissions for purposes of determining the emissions increase that will result from the initial construction and operation of such unit shall equal zero; and thereafter, for all other purposes, shall equal the unit's potential to emit.

(C) For a plantwide applicability limit (PAL) for a stationary source, the baseline actual emissions shall be calculated for existing emissions units in accordance with the procedures contained in Part (A) of this Subparagraph, and for a new emissions unit in accordance with the procedures contained in Part (B) of this Subparagraph.

(2) In the definition of "net emissions increase," the reasonable period specified in 40 CFR 51.165(a)(1)(vi)(C)(1) shall be seven years.

(b) Redesignation to Attainment. If any county or part of a county to which this Rule applies is later designated in 40 CFR 81.334 as attainment for ozone or carbon monoxide, all sources in that county subject to this Rule before the redesignation date shall continue to comply with this Rule.

(c) Applicability. 40 CFR 51.165(a)(2) is incorporated by reference. This Rule applies to the following areas:

(1) Ozone Nonattainment Areas, to major stationary sources and major modifications of sources of volatile organic compounds or nitrogen oxides for which construction commences after the area in which the source is located is designated according to Part (A) or (B) of this Subparagraph:

(A) areas designated in 40 CFR 81.334 as nonattainment for ozone, or

(B) any of the following areas and in that area only when the Director notices in the North Carolina Register that the area is in violation of the ambient air quality standard for ozone:

(i) Charlotte/Gastonia, consisting of Mecklenburg and Gaston Counties; with the exception allowed under Paragraph (l) of this Rule;

(ii) Greensboro/Winston-Salem/High Point, consisting of Davidson, Forsyth, and Guilford Counties and that part of Davie County bounded by the Yadkin River, Dutchmans Creek, North Carolina Highway 801, Fulton Creek and back to Yadkin River; or

(iii) Raleigh/Durham, consisting of Durham and Wake Counties and Dutchville Township in Granville County.

Violations of the ambient air quality standard for ozone shall be determined according to 40 CFR 50.9.

(2) Carbon Monoxide Nonattainment Areas. This Rule applies to major stationary sources and major modifications of sources of carbon monoxide located in areas designated in 40 CFR 81.334 as nonattainment for carbon monoxide and for which construction commences after the area in which the source is located is listed in 40 CFR 81.334 as nonattainment for carbon monoxide.

(d) This Rule is not applicable to:

(1) complex sources of air pollution regulated only under Section .0800 of this Subchapter and not under any other rule in this Subchapter;

(2) emission of pollutants at the new major stationary source or major modification located in the nonattainment area that are pollutants other than the pollutant or pollutants for which the area is nonattainment. (A major stationary source or major modification that is major for volatile organic compounds or nitrogen oxides is also major for ozone.);

(3) emission of pollutants for which the source or modification is not major;

(4) a new source or modification that qualifies for exemption under the provision of 40 CFR 51.165(a)(4); or

(5) emission of compounds listed under 40 CFR 51.100(s) as having been determined to have negligible photochemical reactivity except carbon monoxide.

(e) 15A NCAC 02Q .0102 and .0302 are not applicable to any source to which this Rule applies. The owner or operator of the source shall apply for and receive a permit as required in 15A NCAC 02Q .0300 or .0500.

(f) To issue a permit to a source to which this Rule applies, the Director shall determine that the source meets the following requirements:

(1) The new major stationary source or major modification will emit the nonattainment pollutant at a rate no more than the lowest achievable emission rate;

(2) The owner or operator of the proposed new major stationary source or major modification has demonstrated that all major stationary sources in the State that are owned or operated by this person (or any entity controlling, controlled by, or under common control with this person) are subject to emission limitations and are in compliance, or on a schedule for compliance that is federally enforceable or contained in a court decree, with all applicable emission limitations and standards of this Subchapter that EPA has authority to approve as elements of the North Carolina State Implementation Plan for Air Quality;

(3) The owner or operator of the proposed new major stationary source or major modification will obtain sufficient emission reductions of the nonattainment pollutant from other sources in the nonattainment area so that the emissions from the new major source and associated new minor sources will be less than the emissions reductions by a ratio of at least 1.00 to 1.15 for volatile organic compounds and nitrogen oxides and by a ratio of less than one to one for carbon monoxide. The baseline for this emission offset shall be the actual emissions of the source from which offset credit is obtained. Emission reductions shall not include any reductions resulting from compliance (or scheduled compliance) with applicable rules in effect before the application. The difference between the emissions from the new major source and associated new minor sources of carbon monoxide and the emission reductions shall be sufficient to represent reasonable further progress toward attaining the Ambient Air Quality Standards. The emissions reduction credits shall also conform to the provisions of 40 CFR 51.165(a)(3)(ii)(A) through (G) and (J); and

(4) The North Carolina State Implementation Plan for Air Quality is being carried out for the nonattainment area in which the proposed source is located.

(g) New natural gas-fired electrical utility generating units shall install lowest achievable emission rate technology for NO_X and SO_2.
(h) 40 CFR 51.165(f) is incorporated by reference except that 40 CFR 51.165(f)(10)(iv)(A) is changed to read: "If the emissions level calculated in accordance with Paragraph (f)(6) of this Section is equal to or greater than 80 percent of the PAL level, the Director shall renew the PAL at the same level." 40 CFR 51.165(f)(10)(iv)(B) is not incorporated by reference.
(i) When a particular source or modification becomes a major stationary source or major modification solely by virtue of a relaxation in any enforceable limitation established after August 7, 1980, on the capacity of the source or modification to emit a pollutant, such as a restriction on hours of operation, then the provisions of this Rule shall apply to the source or modification as though construction had not yet begun on the source or modification.
(j) To issue a permit to a source of a nonattainment pollutant, the Director shall determine, in addition to the other requirements of this Rule, that an analysis (produced by the permit applicant) of alternative sites, sizes, production processes, and environmental control techniques for the source demonstrates that the benefits of the source significantly outweigh the environmental and social costs imposed as a result of its location, construction, or modification.
(k) The provisions of 40 CFR 52.21(r)(2) regarding the period of validity of approval to construct are incorporated by reference except that the term "Administrator" is replaced with "Director".
(l) Approval of an application regarding the requirements of this Rule shall not relieve the owner or operator of the responsibility to comply fully with applicable provisions of other rules of this Chapter and any other requirements under local, state, or federal law.
(m) When a source or modification subject to this Rule may affect the visibility of a Class I area named in Paragraph (c) of Rule .0530 of this Section, the following procedures shall be followed:

(1) The owner or operator of the source shall provide an analysis of the impairment to visibility that would occur because of the source or modification and general commercial, industrial and other growth associated with the source or modification;

(2) The Director shall provide written notification to all affected Federal Land Managers within 30 days of receiving the permit application or within 30 days of receiving advance notification of an application. The notification shall be at least 30 days before the publication of the notice for public comment on the application. The notification shall include a copy of all information relevant to the permit application including an analysis provided by the source of the potential impact of the proposed source on visibility;

(3) The Director shall consider any analysis concerning visibility impairment performed by the Federal Land Manager if the analysis is received within 30 days of notification. If the Director finds that the analysis of the Federal Land Manager fails to demonstrate to his satisfaction that an adverse impact on visibility will result in the Class I area, the Director shall provide in the notice of public hearing on the application, an explanation of his decision or notice where the explanation can be obtained;

(4) The Director shall issue permits only to those sources whose emissions will be consistent with making reasonable progress toward the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I areas when the impairment results from manmade air pollution. In making the decision to issue a permit, the Director shall consider the cost of compliance, the time necessary for compliance, the energy and nonair quality environmental impacts of compliance, and the useful life of the source; and

(5) The Director may require monitoring of visibility in or around any Class I area by the proposed new source or modification when the visibility impact analysis indicates possible visibility impairment.

The requirements of this Paragraph shall not apply to nonprofit health or nonprofit educational institutions.
(n) Paragraphs (f) and (j) of this Rule shall not apply to a new major stationary source or a major modification of a source of volatile organic compounds or nitrogen oxides for which construction commences after the area in which the source is located has been designated according to Part (c)(1)(B) of this Rule and before the area is designated in 40 CFR 81.334 as nonattainment for ozone if the owner or operator of the source demonstrates, using the Urban Airshed Model (UAM), that the new source or modification will not contribute to or cause a violation. The model used shall be that maintained by the Division. The Division shall run the model only after the permit application has been submitted. The permit application shall be incomplete until the modeling analysis is completed. The owner or operator of the source shall apply such degree of control and obtain such offsets necessary to demonstrate the new source or modified source will not cause or contribute to a violation.

(o) If the owner or operator of a source is using projected actual emissions to avoid applicability of nonattainment new source review, the owner or operator shall notify the director of the modification before beginning actual construction. The notification shall include:

(1) a description of the project,

(2) identification of sources whose emissions could be affected by the project,

(3) the calculated projected actual emissions and an explanation of how the projected actual emissions were calculated, including identification of emissions excluded by 40 CFR 51.165(a)(1)(xxviii)(B)(3),

(4) the calculated baseline actual emissions and an explanation of how the baseline actual emissions were calculated, and

(5) any netting calculations if applicable.

If upon reviewing the notification, the Director finds that the project will cause a nonattainment new source review evaluation, then the Director shall notify the owner or operator of his findings. The owner or operator shall not make the modification until it has received a permit issued pursuant to this Rule. If a permit revision is not required pursuant to this Rule, the owner or operator shall maintain records of annual emissions in tons per year on a calendar year basis related to the modifications for 10 years following resumption of regular operations after the change if the project involves increasing the emissions unit's design capacity or its potential to emit the regulated NSR pollutant; otherwise these records shall be maintained for five years following resumption of regular operations after the change. The owner or operator shall submit a report to the director within 60 days after the end of each year during which these records must be generated. The report shall contain the items listed in 40 CFR 51.165(a)(6)(v)(A) through (C). The owner or operator shall make the information documented and maintained under this Paragraph available to the Director or the general public pursuant to the requirements in 40 CFR 70.4(b)(3)(viii).

(p) The version of the Code of Federal Regulations incorporated in this Rule is that as of June 13, 2007 except those provisions noticed as stayed in 69 FR 40274, and does not include any subsequent amendments or editions to the referenced material.

History Note: *Authority G.S. 143-215.3(a)(1); 143-215.107(a)(5); 143-215.108(b);*
Eff. June 1, 1981;
Amended Eff. December 1, 1993; December 1, 1992;
Temporary Amendment Eff. March 8, 1994 for a period of 180 days or until the permanent rule is effective, whichever is sooner;
Amended Eff. May 1, 2008; May 1, 2005; July 1, 1998; July 1, 1996; July 1, 1995; July 1, 1994.

15A NCAC 02D .0532 SOURCES CONTRIBUTING TO AN AMBIENT VIOLATION

(a) This Rule applies to new major stationary sources and major modifications to which Rule .0531 of this Section does not apply and which would contribute to a violation of a national ambient air quality standard but which would not cause a new violation.

(b) For the purpose of this Rule the definitions contained in Section II.A. of Appendix S of 40 CFR Part 51 shall apply.

(c) The Rule is not applicable to:

- (1) complex sources of air pollution that are regulated only under Section .0800 of this Subchapter and not under any other rule of this Subchapter;
- (2) emission of pollutants for which the area in which the new or modified source is located is designated as nonattainment;
- (3) emission of pollutants for which the source or modification is not major;
- (4) emission of pollutants other than sulfur dioxide, total suspended particulates, nitrogen oxides, and carbon monoxide;
- (5) a new or modified source whose impact will increase not more than:
  - (A) 1.0 ug/m3of SO2 on an annual basis,
  - (B) 5 ug/m3of SO2 on a 24-hour basis,
  - (C) 25 ug/m3of SO2 on a 3-hour basis,
  - (D) 1.0 ug/m3of total suspended particulates on an annual basis,
  - (E) 5 ug/m3of total suspended particulates on a 24-hour basis,
  - (F) 1.0 ug/m3of NO2 on an annual basis,
  - (G) 0.5 mg/m3of carbon monoxide on an 8-hour basis,
  - (H) 2 mg/m3of carbon monoxide on a one-hour basis,
  - (I) 1.0 ug/m3of PM10 on an annual basis, or
  - (J) 5 ug/m3of PM10 on a 24-hour basis,

at any locality that does not meet a national ambient air quality standard;

- (6) sources which are not major unless secondary emissions are included in calculating the potential to emit;
- (7) sources which are exempted by the provision in Section II.F. of Appendix S of 40 CFR Part 51;
- (8) temporary emission sources which will be relocated within two years; and
- (9) emissions resulting from the construction phase of the source.

(d) 15A NCAC 2Q .0102 and .0302 are not applicable to any source to which this Rule applies. The owner or operator of the source shall apply for and receive a permit as required in 15A NCAC 2Q .0300 or .0500.

(e) To issue a permit to a new or modified source to which this Rule applies, the Director shall determine that the source will meet the following conditions:

- (1) The sources will emit the nonattainment pollutant at a rate no more than the lowest achievable emission rate.
- (2) The owner or operator of the proposed new or modified source has demonstrated that all major stationary sources in the State which are owned or operated by this person (or any entity controlling, controlled by, or under common control with this person) are subject to emission limitations and are in compliance, or on a schedule for compliance which is federally enforceable or contained in a court decree, with all applicable emission limitations and standards of this Subchapter which EPA has authority to approve as elements of the North Carolina State Implementation Plan for Air Quality.
- (3) The source will satisfy one of the following conditions:
  - (A) The source will comply with Subparagraph (e)(3) of Rule .0531 of this Section when the source is evaluated as if it were in the nonattainment area; or
  - (B) The source will have an air quality offset, i.e., the applicant will have caused an air quality improvement in the locality where the national ambient air quality standard is not met by causing reductions in impacts of other sources greater than any additional impact caused by the source for which the application is being made. The emissions reductions creating the air quality offset shall be placed as a condition in the permit for the source reducing emissions. The requirements of this Part may be partially waived if the source is a resource recovery facility burning municipal solid waste, the source must switch fuels due to lack of adequate fuel supplies, or the source is required to be modified as a result of EPA regulations and no exemption from such regulations is available and if:
    - (i) the permit applicant demonstrates that it made its best efforts to obtain sufficient air quality offsets to comply with this Part;

(ii) the applicant has secured all available air quality offsets; and

(iii) the applicant will continue to seek the necessary air quality offsets and apply them when they become available.

(f) At such time that a particular source or modification becomes a major stationary source or major modification solely by virtue of a relaxation in any enforceable limitation established after August 7, 1980, on the capacity of the source or modification to emit a pollutant, such as a restriction on hours of operation, then the provisions of this Rule shall apply to the source or modification as though construction had not yet begun on the source or modification.

(g) The version of the Code of Federal Regulations incorporated in this Rule is that as of January 1, 1989, and does not include any subsequent amendments or editions to the referenced material.

History Note: *Filed as a Temporary Amendment Eff. March 8, 1994 for a period of 180 days or until the permanent rule becomes effective, whichever is sooner;*
Authority G.S. 143-215.3(a)(1); 143-215.107(a)(5); 143-215.108(b); 150B-21.6;
Eff. June 1, 1981;
Amended Eff. July 1, 1994; December 1, 1993; December 1, 1992; October 1, 1989.

SECTION .1900 - OPEN BURNING

15A NCAC 02D .1901 OPEN BURNING: PURPOSE: SCOPE

(a) Open Burning Prohibited. A person shall not cause, allow, or permit open burning of combustible material except as allowed by Rule .1903 and Rule .1904 of this Section.

(b) Purpose. The purpose of this Section is to control air pollution resulting from the open burning of combustible materials and to protect the air quality in the immediate area of the open burning.

(c) Scope. This Section applies to all operations involving open burning. This Section does not authorize any open burning which is a crime under G.S. 14-136 through G.S. 14-140.1, or affect the authority of the Division of Forest Resources to issue or deny permits for open burning in or adjacent to woodlands as provided in G.S. 113-60.21 through G.S. 113-60.31. This Section does not affect the authority of any local government to regulate open burning through its fire codes or other ordinances. The issuance of any open burning permit by the Division of Forest Resources or any local government does not relieve any person from the necessity of complying with this Section or any other air quality rule.

History Note: *Authority G.S. 143-215.3(a)(1); 143-215.107(a)(5);*
Eff. July 1, 1996;
Amended Eff. July 1, 2007; June 1, 2004.

15A NCAC 02D .1902 DEFINITIONS

For the purpose of this Section, the following definitions apply:

(1) "Air Curtain Burner" means a stationary or portable combustion device that directs a plane of high velocity forced draft air through a manifold head into a pit or container with vertical walls in such a manner as to maintain a curtain of air over the surface of the pit and a recirculating motion of air under the curtain.

(2) "Air Quality Action Day Code 'Orange' or above" means an air quality index greater than 100 as defined in 40 CFR Part 58, Appendix G.

(3) "Air quality forecast area" means for

  (a) Asheville air quality forecast area: Buncombe, Haywood, Henderson, Jackson, Madison, Swain, Transylvania, and Yancey Counties;

  (b) Charlotte air quality forecast area: Cabarrus, Gaston, Iredell South of Interstate 40, Lincoln, Mecklenburg, Rowan, and Union Counties;

  (c) Hickory air quality forecast area: Alexander, Burke, Caldwell, and Catawba Counties;

  (d) Fayetteville air quality forecast area: Cumberland and Harnett Counties;

  (e) Rocky Mount air quality forecast area: Edgecombe and Nash Counties;

  (f) Triad air quality forecast area: Alamance, Caswell, Davidson, Davie, Forsyth, Guilford, Randolph, Rockingham, and Stokes Counties; and

  (g) Triangle air quality forecast area: Chatham, Durham, Franklin, Granville, Johnston, Person, Orange, Vance, and Wake Counties.

(4) "Smoke management plan" means the plan developed following the North Carolina Division of Forest Resources' smoke management program and approved by the North Carolina Division of Forest Resources. The purpose of the smoke management plan is to manage smoke from prescribed burns of public and private forests to minimize the impact of smoke on air quality and visibility.

(5) "Dangerous materials" means explosives or containers used in the holding or transporting of explosives.

(6) "HHCB" means the Health Hazards Control Branch of the Division of Epidemiology.

(7) "Initiated" means start or ignite a fire or reignite or rekindle a fire.

(8) "Land clearing" means the uprooting or clearing of vegetation in connection with construction for buildings; right-of-way maintenance; agricultural, residential, commercial, institutional, or industrial development; mining activities; or the initial clearing of vegetation to enhance property value; but does not include routine maintenance or property clean-up activities.

(9) "Log" means any limb or trunk whose diameter exceeds six inches.

(10) "Nonattainment area" means an area identified in 40 CFR 81.334 as nonattainment.

(11) "Nuisance" means causing physical irritation exacerbating a documented medical condition, visibility impairment, or evidence of soot or ash on property or structure other than the property on which the burning is done.

(12) "Occupied structure" means a building in which people may live or work or one intended for housing farm or other domestic animals.

(13) "Off-site" means any area not on the premises of the land-clearing activities.

(14) "Open burning" means the burning of any matter in such a manner that the products of combustion resulting from the burning are emitted directly into the atmosphere without passing through a stack, chimney, or a permitted air pollution control device.

(15) "Operator" as used in .1904(b)(6) and .1904(b)(2)(D) of this Section, means the person in operational control over the open burning.

(16) "Person" as used in 02D .1901(c), means:

  (a) the person in operational control over the open burning; or

  (b) the landowner or person in possession or control of the land when he has directly or indirectly allowed the open burning or has benefited from it.

(17) "Pile" means a quantity of combustible material assembled together in a mass.

(18) "Public pick-up" means the removal of refuse, yard trimmings, limbs, or other plant material from a residence by a governmental agency, private company contracted by a governmental agency or municipal service.

(19) "Public road" means any road that is part of the State highway system; or any road, street, or right-of-way dedicated or maintained for public use.

(20) "RACM" means regulated asbestos containing material as defined in 40 CFR 61.142.

(21) "Refuse" means any garbage, rubbish, or trade waste.

(22) "Regional Office Supervisor" means the supervisor of personnel of the Division of Air Quality in a regional office of the Department of Environment and Natural Resources.

(23) "Salvageable items" means any product or material that was first discarded or damaged and then all, or part, was saved for future use, and include insulated wire, electric motors, and electric transformers.

(24) "Synthetic material" means man-made material, including tires, asphalt materials such as shingles or asphaltic roofing materials, construction materials, packaging for construction materials, wire, electrical insulation, and treated or coated wood.

(25) "Permanent site" means for an air curtain burner, a place where an air curtain burner is operated for more than nine months.

History Note: *Authority G.S. 143-212; 143-213; 143-215.3(a)(1);*
Eff. July 1, 1996;
Amended Eff. July 1, 2007; December 1, 2005; June 1, 2004; July 1, 1998.

.15A NCAC 02D .1903 OPEN BURNING WITHOUT AN AIR QUALITY PERMIT

(a) All open burning is prohibited except open burning allowed under Paragraph (b) of this Rule or Rule .1904 of this Section. Except as allowed under Paragraphs (b)(3) through (b)(9) of this Rule, open burning shall not be initiated in an air quality forecast area that the Department, or the Forsyth County Environmental Affairs Department for the Triad air quality forecast area, has forecasted to be in an Air Quality Action Day Code "Orange" or above during the time period covered by that forecast.

(b) The following types of open burning are permissible without an air quality permit:

(1) open burning of leaves, tree branches or yard trimmings, excluding logs and stumps, if the following conditions are met:

(A) The material burned originates on the premises of private residences and is burned on those premises;

(B) There are no public pickup services available;

(C) Non-vegetative materials, such as household garbage, lumber, or any other synthetic materials are not burned;

(D) The burning is initiated no earlier than 8:00 a.m. and no additional combustible material is added to the fire between 6:00 p.m. on one day and 8:00 a.m. on the following day;

(E) The burning does not create a nuisance; and

(F) Material is not burned when the Division of Forest Resources has banned burning for that area.

(2) open burning for land clearing or right-of-way maintenance if the following conditions are met:

(A) The wind direction at the time that the burning is initiated and the wind direction as forecasted by the National Weather Service at the time that the burning is initiated are away from any area, including public roads within 250 feet of the burning as measured from the edge of the pavement or other roadway surface, which may be affected by smoke, ash, or other air pollutants from the burning;

(B) The location of the burning is at least 1,000 feet from any dwelling, group of dwellings, or commercial or institutional establishment, or other occupied structure not located on the property on which the burning is conducted. The regional office supervisor may grant exceptions to the setback requirements if:

(i) a signed, written statement waiving objections to the open burning associated with the land clearing operation is obtained and submitted to, and the exception granted by, the regional office supervisor before the burning begins from a resident or an owner of each dwelling, commercial or institutional establishment, or other occupied structure within 1,000 feet of the open burning site. In the case of a lease or rental agreement, the lessee or renter shall be the person from whom permission shall be gained prior to any burning; or

(ii) an air curtain burner that complies with Rule .1904 of this Section, is utilized at the open burning site.

Factors that the regional supervisor shall consider in deciding to grant the exception include all the persons who need to sign the statement waiving the objection have signed it, the location of the burn, and the type, amount, and nature of the combustible substances. The regional supervisor shall not grant a waiver if a college, school, licensed day care, hospital, licensed rest home, or other similar institution is less than 1000 feet from the proposed burn site when such institution is occupied.

(C) Only land cleared plant growth is burned. Heavy oils, asphaltic materials such as shingles and other roofing materials, items containing natural or synthetic rubber, or any materials other than plant growth shall not be burned; however, kerosene, distillate oil, or diesel fuel may be used to start the fire;

(D) Initial burning begins only between the hours of 8:00 a.m. and 6:00 p.m., and no combustible material is added to the fire between 6:00 p.m. on one day and 8:00 a.m. on the following day;

(E) No fires are initiated or vegetation added to existing fires when the Division of Forest Resources has banned burning for that area; and

(F) Materials are not carried off-site or transported over public roads for open burning unless the materials are carried off-site or transported over public roads to facilities permitted according to Rule .1904 of this Section for the operation of an air curtain burner at a permanent site;

(3) camp fires and fires used solely for outdoor cooking and other recreational purposes, or for ceremonial occasions, or for human warmth and comfort and which do not create a nuisance and do not use synthetic materials or refuse or salvageable materials for fuel;

(4) fires purposely set to public or private forest land for forest management practices for which burning is acceptable to the Division of Forest Resources and which follows the smoke management plan as outlined in the Division of Forest Resources' smoke management program;

(5) fires purposely set to agricultural lands for disease and pest control and fires set for other agricultural or apicultural practices for which burning is currently acceptable to the Department of Agriculture;

(6) fires purposely set for wildlife management practices for which burning is currently acceptable to the Wildlife Resource Commission;

(7) fires for the disposal of dangerous materials when it is the safest and most practical method of disposal;

(8) fires purposely set by manufacturers of fire extinguishing materials or equipment, testing laboratories, or other persons, for the purpose of testing or developing these materials or equipment in accordance with a standard qualification program;

(9) fires purposely set for the instruction and training of fire-fighting personnel at permanent fire-fighting training facilities;

(10) fires purposely set for the instruction and training of fire-fighting personnel when conducted under the supervision of or with the cooperation of one or more of the following agencies:

(A) the Division of Forest Resources;

(B) the North Carolina Insurance Department;

(C) North Carolina technical institutes; or

(D) North Carolina community colleges, including:

(i) the North Carolina Fire College; or

(ii) the North Carolina Rescue College;

(11) fires not described in Subparagraphs (9) or (10) of this Paragraph, purposely set for the instruction and training of fire-fighting personnel, provided that:

(A) The regional office supervisor of the appropriate regional office and the HHCB have been notified according to the procedures and deadlines contained in the appropriate regional notification form. This form may be obtained by writing the appropriate regional office at the address in Rule .1905 of this Section and requesting it, and

(B) The regional office supervisor has granted permission for the burning. Factors that the regional office supervisor shall consider in granting permission for the burning include type, amount, and nature of combustible substances. The regional office supervisor shall not grant permission for the burning of salvageable items, such as insulated wire and electric motors or if the primary purpose of the fire is to dispose of synthetic materials or refuse. The regional office supervisor of the appropriate regional office shall not consider previously demolished structures as having training value. However, the regional office supervisor of the appropriate regional office may allow an exercise involving the burning of motor vehicles burned over a period of time by a training unit or by several related training units. Any deviations from the dates and times of exercises, including additions, postponements, and deletions, submitted in the schedule in the approved plan shall be communicated verbally to the regional office supervisor of the appropriate regional office at least one hour before the burn is scheduled; and

(12) fires for the disposal of material generated as a result of a natural disaster, such as tornado, hurricane, or flood, if the regional office supervisor grants permission for the burning. The person desiring to do the burning shall document and provide written notification to the regional office supervisor of the appropriate regional office that there is no other practical method of disposal of the waste. Factors that the regional office supervisor shall consider in granting permission for the burning include type, amount, location of the burning, and nature of combustible substances. The regional office supervisor shall not grant permission for the burning if the primary purpose of the fire is to dispose of synthetic

materials or refuse or recovery of salvageable materials. Fires authorized under this Subparagraph shall comply with the conditions of Subparagraph (b)(2) of this Rule.

(c) The authority to conduct open burning under this Section does not exempt or excuse any person from the consequences, damages or injuries that may result from this conduct. It does not excuse or exempt any person from complying with all applicable laws, ordinances, rules or orders of any other governmental entity having jurisdiction even though the open burning is conducted in compliance with this Section.

History Note: *Authority G.S. 143-215.3(a)(1); 143-215.107(a)(5);*
Eff. July 1, 1996;
Amended Eff. July 1, 2007; December 1, 2005; June 1, 2004; July 1, 1998.

15A NCAC 02D .1904 AIR CURTAIN BURNERS

(a) Air quality permits are required for air curtain burners subject to 40 CFR 60.2245 through 60.2265, 60.2810 through 60.2870, 60.2970 through 60.2975, or 60.3062 through 60.3069 or located at permanent sites or where materials are transported in from another site. Air quality permits are not required for air curtain burners located at temporary land clearing or right-of-way maintenance sites for less than nine months unless they are subject to 40 CFR 60.2245 through 60.2265, 60.2810 through 60.2870, 60.2970 through 60.2975, or 60.3062 through 60.3069. The operation of air curtain burners in particulate and ozone nonattainment areas shall cease in any area that has been forecasted by the Department, or the Forsyth County Environmental Affairs Department for the Triad air quality forecast area, to be in an Air Quality Action Day Code "Orange" or above during the time period covered by that forecast.

(b) Air curtain burners shall comply with the following conditions and stipulations:

(1) The wind direction at the time that the burning is initiated and the wind direction as forecasted by the National Weather Service during the time of the burning shall be away from any area, including public roads within 250 feet of the burning as measured from the edge of the pavement or other roadway surface, which may be affected by smoke, ash, or other air pollutants from the burning;

(2) Only collected land clearing and yard waste materials may be burned. Heavy oils, asphaltic materials, items containing natural or synthetic rubber, tires, grass clippings, collected leaves, paper products, plastics, general trash, garbage, or any materials containing painted or treated wood materials shall not be burned. Leaves still on trees or brush may be burned;

(3) No fires shall be started or material added to existing fires when the Division of Forest Resources has banned burning for that area;

(4) Burning shall be conducted only between the hours of 8:00 a.m. and 6:00 p.m.;

(5) The air curtain burner shall not be operated more than the maximum source operating hours-per-day and days-per-week. The maximum source operating hours-per-day and days-per-week shall be set to protect the ambient air quality standard and prevention of significant deterioration (PSD) increment for particulate. The maximum source operating hours-per-day and days-per-week shall be determined using the modeling procedures in Rule .1106(b), (c), and (f) of this Subchapter. This Subparagraph shall not apply to temporary air curtain burners;

(6) An air curtain burner with an air quality permit shall have onsite at all times during operation of the burner a visible emissions reader certified according to 40 CFR Part 60, Method 9 to read visible emissions, and the facility shall test for visible emissions within five days after initial operation and within 90 days before permit expiration;

(7) Air curtain burners shall meet manufacturer's specifications for operation and upkeep to ensure complete burning of material charged into the pit. Manufacturer's specifications shall be kept on site and be available for inspection by Division staff;

(8) Except during start-up, visible emissions shall not exceed ten percent opacity when averaged over a six-minute period except that one six-minute period with an average opacity of more than ten percent but no more than 35 percent shall be allowed for any one-hour period. During start-up, the visible emissions shall not exceed 35 percent opacity when averaged over a six-minute period. Start-up shall not last for more than 45 minutes, and there shall be no more than one start-up per day. Instead of complying with the opacity standards in this Subparagraph, air curtain burners subject to:

   (A) 40 CFR 60.2245 through 60.2265 shall comply with the opacity standards in 40 CFR 60.2250;

   (B) 40 CFR 60.2810 through 60.2870 shall comply with the opacity standards in 40 CFR 60.2860;

   (C) 40 CFR 60.2970 through 60.2975 shall comply with the opacity standards in 40 CFR 60.2971; or

   (D) 40 CFR 60.3062 through 60.3069 shall comply with the opacity standards in 40 CFR 60.3066;

(9) The owner or operator of an air curtain burner shall not allow ash to build up in the pit to a depth higher than one-third of the depth of the pit or to the point where the ash begins to impede combustion, whichever occurs first. The owner or operator of an air curtain burner shall allow the ashes to cool and water the ash prior to its removal to prevent the ash from becoming airborne;

(10) The owner or operator of an air curtain burner shall not load material into the air curtain burner such that it will protrude above the air curtain;

(11) Only distillate oil, kerosene, diesel fuel, natural gas, or liquefied petroleum gas may be used to start the fire; and

(12) The location of the burning shall be at least 500 feet from any dwelling, group of dwellings, or commercial or institutional establishment, or other occupied structure not located on the property on which the burning is conducted. The regional office supervisor may grant exceptions to the setback requirements if a signed, written statement waiving objections to the air curtain burning is obtained from a resident or an owner of each dwelling, commercial or institutional establishment, or other occupied structure within 500 feet of the burning site. In case of a lease or rental agreement, the lessee or renter, and the property owner shall sign the statement waiving objections to the burning. The statement shall be submitted to and approved by the regional office supervisor before initiation of the burn. Factors that the regional supervisor shall consider in deciding to grant the exception include: all the persons who need to sign the statement waiving the objection have signed it; the location of the burn; and the type, amount, and nature of the combustible substances.

Compliance with this Rule does not relieve any owner or operator of an air curtain burner from the necessity of complying with other rules in this Section or any other air quality rules.

(c) Recordkeeping Requirements. The owner or operator of an air curtain burner at a permanent site shall keep a daily log of specific materials burned and amounts of material burned in pounds per hour and tons per year. The logs at a permanent air curtain burner site shall be maintained on site for a minimum of two years and shall be available at all times for inspection by the Division of Air Quality. The owner or operator of an air curtain burner at a temporary site shall keep a log of total number of tons burned per temporary site. Additionally, the owner or operator of air curtain burner subject to:

(1) 40 CFR 60.2245 through 60.2265 shall comply with the monitoring, recordkeeping, and reporting requirements in 40 CFR 60.2245 through 60.2265;

(2) 40 CFR 60.2810 through 60.2870 shall comply with the monitoring, recordkeeping, and reporting requirements in 40 CFR 60.2810 through 60.2870;

(3) 40 CFR 60.2970 through 60.2975 shall comply with the monitoring, recordkeeping, and reporting requirements in 40 CFR 60.2970 through 60.2975; or

(4) 40 CFR 60.3062 through 60.3069 shall comply with comply with the monitoring, recordkeeping, and reporting requirements in 40 CFR 60.3062 through 60.3069.

(d) Title V Considerations. Burners that have the potential to burn 8,100 tons of material or more per year may be subject to Section 15A NCAC 2Q .0500, Title V Procedures.

(e) Prevention of Significant Deterioration Consideration. Burners that burn 16,200 tons per year or more may be subject to 15A NCAC 02D .0530, Prevention of Significant Deterioration.

(f) A person may use a burner using a different technology or method of operation than an air curtain burner as defined under Rule .1902 of this Section if he demonstrates to the Director that the burner is at least as effective as an air curtain burner in reducing emissions and if the Director approves the use of the burner. The Director shall approve the burner if he finds that it is at least as effective as an air curtain burner. This burner shall comply with all the requirements of this Rule.

(g) In addition to complying with the requirements of this Rule, an air curtain burner subject to:

(1) 40 CFR Part 60, Subpart CCCC that commenced construction after November 30, 1999, or that commenced reconstruction or modification on or after June 1, 2001, shall also comply with 40 CFR 60.2245 through 60.2265, or

(2) 40 CFR Part 60, Subpart EEEE that commenced construction after December 9, 2004, or that commenced reconstruction or modification on or after June 16, 2006, shall also comply with 40 CFR 60.2970 through 60.2975.

History Note: *Authority G.S. 143-215.3(a)(1); 143-215.107(a)(5), (10); 143-215.66; 143-215.108; 40 CFR 60.2865;*
Eff. July 1, 1996;
Amended Eff. July 1, 2007; December 1, 2005; August 1, 2004.

15A NCAC 02D .1905 REGIONAL OFFICE LOCATIONS

Inquiries, requests and plans shall be handled by the appropriate Department of Environment and Natural Resources regional offices. They are:

(1) Asheville Regional Office, 2090 Highway 70, Swannanoa, North Carolina 28778
(2) Winston-Salem Regional Office, 585 Waughtown Street, Winston-Salem, North Carolina 27107;
(3) Mooresville Regional Office, 610 East Center Avenue, Suite 301, Mooresville, North Carolina 28115;
(4) Raleigh Regional Office, 3800 Barrett Drive, Raleigh, North Carolina 27611;
(5) Fayetteville Regional Office, Systel Building, 225 Green Street, Suite 714, Fayetteville, North Carolina 28301;
(6) Washington Regional Office, 943 Washington Square Mall, Washington, North Carolina 27889; and
(7) Wilmington Regional Office, 127 Cardinal Drive Extension, Wilmington, North Carolina 28405.

History Note: Authority G.S. 143-215.3(a)(1);
Eff. July 1, 1996;
Amended Eff. December 1, 2005.

15A NCAC 02D .1906 DELEGATION TO COUNTY GOVERNMENTS

(a) The governing body of any county or municipality or group of counties or municipalities may establish a partial air pollution control program to implement and enforce this Section provided that:

(1) It has the administrative organization, staff, financial and other resources necessary to carry out such a program;

(2) It has adopted appropriate ordinances, resolutions, and regulations to establish and maintain such a program; and

(3) It has otherwise complied with G.S. 143-215.112 "Local Air Pollution Control Programs."

(b) The governing body shall submit to the Director documentation demonstrating that the requirements of Paragraph (a) of this Rule have been met. Within 90 days after receiving the submittal from the governing body, the Director shall review the documentation to determine if the requirements of Paragraph (a) of this Rule have been met and shall present his findings to the Commission. If the Commission determines that the air pollution program is adequate, it shall certify the local air pollution program to implement and enforce this Section within its area of jurisdiction.

(c) County and municipal governments shall not have the authority to issue permits for air curtain burners at a permanent site as defined in 15A NCAC 02D .1904.

(d) The three certified local air pollution programs, the Western North Carolina Regional Air Quality Control Agency, the Forsyth County Environmental Affairs Department, and Mecklenburg County Air Quality, a Division of Land Use and Environmental Services Agency, shall continue to enforce open burning rules as part of their local air pollution programs.

History Note: *Authority G.S. 143-215.3(a)(1); 143-215.112;*
Eff. July 1, 1996;
Amended Eff. December 1, 2005; June 1, 2004.

15A NCAC 02D .1907 MULTIPLE VIOLATIONS ARISING FROM A SINGLE EPISODE

(a) Multiple violations arising from a single episode of open burning may result in multiple civil penalties. Factors the Director shall consider in determining the number of violations per episode of open burning include:

(1) the type of material burned,
(2) the amount of material burned,
(3) the location of the burn, and
(4) any other factor relevant to air pollution control or air quality.

(b) Each pile of land clearing or road maintenance debris that does not comply with the specifications of 15A NCAC 02D .1903(b)(2) shall constitute a separate violation.

History Note: Authority G.S. 143-215.3(a)(1); 143-215.107(a)(5);
Eff. July 1, 2007.

SECTION .2400 – CLEAN AIR INTERSTATE RULES

15A NCAC 02D .2401 PURPOSE AND APPLICABILITY

(a) Purpose. The purpose of this Section is to implement the federal Clean Air Interstate Rule and thereby reduce the interstate transportation of fine particulate matter and ozone.

(b) Applicability. This Section applies to the following, which are CAIR NOx units, CAIR SO2 units, and CAIR NOx Ozone Season units to the extent they are subject to the NOx annual trading program, SO2 trading program, and NOx ozone season trading program, respectively, in this Section:

(1) any stationary, fossil-fuel-fired boiler or stationary, fossil-fuel-fired combustion turbine serving at any time, since the later of November 15, 1990 or the start-up of a unit's combustion chamber, a generator with nameplate capacity of more than 25 MWe producing electricity for sale, provided that if a stationary boiler or stationary combustion turbine that does not meet these requirements begins to combust fossil fuel or to serve a generator with nameplate capacity of more than 25 MWe producing electricity for sale, the unit shall become subject to this Section under this Subparagraph on the first date on which the unit both combusts fossil fuel and serves such generator;

(2) notwithstanding Subparagraph (b)(1) of this Rule, a unit that meets the requirements in 40 CFR 96.104(b)(1)(i), (b)(2)(i), or (b)(2)(ii), 96.204(b)(1)(i), (b)(2)(i), or (b)(2)(ii), 96.304(b)(1)(i), (b)(2)(i), or (b)(2)(ii), shall not be subject to this Section under this Subparagraph and shall become subject to this Section under this Subparagraph as provided in 40 CFR 96.104(b)(1)(ii) or (b)(2)(iii), 96.204(b)(1)(ii) or (b)(2)(iii), or 96.304(b)(1)(ii) or (b)(2)(iii);

(3) solely for the purposes of the NOx ozone season trading program, fossil fuel-fired stationary boilers, combustion turbines, or combined cycle systems having a maximum design heat input greater than 250 million Btu per hour except stationary combustion turbines constructed before January 1, 1979, that have a federally enforceable permit that restricts:

  (A) its potential emissions of nitrogen oxides to no more than 25 tons between May 1 and September 30;

  (B) it to burning only natural gas or oil; and

  (C) its hours of operation as described in 40 CFR 96.4(b)(1)(ii) and (iii); or

(4) solely for the purposes of the NOx ozone season trading program, fossil-fuel fired stationary boilers, combustion turbines, or combined cycle systems serving a generator with a nameplate capacity greater than 25 MW electrical and selling any amount of electricity.

(c) Retired unit exemption. Any unit that is permanently retired and is not an opt-in unit under Rule .2411 of this Section shall be exempted from the annual trading program for:

(1) nitrogen oxides if it complies with the provisions of 40 CFR 96.105,

(2) sulfur dioxide if it complies with the provisions of 40 CFR 96.205, or

(3) ozone season nitrogen oxides if it complies with the provisions of 40 CFR 96.305.

(d) Effect on other authorities. No provision of this Section, any application submitted or any permit issued pursuant to Rule .2406 of this Section, or any exemption under 40 CFR 96.105, 96.205, or 96.305 shall be construed as exempting any source or facility covered under this Section or the owner or operator or designated representative of any source or facility covered under this Section from complying with any other requirements of this Subchapter or Subchapter 15A NCAC 02Q or the Clean Air Act. The Environmental Management Commission may specify through rulemaking a specific emission limit lower than that established under this Rule for a specific source if compliance with the lower emission limit is required to attain or maintain the ambient air quality standard for ozone or fine particulate (PM2.5) or any other ambient air quality standard in Section 15A NCAC 02D .0400.

History Note: Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2402 DEFINITIONS

(a) For the purpose of this Section, the definitions in 40 CFR 96.102, 96.202 and 96.302 shall apply except that solely for the purposes of units subject to Rule .2401(b)(3), .2401(b)(4), or .2405(a)(2) of this Section, the term "fossil-fuel-fired" means:

(1) sources that began operation before January 1, 1996, where fossil fuel actually combusted either alone or in combination with any other fuel, comprised more than 50 percent of the annual heat input on a Btu basis during 1995, or, if a source had no heat input in 1995, during the last year of operation of the unit before 1995;

(2) sources that began operation on or after January 1, 1996 and before January 1, 1997, where fossil fuel actually combusted either alone or in combination with any other fuel, comprised more than 50 percent of the annual heat input on a Btu basis during 1996; or

(3) sources that began operation on or after January 1, 1997;

   (A) Where fossil fuel actually combusted either alone or in combination with any other fuel, comprised more than 50 percent of the annual heat input on a Btu basis during any year as determined by the owner or operator of the source and verified by the Director; or

   (B) Where fossil fuel combusted either alone or in combination with any other fuel, is projected to comprise more than 50 percent of the annual heat input on a Btu basis during any year, provided that the unit shall be "fossil-fuel-fired" as of the date, during such year, on which the source begins combusting fossil fuel.

(b) Notwithstanding the provisions of the definition of "commence commercial operation" in 40 CFR 96.302, for a unit under Rules .2401(b)(3), .2401(b)(4) or .2405(a)(2) of this Section, and not serving a generator producing electricity for sale, the unit's date of commencement of operation shall also be the unit's date of commencement of commercial operation.

(c) Notwithstanding the provisions of the definition of "commence operation" in 40 CFR 96.302, and solely for the purposes of 40 CFR Part 96 Subpart HHHH, for a unit that is not a CAIR NOx Ozone Season unit, under Rules .2401(b)(3), .2401(b)(4), or .2405(a)(2) of this Section on the later of November 15, 1990 or the date the unit commenced or commences operation as defined in the first provision of this definition in 40 CFR 96.302 and that subsequently becomes or became such a CAIR NOx Ozone Season unit, the unit's date for commencement of operation shall be the date on which the unit becomes or became a CAIR NOx Ozone Season unit under Rule .2401(b)(3), .2401(b)(4), or .2405(a)(2) of this Section. For a unit with a date of commencement of operation as defined in the first sentence of this Subparagraph and that subsequently undergoes a physical change (other than replacement of the unit by a unit at the same source), such date shall remain the date of commencement of operation of the unit, which shall continue to be treated as the same unit. For a unit with a date of commencement of operation as defined in the first sentence of this Paragraph and that subsequently is replaced by a unit at the same source (e.g., repowered), such date shall remain the replaced unit's date of commencement of operation, and the replacement unit shall be treated as a separate unit with a separate date for commencement of operation as defined in this Paragraph.

(d) For the purposes of this Section, the following definitions apply:

(1) "Modification" means modification as defined in 15A NCAC 02D .0101.

(2) "Reconstruction" means the replacement of components of an existing unit that meets the requirements of 40 CFR 60.15(b)(1).

(3) "Replacement" means, solely for the purposes of Rules .2403 and .2405 of this Section, removing an existing unit and putting in its place at the same facility a functionally equivalent new unit.

(e) For the purpose of this Section, the abbreviations and acronyms listed in 40 CFR 96.103, 96.203, 96.303 shall apply.

History Note: Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2403 NITROGEN OXIDE EMISSIONS

(a) Allocations. The annual allocations of nitrogen oxide allowances are:

FACILITY	ALLOCATIONS FOR 2009-2014 (TONS)	ALLOCATIONS FOR 2015 AND LATER (TONS)
Craven County Wood Energy, LP	498	424
Duke Energy, Belews Creek	10,837	9,220
Duke Energy, Buck	1,355	1,153
Duke Energy, Cliffside	2,932	2,495
Duke Energy, Dan River	792	674
Duke Energy, G.G. Allen	4,338	3,691
Duke Energy, Lincoln	230	196
Duke Energy, Marshall	9,667	8,225
Duke Energy, Riverbend	1,709	1,454
Dynegy-Rockingham Power	194	165
Edgecombe GenCo	807	687
Elizabethtown Power	86	73
Lumberton Power	121	103
Primary Energy, Roxboro	164	140
Primary Energy, Southport	401	341
Progress Energy, Asheville	2,103	1,789
Progress Energy, Blewett	8	7
Progress Energy, Cape Fear	1,244	1,059
Progress Energy, Lee	1870	1591
Progress Energy, L.V. Sutton	2,146	1,826
Progress Energy, Mark's Creek Richmond Co.	374	318
Progress Energy, Mayo	4,004	3,407
Progress Energy, Roxboro	11,578	9,851
Progress Energy, Weatherspoon	674	573
PWC-Butler Warner Generation Plant	77	65
Rosemary Power Station, Halifax	42	36
Southern Power Company Plant Rowan County	25	22
Westmoreland Partners, LLC, Roanoke Valley Energy Facility	1269	1080

In the event that EPA determines that Craven County Wood Energy is not subject to the provisions of this Section, its allocation shall go to the new source growth pool.

(b) Compliance. The emissions of nitrogen oxides of a CAIR NOx source shall not exceed the number of allowances that it has in its compliance account established and administered under Rule .2408 of this Section.

(c) Emission measurement requirements. The emissions measurements recorded and reported according to 40 CFR Part 96 Subpart HH shall be used to determine compliance by each CAIR NOx source with its emissions limitation according to 40 CFR 96.106(c) including 96.106(c)(5) and (6).

(d) Excess emission requirements. The provisions of 40 CFR 96.106(d) shall be used for excess emissions.

(e) Liability. The owner or operator of any unit or source covered under this Section shall be subject to the provisions of 40 CFR 96.106(f).

(f) Modification and reconstruction, replacement, retirement, or change of ownership. The modification or reconstruction of a CAIR NOx unit shall not make that CAIR NOx unit a "new" CAIR NOx unit under Rule .2412 of this Section. The

CAIR NOx unit that is modified or reconstructed shall not change the emission allocation under Paragraph (a) of this Rule. If one or more CAIR NOx units at a facility covered under this Rule is replaced, the new CAIR NOx unit shall not receive an allocation under Rule .2412 of this Section, nor shall it change the allocation of the facility. If the owner of a facility changes, the emission allocations under this Rule and revised emission allocations made under Rule .2413 of this Section shall remain with the facility. If a CAIR NOx unit is retired, the owner or operator and the designated representatives of the CAIR NOx unit shall follow the procedures in 40 CFR 96.105. The allocations of a retired CAIR NOx unit shall remain with the owner or operator of the retired CAIR NOx unit until a reallocation occurs under Rule .2413 of this Section when the allocation shall be removed and given to other CAIR NOx units if the retired CAIR NOx unit is still retired using the procedure in Rule .2413 of this Section.

History Note: *Authority G.S. 143-215.3(a); 143-215.65; 143-215.66; 143-215.107(a)(5), (10);*
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2404 SULFUR DIOXIDE

(a) Applicability. This Rule applies only to units that meet the description in Rule .2401(b)(1) or (2) of this Section.

(b) Allocations. The annual allocation of sulfur dioxide allowances shall be determined by EPA. The allocations for CAIR SO_2 units are in 40 CFR 73.10.

(c) Compliance. The emissions of sulfur dioxides of a source described in Paragraph (a) of this Rule shall not exceed the number of allowances that it has in its compliance account established and administered under Rule .2408 of this Section.

(d) Emission measurement requirements. The emissions measurements recorded and reported according to 40 CFR Part 96 Subpart HHH shall be used to determine compliance by each CAIR SO_2 source with its emissions limitation according to 40 CFR 96.206(c) including 96.206(c)(5) and (6).

(e) Excess emission requirements. The provisions of 40 CFR 96.206(d) shall be used for excess emissions.

(f) Liability. The owner or operator of any unit or source covered under this Section shall be subject to the provisions of 40 CFR 96.206(f).

History Note: *Authority G.S. 143-215.3(a); 143-215.65; 143-215.66; 143-215.107(a)(5), (10);*
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2405 NITROGEN OXIDE EMISSIONS DURING OZONE SEASON

(a) Allocations. The ozone season allocations of nitrogen oxide allowances are:

(1) Facilities that meet the description in Rule .2401(b)(1) or (b)(2) of this Section.

FACILITY	ALLOCATIONS FOR 2009-2014 (TONS)	ALLOCATIONS FOR 2015 AND LATER (TONS)
Craven County Wood Energy, LP	211	179
Duke Energy, Belews Creek	4,917	4,184
Duke Energy, Buck	656	558
Duke Energy, Cliffside	1,350	1,148
Duke Energy, Dan River	436	371
Duke Energy, G.G. Allen	2,096	1,784
Duke Energy, Lincoln	169	144
Duke Energy, Marshall	4,179	3,556
Duke Energy, Riverbend	859	731
Dynegy-Rockingham Power	99	84
Edgecombe GenCo	331	281
Elizabethtown Power	51	43
Lumberton Power	46	39
Primary Energy, Roxboro	83	71
Primary Energy, Southport	213	181
Progress Energy, Asheville	899	765
Progress Energy, Blewett	7	6
Progress Energy, Cape Fear	527	448
Progress Energy, Lee	905	770
Progress Energy, L.V. Sutton	1,023	871
Progress Energy, Mark's Creek Richmond Co.	335	285
Progress Energy, Mayo	1,735	1,476
Progress Energy, Roxboro	5,069	4,314
Progress Energy, Weatherspoon	346	295
PWC-Fayetteville	53	45
Rosemary Power Station, Halifax	26	22
Southern Power Company Plant Rowan County	25	20
Westmoreland Partners, LLC, Roanoke Valley Energy Facility	511	434

In the event that EPA determines that Craven County Wood Energy is not subject to the provisions of this Section, its allocation shall go to the new source growth pool.

(2) Facilities that meet the description in Rule .2401(b)(3) or (b)(4) of this Section.

FACILITY	ALLOCATON FOR 2009-2014 (TONS)	ALLOCATIONS FOR 2015 AND LATER (TONS)
Blue Ridge Paper Products	839	839

FACILITY	ALLOCATON FOR 2009-2014 (TONS)	ALLOCATIONS FOR 2015 AND LATER (TONS)
International Paper Corp., Columbus Co.	307	307
Kapstone Kraft Paper corporation	346	346
Coastal Carolina Clean Power, LLC	113	113
UNC-Chapel Hill	241	241
Weyerhaeuser, New Bern Mill	193	193
Domtar Paper Co.	404	404

(b) Ozone season defined. The ozone season is from May 1 through September 30 of each year.
(c) Change in status. If a unit at a facility named in Subparagraph (a)(2) of this Rule meets the description under Subparagraphs (b)(1) or (b)(2) of Rule .2401 of this Section, it shall lose its allocation under Subparagraph (a)(2) of this Rule and shall receive an allocation under Rule .2412 of this Section as a new unit until it receives an allocation under Rule .2413 of this Section.
(d) Compliance. The nitrogen oxide ozone season emissions of a CAIR NOx Ozone Season source shall not exceed the number of allowances that it has in its compliance account established and administered under Rule .2408 of this Section. For purposes of making deductions for excess emissions for the ozone season in 2008 under the NOx SIP Call (Section 15A NCAC 02D .1400), the Administrator shall deduct allowances allocated under this Rule for the ozone season in 2009.
(e) Emission measurement requirements. The emissions measurements recorded and reported according to 40 CFR Part 96 Subpart HHHH shall be used to determine compliance by each CAIR NOx Ozone Season source with its emissions limitation according to 40 CFR 96.306(c) including 96.306(c)(5) and (6).
(f) Excess emission requirements. The provisions of 40 CFR 96.306(d) shall be used for excess emissions.
(g) Liability. The owner or operator of any unit or source covered under this Section shall be subject to the provisions of 40 CFR 96.306(f).
(h) Modification and reconstruction, replacement, retirement, or change of ownership. The modification or reconstruction of a CAIR NOx Ozone Season unit shall not make that CAIR NOx Ozone Season unit a "new" CAIR NOx Ozone Season unit under Rule .2412. The CAIR NOx Ozone Season unit that is modified or reconstructed shall not change the emission allocation under Paragraph (a) of this Rule. If one or more CAIR NOx Ozone Season units at a facility is replaced, the new CAIR NOx Ozone Season unit shall not receive an allocation under Rule .2412 of this Section, nor shall it change the allocation of the facility. If the owner of a facility changes, the emission allocations under this Rule and revised emission allocations made under Rule .2413 of this Section shall remain with the facility. If a CAIR NOx Ozone Season unit is retired, the owner or operator, and designated representatives, of the CAIR NOx Ozone Season unit shall follow the procedures in 40 CFR 96.305. The allocations of a retired CAIR NOx Ozone Season unit shall remain with the owner or operator of the retired CAIR NOx Ozone Season unit until a reallocation occurs under Rule .2413 of this Section when the allocation shall be removed and given to other CAIR NOx Ozone Season units if the retired CAIR NOx Ozone Season unit is still retired using the procedure in Rule .2413 of this Section.

History Note: *Authority G.S. 143-215.3(a); 143-215.65; 143-215.66; 143-215.107(a)(5), (10);*
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2406 PERMITTING

(a) The owner or operator of any source covered under this Section shall submit permit applications to comply with the requirements of this Section following the procedures and requirements in 15A NCAC 02Q .0500 (Title V permitting procedures) and in:

(1) 40 CFR 96.106(a), 96.121, and 96.122 for each CAIR NOx source;
(2) 40 CFR 96.206(a), 96.221, and 96.222 for each CAIR SO_2 source; and
(3) 40 CFR 96.306(a), 96.321, and 96.322 for each CAIR NOx Ozone Season source.

(b) The Director shall review applications submitted under Paragraph (a) of this Rule and issue permits for compliance with this Section following the procedures and requirements in 15A NCAC 02Q .0500 (Title V permitting procedures) and in:

(1) 40 CFR 96.106(a), 96.120, 96.123, and 96.124 for each CAIR NOx source;
(2) 40 CFR 96.206(a), 96.220, 96.223, and 96.224 for each CAIR SO_2 source; and
(3) 40 CFR 96.306(a), 96.320, 96.323, and 96.324 for each CAIR NOx Ozone Season source.

History Note: Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10); 143-215.108;
Eff. July 1, 2006.

15A NCAC 02D .2407 MONITORING, REPORTING, AND RECORDKEEPING

(a) The owner or operator of a unit covered under this Section shall comply with the monitoring, recordkeeping, and reporting requirements in:

(1) 40 CFR 96.106(b) and (e) and in 40 CFR Part 96, Subpart HH for each CAIR NOx unit;

(2) 40 CFR 96.206(b) and (e) and in 40 CFR Part 96, Subpart HHH for each CAIR SO2 unit; and

(3) 40 CFR 96.306(b) and (e) and in 40 CFR Part 96, Subpart HHHH for each CAIR Ozone Season NOx unit.

(b) To approve or disapprove monitors used to show compliance with Rules .2403, .2404, or .2405 of this Section, the Division shall follow the procedures in:

(1) 40 CFR 96.171 for nitrogen oxides,

(2) 40 CFR 96.271 for sulfur dioxides, and

(3) 40 CFR 96.371 for ozone season nitrogen oxides.

History Note: Authority G.S. 143-215.3(a); 143-215.65; 143-215.66; 143-215.107(a)(5), (10);
Eff. July 1, 2006.

15A NCAC 02D .2408 TRADING PROGRAM AND BANKING

(a) EPA to administer. The United States Environmental Protection Agency (EPA) shall administer the allowance tracking system according to the procedures in:

(1) 40 CFR Part 96, Subpart FF and Subpart GG for nitrogen oxides;
(2) 40 CFR Part 96, Subpart FFF and Subpart GGG for sulfur dioxide; and
(3) 40 CFR Part 96, Subpart FFFF and Subpart GGGG for ozone season nitrogen oxides.

(b) Compliance account. The owners and operators of each source covered under this Section shall have a compliance account in the EPA administered tracking system that satisfies the requirements of:

(1) 40 CFR 96.151 for nitrogen oxides,
(2) 40 CFR 96.251 for sulfur dioxides, and
(3) 40 CFR 96.351 for ozone season nitrogen oxides.

(c) General account. Any person may apply to open a general account to hold and transfer allowances by using the procedures and meeting the requirements in:

(1) 40 CFR 96.151(b) for nitrogen oxides and may close that account using the procedures in 40 CFR 96.157,
(2) 40 CFR 96.251(b) for sulfur dioxides and may close that account using the procedures in 40 CFR 96.257, and
(3) 40 CFR 96.351(b) for ozone season nitrogen oxides and may close that account using the procedures in 40 CFR 96.357.

(d) Allowance transfers.

(1) Any person who has a compliance or general account established under 40 CFR 96.151 may transfer allowances using the procedures in 40 CFR 96.160.
(2) Any person who has a compliance or general account established under 40 CFR 96.251 may transfer allowances using the procedures in 40 CFR 96.260.
(3) Any person who has a compliance or general account established under 40 CFR 96.351 may transfer allowances using the procedures in 40 CFR 96.360.

(e) Submittal of information. Persons with accounts shall submit information to EPA following the requirements of:

(1) 40 CFR 96.152 for nitrogen oxides,
(2) 40 CFR 96.252 for sulfur dioxides, and
(3) 40 CFR 96.352 for ozone season nitrogen oxides.

(f) Banking. Any person who has a compliance account or a general account may bank allowances for future use or transfer under:

(1) 40 CFR 96.155 for nitrogen oxides,
(2) 40 CFR 96.255 for sulfur dioxides, and
(3) 40 CFR 96.355 for ozone season nitrogen oxides.

(g) Appeal Procedures. The appeal procedures for decisions of the Administrator are set forth in

(1) 40 CFR 96.108 for nitrogen oxides,
(2) 40 CFR 96.208 for sulfur dioxides, and
(3) 40 CFR 96.308 for ozone season nitrogen oxides.

History Note: *Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);*
Eff. July 1, 2006.

15A NCAC 02D .2409 DESIGNATED REPRESENTATIVE

(a) Designated representative. The owners and operators of any source covered under this Section shall select a designated representative according to 40 CFR 96.110 for each CAIR NOx source, 96.210 for each CAIR SO_2 source, and 96.310 for each CAIR NOx Ozone Season source. The designated representative shall have the responsibilities and duties set out in 40 CFR 96.110 for a CAIR NOx source, 96.210 for a CAIR SO_2 source, and 96.310 for a CAIR NOx Ozone Season source.

(b) Alternate designated representative. The owners and operators of any source covered under this Section shall select an alternate designated representative according to 40 CFR 96.111 for each CAIR NOx source, 96.211 for each CAIR SO_2 source, and 96.311 for each CAIR NOx Ozone Season source. The alternate designated representative shall have the responsibilities and duties set out in 40 CFR 96.111 for a CAIR NOx source, 96.211 for CAIR SO_2 source, and 96.311 for a CAIR NOx Ozone Season source.

(c) Changing designated representative and alternate designated representative. The owner or operator of any source covered under this Section may change the designated representative or the alternate designated representative using:

(1) 40 CFR 96.112 for a CAIR NOx source;

(2) 40 CFR 96.212 for a CAIR SO_2 source; and

(3) 40 CFR 96.312 for a CAIR NOx Ozone Season source.

(d) A CAIR designated representative or alternative CAIR designated representative may delegate his or her authority to make an electronic submission to the Administrator using:

(1) 40 CFR 96.115 for a CAIR NOx source;

(2) 40 CFR 96.215 for a CAIR SO2 source; and

(3) 40 CFR 96.315 for a CAIR NOx Ozone Season source.

(e) Changes in owners and operators. Whenever the owner or operator of a source or unit covered under this Section changes, the following provisions shall be followed:

(1) 40 CFR 96.112(c) for a CAIR NOx source;

(2) 40 CFR 96.212(c) for a CAIR SO_2 source; and

(3) 40 CFR 96.312(c) for a CAIR NOx Ozone Season source.

(f) Certificate of representation. A complete certificate of representation for a CAIR designated representative or an alternate CAIR designated representative shall meet the requirements of 40 CFR 96.113 for nitrogen oxides, 40 CFR 96.213 for sulfur dioxide, and 40 CFR 96.313 for ozone season nitrogen oxides.

(g) Objections concerning CAIR designated representative. Objections concerning CAIR designated representative shall be handled according to the procedures in 40 CFR 96.114 for nitrogen oxides, 40 CFR 96.214 for sulfur dioxide, and 40 CFR 96.314 for ozone season nitrogen oxides.

History Note: *Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);*
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2410 COMPUTATION OF TIME

Time periods shall be determined as described in:

(1) 40 CFR 96.107 for nitrogen oxides;

(2) 40 CFR 96.207 for sulfur dioxide, and

(3) 40 CFR 96.307 for ozone season nitrogen oxides.

History Note: Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);
Eff. July 1, 2006.

15A NCAC 02D .2411 OPT-IN PROVISIONS

(a) Opting in. The owners and operators of a unit may opt into:

(1) the nitrogen oxide trading program by following the procedures in and meeting the requirements of 40 CFR Part 96 Subpart II,

(2) the sulfur dioxide trading program by following the procedures in and meeting the requirements of 40 CFR Part 96 Subpart III, and

(3) the ozone season nitrogen oxide trading program by following the procedures in and meeting the requirements of 40 CFR Part 96 Subpart IIII.

(b) Permitting. The Director shall permit opt-in units under Paragraph (a) of this Rule according to 15A NCAC 02Q .0500; and

(1) 40 CFR 96.184 and 96.185 for nitrogen oxides and shall allocate allowances according to 40 CFR 96.188,

(2) 40 CFR 96.284 and 96.285 for sulfur dioxides and shall allocate allowances according to 40 CFR 96.288, and

(3) 40 CFR 96.384 and 96.385 for ozone season nitrogen oxides and shall allocate allowances according to 40 CFR 96.388.

(c) Withdrawing. The owners and operators of an opt-in unit under Paragraph (a) of this Rule may withdraw from the trading program according to:

(1) 40 CFR 96.186 for nitrogen oxides,

(2) 40 CFR 96.286 for sulfur dioxides, and

(3) 40 CFR 96.386 for ozone season nitrogen oxides.

(d) Change in regulatory status. If an opt-in unit becomes:

(1) a CAIR NOx unit under 40 CFR 96.104, then 40 CFR 96.187 shall apply,

(2) a CAIR SO_2 unit under 40 CFR 96.204, then 40 CFR 96.287 shall apply, or

(3) a CAIR ozone season NOx unit under 40 CFR 96.304, then 40 CFR 96.387 shall apply.

History Note: *Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10); 143-215.108;*
Eff. July 1, 2006.

15A NCAC 02D .2412 NEW UNIT GROWTH

(a) For nitrogen oxide emissions, the total nitrogen oxide allowances available for allocation in the new unit set-aside for each control period in 2009 through 2014 shall be 2638 tons and the total nitrogen oxide allowances available for allocation in each control period in 2015 and thereafter shall be 1154 tons. Except for the reference to 40 CFR 96.142(b), the procedures in 40 CFR 96.142(c)(2) through (4) shall be used to create allocations for units covered under this Section that commenced operations on or after January 1, 2001 and that are not covered in the table in Rule .2403 of this Section.

(b) For ozone season nitrogen oxides emissions, the total ozone season nitrogen oxide allowances available for allocation in the new unit set-aside for each control period in 2009 through 2014 shall be 1234 tons and the total ozone season nitrogen oxide allowances available for allocation in each control period in 2015 and thereafter shall be 555 tons. Except for the reference to 40 CFR 96.142(b) the procedures in 40 CFR 96.342(c)(2) through (4) shall be used to create allocations for units covered under this Section that commenced operations on or after January 1, 2001 and that are not listed in the table in Rule .2405 of this Section.

(c) New unit allowances in Paragraph (a) of this Rule that are not allocated in a given year shall be redistributed to units under .2401(b)(1) and (2) according to the provisions of 40 CFR 96.142(d) and 96.342(d) except that the divisor used in calculating individual unit allocations:

(1) for nitrogen oxide allowances shall be 2638 tons for each control period in 2009 through 2014 and 1154 tons in each control period in 2015 and thereafter, and

(2) for ozone season nitrogen oxide allowances shall be 1234 tons for each control period in 2009 through 2014 and 555 tons for each control period in 2015 and thereafter.

(d) The Director shall report the allocations to new units to EPA in accordance with 40 CFR 51.123(o)(2) and (aa)(2).

History Note: *Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);*
Eff. July 1, 2006;
Amended Eff. May 1, 2008.

15A NCAC 02D .2413 PERIODIC REVIEW AND REALLOCATIONS

In 2010 and every five years thereafter, the Environmental Management Commission shall review the emission allocations of units covered under Rules .2403 and .2405 of this Section and decide if any revisions are needed. In making this decision the Environmental Management Commission shall consider the following:

(1) the size of the allocation pool for new unit growth under Rule .2412 of this Section;

(2) the amount of emissions allocations requested by units under Rule .2412 of this Section;

(3) the amount of emissions allocations available through the respective trading programs under Rule .2408 of this Section;

(4) the impact of reallocation on existing units;

(5) the impact of reallocations on units covered under Rule .2412 of this Section;

(6) impact on future growth; and

(7) other relevant information on the impacts of reallocation.

Any revisions of allocations shall be consistent with the requirements in 40 CFR 51.123(o)(2)(ii) and (aa)(2)(iii) or 96.141 and 96.341.

History Note: *Authority G.S. 143-215.3(a); 143-215.107(a)(5), (10);*
Eff. July 1, 2006.

GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2001

SESSION LAW 2002-4
SENATE BILL 1078

AN ACT TO IMPROVE AIR QUALITY IN THE STATE BY IMPOSING LIMITS ON THE EMISSION OF CERTAIN POLLUTANTS FROM CERTAIN FACILITIES THAT BURN COAL TO GENERATE ELECTRICITY AND TO PROVIDE FOR RECOVERY BY ELECTRIC UTILITIES OF THE COSTS OF ACHIEVING COMPLIANCE WITH THOSE LIMITS.

The General Assembly of North Carolina enacts:

SECTION 1. Article 21B of Chapter 143 of the General Statutes is amended by adding a new section to read:

"**§ 143-215.107D. Emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) from certain coal-fired generating units.**

(a) As used in this section:

(1) 'Coal-fired generating unit' means a coal-fired generating unit, as defined by 40 Code of Federal Regulations § 96.2 (1 July 2001 Edition), that is located in this State and has the capacity to generate 25 or more megawatts of electricity.

(2) 'Investor-owned public utility' means an investor-owned public utility, as defined in G.S. 62-3.

(b) An investor-owned public utility that owns or operates coal-fired generating units that collectively emitted more than 75,000 tons of oxides of nitrogen (NOx) in calendar year 2000:

(1) Shall not collectively emit from the coal-fired generating units that it owns or operates more than 35,000 tons of oxides of nitrogen (NOx) in any calendar year beginning 1 January 2007.

(2) Shall not collectively emit from the coal-fired generating units that it owns or operates more than 31,000 tons of oxides of nitrogen (NOx) in any calendar year beginning 1 January 2009.

(c) An investor-owned public utility that owns or operates coal-fired generating units that collectively emitted 75,000 tons or less of oxides of nitrogen (NOx) in calendar year 2000 shall not collectively emit from the coal-fired generating units that it owns or operates more than 25,000 tons of oxides of nitrogen (NOx) in any calendar year beginning 1 January 2007.

(d) An investor-owned public utility that owns or operates coal-fired generating units that collectively emitted more than 225,000 tons of sulfur dioxide (SO2) in calendar year 2000:

(1) Shall not collectively emit from the coal-fired generating units that it owns or operates more than 150,000 tons of sulfur dioxide (SO2) in any calendar year beginning 1 January 2009.

(2) Shall not collectively emit from the coal-fired generating units that it owns or operates more than 80,000 tons of sulfur dioxide (SO2) in any calendar year beginning 1 January 2013.

(e) An investor-owned public utility that owns or operates coal-fired generating units that collectively emitted 225,000 tons or less of sulfur dioxide (SO2) in calendar year 2000:

(1) Shall not collectively emit from the coal-fired generating units that it owns or operates more than 100,000 tons of sulfur dioxide (SO2) in any calendar year beginning 1 January 2009.

(2) Shall not collectively emit from the coal-fired generating units that it owns or operates more than 50,000 tons of sulfur dioxide (SO2) in any calendar year beginning 1 January 2013.

(f) Each investor-owned public utility to which this section applies may determine how it will achieve the collective emissions limitations imposed by this section. Compliance with the emissions limitations set out in this section does not alter the obligation of any person to comply with any other federal or State law, regulation, or rule related to air quality or visibility. This subsection shall not be construed to limit the authority of the Commission to impose specific limitations on the emission of oxides of nitrogen (NOx) and sulfur dioxide (SO2) from an individual coal-fired generating unit owned or operated by an investor-owned public utility.

(g) A coal-fired generating unit that is subject to the collective emissions limitations set out in this section on 1 July 2002 shall remain subject to the collective emissions limitations whether or not it thereafter continues to be owned or operated by an investor-owned public utility.

(h) The Commission shall require that any permit or modified permit issued for a coal-fired generating unit that is subject to this section include conditions that provide for testing, monitoring, record keeping, and reporting adequate to assure compliance with the requirements of this section.

(i) The Governor may enter into an agreement with an investor-owned public utility under which the investor-owned public utility voluntarily agrees to transfer to the State any emissions allowances acquired or that may be acquired by the investor-owned public utility pursuant to 42 U.S.C. §§ 7651-7651o, as implemented by 40 Code of Federal Regulations §§ 73.1 through 73.90 (1 July 2001 Edition); 42 U.S.C. 7410(a)(2)(D)(i)(I), as implemented by 40 Code of Federal Regulations § 51.121 (1 July 2001 Edition), related federal regulations, and the associated State Implementation Plan; 42 U.S.C. § 7426, as implemented by 40 Code of Federal Regulations

§ 52.34 (1 July 2001 Edition) and related federal regulations; or any similar program established under federal law that result from compliance with the emissions limitations set out in this section. An agreement entered into pursuant to this subsection shall be binding and shall be enforceable by specific performance. If the Governor enters into an agreement that provides for the transfer of emissions allowances to the State, the Governor shall file verified copies of the agreement with the Attorney General, the Secretary of State, the State Treasurer, the Secretary of Environment and Natural Resources, and the Utilities Commission. The State Treasurer shall hold all emissions allowances that are transferred to the State as provided in this subsection in trust for the people of this State and shall sell, trade, transfer, or otherwise dispose of the emissions allowances only as the General Assembly shall provide by law.

(j) An investor-owned public utility that is subject to the emissions limitations set out in this section shall submit to the Utilities Commission and to the Department on or before 1 April of each year a verified statement pursuant to subsection (i) of G.S. 62-133.6."

SECTION 2. G.S. 143-215.108 reads as rewritten:

"**§ 143-215.108. Control of sources of air pollution; permits required.**

(a)~~After the effective date applicable to any air quality or emission control standards established pursuant to G.S. 143-215.107 and except~~ Except as provided in subsections (a1) and (a2) of this section, no person shall do any of the following things or carry out any of the following activities which contravene or will be likely to contravene ~~such~~ standards established pursuant to G.S. 143-215.107 or set out in G.S. 143-215.107D ~~until or~~ unless ~~such~~ that person ~~shall have applied for and shall have received~~ has obtained from the Commission a permit therefor and ~~shall have~~ has complied with ~~such conditions, if any, as are prescribed by such~~ any conditions of this permit:

(1) Establish or operate any air contaminant source;
(2) Build, erect, use or operate any equipment which may result in the emission of air contaminants or which is likely to cause air pollution;
(3) Alter or change the construction or method of operation of any equipment or process from which air contaminants are or may be emitted;
(4) Enter into an irrevocable contract for the construction and installation of any air-cleaning device, or allow or cause such device to be constructed, installed, or operated.

(a1)The Commission may by rule establish procedures that meet the requirements of section 502(b)(10) of Title V (42 U.S.C. § 7661a(b)(10)) and 40 Code of Federal Regulations § 70.4(b)(12) (1 July 1993 Edition) to allow a permittee to make changes within a permitted facility without requiring a revision of the permit.

(a2)The Commission may adopt rules that provide for a minor modification of a permit. At a minimum, rules that provide for a minor modification of a permit shall meet the requirements of 40 Code of Federal Regulations § 70.7(e)(2) (1 July 1993 Edition). If the Commission adopts rules that provide for a minor modification of a permit, a permittee shall not make a change in the permitted facility while the application for the minor modification is under review unless the change is authorized under the rules adopted by the Commission.

(b) The Commission shall act upon all applications for permits so as to effectuate the ~~purpose~~ purposes of this ~~section,~~ Article by reducing existing air pollution and preventing, so far as reasonably possible, any increased pollution of the air from any additional or enlarged sources.

(c) The Commission shall have the power:

(1) To grant and renew a permit with ~~such~~ any conditions attached ~~as~~ that the Commission believes necessary to achieve the purposes of this ~~section~~ Article or the requirements of the Clean Air Act and implementing regulations adopted by the United States Environmental Protection Agency;

...."

SECTION 3. G.S. 143-215.107(a)(8) reads as rewritten:

"(8) To develop and adopt standards and plans necessary to implement programs to control acid deposition and to regulate the use of sulfur dioxide (SO2) allowances and ~~nitrogen~~ oxides of nitrogen (NOx) emissions in accordance with Title IV and implementing regulations adopted by the United States Environmental Protection Agency."

SECTION 4. G.S. 143-215.114A(a) reads as rewritten:

"(a)A civil penalty of not more than ten thousand dollars ($10,000) may be assessed by the Secretary against any person who:

(1) Violates any classification, standard or limitation established pursuant to ~~G.S. 143-215.107;~~G.S. 143-215.107.

(2) Is required but fails to apply for or to secure a permit required by G.S. 143-215.108 or who violates or fails to act in accordance with the terms, conditions, or requirements of such ~~permit;~~permit.

(3) Violates or fails to act in accordance with the terms, conditions, or requirements of any special order or other appropriate document issued pursuant to ~~G.S. 143-215.110;~~G.S. 143-215.110.

(4) Fails to file, submit, or make available, as the case may be, any documents, data or reports required by this Article or Parts 1 or 7 of Article 21 of this ~~Chapter;~~Chapter.

(5) Violates a rule of the Commission or a local governing body implementing this Article or Parts 1

or 7 of ~~Article 21;~~Article 21.

(6) Violates the offenses set out in G.S. 143-215.114B.

(7) Violates the emissions limitations set out in G.S. 143-215.107D."

SECTION 5. G.S. 143-215-114A is amended by adding a new subsection to read:

"(b1)The Secretary may assess a civil penalty of not more than ten thousand dollars ($10,000) per day for a violation of the emissions limitations set out in G.S. 143-215.107D as provided in this subsection. If at the end of any calendar year, an investor-owned public utility has violated an emissions limitation set out in G.S. 143-215.107D, the violation shall be considered to be continuous from the day that the collective emissions first exceeded the emissions limitation set out in G.S. 143-215.107D through the end of the calendar year and the Secretary may assess a separate civil penalty for each day."

SECTION 6. G.S. 143-215.114B(f) reads as rewritten:

"(f)Any person who negligently violates any classification, standard or limitation established pursuant to ~~G.S. 143-215.107;~~ G.S. 143-215.107 or by G.S. 143-215.107D any term, condition, or requirement of a permit issued pursuant to G.S. 143-215.108 or of a special order or other appropriate document issued pursuant to G.S. 143-215.110 or any rule of the Commission implementing any of the said section, shall be guilty of a Class 2 misdemeanor which may include a fine not to exceed fifteen thousand dollars ($15,000) per day of violation, provided that such fine shall not exceed a cumulative total of two hundred thousand dollars ($200,000) for each period of 30 days during which a violation continues."

SECTION 7. G.S. 143-215.114B(g) reads as rewritten:

"(g)Any person who knowingly and willfully violates any classification, standard, or limitation established in the rules of the Commission pursuant to ~~G.S. 143-215.107 or~~ G.S. 143-215.107; the emissions limitations set out in G.S. 143-215.107D; any term, condition, or requirement of a permit issued pursuant to ~~G.S. 143-215.108~~ G.S. 143-215.108; or of a special order or other appropriate document issued pursuant to G.S. 143-215.110, shall be guilty of a Class H felony, which may include a fine not to exceed one hundred thousand dollars ($100,000) per day of violation, provided that this fine shall not exceed a cumulative total of five hundred thousand dollars ($500,000) for each period of 30 days during which a violation continues. For the purposes of this subsection, the phrase "knowingly and willfully" shall mean intentionally and consciously as the courts of this State, according to the principles of common law, interpret the phrase in the light of reason and experience."

SECTION 8. G.S. 143-215.114B(h)(1) reads as rewritten:

"(1) Any person who knowingly violates any classification, standard, or limitation established in the rules of the Commission pursuant to ~~G.S. 143-215.107 or~~ G.S. 143-

215.107; the emissions limitations set out in G.S. 143-215.107D; any term, condition, or requirement of a permit issued pursuant to ~~G.S. 143-215.108~~ G.S. 143-215.108; or of a special order or other appropriate document issued pursuant to G.S. 143-215.110 and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury shall be guilty of a Class C felony, which may include a fine not to exceed two hundred fifty thousand dollars ($250,000) per day of violation, provided that this fine shall not exceed a cumulative total of one million dollars ($1,000,000) for each period of 30 days during which a violation continues."

SECTION 9. Article 7 of Chapter 62 of the General Statutes is amended by adding a new section to read:

"**§ 62-133.6. Environmental compliance costs recovery.**

(a) As used in this section:

(1) 'Coal-fired generating unit' means a coal-fired generating unit, as defined by 40 Code of Federal Regulations § 96.2 (1 July 2001 Edition), that is located in this State and has the capacity to generate 25 or more megawatts of electricity.

(2) 'Environmental compliance costs' means only those capital costs incurred by an investor-owned public utility to comply with the emissions limitations set out in G.S. 143-215.107D that exceed the costs required to comply with 42 U.S.C. § 7410(a)(2)(D)(i)(I), as implemented by 40 Code of Federal Regulations § 51.121 (1 July 2001 Edition), related federal regulations, and the associated State or Federal Implementation Plan, or with 42 U.S.C. § 7426, as implemented by 40 Code of Federal Regulations § 52.34 (1 July 2001 Edition) and related federal regulations. The term 'environmental compliance costs' does not include:

a. Costs required to comply with a final order or judgment rendered by a state or federal court under which an investor-owned public utility is found liable for a failure to comply with any federal or state law, rule, or regulation for the protection of the environment or public health.

b. The net increase in costs, above those proposed by the investor-owned public utility as part of its plan to achieve compliance with the emissions limitations set out in G.S. 143-215.107D, that are necessary to comply with a settlement agreement, consent decree, or similar resolution of litigation arising from any alleged failure to comply with any federal or state law, rule, or regulation for the protection of the environment or public health.

c. Any criminal or civil fine or penalty, including court costs imposed or assessed for a violation by an investor-owned public utility of any federal or state law, rule, or regulation for the protection of the environment or public health.

d. The net increase in costs, above those proposed by the investor-owned public utility as part of its plan to achieve the emissions limitations set out in G.S. 143-215.107D, that are necessary to comply with any limitation on emissions of oxides of nitrogen (NOx) or sulfur dioxide (SO2) that are imposed on an individual coal-fired generating unit by the Environmental Management Commission or the Department of Environment and Natural Resources to address any nonattainment of an air quality standard in any area of the State.

(3) 'Investor-owned public utility' means an investor-owned public utility, as defined in G.S. 62-3.

(b) The investor-owned public utilities shall be allowed to accelerate the cost recovery of their estimated environmental compliance costs over a seven-year period, beginning 1 January 2003 and ending 31 December 2009. For purposes of this subsection, an investor-owned public utility subject to the provisions of subsections (b) and (d) of G.S. 143-215.107D shall amortize environmental compliance costs in the amount of one billion five hundred million dollars ($1,500,000,000) and an investor-owned public utility subject to the provisions of subsections (c) and (e) of G.S. 143-215.107D shall amortize environmental compliance costs in the amount of eight hundred thirteen million dollars ($813,000,000). During the rate freeze period established in subsection (e) of this section, the investor-owned public utilities shall, at a minimum, recover through amortization seventy percent (70%) of the environmental compliance costs set out in this subsection. The maximum amount for each investor-owned public utility's annual accelerated cost recovery during the rate freeze period shall not exceed one hundred fifty percent (150%) of the annual levelized environmental compliance costs set out in this subsection. The amounts to be amortized pursuant to this subsection are estimates of the environmental compliance costs that may be adjusted as provided in this section. The General Assembly makes no judgment as to whether the actual environmental compliance costs will be greater than, less than, or equal to these estimated amounts. These estimated amounts do not define or limit the scope of the expenditures that may be necessary to comply with the emissions limitations set out in G.S. 143-215.107D.

(c) The investor-owned public utilities shall file their compliance plans, including initial cost estimates, with the Commission and the Department of Environment and Natural Resources not later than 10 days after the date on which this section becomes effective. The Commission shall consult with the Secretary of Environment and Natural Resources and shall consider the advice of the Secretary as to whether an investor-owned public utility's proposed compliance plan is adequate to achieve the emissions limitations set out in G.S. 143-215.107D.

(d) Subject to the provisions of subsection (f) of this section, the Commission shall hold a hearing to review the environmental compliance costs set out in subsection (b) of this section. The Commission may modify and revise those costs as necessary to ensure that they are just, reasonable, and prudent based on the most recent cost information available and determine the annual cost recovery amounts that each investor-owned public utility shall be required to record and recover during calendar years 2008 and 2009. In making its decisions pursuant to this subsection, the Commission shall consult with the Secretary of Environment and Natural Resources to receive advice as to whether the investor-owned public utility's actual and proposed modifications and permitting and construction schedule are adequate to achieve the emissions limitations set out in G.S. 143-215.107D. The Commission shall issue an order pursuant to this subsection no later than 31 December 2007.

(e) Notwithstanding G.S. 62-130(d) and G.S. 62-136(a), the base rates of the investor-owned public utilities shall remain unchanged from the date on which this section becomes effective through 31 December 2007. The Commission may, however, consistent with the public interest:

(1) Allow adjustments to base rates, or deferral of costs or revenues, due to one or more of the following conditions occurring during the rate freeze period:
 a. Governmental action resulting in significant cost reductions or requiring major expenditures including, but not limited to, the cost of compliance with any law, regulation, or rule for the protection of the environment or public health, other than environmental compliance costs.
 b. Major expenditures to restore or replace property damaged or destroyed by force majeure.
 c. A severe threat to the financial stability of the investor-owned public utility resulting from other extraordinary causes beyond the reasonable control of the investor-owned public utility.
 d. The investor-owned public utility persistently earns a return substantially in excess of the rate of return established and found reasonable by the Commission in the investor-owned public utility's last general rate case.

(2) Approve any reduction in a rate or rates applicable to a customer or class of customers during the rate freeze period, if requested to do so by an investor-owned public utility that is subject to the emissions limitations set out in G.S. 143-215.107D.

(f) In any general rate case initiated to adjust base rates effective on or after 1 January 2008, the investor-owned public utility shall be allowed to recover its actual environmental compliance costs in accordance with Article 7 of this Chapter less the cumulative amount of accelerated cost recovery recorded pursuant to subsection (b) of this section.

(g) Consistent with the public interest, the Commission is authorized to approve proposals submitted by an investor-owned public utility to implement optional, market-based rates and services, provided the proposal does not increase base rates during the period of time referred to in subsection (e) of this section.

(h) Nothing in this section shall prohibit the Commission from taking any actions otherwise appropriate to enforce investor-owned public utility compliance with applicable statutes or Commission rules or to order any appropriate remedy for such noncompliance allowed by law.

(i) An investor-owned public utility that is subject to the emissions limitations set out in G.S. 143-215.107D shall submit to the Commission and to the Department of Environment and Natural Resources on or before 1 April of each year a verified statement that contains all of the following:

(1) A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.

(2) The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed during that year.

(3) The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.

(4) An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.

(5) A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.

(6) A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.

(7) A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.

(8) The results of equipment testing related to compliance with G.S. 143-215.107D.

(9) The number of tons of oxides of nitrogen (NOx) and sulfur dioxide (SO2) emitted

during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.

(10) The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.

(11) Any other information requested by the Commission or the Department of Environment and Natural Resources.

(j) The Secretary shall review the information submitted pursuant to subsection (i) of this section and determine whether the investor-owned public utility's actual and proposed modifications and permitting and construction schedule are adequate to achieve the emissions limitations set out in G.S. 143-215.107D and shall advise the Commission as to the Secretary's findings and recommendations.

(k) Any information, advice, findings, recommendations, or determinations provided by the Secretary pursuant to this section shall not constitute a final agency decision within the meaning of Chapter 150B of the General Statutes and shall not be subject to review under that Chapter."

SECTION 10. It is the intent of the General Assembly that the State use all available resources and means, including negotiation, participation in interstate compacts and multistate and interagency agreements, petitions pursuant to 42 U.S.C. § 7426, and litigation to induce other states and entities, including the Tennessee Valley Authority, to achieve reductions in emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) comparable to those required by G.S. 143-215.107D, as enacted by Section 1 of this act, on a comparable schedule. The State shall give particular attention to those states and other entities whose emissions negatively impact air quality in North Carolina or whose failure to achieve comparable reductions would place the economy of North Carolina at a competitive disadvantage.

SECTION 11. The Environmental Management Commission shall study the desirability of requiring and the feasibility of obtaining reductions in emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) beyond those required by G.S. 143-215.107D, as enacted by Section 1 of this act. The Environmental Management Commission shall consider the availability of emissions reduction technologies, increased cost to consumers of electric power, reliability of electric power supply, actions to reduce emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) taken by states and other entities whose emissions negatively impact air quality in North Carolina or whose failure to achieve comparable reductions would place the economy of North Carolina at a competitive disadvantage, and the effects that these reductions would have on public health, the environment, and natural resources, including visibility. In its conduct of this study, the Environmental Management Commission may consult with the Utilities Commission and the Public Staff. The Environmental Management Commission shall report its findings and recommendations to the General Assembly and the Environmental Review Commission annually beginning 1 September 2005.

SECTION 12. The General Assembly anticipates that measures implemented to achieve the reductions in emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) required by G.S. 143-215.107D, as enacted by Section 1 of this act, will also result in significant reductions in the emissions of mercury from coal-fired generating units. The Division of Air Quality of the Department of Environment and Natural Resources shall study issues related to monitoring emissions of mercury and the development and implementation of standards and plans to implement programs to control emissions of mercury from coal-fired generating units. The Division shall evaluate available control technologies and shall estimate the benefits and costs of alternative strategies to reduce emissions of mercury. The Division shall annually report its interim findings and recommendations to the Environmental Management Commission and the Environmental Review Commission beginning 1 September 2003. The Division shall report its final findings and recommendations to the Environmental Management Commission and the Environmental Review Commission no later than 1 September 2005. The costs of implementing any air quality standards and plans to reduce the emission of mercury from coal-fired generating units below the standards in effect on the date this act becomes effective, except to the extent that the emission of mercury is reduced as a result of the reductions in the emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) required to achieve the emissions limitations set out in G.S. 143-215.107D, as enacted by Section 1 of this act, shall not be recoverable pursuant to G.S. 62-133.6, as enacted by Section 9 of this act.

SECTION 13. The Division of Air Quality of the Department of Environment and Natural Resources shall study issues related to the development and implementation of standards and plans to implement programs to control emissions of carbon dioxide (CO2) from coal-fired generating units and other stationary sources of air pollution. The Division shall evaluate available control technologies and shall estimate the benefits and costs of alternative strategies to reduce emissions of carbon dioxide (CO2). The Division shall annually report its interim findings and recommendations to the Environmental Management Commission and the Environmental Review Commission beginning 1 September 2003. The Division shall report its final findings and recommendations to the Environmental Management Commission and the Environmental Review Commission no later than 1 September 2005. The costs of implementing any air quality standards and plans to reduce the emission of carbon dioxide (CO2) from coal-fired generating units below the standards in effect on the date this act becomes effective, except to the extent that the emission of carbon dioxide (CO2) is reduced as a result of the reductions in the emissions of oxides of nitrogen (NOx) and sulfur dioxide (SO2) required to achieve the emissions limitations set out in G.S. 143-215.107D, as enacted by Section 1 of this act, shall not be recoverable pursuant to G.S. 62-133.6, as enacted by Section 9 of this act.

SECTION 14. On or before 1 June of each year, the Department of Environment and Natural Resources and the Utilities Commission shall report on the implementation of this act to the Environmental Review Commission and the Joint Legislative Utility Review Committee. The first report required by this section shall be submitted no later than 1 June 2003.

SECTION 15. If any section or provision of this act is declared unconstitutional or invalid by the courts, the unconstitutional or invalid section or provision does not affect the validity of this act as a whole or any part of this act other than the part declared to be unconstitutional or invalid.

SECTION 16. This act is effective when it becomes law except that G.S. 143-215.107D(i), as enacted by Section 1 of this act, is effective retroactively to 1 June 2002.

In the General Assembly read three times and ratified this the 19th day of June, 2002.

s/ Marc Basnight
President Pro Tempore of the Senate

s/ James B. Black
Speaker of the House of Representatives

s/ Michael F. Easley
Governor

Approved 11:30 a.m. this 20th day of June, 2002

Duke Energy. Carolinas

GEORGE T. EVERETT, Ph.D.
Director
Environment and Legislative Affairs

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MAR 27 2009
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March 27, 2009

Ms. Renne C. Vance, Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, NC 27699-4325

Subject: Docket No. E-7, Sub 718
Duke Energy Carolinas, LLC NO_x and SO_2 Compliance Plan Annual Update

Record No. NC CAP 008

Dear Ms. Vance:

Duke Energy Carolinas, LLC is required by Senate Bill 1078 ("North Carolina Clean Air Legislation") to file information on or before April 1 of each year to update the North Carolina Utilities Commission ("Commission") of the progress to date, upcoming activities and expected plans to achieve the emissions limitations set out in G.S. 143-215.107D. Enclosed for filing are the original and thirty (30) copies of Duke Energy Carolinas' Compliance Plan Annual Update for 2009 that fully describe the Company's efforts to comply with the North Carolina Clean Air Legislation.

The current plan to meet the emission requirements for NO_x and SO_2 includes:

NO_x Control – Duke Energy Carolinas has completed installing controls for NO_x reductions originally planned under the North Carolina Clean Air Legislation. The combination of SCR, SNCR, and low NO_x burners, along with year round operation of these controls, has achieved and continues to maintain annual emissions below Duke Energy Carolinas' final annual target of 31,000 tons of NO_x per year.

SO_2 Control – The installation of wet scrubbers on our twelve largest generating units continues to be our plan for compliance with the 2009 and 2013 SO_2 caps under the North Carolina Clean Air Legislation. During 2008, we completed installation of wet scrubbers on both units at the Belews Creek Station, and we will complete the scrubber controls for the five units at Plant Allen in 2009. As a result of these projects, Duke Energy Carolinas expects to operate well below its 2009 SO_2 emission limit of 150,000 tons. With the final scrubber work at Cliffside Unit 5 to be completed in 2010, we expect to complete our SO_2 controls several years ahead of the 2013 final deadline in the Clean Air Legislation.

Exhibits A and B outline current unit specific technology selections, projected operational dates, expected emission rates, and the corresponding tons of emissions that demonstrate compliance with the legislative requirements to the best of Duke Energy Carolinas' knowledge at this time.

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The current estimate of Environmental Compliance Costs for these pollution control projects is included in Exhibit C and reflects some improvement since last year.

Duke Energy Carolinas will continue to examine the technology selection, implementation schedule and associated costs. Annual updates will be provided to the Commission as required. If you have questions regarding any aspect of our plan, please do not hesitate to contact my office at 919-235-0955.

Sincerely,

George T. Everett

George T. Everett, Ph.D.
Director, Environmental/Legislative Affairs
Duke Energy Carolinas

Enclosures

cc: Robert P. Gruber
Executive Director – Public Staff
4326 Mail Service Center
Raleigh, NC 27699-4326

Duke Energy Carolinas, LLC

General Assembly of North Carolina Session 2001
Senate Bill 1078 – Improve Air Quality/Electric Utilities (NC Clean Air Legislation)
2009 Annual Data Submittal

1. **A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.**

   Exhibits A and B outline the plan for technology selections by facility and unit, actual and projected operational dates, actual and expected emission rates, and the corresponding tons of emissions that demonstrate compliance with the provisions of G.S. 143-215.107D. Changes to the expected plan for meeting these emissions limitations as compared to past compliance plans are described below:

   NO_x Compliance

   - Emission Rate Changes – Expected rates for certain units have been adjusted in this 2009 update based on operating experience in 2008 with installed controls and targeted future performance.

   SO_2 Compliance

   - Emission Rate Changes – Expected rates have been adjusted in this 2009 update based on operating experience in 2008 and targeted future performance.
   - Unit Retirements – Retirement of Dan River 1 & 2 as discussed in the Certificate of Public Convenience and Necessity ("CPCN") Order for the Dan River Combined Cycle Project (Docket E-7 Sub 832) are now reflected in the 2013 SO_2 compliance plan.

2. **The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed during that year.**

   In the 2008 calendar year, Duke Energy Carolinas spent **$268,883,600** on activities in support of compliance with the provisions of G.S. 143-215.107D. Exact amounts associated with each project are provided in Exhibit C, and a description of the associated activities is provided below:

   Allen Steam Station FGD

   - Completed wastewater treatment system
   - Completed duct installation and insulation
   - Completed stack and flue liners
   - Installed and commissioned all major equipment for Unit 1 absorber operation
   - Completed limestone unloading and storage system
   - Received, installed and placed auxiliary transformers in service

<u>Belews Creek Steam Station FGD</u>

- Completed startup activities and achieved substantial completion milestone for the Unit 1 FGD
- Completed construction, commissioning and startup activities for the Unit 2 FGD and achieved substantial completion milestone
- Completed all systems performance testing
- Achieved overall project completion and closeout milestone

<u>Cliffside Steam Station Unit 5 FGD</u>

- Signed Amended and Restated Engineering, Procurement and Construction ("EPC") Agreement with Shaw, Stone & Webster
- Completed site bulk excavation and initial site preparation
- Completed dewatering building foundation
- Completed Unit 5 absorber vessel and absorber building foundations
- Completed chimney concrete shell
- Completed fabrication of all Unit 5 flue liners
- Received and set Unit 5 recycle pump motors

<u>Allen Steam Station SNCR, Unit 5</u>

- Completed installation and commissioning of the Unit 5 SNCR equipment

3. **The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.**

As discussed in the December 20, 2007 order associated with rates and environmental compliance costs (Docket E-7 Sub 829), no additional amounts were amortized related to construction work activity in the 2008 calendar year in support of compliance with the provisions of G.S. 143-215.107D. **$1,050,000,000** was amortized in total for the program through year-end 2007.

4. **An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.**

The estimated 'environmental compliance costs' as defined in G.S. 143-215.107D are provided in Exhibit C. While there has been no significant change to the scope or timing associated with any of these projects, forecasts for active projects have been updated as compared to the 2008 filing. The net overall reduction is $16,672,700 or approximately 1% of the previously forecasted costs and can mostly be attributed to unused contingency or risk items included in the previous forecast.

5. **A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.**

<u>Allen Steam Station FGD</u>

- Request to revise NPDES Permit to include FGD wastewater – Submitted 1/24/2006; received revision 9/11/2006

- Submittal to DENR/ACOE regarding stream crossing of entrance road – Received permits 5/25/2006
- Air Permit Application – Submitted 4/10/2006; received Permit 6/30/2006
- Authorization to Construct (ATC) application for Wastewater Treatment System – Submitted 9/14/2006; received Permit to Construct 12/15/2006
- NOTE: all erosion control permits are in EPC contractor's scope for the Allen FGD Project and were received in 2006 (7/13/2006 and 12/18/2006). EPC contractor also received permit from NCDOT to improve Highway NC273 at the Allen FGD entrance road on 12/3/2008. Stack contractor also applied for air permit associated with flue liner fabrication on 11/1/2006 and received on 2/2/2007.

Belews Creek Steam Station FGD

- Request to revise NPDES Permit to include FGD wastewater – Submitted 6/30/2004; received Permit Revision 5/16/2005
- Initial Erosion Control Permit – Submitted 2/4/2005; received Permit 3/7/2005
- Landfill Site Suitability Application – Submitted 3/30/2005; received Site Suitability Approval Letter 6/19/2006
- Air Permit Application for Belews Creek FGD project – Submitted 4/18/2005; received Air Permit 2/6/2006
- Authorization to Construct (ATC) application for Wastewater Treatment System – Submitted 7/21/2005; received Permit to Construct 12/27/2005
- Authorization to Construct (ATC) application for Constructed Wetlands – Submitted 7/21/2005; received Permit to Construct 12/27/2005
- Revised Landfill Construction Plan Application – Submitted 9/30/2005; received Permit to Construct 6/29/2006
- Air Permit – Notice of Intent to Construct – Submitted 10/11/2005; received Permit to Construct 10/24/2005
- Authorization to Construct Sanitary Waste Lagoon – Submitted 3/23/2006; received Permit to Construct 9/1/2006
- Existing Sewage Lagoon Approval to Decommission – Submitted 10/31/2006; received permit 1/25/2007
- Permit to operate the FGD Residue Landfill – Submitted Certification Report on 9/28/2007; received permit 1/24/2008
- Erosion Control Permit to construct Used Oil Building – Submitted August 2008; received permit 10/10/2008
- Building Permit to construct Used Oil Building – Submitted August 2008; received permit 10/21/2008
- NOTE: Revisions to Erosion Control Permit submitted on various dates; most recent revised permit received 3/30/2006

Cliffside Steam Station Unit 5 FGD

- Air Permit Application for Cliffside Unit 5 FGD project – Submitted 12/16/2005; received 12/15/2006
- Request to revise NPDES Permit (including new Cliffside Unit 6) – Submitted 4/30/2007; Received Permit Revision 8/13/2007
- FAA Permit for Stack – received permit 10/30/2007

- Landfill Site Suitability Application – Submitted 1/7/2008; received 11/18/2008
- Authorization to Construct (ATC) application for Wastewater Treatment System – received Permit to Construct 9/22/2008
- Building Permits from Cleveland & Rutherford Counties for WFGD Control Room – received 1/26/2009
- Landfill Construction Plan Application – Submitted 12/18/08; expect approval in March 2009

Marshall Steam Station FGD

- Landfill Construction Plan Application – Submitted 4/1/04; received 2/4/05
- Sedimentation and Erosion Control Plan Permits
  - Limestone/Gypsum Conveyor – Submitted 6/17/04; received 7/9/04
  - Limestone/Gypsum Conveyor Expansion – Submitted 12/15/04; received 12/30/04
  - *Constructed Wetland Treatment System – Submitted 7/26/04; received 8/18/04*
  - Gypsum Landfill – Submitted 3/31/04; received 4/21/04
- Authorization to Construct (ATC) application for Solids Removal System – Submitted 11/19/04; received 12/22/04
- Authorization to Construct (ATC) application for Constructed Wetlands – Submitted 5/21/04; received 8/10/04
- Air Permit Revisions (for material handling issues) – Submitted 9/2/05; received 12/7/05
- Landfill Permit Documents (to line landfill) – Submitted 12/15/05; received 6/5/06
- Permit to Operate Marshall FGD Landfill – Submitted 10/27/06; received 11/21/06

Allen Steam Station SNCR, Unit 2

- Air Permit Application – Submitted 4/24/06; Received 6/30/06

Allen Steam Station SNCR, Unit 3

- Air Permit Application – Submitted 7/15/04; Received 2/5/05

Allen Steam Station SNCR, Unit 4

- Air Permit Application – Submitted 7/15/05; Received 1/15/06
- Building/Plumbing permit from Gaston County Building and Standards – Received 4/27/06 for municipal water tie-ins

Allen Steam Station SNCR, Unit 5

- Air Permit Application – Submitted 4/24/06; Received 6/30/06

Buck Steam Station Burners, Unit 3

- Air Permit Application – Submitted 9/15/06; Received 2/15/07

Buck Steam Station Burners, Unit 4

- *Air Permit Application – Submitted 9/15/06; Received 2/15/07*

Buck Steam Station SNCR, Unit 5

- Air Permit Application – Submitted 3/10/06; Received 5/16/06

Buck Steam Station SNCR, Unit 6

- Air Permit Application – Submitted 3/10/06; Received 5/16/06

Dan River Steam Station Burners, Unit 1

- Air Permit Application – Submitted 2/23/06; Received 9/11/06

Dan River Steam Station Burners, Unit 2

- Air Permit Application – Submitted 2/23/06; Received 9/11/06

Dan River Steam Station Burners, Unit 3

- Air Permit Application – Submitted 2/23/06; Received 9/11/06

Marshall Steam Station SNCR, Unit 1

- Air Permit Application – Submitted 9/18/05; Received 12/20/05

Marshall Steam Station SNCR, Unit 2

- Air Permit Application – Submitted 9/18/05; Received 12/20/05

Marshall Steam Station SNCR, Unit 3

- Air Permit Application – Submitted 5/14/04; Received 10/13/04

Marshall Steam Station SNCR, Unit 4

- Air Permit Application – Submitted 4/28/06; Received 9/12/06

Riverbend Steam Station SNCR, Unit 4

- Air Permit Application – Submitted 3/20/05; Received 8/1/05

Riverbend Steam Station Burners, Unit 5

- Air Permit Application – Submitted 4/2/04; Received 4/30/04

Riverbend Steam Station SNCR, Unit 5

- Air Permit Application – Submitted 3/20/06; Received 8/1/06

Riverbend Steam Station Burners, Unit 6

- Air Permit Application – Submitted 5/14/03; Received September 2003

Riverbend Steam Station SNCR, Unit 6

- Air Permit Application – Submitted 11/5/05; Received 1/1/06

Riverbend Steam Station SNCR, Unit 7

- Air Permit Application – Submitted 11/5/05; Received 1/1/06

6. **A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.**

Allen Steam Station FGD

- Begin operation of the Unit #1 absorber
- Begin operation of the Unit #3 absorber
- Complete gypsum handling system
- Complete final drawing turnover and archival
- Complete modification to Highway NC273 at the Allen FGD entrance road
- Complete generating unit tie-ins for Units 1-5

Cliffside Steam Station Unit 5 FGD

- Complete erection of the Unit 5 absorber vessel
- Complete initial tie-in to the Unit 5 stack and installation of blanking plates
- Receive and set Unit 5 auxiliary transformer and backfeed power
- Construct wastewater treatment facility
- Erect limestone and gypsum material handling equipment
- Complete steel erection for dewatering building, absorber building and reagent prep building
- Receive equipment and begin ball mill assembly

7. **A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.**

No additional applications for permits are expected.

8. **The results of equipment testing related to compliance with G.S. 143-215.107D.**

No additional equipment related testing occurred in 2008. The SNCR and SCR tests that occurred in prior years that were used in evaluating technology selections are repeated in this 2009 report for reference.

Allen Steam Station SNCR, Unit 1

- SNCR Equipment installation was completed in May 2003 followed by equipment acceptance testing in late 2003. During this test run, it was determined that the SNCR system met all commercial performance guarantees with approximately a 25% reduction in NOx with ammonia slip of less than 5 ppm at full load.
- During the 2004 ozone season, Allen Unit 1 achieved a 0.162# NO_x/MMBTU outlet rate, 5% better than the 0.17#/MMBTU target established for the unit.

Belews Creek Steam Station SCR

- SCR Equipment installation was completed in 2003 in support of the EPA/SIP Call requirements for NO_x reduction. While Belews Creek had operational problems in the first half of the 2004 ozone season, many of these issues were addressed on Belews Creek Unit 1 by August, 2004. Subsequently, tests performed during the months of August and September showed that when the SCR Equipment was in service during this time, emissions averaged 0.07# NO_x/MMBTU.

9. **The number of tons of oxides of nitrogen (NO_x) and sulfur dioxide (SO_2) emitted during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.**

   In the 2008 calendar year, **29,052.3** tons of NO_x and **132,405.8** tons of SO_2 were emitted from the North Carolina based Duke Energy Carolinas coal-fired units located in North Carolina and subject to the emissions limitations set out in G.S 143-215.107D.

10. **The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.**

    No emissions allowances have been acquired by Duke Energy Carolinas resulting from compliance with the emissions limitations set out in G.S. 143-215.107D.

11. **Any other information requested by the Commission or Department of Environment and Natural Resources.**

    No additional information has been requested to be included in this annual data submittal.

Expected Duke Energy Carolinas Compliance for NC Clean Air Legislation as of 4/1/2009
(Exhibit A)

NO$_x$									
				2007 Compliance		2008 Compliance		2009 Compliance	
Facility	Unit	Technology	Operational Date	Actual Rate #/MMBTUs	Tons	Actual Rate #/MMBTUs	Tons	Expected Rate #/MMBTUs	Tons
Allen	1	SNCR	2003	0.176	854	0.176	811	0.170	757
Allen	2	SNCR	2007	0.172	822	0.168	766	0.170	783
Allen	3	SNCR	2005	0.174	1,428	0.180	1,307	0.180	1,464
Allen	4	SNCR	2006	0.192	1,500	0.178	1,304	0.180	1,574
Allen	5	SNCR	2008	0.223	1,837	0.199	1,563	0.180	1,418
Belews Creek	1	SCR	2003	0.047	1,308	0.036	1,446	0.060	2,190
Belews Creek	2	SCR&Burners	2004	0.063	2,122	0.046	1,704	0.060	1,814
Buck	3	Burners	2007	0.255	301	0.262	261	0.280	203
Buck	4	Burners	2007	0.308	222	0.296	198	0.300	138
Buck	5	SNCR	2006	0.156	582	0.163	367	0.160	511
Buck	6	SNCR	2006	0.159	542	0.166	506	0.160	547
Cliffside	1	Tuning Only	2004	0.417	235	0.457	244	0.430	131
Cliffside	2	Tuning Only	2004	0.380	279	0.403	178	0.410	120
Cliffside	3	Tuning Only	2004	0.376	479	0.363	365	0.410	355
Cliffside	4	Tuning Only	2004	0.403	512	0.394	407	0.410	362
Cliffside	5	SCR	2002	0.065	998	0.058	1,066	0.060	1,068
Dan River	1	Burners	2008	0.342	465	0.249	282	0.250	274
Dan River	2	Burners	2006	0.231	372	0.252	299	0.250	297
Dan River	3	Burners	2006	0.219	684	0.197	684	0.210	607
Marshall	1	SNCR	2006	0.210	5,329	0.205	4,706	0.200	4,645
Marshall	2	(combined stack)	2007						
Marshall	3	SNCR/SCR[1]	2005/2008	0.218	5,056	0.225	4,135	0.060	1,376
Marshall	4	SNCR	2007	0.204	4,862	0.210	4,380	0.200	4,472
Riverbend	4	SNCR	2007	0.248	488	0.196	398	0.190	374
Riverbend	5	SNCR&Burners	2008	0.241	473	0.184	392	0.190	360
Riverbend	6	SNCR&Burners	2006	0.213	603	0.197	627	0.190	595
Riverbend	7	SNCR	2006	0.216	664	0.196	656	0.190	588
			Expected Total:		33,013		29,052		27,023
			Compliance Limit:		35,000		35,000		31,000

[1] SNCR Technology in service on Marshall Unit 3 was replaced by SCR Technology in 2008 in support of 8-hour ozone attainment demonstration in the Charlotte region. Similar to other SCR additions to comply with other laws besides the North Carolina Clean Air Legislation, costs associated with this Marshall Unit 3 SCR project are not "environmental compliance costs" within the meaning of that term as used in the North Carolina Clean Air Legislation.

Technology
Burners -- Overfired Air or Separated Overfired Air with associated Mill Classifier installations
SCR -- Selective Catalytic Reduction
SNCR -- Selective Non-Catalytic Reduction

Expected Duke Energy Carolinas Compliance for NC Clean Air Legislation as of 4/1/2009 (Exhibit B)

SO_2

Facility	Unit	Technology	Operational Date	2009 Compliance: Expected Rate #/MMBTUs	2009 Compliance: Tons	2013 Compliance: Expected Rate #/MMBTUs	2013 Compliance: Tons
Allen	1	Scrubber	2009	0.300	1,336	0.150	660
Allen	2	Scrubber	2009	0.400	1,842	0.150	644
Allen	3	Scrubber	2009	0.700	5,694	0.150	1,239
Allen	4	Scrubber	2009	0.750	6,556	0.150	1,321
Allen	5	Scrubber	2009	0.550	4,333	0.150	1,134
Belews Creek	1	Scrubber	2008	0.150	5,476	0.150	5,177
Belews Creek	2	Scrubber	2008	0.150	4,535	0.150	4,811
Buck	3			1.400	1,017		0
Buck	4			1.400	642		0
Buck	5			1.400	4,472	1.400	3,334
Buck	6			1.400	4,784	1.400	3,449
Cliffside	1			1.600	488		0
Cliffside	2			1.600	469		0
Cliffside	3			1.600	1,385		0
Cliffside	4			1.600	1,414		0
Cliffside	5	Scrubber	2010	1.600	28,476	0.150	2,858
Cliffside	6	Scrubber	2011		0	0.080	2,158
Dan River	1			1.750	1,919		0
Dan River	2			1.750	2,081		0
Dan River	3			1.750	5,062	1.750	661
Marshall	1	Scrubber (combined stack)	2007	0.150	3,484	0.150	3,631
Marshall	2		2007				
Marshall	3	Scrubber	2007	0.150	3,439	0.150	3,534
Marshall	4	Scrubber	2006	0.150	3,354	0.150	3,386
Riverbend	4			1.700	3,344	1.700	1,885
Riverbend	5			1.700	3,219	1.700	1,705
Riverbend	6			1.700	5,320	1.700	3,197
Riverbend	7			1.700	5,260	1.700	2,825
			Expected Total:		109,401		47,611
			Compliance Limit:		150,000		80,000

Expected Duke Energy Carolinas Compliance Costs for NC Clean Air Legislation as of 4/1/2009
(Exhibit C)

Facility	Unit(s)	Technology	Operational Date	Spent to Date 2001 ($000)	2002 ($000)	2003 ($000)	2004 ($000)	2005 ($000)	2006 ($000)	2007 ($000)	2008 ($000)	Remaining 2009-2011 ($000)	Project Total ($000)	
Allen	1-5	Scrubber	2009	$0.9	($0.9)	$1,099.8	($11.8)	$5,348.3	$62,752.8	$209,063.2	$153,697.9	$70,851.0	$502,801.2	SO_2
Belews Creek	1-2	Scrubber	2008	$0.0	$0.0	$1,121.3	$5,999.1	$106,433.5	$250,648.5	$128,058.2	$34,628.7	$1,149.3	$528,038.5	SO_2
Cliffside	5	Scrubber	2010	$0.0	$0.0	$978.5	$287.5	$112.0	$3,175.2	$57,777.9	$77,524.6	$145,844.4	$285,700.0	SO_2
Marshall	1-4	Scrubber	2007	$0.0	$0.0	$10,213.7	$92,096.3	$218,129.8	$74,162.8	$23,632.0	($1,249.6)	$0.0	$416,985.0	SO_2
Allen	1	SNCR	2003	$177.3	$162.4	$2,884.1	$364.9	$0.0	$0.0	$0.0	$0.0	$0.0	$3,588.7	NO_x
Allen	2	SNCR	2007	$0.0	$0.0	$0.0	$0.0	$239.3	$2,710.6	$2,331.9	($207.9)	$0.0	$5,074.0	NO_x
Allen	3	SNCR	2005	$0.0	$0.0	$215.7	$2,584.1	$4,091.5	$32.5	$0.0	$0.0	$0.0	$6,923.9	NO_x
Allen	4	SNCR	2006	$0.0	$0.0	$0.0	$217.9	$1,122.2	$4,258.0	$170.9	$16.1	$0.0	$5,785.1	NO_x
Allen	5	SNCR	2008	$0.0	$0.0	$98.9	$164.6	$122.3	$22.7	$2,160.9	$2,424.6	$0.0	$4,993.9	NO_x
Buck	3	Burner	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$614.5	$3,564.6	$0.0	$0.0	$4,179.1	NO_x
Buck	3	Classifier	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$216.0	$0.0	$0.0	$216.0	NO_x
Buck	4	Burner	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$358.3	$1,882.2	$0.7	$0.0	$2,241.1	NO_x
Buck	4	Classifier	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$93.1	$0.0	$0.0	$93.1	NO_x
Buck	5	SNCR	2006	$0.0	$0.0	$0.0	$268.2	$345.9	$4,836.8	$182.7	$160.3	$0.0	$5,793.8	NO_x
Buck	6	SNCR	2006	$0.0	$0.0	$0.0	$265.8	$335.3	$3,814.2	($685.2)	($28.8)	$0.0	$3,701.4	NO_x
Dan River	1	Burner	2008	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1,560.3	$1,633.2	$0.0	$3,193.5	NO_x
Dan River	1	Classifier	2008	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$124.4	$0.0	$0.0	$124.4	NO_x
Dan River	2	Burner	2006	$0.0	$0.0	$0.0	$0.0	$775.4	$1,693.6	$238.8	$0.0	$0.0	$2,707.8	NO_x
Dan River	2	Classifier	2005	$0.0	$0.0	$0.0	$0.0	$130.8	$0.0	$0.0	$0.0	$0.0	$130.8	NO_x
Dan River	3	Burner	2006	$7.5	$162.3	$22.2	$512.8	$679.0	$1,441.4	$377.2	$0.0	$0.0	$3,202.4	NO_x
Dan River	3	Classifier	2005	$0.0	$0.0	$0.0	$0.0	$184.3	$0.0	$0.0	$0.0	$0.0	$184.3	NO_x
Marshall	1	SNCR	2006	$0.0	$0.0	$0.8	$167.2	$1,418.4	$2,106.3	$181.7	$0.0	$0.0	$3,874.4	NO_x
Marshall	2	SNCR	2007	$0.0	$0.0	$197.6	$185.4	$778.3	$2,760.7	$1,382.3	$322.2	$0.0	$5,626.5	NO_x
Marshall	3	SNCR	2005	$0.0	$0.0	$1,577.4	$652.1	$2,042.4	$32.0	$0.0	$0.0	$0.0	$4,303.8	NO_x
Marshall	4	SNCR	2007	$0.0	$0.0	$0.0	$0.0	$43.3	$2,613.6	$494.2	$0.0	$0.0	$3,151.0	NO_x
Riverbend	4	SNCR	2007	$0.0	$0.0	$0.0	$45.6	$474.3	$1,082.2	$1,981.8	($53.1)	$0.0	$3,530.7	NO_x
Riverbend	5	Burner	2005	$362.8	$284.3	$2.8	$2,313.4	$180.0	$0.0	$0.0	$0.0	$0.0	$3,143.3	NO_x
Riverbend	5	Classifier	2005	$0.0	$0.0	$0.0	$159.6	$0.0	$0.0	$0.0	$0.0	$0.0	$159.6	NO_x
Riverbend	5	SNCR	2008	$0.0	$0.0	$0.0	$1.5	$321.7	$1,474.6	$2,586.5	$5.6	$0.0	$4,389.9	NO_x
Riverbend	6	Burner	2005	$144.0	$416.1	$12.2	$510.4	$2,096.4	$0.0	$0.0	$0.0	$0.0	$3,179.1	NO_x
Riverbend	6	Classifier	2005	$0.0	$0.0	$0.0	$0.0	$189.4	$0.0	$0.0	$0.0	$0.0	$189.4	NO_x
Riverbend	6	SNCR	2006	$0.0	$0.0	$0.0	$1.5	$340.3	$3,454.1	$503.7	$4.4	$0.0	$4,304.1	NO_x
Riverbend	7	SNCR	2006	$0.0	$0.0	$0.0	$48.5	$485.8	$3,939.0	$520.9	$4.7	$0.0	$4,998.8	NO_x
			Subtotals:	$692.4	$1,024.2	$18,424.9	$106,834.5	$346,420.0	$427,984.4	$438,400.1	$268,883.6	$217,844.7		
											NC Clean Air Legislation program forecast [1]:	$1,826,508.8		

[1] The NC Clean Air Legislation program forecast excludes all financing-related accounting entries

VERIFICATION

I, George T .Everett, state and attest that the attached information updating the North Carolina Utilities Commission on progress to date, upcoming activities, and expected strategies to achieve the emissions limitations set out in N.C.G.S. 143-215.107.D (Annual Update) is filed on behalf of Duke Energy Carolinas, LLC; that I have reviewed said Annual Update, and, in the exercise of due diligence have made reasonable inquiry into the accuracy of the information provided therein; and that, to the best of my knowledge, information, and belief, all of the information contained therein is accurate and true, and no material information or fact has been knowingly omitted or misstated therein.

George T. Everett
George T. Everett
Director, Environmental and Legislative Affairs

3/27/2009
Date

Subscribed and sworn to before me,
this 27th day of March, 2009.

Maria Edwards
NOTARY PUBLIC

My commission expires: 3/2/2013

CERTIFICATE OF SERVICE

I certify that a copy of Duke Energy Carolinas, LLC's NO_x and SO_2 Compliance Plan Annual Update in No. E-7, Sub 718, has been served by electronic mail (e-mail), hand delivery or by depositing a copy in the United States Mail, first class postage prepaid, properly addressed to parties of record.

This the 27th day of March, 2009.

George T. Everett

George T. Everett
Director, Environmental/Legislative Affairs
Duke Energy Carolinas, LLC
3700 Glenwood Avenue, Suite 330
Raleigh NC 27612
(919) 239-0955

Progress Energy

August 17, 2009

Mr. Dee Freeman
Secretary
North Carolina Department of Environment and Natural Resources
1601 Mail Service Center
Raleigh, NC 27699-1601

Dear ~~Secretary Freeman~~: Dee

In accordance with amended G.S. 62-110.1, Progress Energy Carolinas, Inc. (PEC, Company) submits the attached revised report regarding the current status of and future plans for compliance with the provisions of the North Carolina Clean Smokestacks Act.

As I have noted before, we regularly review and refine our compliance strategy, weighing a number of factors such as system load projections, new natural gas supply, natural gas-fired generation options, coal unit retirements, updated load and energy forecasts, updated fuel costs, updated capital and operating costs, and federal and state environmental legislative and regulatory developments. As a result of recent resource planning studies taking all of these drivers into account, PEC has determined that retirement of a coal-fired plant and replacement of that plant with combined-cycle natural gas-fired units represents a cost- effective resource plan for our system. Accomplishing this retirement and replacement by 2013 eliminates the need for a sulfur dioxide scrubber on Sutton Unit 3 in order to comply with the 2013 Clean Smokestacks Act limits. This revised strategy is described in the attached updated Clean Smokestacks report.

I want to thank you and your staff for your assistance and support of SB 1004, which will help facilitate our plans for natural-gas fired generation. We look forward to continuing our positive working relationship with the Department to facilitate fulfillment of the Company's obligations with this important law.

Please contact me at (919) 546-3775 if you have any questions.

Sincerely,

Caroline Choi
Director, Energy Policy and Strategy

c: North Carolina Utilities Commission
Keith Overcash, DAQ

Progress Energy Service Company, LLC
P.O. Box 1551
Raleigh, NC 27602

VERIFICATION

STATE OF NORTH CAROLINA)
)
COUNTY OF WAKE)

NOW, BEFORE ME, the undersigned, personally came and appeared, Paula Sims, who first duly sworn by me, did depose and say:

That she is Paula Sims, Senior Vice President-Power Operations of Carolina Power & Light Company, d/b/a Progress Energy Carolinas, Inc.; she has the authority to verify the foregoing Progress Energy Carolinas, Inc. North Carolina Clean Smokestacks Act Calendar Year 2008 Progress Report - Revision; that she has read said revised Report and knows the contents thereof; are true and correct to the best of her knowledge and beliefs.

Paula Sims
Senior Vice President-Power Operations
Progress Energy Carolinas, Inc.

Subscribed and sworn to me
this 17 day of August, 2009.

Notary Public

246373

Revised 2008 CSA Report

Progress Energy Carolinas, Inc. (PEC)
North Carolina Clean Smokestacks Act
Calendar Year 2008 Progress Report

On June 20, 2002, North Carolina Senate Bill 1078, also known as the "Clean Smokestacks Act," was signed into effect. This law requires significant reductions in the emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) from utility owned coal-fired power plants located in North Carolina. Section 9(i), which is now incorporated as Section 62-133.6(i) of the North Carolina General Statutes, requires that an annual progress report regarding compliance with the Clean Smokestacks Act be submitted on or before April 1 of each year. The report must contain the following elements, taken verbatim from the statute:

1. A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.
2. The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed that year.
3. The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.
4. An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.
5. A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.
6. A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.
7. A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.
8. The results of equipment testing related to compliance with G.S. 143-215.107D.
9. The number of tons of oxides of nitrogen (NOx) and sulfur dioxide (SO_2) emitted during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.
10. The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.
11. Any other information requested by the Commission or the Department of Environment and Natural Resources.

Information responsive to each of these report elements follows. The responses are given by item number in the order in which they are presented above.

1. A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.

Under G.S. § 143-215.107D(f), "each investor-owned public utility…may determine how it will achieve the collective emissions limitations imposed by this section." PEC originally submitted its compliance plan on July 29, 2002. Appendix A contains an updated version of this plan, effective July 31, 2009. We continue to evaluate various design, technology and generation options that could affect our future compliance plans.

2. **The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed that year.**

In 2008, Progress Energy Carolinas, Inc. incurred actual capital costs of $114,164,000.

Mayo

Engineering, procurement, and construction work continued throughout 2008. Major accomplishments included completion of the absorber, completion of the chimney, beginning construction of the waste water treatment system, and beginning commissioning and start-up activities. At year end, the project was 83% complete. Construction occurred on schedule to support final tie-in of the scrubber in March, 2009 with initial operation in early April, 2009.

Roxboro

The scrubbers on Units 2 and 4 operated successfully throughout the year. Construction of the scrubbers on Units 1 and 3 was completed with Unit 3 going into service on May 6, 2008 and Unit 1 going into service on December 16, 2008. At the end of 2008, the Roxboro project was 96% complete.

3. **The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.**

Progress Energy Carolinas, Inc. amortized $15,000,000 in 2008.

4. **An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.**

Appendix B contains the capital costs incurred toward compliance with G.S. § 143-215.107D through 2008 and the projected costs for future years through 2013. The costs shown are the net costs to PEC, excluding the portion for which the Power Agency is responsible. The estimated total capital costs, including escalation, are currently projected to be $1.068 billion. This represents a decrease of $334 million from the April 2009 cost estimate of $1.402 billion.

We regularly review and refine our compliance strategy, weighing a number of factors such as system load projections, new natural gas supply, natural gas-fired generation options, coal unit retirements, updated load and energy forecasts, updated fuel costs, updated capital and operating costs, and federal and state environmental legislative and regulatory developments. As a result of recent resource planning studies taking all of these drivers into account, PEC has determined that retirement of a coal-fired plant and replacement of that plant with a combined-cycle natural gas-fired unit represents a cost-effective resource plan for our system. Accomplishing this retirement and replacement by 2013 eliminates the need for a sulfur dioxide scrubber on Sutton Unit 3 in order to comply with the 2013 Clean Smokestacks Act limits.

With this plan, additional controls are not needed at Sutton 3 to meet the 2013 Clean Smokestacks Act limits, therefore that unit is no longer shown in Appendix B and the compliance costs have been reduced accordingly.

5. **A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.**

Progress Energy applied for or received the following permits in 2008:

Roxboro Plant

Air Permit

Agency approval was received on April 23, 2008, which incorporated revised limits for SO_2 and NOx based on scrubber stack dispersion analysis.

Authorization to Construct

A request for an Authorization to Construct for revisions to the waste water system to temporarily reroute the backwash discharge line from the flush pond to the settling pond was submitted on April 10, 2008 and approved on April 18, 2008.

Mayo Plant

Erosion and Sediment Control Plan

Revision I to the Erosion and Sediment Control Plan for an increase in disturbed land for additional lay down area for the flue gas desulfurization system was submitted on April 17, 2008 and was approved on May 8, 2008.

Revision J to the Erosion and Sediment Control Plan for an increase in disturbed land (additional borrow area) was submitted on October 28, 2008 and was approved on December 17, 2008.

6. **A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.**

Mayo

The SO_2 scrubber at Mayo has been completed and began operation in early April, 2009. The bioreactor was placed into service in June, 2009. The remaining construction activities at Mayo for 2009 involve resolution of project punch-list items.

Roxboro

During 2009, the remaining construction activities at Roxboro involve final grading, paving and roadwork, resolution of project punch-list items, and additional construction related to the waste water treatment settling and flush ponds.

7. **A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.**

The following permit applications and permit approvals are anticipated for 2009:

Roxboro Plant

Authorization to Construct

A request for addendum for the Authorization to Construct for repairs to the gypsum settling pond and flush pond for the waste water treatment system was submitted on January 12, 2009. Agency approval was obtained on May 15, 2009.

A request for Authorization to Construct for an additional settling pond for the waste water treatment system was submitted on March 11, 2009. Agency approval was obtained on June 15, 2009.

Erosion and Sedimentation Control Plan

Additional plan revisions may be necessary as construction plans are further developed.

Mayo Plant

Air Permit

A renewal application for the Title V Air Permit was submitted on November 30, 2007. This application contained an update to include NSPS requirements for the emergency quench water pump. Agency approval for the quench water pump was obtained on May 27, 2009.

A permit application submitted for changes to the air permit on January 15, 2009 included revisions to the limestone silo control device arrangement and installation of a dry sorbent injection system for SO_3 control. Agency approval was obtained on May 27, 2009.

NPDES Permit

A revision to the NPDES permit to include limestone and gypsum truck traffic in support of scrubber operation was requested on February 11, 2009 with approval expected in the third quarter 2009.

Authorization to Construct

A request for an addendum to the Authorization to Construct for the waste water treatment system was submitted on September 12, 2008, which revises the design of the HDPE liner and base of the settling pond. Approval of this request was issued on February 23, 2009.

Erosion and Sedimentation Control Plan

Plan revisions may be necessary as construction plans are further developed.

8. The results of equipment testing related to compliance with G.S. 143-215.107D.

Performance testing of the scrubbers on Roxboro Units 3 and 4 was completed in 2008. The testing confirmed that each scrubber achieved its performance guarantee of 97% SO_2 removal efficiency.

Testing of the scrubber at Mayo is planned for later this year.

9. The number of tons of oxides of nitrogen (NOx) and sulfur dioxide (SO_2) emitted during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.

The affected coal-fired PEC units have achieved a 59% reduction in NOx and a 56% reduction in SO_2 since 2002. The total calendar year 2008 emissions from the affected coal-fired Progress Energy Carolinas units are:

NOx 24,190 tons
SO_2 94,221 tons

10. The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.

During 2008, PEC did not acquire any allowances as a result of compliance with the emission limitations set out in N.C. General Statute 143-215.107D.

11. Any other information requested by the Commission or the Department of Environment and Natural Resources.

There have been no additional requests for information from the North Carolina Utilities Commission or the Department of Environment and Natural Resources since the last report.

Appendix A

Progress Energy Carolinas, Inc's (PEC) Air Quality Improvement Plan Supplement

July 31, 2009

On June 20, 2002, Governor Easley signed into law SB1078, which caps emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) from utility owned coal-fired power plants located in North Carolina. Under the law, G.S. § 143-215.107D, PEC's annual NOx emissions must not exceed 25,000 tons beginning in 2007 and annual SO_2 emissions must not exceed 100,000 tons beginning in 2009 and 50,000 tons beginning in 2013. These caps represent a 56% reduction in NOx emissions from 2001 levels and a 74% reduction in SO_2 emissions from 2001 levels for PEC.

PEC owns and operates 18 coal-fired units at seven plants in North Carolina. The locations of these plants are shown on Attachment 1. Under G.S. § 143-215.107D(f), "each investor-owned public utility…may determine how it will achieve the collective emissions limitations imposed by this section."

Nitrogen Oxides Emissions Control Plan

PEC has been evaluating and installing NOx emissions controls on its coal-fired power plants since 1995 in order to comply with Title IV of the Clean Air Act and the NOx SIP Call rule adopted by the Environmental Management Commission (EMC). Substantial NOx emissions reductions have been achieved (24,383 tons of NOx in 2007 compared with 112,000 tons in 1997), and compliance with the Clean Smokestacks Act's 25,000 ton cap was achieved in calendar year 2007. This target was achieved with a mix of combustion controls (which minimize the formation of NOx), such as low-NOx burners and over-fire air technologies, and post-combustion controls (which reduce NOx produced during the combustion of fossil fuel to molecular nitrogen), such as selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) technologies.

Attachment 2 details PEC's North Carolina coal-fired electric generating units, their summer net generation capability, and installed NOx control technologies.

Sulfur Dioxide Emissions Control Plan

PEC has installed wet flue gas desulfurization systems (FGD or "scrubbers") to remove 97% of the SO_2 from the flue gas at its Asheville, Mayo and Roxboro boilers.

Wet scrubbers produce unique waste and byproduct streams. Issues related to wastewater permitting and solid waste disposal are being addressed for each site. PEC is treating the scrubber wastewater stream at the Asheville Plant using an innovative constructed wetlands treatment system to ensure compliance with discharge limits. A bioreactor technology will be used for the Roxboro and Mayo Plants.

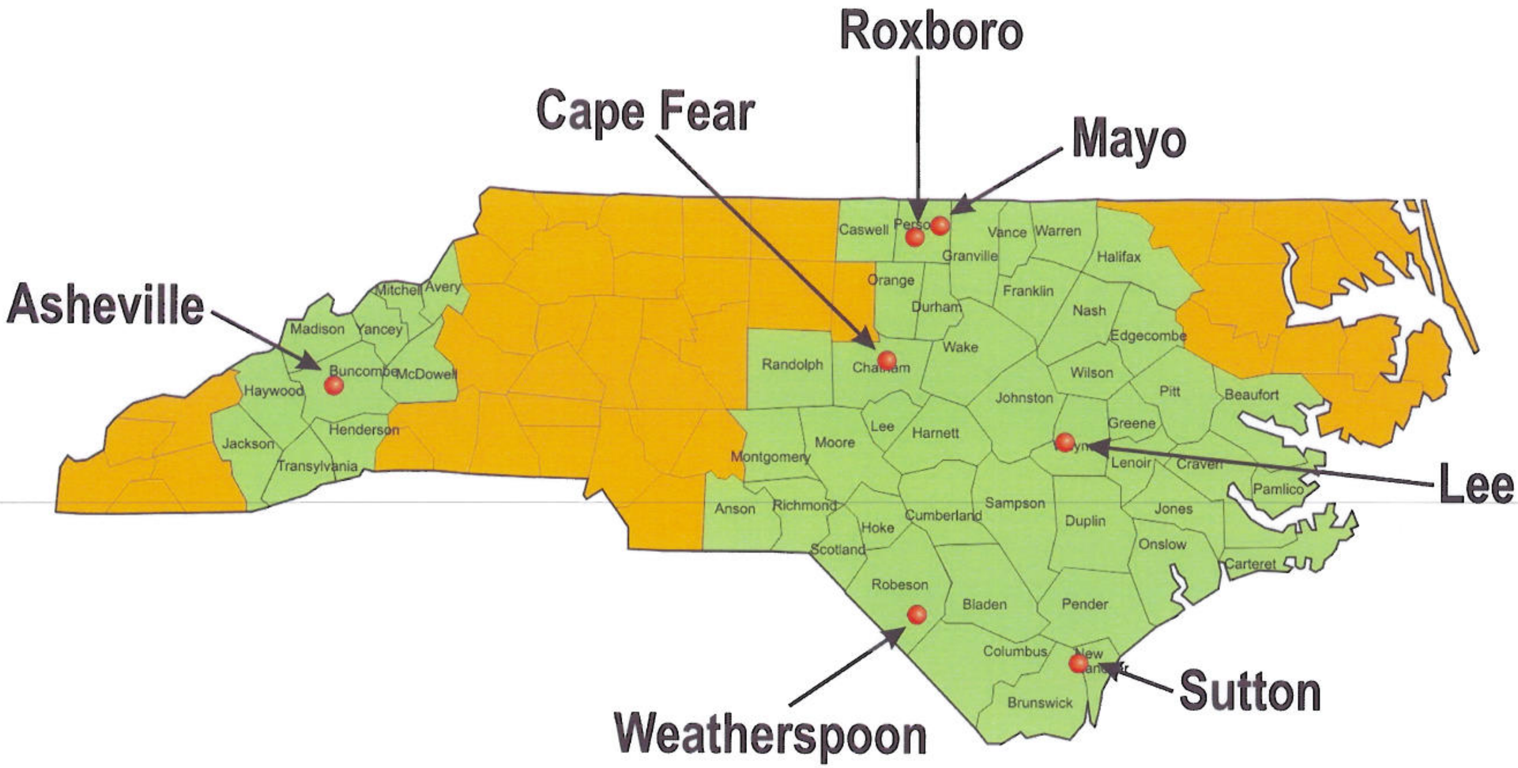
A contract has been executed with a gypsum product end-user that will construct a facility near the Roxboro Plant to use the synthetic gypsum produced by the Roxboro and Mayo Plants for the manufacture of drywall products. PEC also has entered into an agreement that enables PEC to sell synthetic gypsum produced at the Asheville Plant.

We regularly review and refine our compliance strategy, weighing a number of factors such as system load projections, new natural gas supply, natural gas-fired generation options, coal unit retirements, updated load and energy forecasts, updated fuel costs, updated capital and operating costs, and federal and state environmental legislative and regulatory developments. As a result of recent resource planning studies taking all of these drivers into account, PEC has determined that retirement of a coal-fired plant and replacement of that plant with a combined-cycle natural gas-fired unit represents a cost-effective resource plan for our system. Accomplishing this retirement and replacement by 2013 eliminates the need for a sulfur dioxide scrubber on Sutton Unit 3 in order to comply with the 2013 Clean Smokestacks Act limits.

With this plan, additional controls are not needed at Sutton 3 to meet the 2013 Clean Smokestacks Act limits, therefore that unit is no longer shown in Appendix B and the compliance costs have been reduced accordingly.

Attachment 3 details PEC's North Carolina coal-fired electric generating units, their summer net generation capability, installed SO_2 control technologies and those planned for installation. As technologies evolve or other circumstances change, a different mix of controls may be selected. Attachment 3 also projects annual SO_2 emissions on a unit-by-unit basis based on the energy demand forecast and expected efficiencies of the SO_2 emissions controls employed. These projections are based on the planned removal technologies and PEC's current fuel and operating forecasts. This information is provided only to show how compliance may be achieved and is not intended in any way to suggest unit-specific emission limits. Actual emissions for each unit may be substantially different.

Attachment 1: Location of PEC's Coal-Fired Power Plants in North Carolina



Attachment 2: PEC's 2009 NOx Control Plan for North Carolina Coal-fired Units

Unit	MW Rating	Control Technology	Operation Date[1]
Asheville 1	191	LNB/AEFLGR/**SCR**	2007
Asheville 2	185	LNB/OFA/SCR	
Cape Fear 5	144	ROFA/ROTAMIX	
Cape Fear 6	172	ROFA/ROTAMIX	
Lee 1	74	WIR	
Lee 2	77	**LNB**	2006
Lee 3	246	LNB/**ROTAMIX**	2007
Mayo 1	742	LNB/OFA/SCR	
Roxboro 1	369	LNB/OFA/SCR	
Roxboro 2	662	TFS2000/SCR	
Roxboro 3	695	LNB/OFA/SCR	
Roxboro 4	698	LNB/OFA/SCR	
Sutton 1	93	SAS	
Sutton 2	104	**LNB**	2006
Sutton 3	403	LNB/ROFA/ROTAMIX	
Weatherspoon 1	48		
Weatherspoon 2	49		
Weatherspoon 3	75	WIR	
Total	5,027		

AEFLGR – Amine-Enhanced Flue Lean Gas Reburn
LNB = Low NOx Burner
SNCR = Selective Non-Catalytic Reduction
OFA = Overfire Air
ROFA = Rotating Opposed-fired Air
ROTAMIX = Injection of urea to further reduce NOx
WIR = Underfire Air
TFS2000 = Combination Low-NOx Burner/Overfire Air
SAS = Separated Air Staging

[1] This is the operation date for the control technology installed to comply with the North Carolina Improve Air Quality/Electric Utilities Act only (shown in bold).

Attachment 3: PEC's 2009 SO_2 Control Plan for North Carolina Coal-Fired Units

Unit	MW Rating	Technology	Operation Date	Projected SO_2 Tons, 2009[1]	Projected SO_2 Tons, 2013
Asheville 1	191	Scrubber	2005	1,003	316
Asheville 2	185	Scrubber	2006	770	286
Cape Fear 5	144			4,829	5,910
Cape Fear 6	172			6,705	6,186
Lee 1	74	Retirement	2013	2,086	0
Lee 2	77	Retirement	2013	2,325	0
Lee 3	246	Retirement	2013	8,369	0
Mayo 1	742	Scrubber	2009	5,232	1,969
Roxboro 1	369	Scrubber	2008	1,341	884
Roxboro 2	662	Scrubber	2007	2,687	1,203
Roxboro 3	695	Scrubber	2008	2,716	1,333
Roxboro 4	698	Scrubber	2007	3,120	1,351
Sutton 1	93			2,428	3,417
Sutton 2	104			2,428	3,992
Sutton 3	403			12,251	13,920
Weatherspoon 1	48			851	1,177
Weatherspoon 2	49			851	1,310
Weatherspoon 3	75			1,947	2,441
Total	5,027			61,938	45,695

[1] Unit by unit emissions are illustrative only and specific emissions limits should not be inferred. Actual emissions in 2009 and 2013 may be different from unit to unit.

Appendix B

PEC Actual Costs Through 2008 and Projected Costs Through 2013

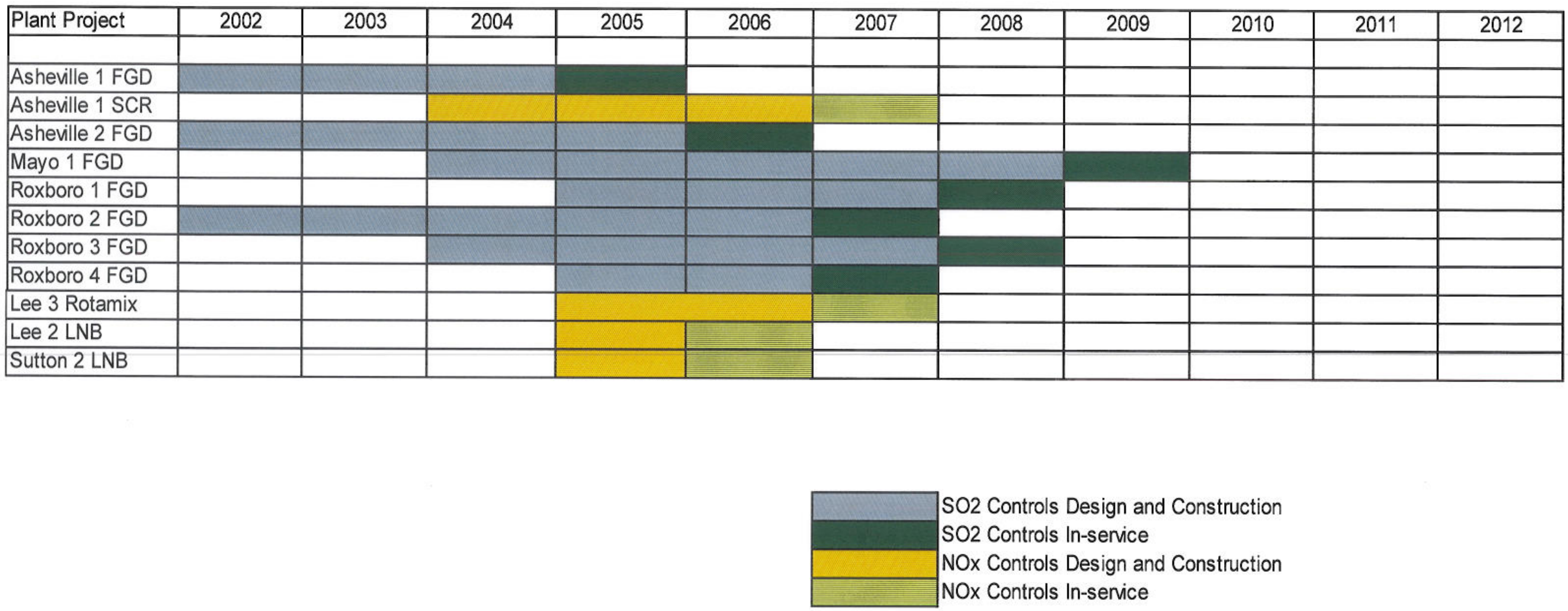
PGN Financial View Cost Net of Power Agency Reimbursement (in thousands)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Asheville 1 FGD	$ 100	$ 9,652	$ 33,574	$ 35,769	$ 3,930	-$ 1,850	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 81,175**
Asheville 1 SCR	$ 0	$ 0	$ 688	$ 1,423	$ 14,608	$ 11,942	-$ 262	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 28,400**
Asheville 2 FGD	$ 100	$ 7,742	$ 28,390	$ 24,238	$ 11,701	-$ 1,543	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 70,629**
Asheville FGD Common	$ 467	$ 0	$ 0	$ 0	$ 0	-$ 479	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**-$ 12**
Mayo 1 FGD	$ 187	$ 0	$ 276	$ 644	$ 22,794	$ 104,886	$ 67,703	$ 24,684	$ 2,596	$ 0	$ 0	$ 0	**$ 223,769**
Roxboro FGD Common	-$ 15	$ 5,560	$ 10,030	$ 51,717	$ 72,934	$ 36,491	-$ 1,360	$ 2,524	$ 0	$ 4,000	$ 0	$ 0	**$ 181,881**
Roxboro 1 FGD	$ 434	$ 0	$ 0	$ 3,135	$ 12,164	$ 32,841	$ 24,905	$ 1,387	$ 0	$ 0	$ 0	$ 0	**$ 74,866**
Roxboro 2 FGD	$ 120	$ 3,574	$ 6,848	$ 30,782	$ 46,014	$ 18,975	-$ 357	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 105,955**
Roxboro 3 FGD	$ 0	$ 0	$ 244	$ 10,628	$ 36,661	$ 49,985	$ 9,006	$ 293	$ 0	$ 0	$ 0	$ 0	**$ 106,817**
Roxboro 4 FGD	$ 0	$ 0	$ 0	$ 9,074	$ 28,550	$ 57,610	$ 1,876	$ 125	$ 0	$ 0	$ 0	$ 0	**$ 97,235**
Lee 3 Rotamix	$ 0	$ 0	$ 0	$ 198	$ 6,424	$ 600	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 7,222**
Lee 2 LNB	$ 0	$ 0	$ 133	$ 273	$ 1,886	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 2,292**
Sutton 2 LNB	$ 0	$ 0	$ 0	$ 236	$ 1,900	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 2,136**
Total without Waste Water	**$ 1,393**	**$ 26,527**	**$ 80,184**	**$ 168,118**	**$ 259,566**	**$ 309,456**	**$ 101,510**	**$ 29,014**	**$ 2,596**	**$ 4,000**	**$ 0**	**$ 0**	**$ 982,364**
Asheville WWT	$ 0	$ 0	$ 0	$ 12,365	$ 1,289	-$ 306	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	**$ 13,348**
Mayo WWT	$ 0	$ 0	$ 0	$ 0	$ 0	$ 4,042	$ 6,604	$ 9,814	$ 719	$ 0	$ 0	$ 0	**$ 21,179**
Roxboro WWT	$ 0	$ 0	$ 0	$ 791	$ 11,965	$ 16,932	$ 5,127	$ 8,532	$ 5,317	$ 2,800	$ 0	$ 0	**$ 51,464**
Total Waste Water Treatment	**$ 0**	**$ 0**	**$ 0**	**$ 13,156**	**$ 13,253**	**$ 20,668**	**$ 11,732**	**$ 18,346**	**$ 6,036**	**$ 2,800**	**$ 0**	**$ 0**	**$ 85,991**
Total NC Smokestacks	**$ 1,393**	**$ 26,527**	**$ 80,184**	**$ 181,273**	**$ 272,819**	**$ 330,124**	**$ 113,242**	**$ 47,360**	**$ 8,632**	**$ 6,800**	**$ 0**	**$ 0**	**$ 1,068,355**
Total Estimated AFUDC							**$ 6,148**	**$ 2,780**	**$ 118**	**$ 0**	**$ 0**	**$ 0**	**$ 9,047**

Notes:

1. Historic year costs are actual, current year costs are projected, and future year costs are escalated
2. Costs reflect the Power Agency contribution

Appendix C
PEC's Clean Smokestacks Act Compliance Plan



Appendix N

Contingency Measures Documentation

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1 Introduction

Section 172(c)(9) requires that the nonattainment State Implementation Plan (SIP) contain specific measures that would take effect upon a State's failure to attain the fine particulate matter ($PM_{2.5}$) standard in a given area. These contingency measures must be fully adopted rules or control measures that are ready to be implemented quickly upon failure to meet the standard by the attainment date. Additionally, the contingency measures must be beyond the modeled controls needed to demonstrate attainment of the standard. Finally, the SIP should contain trigger mechanisms for the contingency measures, specify a schedule for implementation, and indicate that the measures will be implemented without further action by the State or by the United States Environmental Protection Agency (USEPA).

In the April 25, 2007, Clean Air Fine Particle Implementation Rule (72 FR 20586), the USEPA stated that the measures should provide for emission reductions equivalent to about one year of reductions needed for Reasonable Further Progress (RFP). However, since North Carolina is able to model attainment of the $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) within five years of designation, RFP is not required. The USEPA's guidance to the North Carolina Division of Air Quality (NCDAQ) was to have contingency measures that amounted to one-seventh of the emission reductions that occurred between the base year 2002 and the attainment year 2009, or approximately one year's worth of emission reductions.

The NCDAQ modeled the emission reductions that occurred as a result of the North Carolina Clean Smokestacks Act (CSA) legislation, which requires coal-fired power plants in North Carolina to reduce annual sulfur dioxide (SO_2) emissions by 49% by 2009 and by 74% by 2013 and to reduce the annual nitrogen oxides (NO_x) emissions by 78% by 2009. These emission reductions went well beyond what was needed to attain the annual $PM_{2.5}$ NAAQS of 15.0 microgram per cubic meter ($\mu g/m^3$), evident by the predicted future design values being over 1.5 $\mu g/m^3$ below the $PM_{2.5}$ NAAQS. Therefore, the NCDAQ thought it was unreasonable to require contingency measures of such a large quantity when the State had already reduced a significant amount of the precursor pollutants throughout the State.

Another suggestion by the USEPA was to do sensitivity modeling to determine approximately the level of emission reductions needed to model 15.0 $\mu g/m^3$ and use one-seventh of this emission reduction level to determine the amount of contingency measures needed. The NCDAQ did not believe it was a wise use of State resources to perform further modeling when both nonattainment areas have already attained the annual $PM_{2.5}$ NAAQS.

Therefore, the NCDAQ has documented the expected 2009 utility emissions, based on the latest CSA compliance plans, which go beyond what was modeled in the attainment demonstration, as well as the estimated emission reductions expected in 2010. All of these emission reductions will take place without further action from the State. Since the purpose of the contingency measures is to provide for the implementation of measures in the event an area fails to attain the NAAQS, the NCDAQ believes it has met the spirit of this requirement.

2 Region for Contingency Measures

Since the most significant man-made emissions contributor to $PM_{2.5}$ formation in North Carolina is the precursor pollutant SO_2, the NCDAQ has elected to have only SO_2 contingency measures. Under the section for RFP in the Implementation Rule, geographic coverage of emission sources is discussed (72 FR 20636). Due to the regional nature of $PM_{2.5}$, it makes senses that sources of SO_2 outside of the nonattainment area may be impacting the $PM_{2.5}$ concentrations in the nonattainment area. Therefore, the USEPA is allowing states to consider emission reductions from emission sources up to 200 kilometer (km) beyond the nonattainment area for contingency measures. The NCDAQ has elected to go beyond the nonattainment areas for its contingency measure plan.

For the Hickory nonattainment area's contingency measures, the NCDAQ has elected to include all counties that are within, or bisected by, a 75 km circle from the nonattainment area boundary. Figure 2-1 displays the region that contingency measures are being considered for the Hickory nonattainment area. The yellow and blue lines represents a 75 km and 200 km radius, respectively, from the nonattainment area boundary. The emissions from all counties that are shaded are considered in the analysis. For simplicity, these counties will be referred to as the region of influence for the Hickory nonattainment area.

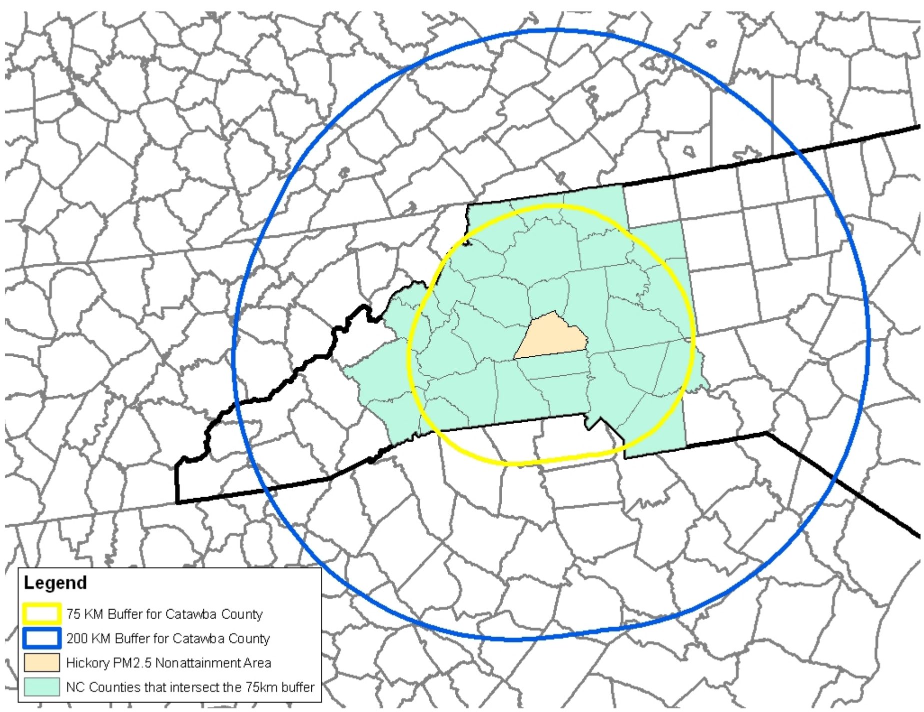

Figure 2-1. The shaded counties represent the region where SO_2 contingency measures were considered for the Hickory nonattainment area.

Similarly, for the Greensboro/Winston-Salem/High Point nonattainment area (referred to as the Triad area), all counties within, or bisected by, a 75 km circle from the nonattainment area boundary are considered for contingency measures. Figure 2-2 displays the region that contingency measures are being considered for the Triad nonattainment area. Again, the yellow and blue lines represents a 75 km and 200 km radius, respectively, from the nonattainment area boundary. The emissions from all counties that are shaded are considered in the analysis. For simplicity, these counties will be referred to as the region of influence for the Triad nonattainment area.

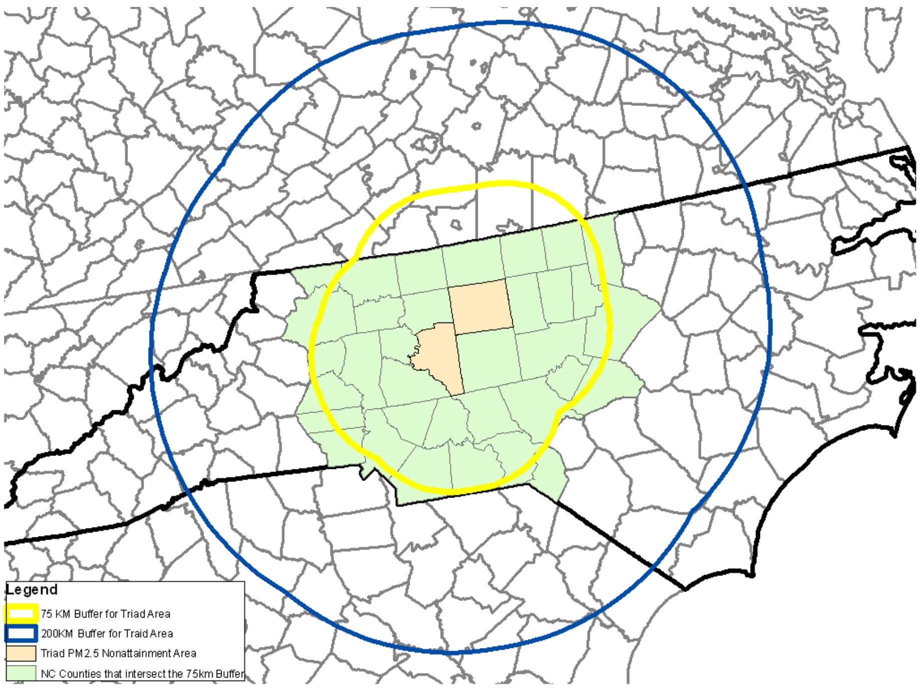

Figure 2-2. The shaded counties represent the region where SO_2 contingency measures were considered for the Triad nonattainment area.

3 2002 Baseline SO_2 Emissions

Table 3-1 displays the 2002 baseline SO_2 emissions, by source sector, for the counties located within the region of influence for the Hickory nonattainment area. The total 2002 baseline SO_2 emissions for the region of influence is 215,080 tons per year. Table 3-2 displays the 2002 baseline SO_2 emissions, by source sector, for the counties located within the region of influence for the Triad nonattainment area. The total 2002 baseline SO_2 emissions for the region of influence is 401,290 tons per year.

Table 3-1 2002 Baseline SO2 Emissions For Hickory Region of Influence

County	Point	Non-road Mobile	Area	Highway Mobile
Alexander	4.0	17.4	23.5	28.2
Alleghany	0.3	8.8	13.0	10.7
Ashe	22.0	16.8	31.1	29.2
Avery	12.2	15.7	43.7	24.3
Buncombe	17,031.5	137.5	235.0	278.4
Burke	242.3	36.9	70.5	166.6
Cabarrus	2,081.4	126.9	57.0	233.2
Caldwell	37.8	34.3	56.9	101.5
Catawba	82,371.7	99.7	91.5	259.8
Cleveland	172.4	54.6	88.9	119.8
Davidson	408.0	101.7	97.5	229.9
Davie	16.0	24.3	24.7	75.4
Forsyth	3,784.3	157.6	244.0	455.3
Gaston	54,597.3	106.2	90.8	296.1
Henderson	1.7	58.2	62.2	105.4
Iredell	539.6	102.4	108.2	323.6
Lincoln	17.8	42.5	68.5	90.4
Mc Dowell	50.7	55.5	32.2	88.9
Mecklenburg	867.7	836.8	356.5	1,122.0
Mitchell	23.6	42.9	21.1	16.2
Polk	1.2	11.1	28.2	41.7
Rowan	10,600.6	86.6	116.1	229.0
Rutherford	29,902.4	45.0	47.3	71.8
Stanly	1,654.0	39.2	40.9	92.0
Surry	320.5	36.2	55.2	125.5
Union	169.1	187.0	62.5	170.7
Watauga	40.1	46.3	85.0	47.6
Wilkes	95.1	26.6	83.8	82.6
Yadkin	7.0	21.3	28.2	72.0
Yancey	5.3	26.6	29.5	18.9
Total	205,077.6	2,602.6	2,393.5	5,006.7

Table 3-2 2002 Baseline SO2 Emissions For Triad Region of Influence

County	Point	Non-road Mobile	Area	Highway Mobile
Alamance	23.9	77.2	75.6	210.8
Alexander	4.0	17.4	23.5	28.2
Alleghany	0.3	8.8	13.0	10.7
Anson	172.1	36.8	20.3	39.4

Table 3-2 2002 Baseline SO2 Emissions For Triad Region of Influence

County	Point	Non-road Mobile	Area	Highway Mobile
Cabarrus	2,081.4	126.9	57.0	233.2
Caswell	0.0	17.4	18.9	27.1
Catawba	82,371.7	99.7	91.5	259.8
Chatham	11,871.7	55.2	42.3	99.9
Davidson	408.0	101.7	97.5	229.9
Davie	16.0	24.3	24.7	75.4
Durham	593.3	215.6	117.3	337.8
Forsyth	3,784.3	157.6	244.0	455.3
Gaston	54,597.3	106.2	90.8	296.1
Granville	1.5	49.6	33.6	117.6
Guilford	282.2	376.3	231.8	675.2
Harnett	0.0	72.4	62.1	107.0
Iredell	539.6	102.4	108.2	323.6
Lee	90.7	45.3	31.1	64.8
Lincoln	17.8	42.5	68.5	90.4
Mecklenburg	867.7	836.8	356.5	1,122.0
Montgomery	54.2	18.8	31.8	46.8
Moore	14.7	48.9	54.3	87.1
Orange	148.6	96.0	122.9	247.7
Person	126,780.3	23.2	40.8	33.8
Randolph	3.0	66.4	88.1	218.2
Richmond	64.8	47.4	37.9	65.5
Rockingham	5,290.8	56.4	66.6	109.3
Rowan	10,600.6	86.6	116.1	229.0
Scotland	252.1	31.9	46.1	48.0
Stanly	1,654.0	39.2	40.9	92.0
Stokes	83,483.9	24.7	45.8	43.9
Surry	320.5	36.2	55.2	125.5
Union	169.1	187.0	62.5	170.7
Wake	76.4	657.4	346.1	961.5
Wilkes	95.1	26.6	83.8	82.6
Yadkin	7.0	21.3	28.2	72.0
Total	386,738.6	4,038.1	3,075.3	7,437.8

4 Contingency Measures

As stated above, the NCDAQ has elected to have only SO_2 contingency measures. As can be seen in Tables 3-1 and 3-2, the vast majority of the SO_2 emissions come from point sources (approximately 96%). Therefore, the NCDAQ only looked at the point source sector for emissions reductions, and specifically the coal-fired power plants since they make up the majority of the point source SO_2 emissions.

In June 2002, the North Carolina General Assembly enacted the CSA, requiring coal-fired power plants to reduce annual SO_2 emissions by 49% by 2009 and 74% by 2013. Additionally, this legislation required reductions in annual nitrogen oxide emissions. One of the first state laws of its kind in the nation, this legislation provides a model for other states in controlling multiple air pollutants from older coal-fired power plants. The reduction in emissions achieved through the CSA are not allowed to be traded in the National emissions trading program, but rather are held in trust by the citizens of North Carolina.

Since the first phase-in year is 2009, which coincides with the attainment year for the $PM_{2.5}$ nonattainment areas, some of the SO_2 reductions expected from the CSA were modeled as part of the attainment demonstration. However, not all of the units expecting to have controls operational in 2009 were modeled at full compliance. Additionally, one facility's controls will be fully implemented during the middle of 2010. Since these additional emission reductions were not modeled as part of the attainment demonstrations and will take place in 2010 without further action from the State or the USEPA, they can be considered as contingency measures. Additionally, when the attainment demonstration modeling project started, the latest compliance plan for CSA was the 2006 plan. The utility companies now have a better understanding of what the SO_2 emissions will be in 2009 and are reflected in the 2009 CSA compliance plan. The difference between the emissions modeled and the current expectations for the 2009 emissions are further emission reductions that are expected to occur that were not modeled as part of the attainment demonstration.

All the Duke Energy and Progress Energy units that are in the area of influence for both nonattainment areas were reviewed to determine the difference in the 2009 emissions modeled and the current expectation based on the latest CSA compliance plan. The units that were considered for the analysis of emission reductions to occur in 2010 include:

- Duke Energy Allen Steam Station, units 1 through 5, located in Gaston County;
- Duke Energy Cliffside, unit 5, located in Rutherford County; and
- Progress Energy Mayo, unit 1, located in Person County.

The table below shows the 2009 emissions modeled based on the 2006 CSA compliance plan, the expected 2009 emissions based on the latest CSA compliance plan and the difference between them. The 2006 CSA compliance plan is attached to this appendix and the 2009 CSA compliance plan can be found in Appendix M.

Table 4-1 Comparison of Modeled 2009 Emissions to Expected 2009 Emissions

Unit	Area of Influence	2009 Modeled Emissions	Expected 2009 Emissions	Difference
Duke Energy Facilities				
Allen Unit 1	Both Areas	2,659	1,336	-1,323
Allen Unit 2		2,488	1,842	-646
Allen Unit 3		9,864	5,694	-4,170
Allen Unit 4		10,746	6,556	-4,190
Allen Unit 5		4,215	4,333	118
Belews Unit 1	Triad Area	5,927	5,476	-451
Belews Unit 2		4,579	4,535	-44
Buck Unit 3	Both Areas	1,542	1,017	-525
Buck Unit 4		983	642	-341
Buck Unit 5	Both Areas	4,412	4,472	60
Buck Unit 6		4,410	4,784	374
Dan River Unit 1	Triad Area	2,184	1,919	-265
Dan River Unit 2		2,336	2,081	-255
Dan River Unit 3		5,202	5,062	-140
Cliffside Unit 1	Hickory Area	1,170	488	-682
Cliffside Unit 2		1,198	469	-729
Cliffside Unit 3		2,243	1,385	-858
Cliffside Unit 4		2,213	1,414	-799
Cliffside Unit 5		31,193	28,476	-2717
Marshall Unit 1	Both Areas	1,952	1,742	-210
Marshall Unit 2		1,940	1,742	-198
Marshall Unit 3		3,539	3,439	-100
Marshall Unit 4		3,333	3,354	21
Riverbend Unit 4	Both Areas	3,635	3,344	-291
Riverbend Unit 5		3,641	3,219	-422
Riverbend Unit 6		5,799	5,320	-479
Riverbend Unit 7		5,942	5,260	-682
Progress Energy Facilities				
Asheville Unit 1	Hickory Area	864	1,003	139
Asheville Unit 2		886	770	-116
Cape Fear Unit 5	Triad Area	6,249	4,829	-1,420
Cape Fear Unit 6		7,725	6,705	-1,020
Mayo Unit 1	Triad Area	14,361	5,232	-9,129
Roxboro Unit 1	Triad Area	1,741	1,341	-400
Roxboro Unit 2		2,853	2,687	-166
Roxboro Unit 3		2,928	2,716	-212
Roxboro Unit 4		2,363	3,120	757
Total Emissions		169,315	137,804	-31511

This difference of 31,511 tons per year of SO_2 emissions represents emissions that were not modeled but are expected to occur in 2009 within the area of influences of the two nonattainment areas combined. The expected versus modeled SO_2 emissions will be 25,749 tons per year lower within the Triad's area of influence and 18,766 tons per year lower within the Hickory's area of influence.

To estimate the additional amount of SO_2 emissions that will be reduced in 2010, the 2009 annual SO_2 emissions that were listed in the 2009 CSA compliance plan were subtracted from the 2013 annual emissions. For the unit that the control equipment is expected to come on-line in the middle of 2010, only a half-year compliance was considered, i.e., half of the controlled emissions plus half of the uncontrolled emissions. The 2013 annual emissions represent full implementation of the control measures and is a conservative surrogate for estimating 2010 SO_2 emissions since 2013 energy demands will be higher than 2010 and therefore the expected emissions for 2013 will be slightly higher than 2010. Table 4-2 displays the expected compliance period, the expected 2009 emissions, the estimated 2010 emissions, area impacted and the estimated emission reductions for the units considered for the contingency measures.

Table 4-2 Estimated Emission Reductions Expected from Clean Smokestacks Act

Unit	Compliance Period	Area of Influence	2009 SO2 (tons/year)	2010 SO2 (tons/year)	Reductions (tons/year)
Allen –1	Early 2009	Both areas	1,336	660	- 676
Allen – 2	Early 2009		1,842	644	-1,198
Allen – 3	Late 2009		5,694	1,239	-4,455
Allen – 4	Late 2009		6,556	1,321	-5,235
Allen – 5	Mid 2009		4,333	1,134	-3,199
Cliffside – 5	Mid 2010	Hickory	28,476	15,667	-12,809
Mayo – 1	Late 2009	Triad	5,232	1,969	-3,263

To demonstrate that the expected emission reductions have an impact on the nonattainment areas, the NCDAQ relied on the back trajectory analysis that was done for the $PM_{2.5}$ nonattainment boundary recommendation package. For the details of how these trajectory analyses were created, please refer to the documentation used for the boundary recommendation package attached to this appendix.

Figure 4-1 displays the location of the utilities subject to the CSA. Figures 4-2 and 4-3 displays the back trajectory analysis for the Hickory and Lexington $PM_{2.5}$ monitors, respectively. The back trajectories were overlaid on a map with the utility locations displayed with red dots. It is clear from these figures that the air masses pass over or near large utility plants on days when high $PM_{2.5}$ levels were observed at the monitors.

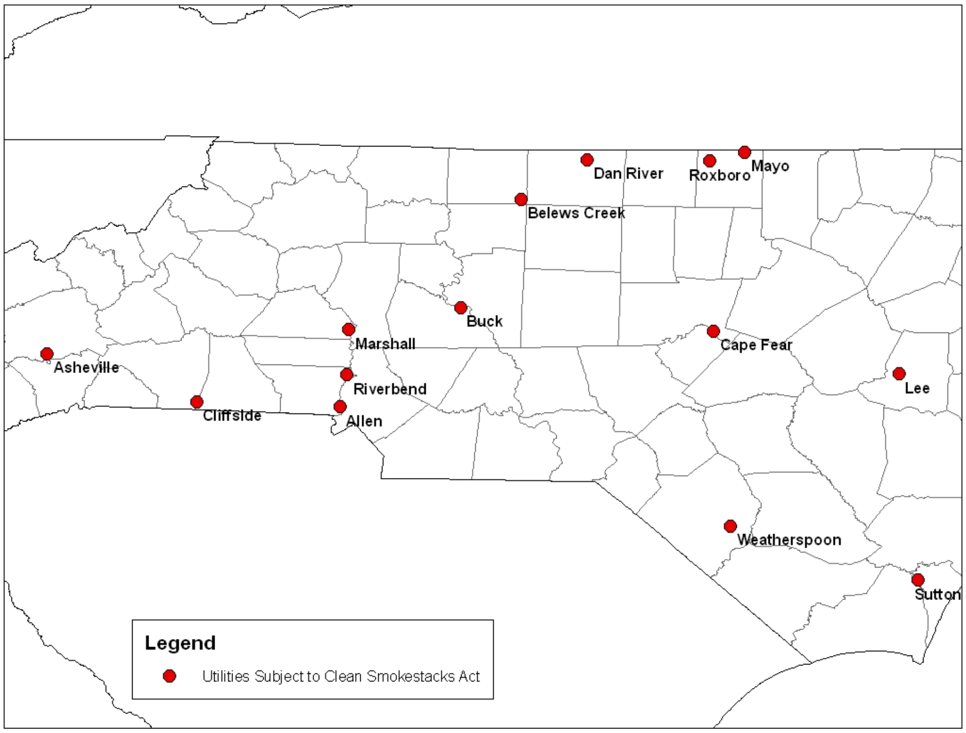

Figure 4-1. Location of the Utilities Subject to the CSA.

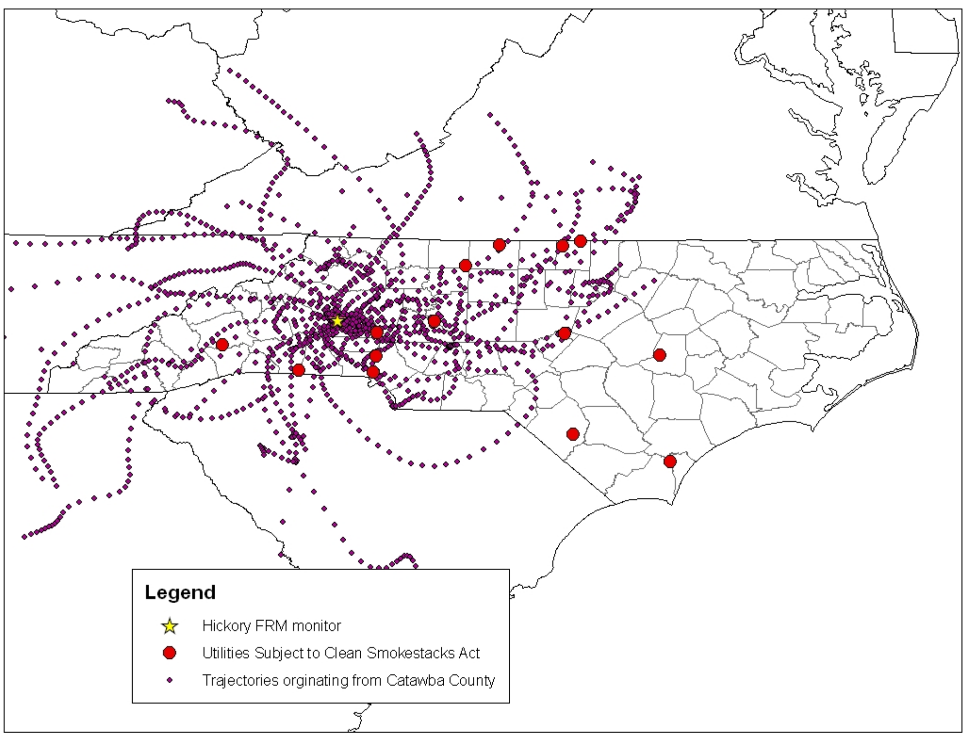

Figure 4-2. Back Trajectory Analysis for Hickory $PM_{2.5}$ Monitor.

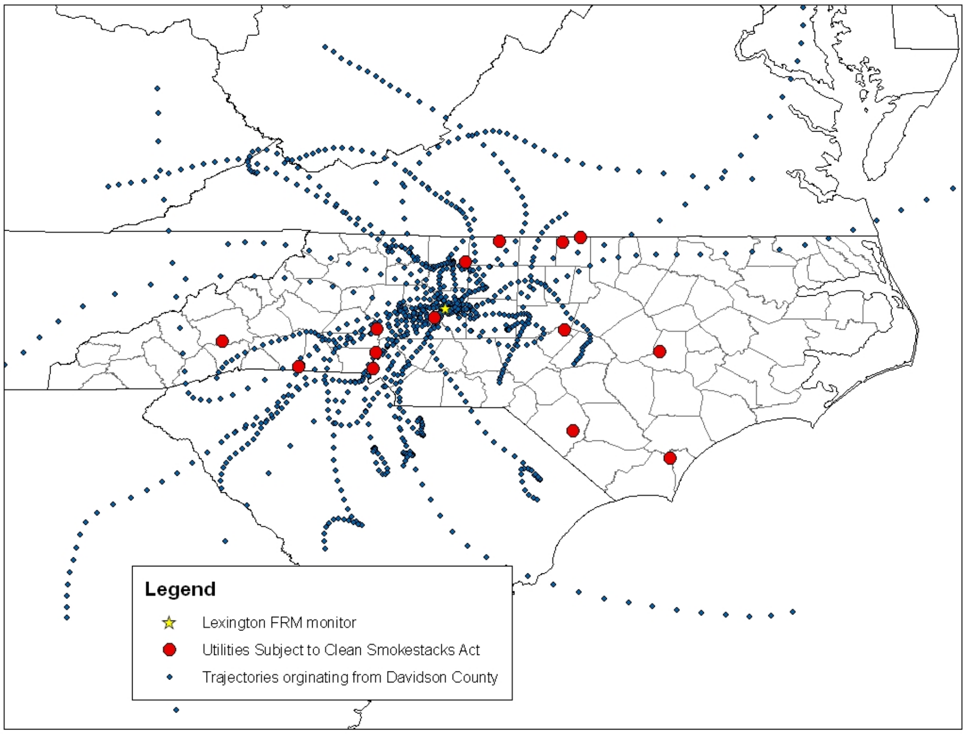

Figure 4-3. Back Trajectory Analysis for Lexington $PM_{2.5}$ Monitor.

4.1 Hickory Area Contingency Measure Reductions

In order to estimate the total emission reductions from point sources in 2010, the other point sources located within the region of influence had to be grown from 2009 to 2010. The NCDAQ estimated that the other point sources within the region of influence would grow approximately 50 tons.

The total reduction that is expected beyond the emissions that were modeled in the attainment demonstration is 18,766 tons in 2009 emissions and approximately 27,500 tons per year that are expected to occur between 2009 and 2010, for a total of over 46,000 tons per year of SO_2 emissions reduced. This is approximately a twenty-two percent reduction from the 2002 baseline SO_2 emissions for the Hickory region of influence, which is a significant reduction of emissions. This reduction in emissions beyond what was modeled should satisfy the contingency measure requirement for this nonattainment area.

4.2 Triad Area Contingency Measure Reductions

Again, in order to estimate the total emission reductions from point sources in 2010 for the Triad region of influence, the other point sources located within the region of influences had to be grown from 2009 to 2010. The NCDAQ estimated that the other point sources within the region of influence would grow approximately 85 tons.

The total reduction that is expected beyond the emissions that were modeled in the attainment demonstration is 25,749 tons in 2009 emissions and approximately 18,000 tons per year that are expected to occur between 2009 and 2010, for a total of over 43,000 tons per year of SO_2 emissions reduced. This is approximately an eleven percent reduction from the 2002 baseline SO_2 emissions for the Triad area of influence, which again is a significant reduction of emissions. This reduction in emissions beyond what was modeled should satisfy the contingency measure requirement for this nonattainment area.

5 Conclusions

The NCDAQ believes that existing control measures required by the North Carolina Clean Smokestacks Act results in a sufficient amount of SO_2 emission reductions to adequately meet the contingency measure requirements of Section 172(c)(9). The Hickory area is expected to achieve over 46,000 tons per year of SO_2 reduction and the Triad area is expected to achieve over 43,000 tons per year SO2 reductions. Considering the purpose of contingency measures is to require further emission reductions in case a nonattainment area does not attain the NAAQS by the prescribed attainment date and both nonattainment areas in have already attained the $PM_{2.5}$ NAAQS, the NCDAQ firmly believes that North Carolina has more than fulfilled the contingency measure requirement.

Attachment 1

2006 Clean Smokestacks Act Compliance Plan

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Duke Power.
A Duke Energy Company

George T. Everett, Ph.D.
Director, Environmental/Legislative Affairs

919-235-0955
gteverett@duke-energy.com

March 30, 2006

Ms. Geneva S. Thigpen, Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, NC 27699-4325

2006
Clerk's Office
N.C. Utilities Commission

Subject: Docket No. E-7, Sub 718
Duke Power Compliance Plan Annual Update NO_x Control

Record No. NC CAP 005

Dear Ms. Thigpen:

Duke Power is required by Senate Bill 1078 to file information on or before 1 April of each year to update the Commission on progress to date, upcoming activities and expected strategies to achieve the emissions limitations set out in G.S. 143-215.107D. Enclosed for filing are the original and thirty (30) copies of Duke Power's Compliance Plan Annual Update for 2006 that fully describe the company's efforts to comply with this clean air legislation.

The current plan to meet the emission requirements for NO_x and SO_2 includes:

NO_x Control – The installation of Selective Catalytic Reduction (SCR) on Cliffside Steam Station Unit 5 and Belews Creek Steam Station Units 1&2 has been completed. Our NOx plans include installation of Selective Non-Catalytic Reduction (SNCR) at 15 units, and burner work at our remaining sites with the exception of Cliffside Units 1-4. With these installations, Duke can demonstrate compliance with our 2007 and 2009 NOx caps under Senate Bill 1078.

SO_2 Control – The installation of wet scrubbers on our twelve largest generating units continues to be our plan. We have worked with the Department of Environment and Natural Resources on a plan to accelerate the scrubber installation schedule at Plant Allen. Acceleration of the Allen scrubbers maintains our design and construction continuity and helps assure Duke Power can meet the recently finalized Clean Air Interstate Rule. Costs for our scrubber projects have gone up at Plant Allen due to increases in material (steel and petroleum-based products) and labor costs. Explanations for these increases have been shared with the Public Staff.

Exhibits A and B outline current unit specific technology selections, projected operational dates, expected emission rates, and the corresponding tons of emissions that demonstrate compliance with the legislative requirements to the best of Duke Power's knowledge at this time. The projected estimates of 'environmental compliance costs' for these pollution control projects are included in Exhibit C.

Duke Power will continue to examine the technology selection, implementation schedule and associated costs. Annual updates will be provided to the NC Utilities Commission as required. If you have questions regarding any aspect of our plan, please do not hesitate to contact my office at 919-235-0955.

Sincerely,

George T. Everett

George T. Everett, Ph.D.
Director, Environmental/Legislative Affairs
Duke Power

Enclosures

cc: Robert P. Gruber
Executive Director – Public Staff
4326 Mail Service Center
Raleigh, NC 27699-4326

Duke Power Company

General Assembly of North Carolina Session 2001
Senate Bill 1078 – Improve Air Quality/Electric Utilities (NC Clean Air Legislation)
2006 Annual Data Submittal

1. A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.

Exhibits A and B outline the plan as of this date for technology selections by facility and unit, projected operational dates, expected emission rates, and the corresponding tons of emissions that demonstrate compliance with the provisions of G.S. 143-215.107D. Changes to the expected plan for meeting these emissions limitations as compared to past compliance plans are highlighted in these exhibits and described below:

<u>NO_x Compliance</u>

- Technology Change – The Dan River Unit 3 SNCR project has been deleted from the plan because of the expected high cost to install and operate a single unit SNCR system.
- Schedule Changes – Numerous project schedule changes are included in this 2006 update:
  - The Buck Units 3&4 Burner projects were accelerated from 2008 to the spring of 2007 to better support compliance with the Phase I cap of 35,000 tons per year.
  - The Buck Unit 5 SNCR project was accelerated to the fall of 2006 to better align with the Buck Unit 6 SNCR schedule and allow for the most effective outage and work sequencing.
  - The Dan River Units 2&3 Burner projects were delayed until the fall of 2006 because of the elimination of the pollution control project (PCP) exemption in July 2005 and its effect on the permitting process.
  - The Riverbend Unit 4 SNCR project was accelerated to the spring of 2007 for outage optimization and to better support compliance with the Phase I cap of 35,000 tons per year.
  - The Riverbend Units 6&7 SNCR projects were accelerated to the fall of 2006 for outage optimization.
- Rate Changes – Expected rates have been adjusted in this 2006 update based on 2005 operational performance, project schedule changes and other factors:
  - Allen Units 1-5 expected rates were adjusted based on 2005 ozone season performance; Allen Units 1&3 SNCR operation demonstrated that 0.16 could be achieved with system optimization.
  - The Belews Creek Units 1&2 expected rates were also lowered based on 2005 ozone season results.
  - The Buck Units 3&4 rates were adjusted as a result of the Burner project accelerations.

- Buck Units 5&6 expected rates were lowered based on 2005 ozone season performance along with SNCR equipment guarantees.
- Cliffside Units 1&2 expected rates increased based on 2005 ozone season performance.
- The Cliffside 5 expected rate decreased slightly based on 2005 ozone season performance of the SCR equipment.
- The Dan River Unit 2 expected rate was adjusted slightly based on expected performance.
- The Dan River Unit 3 expected rate was changed based on expected performance of the burner equipment, the burner outage schedule and the deletion of the SNCR equipment.
- The Marshall Unit 2 expected rate changed due to the timing of the SNCR installation outage and 2005 ozone season performance.
- The Marshall Units 3&4 expected rates changed based on the 2005 ozone season performance and the current SNCR installation outage schedule; the 2009 expected rates for these units reflect expected further optimization of the SNCR equipment.
- The Riverbend expected rates were adjusted based on the SNCR installation schedule changes and lower SNCR equipment guarantees.

Because the expected 2009 NO_x emissions are so close to the 31,000 ton limit, Duke will continue to evaluate options to improve performance, including the addition of SCR on Marshall Unit 3 and reconsideration of a Dan River Unit 3 SNCR system.

<u>SO_2 Compliance</u>

- New Pulverized Coal (PC) Units – This 2006 update includes the proposed addition of two new 800 MW coal units in 2011 and 2012 at the Cliffside Steam Station. The 2013 expected compliance plan includes these units along with the associated retirement of Cliffside Units 1-4 if the new units are put in service.
- Schedule Changes – Both the Belews Creek Unit 2 and Cliffside Unit 5 FGD (Scrubber) operational dates were adjusted in this plan. The Belews Creek Unit 2 operational date has shifted slightly from the fall of 2007 until early 2008; the Cliffside 5 operational date has shifted out to 2010 to better align with the proposed operational dates for the new units.
- Rate Changes – Expected rate changes have been adjusted in this 2006 update based on changes to operational dates and other considerations:
  - The Allen expected rates were adjusted based on the new sequencing of FGD operational dates in 2009; Allen Units 1, 2 & 5 are now expected to be operational in the spring of 2009 and supported by one FGD absorber while Units 4&5 are expected to be operational in the fall of 2009 and supported by the second FGD absorber.
  - The Buck rates were adjusted based on the expected use of a lower sulfur coal
  - The Cliffside rates were adjusted based on the expected use of a higher sulfur coal and the FGD operational date change for Unit 5.

2. **The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed during that year.**

In the 2005 calendar year, Duke Power Company spent $346,420,000 on activities in support of compliance with the provisions of G.S. 143-215.107D. Exact amounts associated with each project are provided in Exhibit C, and a description of the associated activities is provided below:

Allen Steam Station FGD

- Initiated Phase II portion of project including preliminary engineering, project scope development, plant interface studies, contract exhibits and project estimates

Belews Creek Steam Station FGD

- Executed the Engineering, Procurement and Construction (EPC) agreement with the Consortium of ALSTOM Power Inc. and Shaw/Stone & Webster (Alstom/Shaw)
- Mobilized the project's construction management team to the Belews Creek site and initiated construction activities
- Completed the installation of a new fuel oil tank and the removal of the existing fuel oil and elevated water storage tanks from the area planned for the main portions of the FGD system
- Removed the existing hill from the area planned for the main portions of the FGD system (approximately 300,000 cubic yards of soil and rock)
- Initiated construction of the major foundations for the FGD system
- Completed approximately 20% of the overall project (approximately 10% of the construction activities)

Cliffside Steam Station Unit 5 FGD

- Continued preliminary construction planning and development of conceptual site layout

Marshall Steam Station FGD

- Completed fabrication and installation of absorber outlet ducts and flue liners
- Completed site earthwork for gypsum landfill, wetlands (including plantings)
- Completed all remaining major building and equipment foundations including wetlands equalization basin, transformers, switchgear and major tanks
- Completed structural steel erection for absorber, reagent prep, dewatering buildings, transfer towers 1&2, limestone unloading & stackout, and duct support sections 1 through 11
- Completed assembly of ball mills, absorber recycle pumps, hydrocyclones, dewatering belt filters, limestone unloading and major field-erected tanks
- Completed installation of underground piping, above group piping systems and makeup water station tie-ins

- Completed majority of transformers setting, switchgear and underground ductbank work
- Completed majority of material handing equipment installation
- Completed erection of all wastewater treatment tanks and sludge press building

Allen Steam Station SNCR, Unit 2

- Completed preliminary engineering

Allen Steam Station SNCR, Unit 3

- Completed installation of Unit 3 SNCR equipment and supporting plant air equipment

Allen Steam Station SNCR, Unit 4

- Completed detailed engineering and received mechanical, electrical and installation drawings
- Procured material in preparation for 2006 installation

Allen Steam Station SNCR, Unit 5

- Completed preliminary engineering

Buck Steam Station SNCR, Unit 5

- Completed preliminary engineering

Buck Steam Station SNCR, Unit 6

- Completed preliminary engineering

Dan River Steam Station Burners, Unit 2

- Completed detailed engineering and material procurement in preparation for 2006 installation

Dan River Steam Station Classifiers, Unit 2

- Completed installation of advanced static classifier technology in fall of 2005

Dan River Steam Station Burners, Unit 3

- Completed detailed engineering and material procurement in preparation for 2006 installation

Dan River Steam Station Classifiers, Unit 3

- Completed installation of advanced static classifier technology in fall of 2005

Marshall Steam Station SNCR, Unit 1

- Completed detailed engineering and received mechanical, electrical and installation drawings
- Procured material in preparation for 2006 installation

Marshall Steam Station SNCR, Unit 2

- Completed preliminary engineering

Marshall Steam Station SNCR, Unit 3

- Completed installation of SNCR equipment

Marshall Steam Station SNCR, Unit 4

- Continued preliminary engineering and planning for project

Riverbend Steam Station SNCR, Unit 4

- Completed preliminary engineering

Riverbend Steam Station Burners, Unit 5

- Incurred final costs associated with project to install burners on unit in early 2005

Riverbend Steam Station SNCR, Unit 5

- Completed preliminary engineering

Riverbend Steam Station Burners, Unit 6

- Completed installation of SOFA technology on unit in spring of 2005

Riverbend Steam Station Classifiers, Unit 6

- Completed installation of advanced static classifier technology in spring of 2005

Riverbend Steam Station SNCR, Unit 6

- Completed preliminary engineering

Riverbend Steam Station SNCR, Unit 7

- Completed preliminary engineering

3. **The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.**

In the 2005 calendar year, **$311,236,000** was amortized related to construction work activity in support of compliance with the provisions of G.S. 143-215.107D. **$637,429,142** in total has now been amortized for the program through year-end 2005.

4. **An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.**

The estimated 'environmental compliance costs' as defined in G.S. 143-215.107D are provided in Exhibit C. Changes to the expected costs as compared to past compliance plans are highlighted in this exhibit and described below:

- Allen FGD Project – The Allen FGD estimate has increased since 2005 and is attributable to ramp up in the power generation and/or environmental retrofit construction market, and continued escalation of labor costs. The Cliffside 5 FGD estimate is also affected by these issues, but is expected to be offset by savings if this project is executed in conjunction with the proposed construction of new generating units at the Cliffside station.
- SNCR Projects – In addition to the deletion of the Dan River Unit 3 SNCR project, refinement of the SNCR work scope at each location has resulted in a lower overall estimated cost. The most significant change to this scope over the last year has been to remove the Riverbend central reagent (urea) distribution center scope of work and replace with individual station storage and dilution water equipment.
- Dan River Unit 3 Burner Project – The Dan River Unit 3 Burner project experienced some costs increases estimated at $470,000 due to the delay in installation discussed above.

5. **A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.**

<u>Belews Creek Steam Station FGD</u>

- NPDES Permit Modification – Submitted 6/30/04; received 5/16/05
- Initial Erosion Control Permit – Submitted 2/4/05; received 3/7/05
- Landfill Site Suitability Application – Submitted 3/30/05; expect Site Suitability by April 2006
- Air Permit Application for Belews Creek FGD project – Submitted 4/18/05; received 2/6/06
- Request to revise NPDES Permit to include FGD wastewater – Submitted 6/30/04; received permit revision 5/16/05
- Authorization to Construct (ATC) application for Wastewater Treatment System – Submitted 7/21/05; received 12/27/05
- Authorization to Construct (ATC) application for Constructed Wetlands – Submitted 7/21/05; expect final permit April 2006
- Revised Landfill Construction Plan Application – Submitted 9/30/05; expect permit July 2006
- Air Permit – Notice of Intent to Construct – Submitted 10/11/05; received 10/24/05
- NOTE: Revisions to Erosion Control Permit submitted on various dates; most recent revised permit received 12/20/05

Cliffside Steam Station Unit 5 FGD

- Air Permit Application – Submitted 12/16/05
- NOTE: A complimentary PSD permit application was submitted on this same 12/16/05 date for the proposed new generating units at the Cliffside site. If this associated PSD air permit is not approved or withdrawn, it will be necessary to submit a revised Air Permit Application for a standalone Unit 5 FGD.

Marshall Steam Station FGD

- Landfill Construction Plan Application – Submitted 4/1/04; received 2/4/05
- Sedimentation and Erosion Control Plan Permits
  - Limestone/Gypsum Conveyor – Submitted 6/17/04; received 7/9/04
  - Limestone/Gypsum Conveyor Expansion – Submitted 12/15/04; received 12/30/04
  - Constructed Wetland Treatment System – Submitted 7/26/04; received 8/18/04
  - Gypsum Landfill – Submitted 3/31/04; received 4/21/04
- Authorization to Construct (ATC) application for Solids Removal System – Submitted 11/19/04; received 12/22/04
- Authorization to Construct (ATC) application for Constructed Wetlands – Submitted 5/21/04; received 8/10/04

Allen Steam Station SNCR, Unit 3

- Air Permit Application – Submitted 7/15/04; Received 2/5/05

Allen Steam Station SNCR, Unit 4

- Air Permit Application – Submitted 7/15/05; Received 1/15/06

Marshall Steam Station SNCR, Unit 1

- Air Permit Application – Submitted 9/18/05; Received 12/20/05

Marshall Steam Station SNCR, Unit 2

- Air Permit Application – Submitted 9/18/05; Received 12/20/05

Marshall Steam Station SNCR, Unit 3

- Air Permit Application – Submitted 5/14/04; Received 10/13/04

Riverbend Steam Station SNCR, Unit 4

- Air Permit Application – Submitted 3/20/05; Received 8/1/05

Riverbend Steam Station Burners, Unit 5

- Air Permit Application – Submitted 4/2/04; Received 4/30/04

Riverbend Steam Station SNCR, Unit 5

- Air Permit Application – Submitted 3/20/05; Received 8/1/05

Riverbend Steam Station Burners, Unit 6

- Air Permit Application – Submitted 5/14/03; Received September 2003

Riverbend Steam Station SNCR, Unit 6

- Air Permit Application – Submitted 11/5/05; Received 1/1/06

Riverbend Steam Station SNCR, Unit 7

- Air Permit Application – Submitted 11/5/05; Received 1/1/06

6. A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.

Allen Steam Station FGD

- Finalize EPC agreement with the Alstom/Shaw consortium
- Relocate existing plant services including ash sluice lines, diesel oil tank, electrical and potable water lines
- Relocate existing rail spurs and switches
- Construct new FGD entrance road from state highway
- Begin earthwork and grading for project, including initial site clearing
- Begin installation of piles and foundations
- Install new ductwork tie-ins to Unit 2

Belews Creek Steam Station FGD

- Complete the construction of the major foundations for the FGD system
- Complete the construction of the concrete shell for the two new chimneys
- Complete all construction on approximately 5% of the sub-systems that make up the total FGD system
- Complete construction of the Constructed Wetlands (part of the wastewater treatment system)
- Initiate commissioning activities on the completed sub-systems of the total FGD system
- Achieve a completion status of 75% on the overall project (65% of construction activities)

Cliffside Steam Station Unit 5 FGD

- Continue engineering study to finalize the project scope, funding and implementation schedule

Marshall Steam Station FGD

- Mobilize large crane for ductwork installation
- Complete initial tie-in of the Unit 4 ductwork and install blanking plate
- Complete ductwork installation using large crane
- Complete construction, turnover and commissioning of Unit 4 and common systems

- Complete final tie-in of the Unit 4 ductwork and removal of blanking plate
- Begin testing and tuning of Unit 4 and common systems
- Achieve Substantial Completion for Unit 4 and common systems
- Complete initial tie-in of the Unit 3 ductwork and install blanking plate
- Complete construction, turnover and commissioning of Unit 3 systems
- Complete final tie-in of the Unit 3 ductwork and removal of blanking plate
- Begin testing and tuning of Unit 3 and common systems
- Achieve Substantial Completion for Unit 3 systems

Allen Steam Station SNCR, Unit 2

- Complete detailed engineering for SNCR equipment and reagent storage
- Begin material procurement activities in support of installation in early 2007
- Complete procurement and construction of reagent storage equipment

Allen Steam Station SNCR, Unit 4

- Complete installation of SNCR equipment, including incremental compressed air and dilution water systems, in time to support 2006 ozone season operation

Allen Steam Station SNCR, Unit 5

- No significant activity expected in 2006

Buck Steam Station Burners, Unit 3

- Complete detailed engineering and material procurement activities in support of installation in early 2007

Buck Steam Station Classifiers, Unit 3

- No significant activity expected in 2006

Buck Steam Station Burners, Unit 4

- Complete detailed engineering and material procurement activities in support of installation in early 2007

Buck Steam Station Classifiers, Unit 4

- No significant activity expected in 2006

Buck Steam Station SNCR, Unit 5

- Complete detailed engineering and material procurement activities in support of installation in late 2006
- Substantially complete installation of SNCR equipment including incremental air, dilution water and storage needs in time to support 2007 operation

Buck Steam Station SNCR, Unit 6

- Complete detailed engineering and material procurement activities in support of installation in late 2006
- Substantially complete installation of SNCR equipment including incremental air, dilution water and storage needs in time to support 2007 operation

Dan River Steam Station Burners, Unit 1

- No significant activity expected in 2006

Dan River Steam Station Burners, Unit 2

- Substantially complete installation of burners

Dan River Steam Station Burners, Unit 3

- Substantially complete installation of burners

Marshall Steam Station SNCR, Unit 1

- Complete installation of SNCR equipment in time to support 2006 ozone season operation

Marshall Steam Station SNCR, Unit 2

- Complete detailed engineering for SNCR equipment and reagent storage
- Begin material procurement activities in support of installation in early 2007
- Complete procurement and construction of reagent storage equipment

Marshall Steam Station SNCR, Unit 4

- Complete detailed engineering for SNCR equipment
- Begin material procurement activities in support of installation in early 2007

Riverbend Steam Station SNCR, Unit 4

- Complete detailed engineering for SNCR equipment
- Begin material procurement activities in support of installation in early 2007

Riverbend Steam Station SNCR, Unit 5

- Complete detailed engineering for SNCR equipment
- Begin material procurement activities in support of installation in late 2007

Riverbend Steam Station SNCR, Unit 6

- Complete detailed engineering and material procurement activities in support of installation in late 2006
- Substantially complete installation of SNCR equipment including reagent storage needs in time to support 2007 operation

Riverbend Steam Station SNCR, Unit 7

- Complete detailed engineering and material procurement activities in support of installation in late 2006
- Substantially complete installation of SNCR equipment including incremental air and dilution water needs in time to support 2007 operation

7. A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.

Allen Steam Station FGD

- Authorization to Construct (ATC) application for Wastewater Treatment System – Plan to submit August 2006; expect to receive February 2007
- Air Permit Application – Plan to submit April 2006; expect to receive approval July 2006
- Request to revise NPDES Permit to include FGD wastewater – Submitted 1/24/2006; expect to receive revision May 2006
- Submittal to DENR/ACOE regarding stream crossing of entrance road – Plan to submit March 2006
- NOTE: all erosion control permits are in EPC contractor's scope for the Allen FGD Project

Belews Creek Steam Station FGD

- Authorization to Construct (ATC) application for Sanitary Waste Lagoon – Plan to submit March 2006; expect to receive September 2006

Cliffside Steam Station Unit 5 FGD

- NOTE: A complimentary PSD permit application was submitted on 12/16/05 for the proposed new generating units at the Cliffside site. If this associated PSD air permit is not approved or withdrawn, it will be necessary to submit a revised Air Permit Application for a standalone Unit 5 FGD. This application would be made in the 3rd or 4th Quarter of 2006.

Allen Steam Station SNCR, Unit 2

- Air Permit Application – Plan to submit July 2006; expect to receive approval January 2007

Allen Steam Station SNCR, Unit 4

- Authorization to Construct (ATC) application for the dilution water piping – Plan to submit to the City of Belmont March 2006

Buck Steam Station Burners, Unit 3

- Air Permit Application – Plan to submit March 2006; expect to receive approval February 2007

Buck Steam Station Burners, Unit 4

- Air Permit Application – Plan to submit March 2006; expect to receive approval February 2007

Buck Steam Station SNCR, Unit 5

- Air Permit Application – Plan to submit March 2006; expect to receive approval July 2006

Buck Steam Station SNCR, Unit 6

- Air Permit Application – Plan to submit March 2006; expect to receive approval July 2006

Dan River Steam Station Burners, Unit 1

- Air Permit Application – Submitted 2/23/06; expect to receive approval August 2006

Dan River Steam Station Burners, Unit 2

- Air Permit Application – Submitted 2/23/06; expect to receive approval September 2006

Dan River Steam Station Burner Project, Unit 3

- Air Permit Application – Submitted 2/23/06; expect to receive approval September 2006

Marshall Steam Station SNCR, Unit 4

- Air Permit Application – Plan to submit September 2006; expect to receive approval January 2007

8. The results of equipment testing related to compliance with G.S. 143-215.107D.

No additional equipment related testing occurred in 2005. The SNCR and SCR tests that occurred in prior years that were used in evaluating technology selections are repeated in this 2006 report for reference.

Allen Steam Station SNCR, Unit 1

- SNCR Equipment installation was completed in May 2003 followed by equipment acceptance testing in late 2003. During this test run, it was determined that the SNCR system met all commercial performance guarantees with approximately a 25% reduction in NOx with ammonia slip of less than 5 ppm at full load
- During the 2004 ozone season, Allen Unit 1 achieved a 0.162# NO_x/MMBTU outlet rate, 5% better than the 0.17#/MMBTU target established for the unit.

Belews Creek Steam Station SCR

- SCR Equipment installation was completed in 2003 in support of the EPA/SIP Call requirements for NO_x reduction. While Belews Creek had operational problems in the first half of the 2004 ozone season, many of these issues were addressed on Belews Creek Unit 1 by August, 2004. Subsequently, tests performed during the months of August and September showed that when the SCR Equipment was in service during this time, emissions averaged 0.07# NO_x/MMBTU

9. The number of tons of oxides of nitrogen (NO_x) and sulfur dioxide (SO_2) emitted during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.

In the 2005 calendar year, 56,073.3 tons of NO_x and 298,780.5 tons of SO_2 were emitted from the North Carolina based Duke Power Company coal-fired units located in North Carolina and subject to the emissions limitations set out in G.S 143-215.107D.

10. The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.

No emissions allowances have been acquired by Duke Power Company resulting from compliance with the emissions limitations set out in G.S. 143-215.107D.

11. Any other information requested by the Commission or Department of Environment and Natural Resources.

No additional information has been requested to be included in this annual data submittal.

Expected Duke Power Company Compliance for NC Clean Air Plan as of 4/1/2006 (Exhibit A)

NO_x							
				2007 Compliance		2009 Compliance	
Facility	Unit	Technology	Operational Date	Expected Rate #/MMBTUs	Tons	Expected Rate #/MMBTUs	Tons
Allen	1	SNCR	2003	0.160	901	0.160	851
Allen	2	SNCR	2007	0.180	799	0.160	798
Allen	3	SNCR	2005	0.160	1,409	0.160	1,297
Allen	4	SNCR	2006	0.160	1,537	0.160	1,451
Allen	5	SNCR	2008	0.220	2,078	0.160	1,377
Belews Creek	1	SCR	2003	0.065	1,942	0.060	2,425
Belews Creek	2	SCR&Burners	2004	0.060	2,260	0.060	1,871
Buck	3	Burners	2007	0.280	489	0.220	308
Buck	4	Burners	2007	0.280	295	0.220	196
Buck	5	SNCR	2006	0.150	582	0.150	605
Buck	6	SNCR	2006	0.150	581	0.150	604
Cliffside	1	Tuning Only	2004	0.360	302	0.360	255
Cliffside	2	Tuning Only	2004	0.360	300	0.360	262
Cliffside	3	Tuning Only	2004	0.400	587	0.400	544
Cliffside	4	Tuning Only	2004	0.400	593	0.400	538
Cliffside	5	SCR	2002	0.060	1,099	0.060	1,141
Dan River	1	Burners	2008	0.370	614	0.220	345
Dan River	2	Burners	2006	0.220	388	0.220	369
Dan River	3	Burners	2006	0.220	828	0.220	825
Marshall	1	SNCR	2006	0.170	2,212	0.170	2,256
Marshall	2	SNCR	2007	0.190	2,008	0.170	2,241
Marshall	3	SNCR	2005	0.190	4,322	0.180	4,328
Marshall	4	SNCR	2007	0.190	4,305	0.180	4,078
Riverbend	4	SNCR	2007	0.200	466	0.170	400
Riverbend	5	SNCR&Burners	2008	0.240	516	0.170	401
Riverbend	6	SNCR&Burners	2006	0.150	570	0.150	565
Riverbend	7	SNCR	2006	0.150	549	0.150	578
			Expected Total:		32,533		30,909 *** NOTE 1 ***
			Compliance Limit:		35,000		31,000

*** NOTE 1 *** Because the expected 2009 NO_x emissions are so close to the 31,000 ton limit, Duke will continue to evaluate options to improve performance, including SCR on Marshall Unit 3 and/or SNCR on Dan River Unit 3.

Technology:
Burners -- Overfired Air or Separated Overfired Air with associated Mill Classifier installations
SCR -- Selective Catalytic Reduction
SNCR -- Selective Non-Catalytic Reduction

Changes from 4/1/2005 Plan Highlighted

Expected Duke Power Company Compliance for NC Clean Air Plan as of 4/1/2006 (Exhibit B)

SO_2							
				2009 Compliance		2013 Compliance	
Facility	Unit	Technology	Operational Date	Expected Rate #/MMBTUs	Tons	Expected Rate #/MMBTUs	Tons
Allen	1	Scrubber	2009	0.500	2,659	0.150	747
Allen	2	Scrubber	2009	0.500	2,488	0.150	727
Allen	3	Scrubber	2009	1.200	9,864	0.150	1,183
Allen	4	Scrubber	2009	1.200	10,746	0.150	1,031
Allen	5	Scrubber	2009	0.500	4,215	0.150	1,217
Belews Creek	1	Scrubber	2008	0.150	5,927	0.150	5,512
Belews Creek	2	Scrubber	2008	0.150	4,579	0.150	4,639
Buck	3			1.100	1,543	1.100	1,748
Buck	4			1.100	983	1.100	1,087
Buck	5			1.100	4,412	1.100	3,671
Buck	6			1.100	4,410	1.100	4,297
Cliffside	1			1.650	1,170	0.000	0
Cliffside	2			1.650	1,198	0.000	0
Cliffside	3			1.650	2,243	0.000	0
Cliffside	4			1.650	2,213	0.000	0
Cliffside	5	Scrubber	2010	1.650	31,193	0.150	2,755
Cliffside	6	Scrubber	2011	0.000	0	0.080	2,240
Cliffside	7	Scrubber	2012	0.000	0	0.080	2,237
Dan River	1			1.400	2,184	1.400	2,233
Dan River	2			1.400	2,336	1.400	2,368
Dan River	3			1.400	5,202	1.400	5,229
Marshall	1	Scrubber	2007	0.150	1,952	0.150	1,971
Marshall	2	Scrubber	2007	0.150	1,940	0.150	1,592
Marshall	3	Scrubber	2007	0.150	3,539	0.150	3,520
Marshall	4	Scrubber	2006	0.150	3,333	0.150	3,387
Riverbend	4			1.550	3,635	1.550	3,620
Riverbend	5			1.550	3,641	1.550	3,454
Riverbend	6			1.550	5,799	1.550	5,736
Riverbend	7			1.550	5,942	1.550	5,891
			Expected Total:		129,346		72,090
			Compliance Limit:		150,000		80,000

Changes from 4/1/2005 Plan Highlighted

Expected Duke Power Company Compliance Plan for NC Clean Air Plans of [illegible]/20[illegible]
(Exhibit C)

Facility	Unit(s)	Technology	Operational Date	Spent to Date 2001 ($000)	Spent to Date 2002 ($000)	Spent to Date 2003 ($000)	Spent to Date 2004 ($000)	Spent to Date 2005 ($000)	Remaining 2006-2010 ($000)	Project Total ($000)	
Allen	1-5	Scrubber	2009	$0.9	($0.9)	$1,099.8	($11.8)	$5,348.3	$420,820.3	$427,256.6	SO_2
Belews Creek	1-2	Scrubber	2008	$0.0	$0.0	$1,121.3	$5,999.1	$106,433.5	$422,757.4	$536,311.3	SO_2
Cliffside	5	Scrubber	2010	$0.0	$0.0	$978.5	$287.5	$112.0	$250,798.4	$252,176.3	SO_2
Marshall	1-4	Scrubber	2007	$0.0	$0.0	$10,213.7	$92,096.3	$218,129.8	$102,994.6	$423,434.4	SO_2
Allen	1	SNCR	2003	$177.3	$162.4	$2,884.1	$364.9	$0.0			
Allen	2	SNCR	2007	$0.0	$0.0	$0.0	$0.0	$239.3	$0.0	$3,588.7	NO_x
Allen	3	SNCR	2005	$0.0	$0.0	$215.7	$2,584.1	$4,091.5	$4,821.6	$5,061.0	NO_x
Allen	4	SNCR	2006	$0.0	$0.0	$0.0	$217.9	$1,122.2	$0.0	$6,891.4	NO_x
Allen	5	SNCR	2008	$0.0	$0.0	$98.9	$164.6	$122.3	$4,410.1	$5,750.2	NO_x
Buck	3	Burner	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$4,224.0	$4,609.8	NO_x
Buck	3	Classifier	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$3,775.0	$3,775.0	NO_x
Buck	4	Burner	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$292.0	$292.0	NO_x
Buck	4	Classifier	2007	$0.0	$0.0	$0.0	$0.0	$0.0	$2,077.0	$2,077.0	NO_x
Buck	5	SNCR	2006	$0.0	$0.0	$0.0	$0.0	$0.0	$172.0	$172.0	NO_x
Buck	6	SNCR	2006	$0.0	$0.0	$0.0	$268.2	$345.9	$4,828.0	$5,442.1	NO_x
Dan River	1	Burner	2008	$0.0	$0.0	$0.0	$265.8	$335.3	$3,150.0	$3,751.1	NO_x
Dan River	1	Classifier	2008	$0.0	$0.0	$0.0	$0.0	$0.0	$2,112.0	$2,112.0	NO_x
Dan River	2	Burner	2006	$0.0	$0.0	$0.0	$0.0	$0.0	$171.0	$171.0	NO_x
Dan River	2	Classifier	2005	$0.0	$0.0	$0.0	$0.0	$775.4	$1,231.1	$2,006.5	NO_x
Dan River	3	Burner	2006	$0.0	$0.0	$0.0	$0.0	$130.8	$0.0	$130.8	NO_x
Dan River	3	Classifier	2005	$7.5	$162.3	$22.2	$512.8	$679.0	$1,832.5	$3,216.3	NO_x
Marshall	1	SNCR	2006	$0.0	$0.0	$0.0	$0.0	$184.3	$0.0	$184.3	NO_x
Marshall	2	SNCR	2007	$0.0	$0.0	$0.8	$167.2	$1,418.4	$2,620.0	$4,206.4	NO_x
Marshall	3	SNCR	2005	$0.0	$0.0	$197.6	$185.4	$778.3	$5,292.0	$6,453.2	NO_x
Marshall	4	SNCR	2007	$0.0	$0.0	$1,577.4	$652.1	$2,042.4	$0.0	$4,271.8	NO_x
Riverbend	4	SNCR	2007	$0.0	$0.0	$0.0	$0.0	$43.3	$3,925.0	$3,968.3	NO_x
Riverbend	5	Burner	2005	$0.0	$0.0	$0.0	$45.6	$474.3	$3,323.2	$3,843.1	NO_x
Riverbend	5	Classifier	2005	$362.8	$284.3	$2.8	$2,313.4	$180.0	$0.0	$3,143.3	NO_x
Riverbend	5	SNCR	2008	$0.0	$0.0	$0.0	$159.6	$0.0	$0.0	$159.6	NO_x
Riverbend	6	Burner	2005	$0.0	$0.0	$0.0	$1.5	$321.7	$3,758.3	$4,081.5	NO_x
Riverbend	6	Classifier	2005	$144.0	$416.1	$12.2	$510.4	$2,096.4	$0.0	$3,179.1	NO_x
Riverbend	6	SNCR	2006	$0.0	$0.0	$0.0	$0.0	$189.4	$0.0	$189.4	NO_x
Riverbend	7	SNCR	2006	$0.0	$0.0	$0.0	$1.5	$340.3	$4,326.1	$4,667.9	NO_x
				$0.0	$0.0	$0.0	$48.5	$485.8	$4,402.8	$4,937.0	NO_x
			Subtotals:	$692.4	$1,024.2	$18,424.9	$106,834.5	$346,420.0	$1,258,114.4		
								NC-CAP Total:	$1,731,510.4		

Significant changes from 4/1/2005 Plan Highlighted

Progress Energy

March 30, 2006

MAR 3 0 2006

Mrs. Geneva S. Thigpen
Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, NC 27699-4325

Re: Annual NC Clean Smokestacks Act Compliance Report
Docket No. E-2, Sub 815

Dear Mrs. Thigpen:

Progress Energy Carolinas, Inc. submits the attached report for calendar year 2005 regarding the status of compliance with the provisions of the North Carolina Clean Smokestacks Act. Section 9(i) of the Act requires that an annual report of compliance progress be submitted to the Commission by April 1 of each year for the previous calendar year.

Very truly yours,

Len S. Anthony /mhm

Len S. Anthony
Deputy General Counsel-Regulatory Affairs

LSA:mhm

Attachment

232822

Progress Energy Service Company, LLC
P.O. Box 1551
Raleigh, NC 27602

Progress Energy

March 30, 2006

Mr. William G. Ross, Jr.
Secretary
North Carolina Department of Environment and Natural Resources
1601 Mail Service Center
Raleigh, NC 27699-1601

Dear Secretary Ross:

Progress Energy Carolinas, Inc. (PEC) submits the attached report for calendar year 2005 regarding the status of compliance with the provisions of the North Carolina Clean Smokestacks Act. Section 9(i) of the Act requires that an annual compliance progress report be submitted by April 1 of each year for the previous calendar year. PEC appreciates the efforts of your staff to work with us and looks forward to continuing our positive working relationship to facilitate fulfillment of PEC's obligations with this important law.

Please don't hesitate to contact me at (919) 546-3775 if you have any questions.

Sincerely,

Caroline Choi
Director, Environmental Services

c: North Carolina Utilities Commission
Keith Overcash, DAQ

Progress Energy Service Company, LLC
PO Box 1551
Raleigh, NC 27602

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Progress Energy Carolinas, Inc.
North Carolina Clean Smokestacks Act
Calendar Year 2005 Progress Report

On June 20, 2002, North Carolina Senate Bill 1078, also known as the "Clean Smokestacks Act," was signed into effect. This law requires significant reductions in the emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) from utility owned coal-fired power plants located in North Carolina. Section 9(i) of the bill, which is now incorporated as Section 62-133.6(i) of the North Carolina General Statutes, requires that an annual progress report regarding compliance with the Clean Smokestacks Law be submitted on or before April 1 of each year. The report must contain the following elements, taken verbatim from the statute:

1. A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.
2. The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed that year.
3. The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.
4. An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.
5. A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.
6. A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.
7. A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.
8. The results of equipment testing related to compliance with G.S. 143-215.107D.
9. The number of tons of oxides of nitrogen (NOx) and sulfur dioxide (SO_2) emitted during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.
10. The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.
11. Any other information requested by the Commission or the Department of Environment and Natural Resources.

Information responsive to each of these report elements follows. The responses are given by item number in the order in which they are presented above.

1. **A detailed report on the investor-owned public utility's plans for meeting the emissions limitations set out in G.S. 143-215.107D.**

The plan for Progress Energy Carolinas, Inc. was originally submitted on July 29, 2002. Appendix A contains an updated version of this plan, effective April 1, 2006. We continue to evaluate various design, technology and generation options that could affect our future compliance plans.

2. **The actual environmental compliance costs incurred by the investor-owned public utility in the previous calendar year, including a description of the construction undertaken and completed that year.**

The actual capital costs incurred by Progress Energy in 2005 were $181,274,000.

We successfully placed in service our first wet scrubber on Asheville Unit 1 in November 2005. A significant amount of work was performed at the Asheville plant in 2005 in order to place the Unit 1 scrubber in service. This work included the installation of electrical power and control cables and circuits, piping, pumps, valves, oxidation air compressors, instruments and controls (including the scrubber distributed control system), agitators, absorber tower outlet hood, spray headers, trays and other tower internals, limestone and gypsum handling equipment, and gypsum dewatering equipment. Work efforts also included constructing the wetlands and industrial wastewater treatment system for treating scrubber blowdown wastewater, completing ductwork from the precipitator to the scrubber tower and from the scrubber tower to the stack, and installing new induced draft fans and various other process equipment. Much of the equipment noted above was also installed for the Asheville Unit 2 scrubber, which will be placed in service in 2006.

In addition to the scrubber projects at Asheville, detailed design, engineering and procurement activities began for the Asheville Unit 1 SCR, which will be installed and operational in late 2007. Based on the changes in forecasted energy demand, the in-service date for these NOx controls was accelerated from 2008 to ensure compliance with the Act's annual tonnage cap. Detailed design and engineering activities included preparation of various specifications and bill of materials, civil engineering of foundation systems, structural engineering of flue gas path components and associated structural steel, and mechanical engineering for various piping systems. Work on the Asheville Unit 1 SCR also included issuing purchase orders for the SCR catalyst, ammonia injection grids, static mixers, urea to ammonia system equipment, ash handling system changes, and sonic horns.

At the Roxboro plant, environmental projects work increased significantly in 2005. Engineering, procurement and construction began or continued for each of the four units. The new electrical switchgear building that will provide power for much of the common scrubber equipment was completed. Various power distribution panels and load centers located in the electrical switchgear building were placed into service. Purchase orders were issued for most of the major equipment. Structural steel was erected, along with various floor elevations for the new limestone preparation/gypsum dewatering building. Erection began on the limestone ball mills and the limestone storage silos. Two new concrete chimney shells (one for Units 1 and 2 and one for Units 3 and 4) were constructed. Many of the fiberglass reinforced plastic sections that make up the flue gas liners were fabricated off site to be ready for installation beginning in early 2006. Foundations were completed for all four absorber towers and their adjacent pump buildings. The ceramic tile-lined concrete absorber tower for the Unit 2 scrubber was built. Excavation began for the limestone storage pile and conveying equipment. Erection also started on the pipe bridge between the absorber towers and the limestone preparation/gypsum dewatering building.

At the Mayo plant, initial general arrangement drawings for the wet scrubber were developed. Engineering studies were completed for the scrubber distributed controls system, electrical power distribution, and induced draft fans options. Work began on the water supply, scrubber blowdown wastewater treatment, and boiler/ductwork transient analysis studies. Engineering was also performed to support the modeling required to determine the height of the new chimney. A purchase order was issued for the absorber recycle pumps. The procurement of these pumps requires a long lead time; they were purchased in 2005 to ensure availability and minimize cost increases. A milestone project schedule was developed. There were no construction activities in 2005.

At the Lee plant, preliminary engineering, design, and procurement activities were initiated for the installation of low-NOx burners in 2006. The PSD permit application was prepared and submitted to the Division of Air Quality for review and approval. There were no construction activities in 2005.

At the Sutton Plant, preliminary engineering, design, and procurement activities were initiated for the installation of low-NOx burners in 2006. There were no construction activities in 2005.

3. The amount of the investor-owned public utility's environmental compliance costs amortized in the previous calendar year.

Progress Energy Carolinas, Inc. amortized $147 million in 2005.

4. An estimate of the investor-owned public utility's environmental compliance costs and the basis for any revisions of those estimates when compared to the estimates submitted during the previous year.

Appendix B contains the capital costs incurred toward compliance with G.S. 143-215.107D in 2005 and the projected costs for future years through 2013, which show the net cost to PEC excluding the portion for which the Power Agency is responsible. The estimated total capital costs, including escalation, are currently projected to be between $1.1B and $1.4B, with the current point estimate being $1.36B. This represents an increase of 52% from the 2005 cost estimate of $895 million. Prior reports have discussed the cost impact of project scope changes such as the use of a wet scrubber at Asheville in lieu of a dry scrubber, the capability to burn higher sulfur coals, and increased sulfur removal efficiency; all of which provide increased fuel flexibility for the Asheville, Roxboro, and Mayo plants. These additional cost increases reflect 1) increased costs for materials of construction, such as steel, concrete, and electrical power and control cables; 2) the need for a greater volume of these materials than originally forecast; 3) increased costs for equipment, such as pumps, fans, and electrical transformers; 4) the addition of wastewater treatment facilities, which were not included in the original program estimate; and 5) adjusting future project costs based on the actual project costs for our first completed scrubber and the current detailed cost estimates for the scrubbers under construction. It should be noted that significant design work remains to be completed, especially for the SO_2 controls at Mayo, Cape Fear, and Sutton. Our current estimates are subject to further adjustment as the engineering for these projects is completed.

The cost increases that we are experiencing are not unique to PEC. Other utilities with major construction projects for environmental controls are experiencing similar increases. Significant cost increases are also being experienced on other, non-utility, large construction projects in North Carolina, especially in the Raleigh area. For example, the project costs for the expansion of Terminal C at the Raleigh Durham International Airport were recently reported to have increased by 23% over the last 3 years due to inflation and rising building costs; projected costs for new Wake County schools were recently reported to have increased by 18-20% a year compared with an overall inflation rate of 2.7 to 3.4% due to higher prices for construction materials; the project costs for the planned commuter rail service from Raleigh to Durham were recently reported to have increased by 9% since 2004 (not adjusted for inflation); and the costs for the new Raleigh convention center currently under construction were recently reported to have increased by 12% due to the volatility of equipment and material prices in the construction market.

Independent cost indices, such as the Chemical Engineering Plant Cost Index, also show that the costs for construction labor and materials have increased sharply. The net overall plant escalation from December 2002 through November 2005 was 19%, which is substantially higher than the 2.0 to 2.5% per year (7.7% over the same December 2002-November 2005 period) escalation rates used for the original program cost estimates.

5. A description of all permits required in order to comply with the provisions of G.S. 143-215.107D for which the investor-owned public utility has applied and the status of those permits or permit applications.

Progress Energy applied for the following permits in 2005:

Asheville Plant

Erosion and Sedimentation Control Plan

Several updates were submitted for the erosion and sedimentation control plan:

- Rev H for the wastewater treatment discharge pipeline, truck scale, truck wash station was approved April 6, 2005.
- Rev 1 for the river pumps conduit was approved June 2, 2005.
- Rev I for the Unit 1 SCR was approved November 14, 2005.

NPDES Permit

An Authorization to Construct (ATC) the wastewater treatment system for the pretreatment of flue gas desulfurization wastewater was approved March 29, 2005 –ATC No. 0000396A03.

The ATC engineer's certifications for pretreatment and constructed wetlands were submitted November 8, 2005.

Roxboro Plant

Air Permit

An update to the air permit for coal handling and limestone handling was submitted on August 25, 2005. This permit was issued on February 9, 2006.

Erosion and Sedimentation Control Plan

Several updates were submitted for the erosion and sedimentation control plan:

- Rev G for the gypsum storage area was approved January 21, 2005
- Rev H was rolled in with Rev G (revision H was a response to questions on revision G) and so was also approved January 21, 2005.
- Rev I for the emergency access road, fire protection piping, conduit, temporary haul road was approved May 17, 2005.
- Rev J for the makeup water pipeline, gypsum conveyor foundations, settling pond and bioreactor site was approved September 13, 2005

Wetlands Permitting

An Army Corps of Engineers permit and water quality certification to fill wetlands for gypsum storage area was received September 6, 2005.

NPDES permit

An NPDES permit for the wastewater treatment system was received August 10, 2005.

Submissions were made for the Authorization to Construct (ATC) the wastewater treatment system on October 3, November 1 and December 2, 2005. Approval for construction of the settling basin is expected in March 2006. Approval for the construction of the bioreactor is expected in the second quarter of 2006.

Dam/Impoundment Safety

Progress Energy's letter to the NCUC identifying work in the ash pond was approved December 5, 2005.

Lee Plant

Air Permit

A prevention of significant deterioration (PSD) permit application for the installation of low NOx burners was submitted on December 7, 2005. A draft permit was received February 13, 2006 and is expected to be final in March 2006.

Sutton Plant

Air Permit

Air permit 01318T18 for the installation of Low NOx Burners was received February 21, 2005.

6. A description of the construction related to compliance with the provisions of G.S. 143-215.107D that is anticipated during the following year.

Appendix C presents the planned construction schedule for compliance with G.S. 143-215.107D. Please note that this is a projected schedule of construction activity through 2013 that is subject to modification. The schedule will be updated as part of this report each year.

The planned construction activities at Asheville in 2006 include the completion of the mechanical, electrical and controls systems for the Unit 2 scrubber. This includes completion of the flue gas ductwork from the precipitator to the absorber tower, and installation, checkout and commissioning of the major equipment including the distributed controls system and absorber recycle pumps. Systems common to both Units 1 and 2 were commissioned during the checkout and startup activities for the Unit 1 scrubber. The unit 2 scrubber is expected to be placed into service at the end of May

Construction activities will also begin for the Asheville Unit 1 SCR project. These activities include installation of foundations for the new SCR structural steel; fabrication, delivery and erection of the SCR support steel; fabrication and delivery of the inlet and outlet ducts for the SCR and the SCR reactor modules; and various mechanical and electrical activities to support placing this SCR in service in 2007.

At Roxboro, the significant construction activities for the Unit 2 scrubber include installation of the absorber recycle pumps, hydroclones, oxidation air compressors, absorber tower outlet hood, flue gas ductwork from the precipitator to the absorber tower and from the absorber tower to the chimney, spray headers, trays and other tower internals, agitators, and various process piping and tanks. Flue liners for each boiler will be installed in the chimney. The structural steel for the absorber recycle pump building will be erected. Systems common to the scrubbers for all units such as the gypsum handling conveyors, limestone handling and preparation equipment (conveyors, feeders, silos, and ball mills), dewatering equipment (belt filters), wastewater treatment settling ponds and bio-reactor will be installed. Various mechanical, electrical and controls equipment that support the scrubber process will also be installed. Installation of the gypsum conveyor from the dewatering building to the storage pile will begin. Construction activities for the Unit 3 and Unit 4 scrubbers will include the erection of the absorber tower for each unit and installation of the flue gas liners in the Units 3 and 4 chimneys. Installation will begin for various electrical power and control cables and circuits along with the installation of various process equipment and piping. Minimal construction activities for Unit 1 will be performed. Construction of these systems and the scrubber blowdown wastewater treatment system will continue through 2008.

7. **A description of the applications for permits required in order to comply with the provisions of G.S. 143-215.107D that are anticipated during the following year.**

Several recent changes to permitting processes in the state have dramatically increased the lead time to prepare and review environmental permits necessary for Clean Smokestacks projects. A recent court decision [D.C. Circuit Court of Appeals Decision in *New York v. EPA*, No. 02-1387 (June 24, 2005)] eliminated the provision exempting pollution control equipment from new source review. For Progress Energy Carolinas, this results in increased costs for consultants and modeling. For the NC Division of Air Quality (DAQ), this results in longer permit application processing times. For example, the application for the installation of a low-NOx burner, which formerly took 3-4 months, now requires review under the PSD program, a process typically lasting a year or more. The staff at the DAQ has expedited this process for the recent permit submission for the Lee plant. We appreciate the collaborative efforts the DAQ staff has made to assure our construction and installation schedules remain on track. However, the longer permit processing times continue to be a serious concern for future projects as not every permit can reasonably be expedited. PEC wishes to work collaboratively with the DAQ to prevent such delays from occurring.

The following permit applications and permit approvals are anticipated for 2006:

Asheville Plant

Air Permit

Revisions to the air permit may be necessary to test and, if necessary, install technology to reduce emissions of SO_3.

Erosion and Sedimentation Control Plan

Revision J for the construction of the demineralizer pipe, pump and ductbank was approved in January 2006.

Roxboro Plant

Air Permit

Revisions to the air permit will be necessary to address fugitive emissions of hydrogen sulfide from the wastewater treatment system.

NPDES Permit

The ATC for the gypsum settling pond was received March 3, 2006.
Receipt of the ATC for the bioreactor is anticipated in the second quarter 2006.

Erosion and Sedimentation Control Plan

- Rev K for the haul road, transformers, main plant area wastewater pipe trench and gypsum conveyor foundations was approved in February 2006
- Rev L for burying the wastewater pipeline - approval is anticipated second quarter 2006

Additional revisions to the plan may be necessary.

Mayo Plant

Air Permit

A construction permit will be required for the flue gas desulfurization system - anticipated submission Spring 2005.

NPDES Permit

NPDES permit modification application for wastewater treatment system submitted February 23, 2006.

A request for authorization to construct the wastewater treatment system is expected to be submitted in the fourth quarter 2006.

Erosion and Sedimentation Control Plan

The first of the erosion and sedimentation plans for the main construction area and laydown yards will be submitted during the second quarter, 2006. Additional plan revisions will be necessary as construction plans are developed.

<u>Cape Fear Plant</u>

Air Permit

A construction permit may be required to conduct a trial of an air pollution control technology. If required, this permit application will be submitted during the second quarter of 2006.

<u>Lee Plant</u>

Air Permit

A construction permit will be required for the installation of the Rotamix system for NOx control. This permit application will be submitted during the second quarter 2006.

8. The results of equipment testing related to compliance with G.S. 143-215.107D.

No equipment testing related to compliance with G.S. 143-215.107D occurred in 2005.

9. The number of tons of oxides of nitrogen (NOx) and sulfur dioxide (SO_2) emitted during the previous calendar year from the coal-fired generating units that are subject to the emissions limitations set out in G.S. 143-215.107D.

The total calendar year 2005 emissions from the affected coal-fired Progress Energy Carolinas units are:

NOx 49,621 tons
SO_2 202,041 tons

10. The emissions allowances described in G.S. 143-215.107D(i) that are acquired by the investor-owned public utility that result from compliance with the emissions limitations set out in G.S. 143-215.107D.

During 2005, PEC did not acquire any allowances as a result of compliance with the emission limitations set out in N.C. General Statute 143-215.107D.

11. Any other information requested by the Commission or the Department of Environment and Natural Resources.

NC Clean Smokestacks Audit Public Staff Data Request No. 5 was issued to Progress Energy Carolinas in February of 2005, and a response was provided on March 4, 2005. NC Clean Smokestacks Commission staff request was issued to Progress Energy Carolinas in April of 2005, and a response was provided on May 2, 2005 with revisions filed on May 6, 2005. NC Clean Smokestacks Audit Public Staff Data Request No. 6 was issued to Progress Energy Carolinas in February of 2006, and a response was provided on March 24, 2006.

Appendix A

Progress Energy Carolinas, Inc's (PEC) Air Quality Improvement Plan Supplement

April 1, 2006

On June 20, 2002, Governor Easley signed into law SB1078, which caps emissions of nitrogen oxides (NOx) and sulfur dioxide (SO_2) from utility owned coal-fired power plants located in North Carolina. PEC's annual NOx emissions must be less than 25,000 tons beginning in 2007 and annual SO_2 emissions must be less than 100,000 tons beginning in 2009 and less than 50,000 tons beginning in 2013. These caps represent a 56% reduction in NOx emissions from 2001 levels and a 74% reduction in SO_2 from 2001 levels for PEC.

PEC owns and operates 18 coal-fired units at seven plants in North Carolina. The locations of these plants are shown on Attachment 1.

Nitrogen Oxides Emissions Control Plan

PEC has been evaluating and installing NOx emissions controls on its coal-fired power plants since 1995 in order to comply with Title IV of the Clean Air Act and the NOx SIP Call rule adopted by the Environmental Management Commission (EMC). Substantial NOx emissions reductions have already been achieved (50,000 tons of NOx in 2004 compared with 112,000 tons in 1997) and further reductions will ensure compliance with the Clean Smokestacks Act 25,000 ton cap in calendar year 2007. This target will be achieved with a mix of combustion controls (which minimize the formation of NOx) such as low-NOx burners and over-fire air technologies, and post-combustion controls (which reduce NOx produced during the combustion of fossil fuel to molecular nitrogen) such as selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) technologies.

Attachment 2 details PEC's North Carolina coal-fired electric generating units, their name plate generation capacity, the control technologies already installed, and those planned for installation. As technologies evolve or other circumstances change, a different mix of controls may be selected. Attachment 2 also projects the NOx emissions on a unit-by-unit basis based on the energy demand forecast and expected efficiencies of the NOx emissions controls employed. This information is provided only to show how compliance may be achieved and is not intended in any way to suggest unit-specific emission limits. Actual emissions for each unit may be substantially different in 2007.

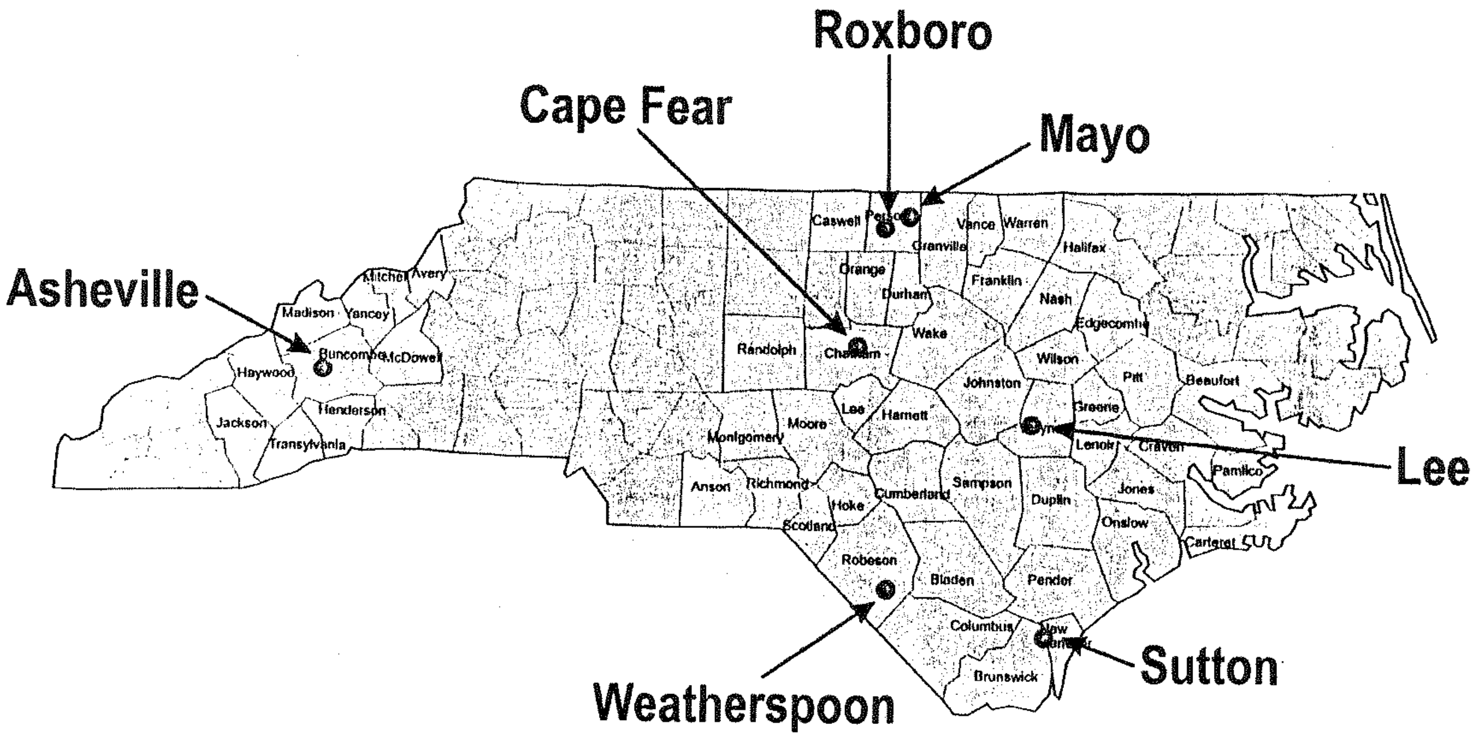
Sulfur Dioxide Emissions Control Plan

PEC will be installing wet flue gas desulfurization systems (FGD or "scrubbers") to remove 97% of the SO_2 from the flue gas of its Asheville, Roxboro and Mayo boilers. Screening studies will be conducted for the Cape Fear 5 and 6 and Sutton 3 units to select the most appropriate technology for these plants. Wet scrubbers produce unique waste and by-product streams. Issues related to wastewater permitting and solid waste disposal are being addressed for each site. PEC plans to treat the scrubber wastewater stream at the Asheville Plant using an innovative constructed wetlands treatment system to ensure compliance with discharge limits. A bioreactor technology is being evaluated for the Roxboro Plant. A contract has been executed with a gypsum product end-user that will construct a wallboard facility near the Roxboro plant to use the synthetic gypsum produced by the Roxboro and Mayo plants for the manufacture of drywall products. PEC is also negotiating with another gypsum company for the use of the synthetic gypsum that will be produced at the Asheville plant

Specific units are listed in Attachment 3 with data on projected schedules and projected annual emissions in 2009 and 2013. These projections assume a 97% SO_2 removal efficiency, forecasted energy demand, 3.3 lbs SO_2/Mbtu coal on scrubbed units, and 1.2 lbs SO_2/Mbtu coal on the other units. Please note that these are projected schedules and are subject to revision.

Particular units controlled and control technologies utilized are subject to change depending on future developments in SO_2 removal technologies, energy demand, sulfur content of coal, and other circumstances which may produce a more optimal plan for meeting the SO_2 emissions limits in 2009 and 2013. DENR will be advised as changing circumstances dictate.

Attachment 1: Location of PEC's Coal-Fired Power Plants in North Carolina



1

Attachment 2: PEC NOx Control Plan for North Carolina Coal-fired Units

Unit	MW Rating	Control Technology	Operation Date[1]	Projected NOx Tons, 2007[2]
Asheville 1	198	LNB/AEFLGR/**SCR**	2009	2,625
Asheville 2	194	LNB/OFA/SCR		432
Cape Fear 5	143	ROFA/ROTAMIX		580
Cape Fear 6	173	ROFA/ROTAMIX		770
Lee 1	79	WIR		928
Lee 2	76	**LNB**	2006	493
Lee 3	252	LNB/OFA/**ROTAMIX**	2010	1,689
Mayo 1	745	LNB/OFA/SCR		1,741
Roxboro 1	385	LNB/OFA/SCR		1,084
Roxboro 2	670	TFS2000/SCR		1,292
Roxboro 3	707	LNB/OFA/SCR		2,036
Roxboro 4	700	LNB/OFA/SCR		1,938
Sutton 1	97	SAS		1,008
Sutton 2	106	**LNB**	2006	1,116
Sutton 3	410	LNB/ROFA/ROTAMIX		3,716
Wspn 1	49			879
Wspn 2	49			915
Wspn 3	78	WIR		1,028
Total	5,111			24,271

AEFLGR – Amine Enhanced Flue Lean Gas Reburn
LNB – Low NOx Burner
SNCR – Selective Non-Catalytic Reduction
OFA – Overfire Air
ROFA – Rotating Opposed-fired Air
ROTAMIX = Injection of Ammonia to further reduce NOx (used in combination with ROFA)
WIR – Underfire Air
TFS2000 = Combination Low-NOx Burner/Overfire Air
SAS – Separated Air Staging

[1] Note: This is the operation date for the control technology installed to comply with the North Carolina Improve Air Quality/Electric Utilities Act only (shown in bold).
[2] Unit by unit emissions are illustrative only and specific emissions limits should not be inferred. Actual emissions in 2007 may be different from unit to unit

Attachment 3: PEC SO_2 Control Plan for North Carolina Coal-Fired Units

Unit	MW Rating	Technology	Operation Date	Projected SO_2 Tons, 2009[1]	Projected SO_2 Tons, 2013[1]
Asheville 1	198	Scrubber	2005	864	818
Asheville 2	194	Scrubber	2006	886	960
Cape Fear 5	143	Scrubber	2012	6,249	656
Cape Fear 6	173	Scrubber	2011	7,725	787
Lee 1	79			2,940	2,660
Lee 2	76			2,637	2,756
Lee 3	252			10,078	7,493
Mayo 1	745	Scrubber	2009	14,361	3,203
Roxboro 1	385	Scrubber	2008	1,741	1,700
Roxboro 2	670	Scrubber	2007	2,853	2,577
Roxboro 3	707	Scrubber	2008	2,928	3,005
Roxboro 4	700	Scrubber	2007	2,363	2,902
Sutton 1	97			4,402	3,217
Sutton 2	106			4,052	2,768
Sutton 3	410	Scrubber	2012	16,269	1,823
Wspn 1	49			1,458	1,208
Wspn 2	49			1,587	1,286
Wspn 3	78			3,301	3,480
Total	5,111			86,692	44,485

[1] Unit by unit emissions are illustrative only and specific emissions limits should not be inferred. Actual emissions in 2009 and 2013 may be different from unit to unit.

[2] Projections are based on 97% SO2 removal efficiency, forecasted energy demand, 3.3 lbs SO2/Mbtu coal on scrubbed units, and 1.2 lbs SO2/Mbtu coal on others

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ATTACHMENT B
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Appendix B
PEC's Actual Costs Through 2005 and Projected Costs Through 2013 for Clean Smokestacks Compliance (thousands)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Asheville 1 FGD	$100	$9,652	$33,574	$35,769	$3,141	$0	$0	$0	$0	$0	$0	$0	$82,235
Asheville 1 SCR	$0	$0	$688	$1,423	$17,278	$16,363	$0	$0	0	0	0	$0	$35,752
Asheville 2 FGD	$100	$7,742	$28,390	$24,238	$10,806	$0	$0	$0	$0	$0	$0	$0	$71,277
Asheville FGD Common	$467	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$467
Mayo 1 FGD	$187	$0	$276	$644	$16,024	$63,680	$78,655	$38,649	$4,462	$0	$0	$0	$202,578
Roxboro FGD Common	$403	$5,561	$10,033	$51,717	$56,598	$10,483	$10,365	$1,670	$0	$0	$0	$0	$146,830
Roxboro 1 FGD	$0	$0	$0	$3,135	$14,805	$23,978	$35,070	$3,670	$0	$0	$0	$0	$80,657
Roxboro 2 FGD	$120	$3,574	$6,848	$30,782	$45,196	$10,783	$1,117	$0	$0	$0	$0	$0	$98,420
Roxboro 3 FGD	$0	$0	$244	$10,628	$42,069	$30,823	$11,522	$0	$0	$0	$0	$0	$95,285
Roxboro 4 FGD	$0	$0	$0	$9,075	$33,745	$35,090	$6,384	$0	$0	$0	$0	$0	$84,294
Cape Fear 5 FGD	$0	$0	$0	$0	$0	$0	$0	$528	$24,065	$33,006	$25,283	$0	$82,881
Cape Fear 6 FGD	$0	$0	$0	$0	$0	$0	$528	$20,751	$32,695	$24,666	$0	$0	$78,640
Lee 3 ROFA	$0	$0	$0	$198	$14,603	$0	$0	$0	$0	$0	$0	$0	$14,800
Sutton 3 FGD	$0	$0	$0	$0	$536	$0	$0	$9,988	$57,407	$58,805	$42,200	$6,309	$175,244
Lee 2 LNB	$0	$0	$133	$273	$2,723	$57	$0	$0	$0	$0	$0	$0	$3,187
Sutton 2 LNB	$0	$0	$0	$236	$1,822	$59	$0	$0	$0	$0	$0	$0	$2,117
Asheville WWT	$0	$0	$0	$12,365	$0	$0	$0	$0	$0	$0	$0	$0	$12,365
Mayo WWT	$0	$0	$0	$0	$0	$1,415	$14,415	$3,461	$0	$0	$0	$0	$19,291
Cape Fear WWT	$0	$0	$0	$0	$0	$0	$0	$3,271	$12,344	$739	$0	$0	$16,353
Roxboro WWT	$0	$0	$0	$791	$26,791	$12,602	$1,710	$0	$0	$0	$0	$0	$41,895
Sutton WWT	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,849	$13,821	$1,055	$17,724
Total	$1,377	$26,529	$80,186	$181,274	$286,137	$205,334	$159,765	$81,987	$130,972	$120,064	$81,303	$7,364	$1,362,293
Estimated AFUDC							$4,000	$10,000	$9,000	$20,000	$21,000	$800	$64,800

Note: Excludes Power Agency ownership: 16.17% of Mayo, 3.77% of Roxboro Common, and 12.94% of Roxboro 4

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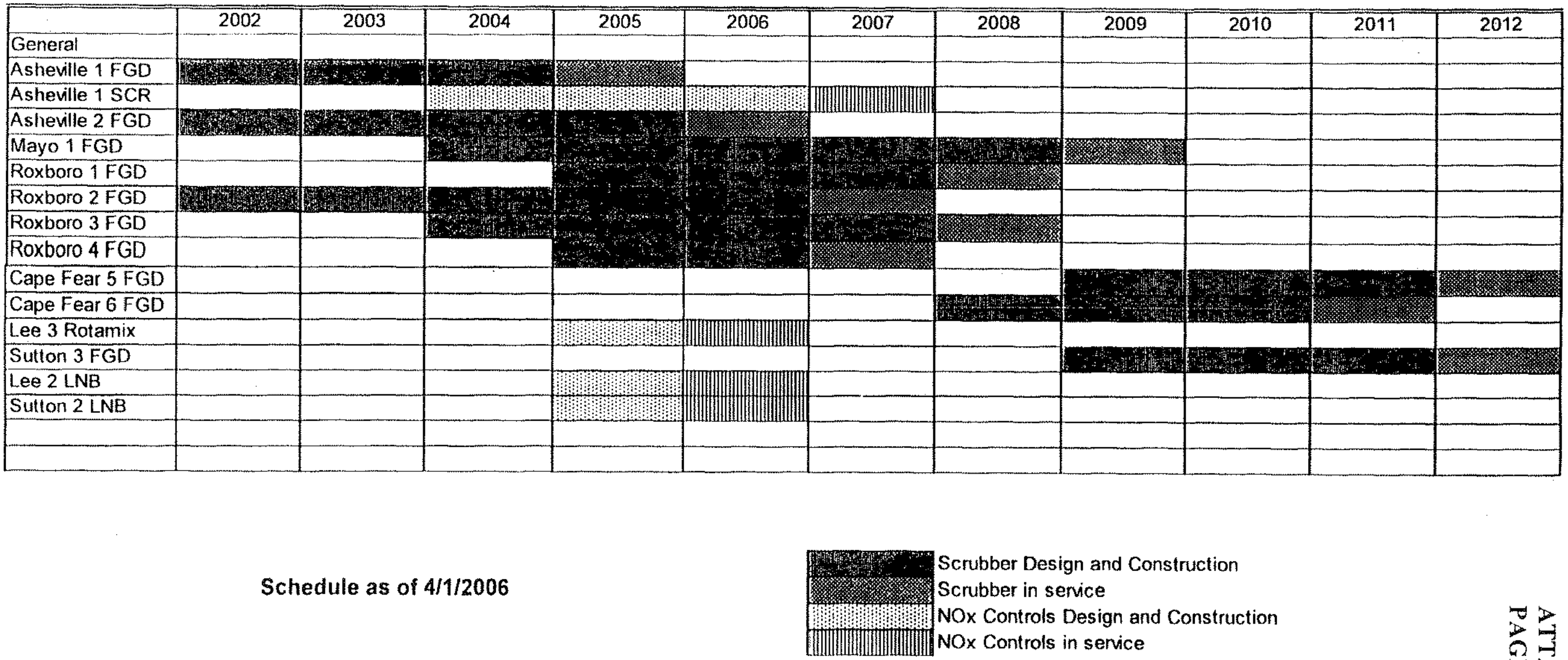
Appendix C
PEC Clean Smokestacks Compliance Plan



Schedule as of 4/1/2006

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Attachment 2

Catawba and Davidson Counties Trajectory Analysis

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Catawba and Davidson Counties HYSPLIT Back-Trajectory Analysis to Determine $PM_{2.5}$ Source Regions

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1. Introduction

The purpose of this analysis is to access the source regions, in particular according to state boundaries, which contribute significantly to elevated daily Fine Particulate Matter ($PM_{2.5}$) levels in North Carolina. The North Carolina Division of Air Quality (NC DAQ) has identified a specific need to know the regions, specifically according to state boundaries, which contribute significantly to primary and secondary $PM_{2.5}$ in North Carolina. The Environmental Protection Agency (EPA) has established standards for $PM_{2.5}$ at 15 $\mu g/m^3$ for the annual standard and 65 $\mu g/m^3$ for the 24-hour standard.

2. Methodology

An analysis of the National Oceanic and Atmospheric Administration Air Resource Laboratory (NOAA ARL) HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT; Draxler and Rolph, 2003) model back trajectories was performed in order to access the sources that contribute to elevated $PM_{2.5}$ levels in North Carolina. An analysis of observed 24-hour average $PM_{2.5}$ values throughout from North Carolina's $PM_{2.5}$ monitor network determined that the two monitors with the highest annual $PM_{2.5}$ values in North Carolina are located in Catawba and Davidson Counties. The monitors located in these counties are Federal Reference Method (FRM) monitors and sample $PM_{2.5}$ every three days. Because these monitors had the two highest annual-average $PM_{2.5}$ values, the monitors located in these two counties were chosen as the endpoints for the HYSPLIT back trajectories. The specific location of Catawba County monitor is 35.73°N, 81.36°W, while the Davidson County monitor is located at 35.81°N, 80.26°W.

$PM_{2.5}$ data from January 1, 1999 through June 30, 2002 was analyzed to identify days when the 24-hour average $PM_{2.5}$ value was greater than or equal to 27.9 $\mu g/m^3$. This concentration was chosen since it represents the midpoint of the yellow AQI range (15.5$\mu g/m^3$ – 40.4$\mu g/m^3$) for $PM_{2.5}$, and conversations with EPA representatives have indicated that values above this point could pose a significant health risk. From the three and half years of available $PM_{2.5}$ data from those two monitors, there were a total of 41 days from the Catawba County monitor and 32 days from the Davidson County monitor where the 24-hour average $PM_{2.5}$ value was greater than or equal to 27.9 $\mu g/m^3$. The dates and observed 24-hour average $PM_{2.5}$ of these days are shown in Table 1.

For the days indicated above, HYSPLIT back trajectories were run. Thirty-six hour back trajectories ending at 17UTC, noon Eastern Daylight Time, were run separately for each monitor using the model vertical velocity option. The trajectories were run at three separate heights, specifically 10, 300 and 1000 meters above ground level (AGL). The 10 and 300-meter trajectory levels are heights of lower level circulations, while the 1000-meter trajectory level represents the top of the mixed layer and is generally a transport level. The choice of these levels is based on the experience of NC DAQ meteorologists, who use the HYSPLIT model trajectories as a routine part of their ozone and $PM_{2.5}$ forecast process. 17UTC (Noon EDT) was chosen as the ending time of the trajectories because it represents a time when significant mixing of the boundary and residual layers has occurred, but significant contributions from local-secondary production has not occurred.

3. Results

Table 1 shows the results of the analysis of the back trajectories. Columns 4 and 5 in Table 1 identify the primary and secondary source regions. The primary source region identifies the most significant region(s) contributing to the $PM_{2.5}$ in that county on that day, as determined by the meteorologists. The secondary source region identifies a region(s) that, while is not a primary contributor, does appear to contribute to a significant portion of the $PM_{2.5}$ on that day. Note that while there is always a primary source identified for a given day, there may not be secondary source identified.

Figures 1-4 show composites of the back trajectories originating from the Catawba County site at 10, 300, and 1000 meters AGL for those days when $PM_{2.5}$ concentrations were high. Note that the trajectories are relatively short, indicating regional stagnation and recirculation. Figures 5-8 show similar composites for the Davidson County site.

Analysis of the HYSPLIT back trajectories showed that on the majority of the days the primary source region of the back trajectory was North Carolina. Table 2 shows the distribution of both primary and secondary source regions for the trajectories for both Catawba and Davidson counties. Of the 41 days for which back trajectories were run for the Catawba County monitor, 31 (76%) of them were considered to have North Carolina as the primary source region (Figure 9). Tennessee and Virginia were considered to be primary sources on 9 (22%) and 6 (15%) days, respectively. Significant secondary sources were South Carolina, Tennessee, and Georgia, which contributed on 9 (22%), 8 (20%), and 7 (17%) days respectively (Figure 10). Figure 11 shows the percent of the days in which each region was identified as either a primary or secondary source, or both.

There were 27 (66%) days when North Carolina was identified to be the only primary source region, while there were 4 (10 %) days when North Carolina and another state(s) was identified to be the source region, and 10 (24%) days when North Carolina was not identified as part of the source region. This result is significant, since it indicates that nearly 35 percent of the days when $PM_{2.5}$ was greater than or equal to 27.9 $\mu g/m^3$, back-trajectory analysis indicates transport from neighboring states, in particular Tennessee, Virginia, Georgia and South Carolina.

For the Davidson county monitor, 26 (81%) of the 31 days for which the trajectories were run indicated North Carolina as the primary source (Table 2, Figure 12). Note that there was one day for which a trajectory could not be run due to missing data. Other significant primary sources were Virginia, with 7 (23%) days, and South Carolina and Tennessee, each with 4 (13%) days. Significant secondary sources were South Carolina, Tennessee, and Virginia, each with 5 (16%) days, and Ohio with 4 (13%) days (Figure 13). Of the 31 days for which the back trajectories were run, 17 (55%) of them indicated North Carolina as the only primary source region, while on 14 (45%) days trajectories indicated another state as the primary source region. As with the Catawba County analysis, there were a significant percentage of days when trajectory analysis indicates transport from neighboring states on days when $PM_{2.5}$ was greater than or equal to 27.9 $\mu g/m^3$. The percent of days in which each region contributed as a primary or secondary source (or both), is shown in Figure 14.

Another interesting analysis is examining the 24-hour average $PM_{2.5}$ value and the associated primary source region. The trajectories run for each monitor were divided into an upper third, a middle third, and a lower third based on the observed $PM_{2.5}$ concentration. For the Catawba County monitor the upper third consists of a $PM_{2.5}$ range between 32.8 and 54.7 $\mu g/m^3$, the middle third from 30.0 and 32.7 $\mu g/m^3$, and the lower third from 28.1 to 29.6 $\mu g/m^3$. Note that there are 14 days included in the upper and middle thirds, and only 13 days included in the bottom third (Tables 3-5).

For the upper third of the days for the Catawba County monitor site, North Carolina was the primary source on 10 days, followed by Tennessee and Virginia with 2 days each. South Carolina, Tennessee, Virginia and Georgia are common secondary source regions. For total days (primary and secondary combined), North Carolina was identified on 10 days, followed by Tennessee on 5 days and South Carolina, Virginia, and Georgia each on 3 days. The results for the middle and lower third of the days are similar to those for the upper third. The same analysis for the Davidson County monitor site yields similar results. Note also that 11 days are included in the upper and middle thirds, while only 10 days are included in the bottom third.

Another analysis that was performed using the back trajectories was to quantify the residence time that the trajectories spent in each state, other than North Carolina. This was accomplished by analyzing each trajectory individually and recording the amount of time the trajectory spent in each individual state. Since trajectories were run at multiple heights, to avoid double counting, only the maximum time that all trajectory heights spent in any one state are reported. Obviously, since the end points of the trajectories are within North Carolina, some time for each trajectory must be spent in North Carolina. The results of the analysis for Davidson and Catawba counties are shown in Tables 6 and 7 respectively. Note that this analysis contains seven events in 2002 for Catawba County and four events in 2002 for Davidson County that are not included in the previous analysis of the trajectories.

For Catawba County, the maximum number of hours the trajectories spent in another state for all events was 258 in Tennessee (recall that an event is a day where the PM2.5

concentration exceeded 27.9 $\mu g/m^3$ at the monitor in that county). This represents 15.6 percent of the total trajectory time (36 hours/event * 46 events = 1656), with an average of 18.4 hours per event. The average represents the average hours the trajectory spent in each state for only those events where the trajectory spent at least some amount of time in the state (zero hour events are not included in the average). Other results include 207 hours (12.5% of total) for South Carolina, with an average of 18.8 hours per event, and 201 hours (12.1% of total) for Kentucky, with an average of 14.4 hours per event.

For Davidson County, the maximum number of hours the trajectories spent in another state for all events was 278 in South Carolina. This was 22.7 percent of the total trajectory time (36 hours/event * 34 days), with an average of 19.9 hours spent in South Carolina for each event. Virginia had a total of 275 hours (22.5% of total) with an average of 14.5 hours per event. Tennessee had a total of 166 hours (13.6 % of total) with an average of 15.1 hours per event.

4. Discussion

Analysis of HYSPLIT back trajectories from two $PM_{2.5}$ monitor locations in North Carolina on days when 24-hour average $PM_{2.5}$ levels were 27.9 $\mu g/m^3$ or greater indicates that while North Carolina is the primary source region for the majority of those days, states neighboring and near North Carolina (including Kentucky, West Virginia, and Ohio) were shown through the trajectory analysis to be potential sources of transported pollution. Back trajectories run from points in Catawba and Davidson Counties in North Carolina show a significant percentage of days for which neighboring states could be considered primary sources for transported pollution. Significant secondary states include South Carolina, Tennessee, and Virginia. Other states with slightly fewer days when back trajectories indicated potential transport include Georgia, Kentucky, and the Ohio Valley.

REFERENCES

Draxler, R.R. and Rolph, G.D., 2003. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://www.arl.noaa.gov/ready/hysplit4.html). NOAA Air Resources Laboratory, Silver Spring, MD.

County	Date	PM 2.5	Primary	Secondary	Notes
Davidson	1/1/2000	46.8	NC (Millenium Celebration)		**Low**: NC (calm conditions) and CLT; **Mid and Upper**: Upstate SC and GA
Davidson	8/13/1999	44.8	NC / SC		**Low**: NC and Eastern SC; **Mid:** SC and NC; **Upper**: NC and Upstate SC
Davidson	6/21/2001	41.6	NC	Central SC	**Low and Mid**: NC and Central SC; **Upper:** NC, Northeast TN and SW Virginia (minor)
Davidson	7/23/1999	40.5	E. KY, SW. VA	Ohio Valley	**Low and Mid:** SW Virginia and E. KY; **Upper:** long transport from Ohio Valley
Davidson	1/5/2002	39.2	NC / TN		**Low**: NC and NE TN; **Mid**: NC and Eastern TN; **Upper:** TN
Davidson	7/17/1999	38.9	NC	Central SC	**Low**: NC (CLT); **Mid**: NC and SC; **Upper**: NC and SW Virginia
Davidson	12/11/2000	38.7			Missing Data
Davidson	10/21/2000	37.7	SW. VA / E. TN	NC	**Low**: NC and Upstate SC; **Mid**: Eastern TN: **Upper**: SW VA and Eastern TN
Davidson	7/18/2001	37.7	NC / SC	SE. TN / N. GA	**Low**: SC and some NC; **Mid**: NC and Northern GA; **Upper**: NC, Eastern TN, N. GA
Davidson	7/5/1999	36.6	NC	Eastern TN (significant)	**Low**: All in NC; **Mid**: Origin in NE TN; **Upper**: Crosses KY, WV, VA
Davidson	6/2/2000	34.9	NC	Eastern TN	Missing Data
Davidson	6/29/2000	34.1	NC / N. GA / N. SC	Aloft from Ohio Valley	**Low**: NC, SC, and GA; **Mid**: NC and GA (ATL); **Upper**: Ohio Valley
Davidson	8/7/1999	33.8	NC	SW. VA	**Low**: NC; **Mid**: NC and SW VA; **Upper**: NC (CLT)
Davidson	7/2/2000	32.7	NC (CLT)	North Central SC	**Low**: Completely in NC; **Mid**: NC and Upstate SC; **Upper**: NC and Upstate SC
Davidson	8/28/1999	32.1	NC	SW. VA (less sig)	**Low**: NC; **Mid**: NC and SW VA; **Upper** NC and SW VA
Davidson	11/11/1999	31.8	TN		**Low, Mid, and Upper**: Long transport from Tennessee
Davidson	8/16/2000	31.2	NC / VA	Ohio Valley	Missing Data
Davidson	8/19/1999	31.1	NC / VA	Ohio Valley	**Low**: NC, VA, and WV; **Mid**: Eastern VA; **Upper**: NC, SW VA, and Ohio Valley
Davidson	10/27/2000	31.1	VA		**Low, Mid, and Upper**: Virginia
Davidson	1/21/1999	31.0	NC (CLT, I-85)	Upstate SC	**Low**: All in NC; **Mid and Upper**: long transport from the west
Davidson	11/8/2000	30.7	NC		**Low:** Short over NC; **Mid and Upper**: Long transport from the south (SC, GA, FL)
Davidson	7/20/1999	30.6	NE. TN, SW. VA, NC		**Low**: NC and Upstate SC; **Mid**: E. TN and NC **Upper**: VA, KY, and TN
Davidson	8/16/1999	30.1	NC		**Low, Mid, and Upper**: All completely in NC (short trajectories)
Davidson	6/11/1999	29.8	NC (PP, I-40)	Tidewater of VA (minimal)	**Low, Mid, and Upper** all over NC and originate in the Atlantic
Davidson	2/9/2000	29.4	NC	I-95 Virginia	**Low**: NC and VA; **Mid**: NC and VA; **Upper**: NC (over the mountains)
Davidson	5/30/1999	29.1	NC (CLT)	NC	**Low, Mid, and Upper** all in NC and very northern SC
Davidson	8/8/2001	29.0	Ohio Valley	WV / VA / NC	**Low**: NC and SW VA; **Mid**: VA and WV; **Upper:** VA, WV and Ohio Valley
Davidson	10/30/1999	28.5	NC		Missing Data
Davidson	8/17/2001	28.5	NC / SC	GA (ATL)	**Low**: NC (CLT) and SC; **Mid**: Mostly SC, some NC; **Upper**: NC and GA (ATL)
Davidson	7/8/1999	28.4	NC	Upstate SC, Eastern TN (3rd)	**Low**: NC; **Mid**: Upstate SC; **Upper**: NE Tennessee
Davidson	10/18/2000	28.0	NC	Eastern TN	**Low**: Completely in NC; **Mid**: Completely in NC; **Upper**: long transport from TN
Davidson	8/14/2001	27.9	NC / VA	WV	**Low**: NC and SW VA; **Mid**: NC, Central VA, and WV; **Upper**: VA, WV, and Ohio Valley

Table 1. Days when observed $PM_{2.5}$ values in Catawba and Davidson Counties was above 27.8 ug/m^3. Indicated in the table is the county, date, $PM_{2.5}$ observed value, the primary and secondary sources as determined by the NC DAQ meteorologists, and any notes made by the meteorologists concerning that days trajectories. Purple shading indicates observed values greater than 39.9 ug/m^3, red shading between 35.0 ug/m^3 and 39.9 ug/m^3, orange shading between 30.0 ug/m^3 to 34.9 ug/m^3, yellow shading between 27.9 ug/m^3 and 29.9 ug/m^3. Blue shading indicates known fire events in North Carolina. On days with missing EDAS data, surface maps were used to determine the source region(s).

County	Date	PM 2.5	Primary	Secondary	Notes
Catawba	11/2/2000	54.7	NC (Fire Event)	Ohio Valley	**Low and Mid**: Completely in NC; **Upper**: Long transport from the Ohio Valley
Catawba	11/8/2000	50.1	NC (Fire Event)	SC / E. GA / FL (minor)	**Low, Mid, and Upper**: Short trajectories in NC, then long transport from the south
Catawba	1/21/1999	41.0	NC	Upstate, North Central GA	**Low**: all in NC; **Mid**: NC, Upstate SC, and N. GA; **Upper**: long transport from the southwest
Catawba	6/21/2001	40.0	NC	SC (minor)	**Low**: NC and Upstate SC; **Mid**: Completely NC; **Upper**: All NC except for couple hours in TN
Catawba	10/21/2000	38.0	NC	N. SC and E. TN	**Low**: NC and Upstate SC; **Mid**: Eastern TN and N. GA; **Upper**: Central TN and Northern MS
Catawba	10/27/2000	36.7	SW. VA / WV	Southern Ohio Valley	**Low**: SW VA and Eastern KY; **Mid and Upper**: SW VA, Western WV, Southern Ohio Valley
Catawba	7/23/1999	36.1	NE. TN / OV / SW. VA		**Low and Mid**: Northern TN; **Upper**: long transport from the northwest
Catawba	8/7/2000	34.2	NC	Eastern TN, GA (ATL)	**Low and Mid**: NC and Northern GA; **Upper**: Eastern TN and Northern GA
Catawba	3/31/1999	30.0	NC	Northern SC	**Low**: NC; **Mid**: NC, minor SC and VA; **Upper**; Upstate SC
Catawba	2/9/2000	33.5	NC	Eastern TN, Northern GA	**Low**: NC and very minor VA; **Mid**: NC and very minor SC; **Upper**: NC, E. TN, and N. GA
Catawba	6/5/1999	33.2	NC		**Low, Mid, and Upper**: NC (CLT and Triad)
Catawba	8/7/1999	33.1	NC	SW. VA	**Low and Mid**: Mostly NC, few hours in SW VA; **Upper**: Mostly in NC, few hours in NE TN
Catawba	1/1/2000	33.0	Millenium		**Low, Mid, and Upper**: NC and transport from the west
Catawba	2/21/2001	32.8	Eastern TN	Northern GA	**Low**: Eastern TN and Northern GA; **Mid**: NE TN, SW VA (minor), and TN; **Upper**: TN and KY
Catawba	7/8/2000	32.7	NC		**Low and Mid**: Completely in NC; **Upper**: NC and Upstate SC (minor, mostly NC)
Catawba	7/17/1999	32.3	NC	Upstate SC	**Low and Mid**: NC and Upstate SC; **Upper**: All in NC
Catawba	8/2/2001	32.0	NC		**Low, Mid, and Upper**: Trajectories completely in NC
Catawba	6/8/1999	31.7	NE. TN / SW. VA / KY		**Low**: NE TN and SW VA; **Mid and Upper**: NE TN, SW VA, KY;
Catawba	8/16/1999	31.1	NC		**Low and Mid**: Completely in NC; **Upper**: NC and Upstate SC (CLT area)
Catawba	8/13/1999	31.0	NC	SC	**Low**: Completely in NC; **Mid**: NC and Upstate SC (CLT); **Upper**: NC
Catawba	6/2/2000	31.0	Eastern TN	N. GA and NC	missing data
Catawba	7/20/1999	30.9	NC / E. TN		**Low**: Completely in NC; **Mid and Upper**: Eastern TN
Catawba	5/3/2000	30.8	NC	VA and SC	**Low**: majority NC and VA; **Mid**: NC (half), VA (half); **Upper**: mostly NC, minor SC
Catawba	7/23/2000	30.6	NC		**Low, Mid, and Upper**: Completely in NC
Catawba	9/7/2001	30.4	NC	NE. TN	**Low and Mid**: Completely in NC; **Upper**: NC and NE Tennessee
Catawba	8/26/2001	30.2	NC	Eastern TN and SC (minor)	**Low**: Completely in NC; **Mid**: Mostly in NC, few hours in Upstate SC; **Upper**: Eastern TN
Catawba	1/30/1999	30.0	NC		**Low, Mid, and Upper**: NC and VA (few hours);
Catawba	2/17/1999	30.0	NC / N. GA / Upstate SC		missing data
Catawba	8/19/1999	29.6	Ohio Valley / SW. VA		**Low**: NC, SW VA, and WV; **Mid**: NC, VA, and WV; **Upper**: NC, NE TN, SW VA, and E. KY
Catawba	7/2/2000	29.4	NC	SC	**Low**: NC (CLT); **Mid**: NC and Upstate SC; **Upper**: NC and Central SC
Catawba	7/18/2001	29.3	NC	SE. TN and N. GA	**Low**: NC and Northern GA; **Mid and Upper**: Southeast TN and Northest MS
Catawba	7/5/2000	29.1	Eastern and Central TN		**Low, Mid, and Upper**: Transport from Central and Eastern Tennessee
Catawba	11/18/2001	29.0	NC	VA / Ohio Valley (upper)	**Low and Mid**: NC and VA; **Upper**: SW VA, KY, and Southern Ohio Valley
Catawba	8/10/1999	28.4	NC	E. TN	**Low and Mid**: All in NC; **Upper**: transport from KY and TN
Catawba	6/4/2002	28.4	SC	NC	**Low**: Upstate SC and NC; **Mid**: SC and NC; **Upper**: SC and NC
Catawba	7/5/1999	28.2	NE. TN	SW. VA / KY	**Low**: NE TN; **Mid**: NE TN and SW VA; **Upper**: SW VA and KY
Catawba	6/11/2000	28.2	NC / NE. TN / SC		**Low and Mid**: Majority Upstate SC, some NC; **Upper**: NC and some NE TN and Upstate SC
Catawba	8/16/2000	28.2	NE. TN / SW. VA	KY	missing data
Catawba	10/18/2000	28.2	NC	NE and Central TN	**Low**: Completely in NC; **Mid and Upper**: Eastern and Central TN
Catawba	8/4/1999	28.1	NC / VA		**Low, Mid, and Upper**: NC and SW VA
Catawba	9/31/01	28.1	NC	SW. VA and E. KY	**Low and Mid**: Completely in NC; **Upper**: SW VA and SE KY

Table 1 Continued

Table 2. Number of days that the HYSPLIT back trajectories indicated a region as a primary or secondary source for locations in Catawba and Davidson Counties in North Carolina.

Catawba County					***Davidson County***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	31	2	33		North Carolina	26	2	28
South Carolina	3	9	12		South Carolina	4	5	9
Tennessee	9	8	17		Tennessee	4	5	9
Virginia	6	5	11		Virginia	7	5	12
Georgia	1	7	8		Georgia	1	2	3
Kentucky	1	3	4		Kentucky	1	0	1
Ohio Valley	2	3	5		Ohio Valley	1	4	5
NC Only	27				NC Only	17		
NC + Other	4				NC + Other	9		
No NC	10				No NC	5		

Table 3. Number of days in the highest one-third of 24-hour average $PM_{2.5}$ values for all days for which HYSPLIT trajectories were run. Specific $PM_{2.5}$ values were 32.8 – 54.7 µg/m^3 for Catawba County and 34.9 – 46.8 µg/m^3 for Davidson County.

Catawba County – Upper Third					***Davidson County – Upper Third***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	10	0	10		North Carolina	8	1	9
South Carolina	0	3	3		South Carolina	2	2	4
Tennessee	2	3	5		Tennessee	2	3	5
Virginia	2	1	3		Virginia	2	0	2
Georgia	0	3	3		Georgia	0	1	1
Kentucky	0	0	0		Kentucky	1	0	1
Ohio Valley	1	1	2		Ohio Valley	0	1	1

Table 4. Number of days in the middle one-third of 24-hour average $PM_{2.5}$ values for all days for which HYSPLIT trajectories were run. Specific $PM_{2.5}$ values were 30.0 – 32.8 μg/m^3 for Catawba County and 30.6 – 34.1 μg/m^3 for Davidson County.

Catawba County – Middle Third					***Davidson County – Middle Third***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	10	0	10		North Carolina	9	0	9
South Carolina	1	4	5		South Carolina	1	2	3
Tennessee	3	2	5		Tennessee	2	0	2
Virginia	2	1	3		Virginia	4	2	6
Georgia	1	0	1		Georgia	1	0	1
Kentucky	1	0	1		Kentucky	0	0	0
Ohio Valley	1	0	1		Ohio Valley	0	3	3

Table 5. Number of days in the lowest one-third of 24-hour average $PM_{2.5}$ values for all days for which HYSPLIT trajectories were run. Specific $PM_{2.5}$ values were 28.1 – 29.6 μg/m^3 for Catawba County and 27.9 – 30.1 μg/m^3 for Davidson County.

Catawba County – Lower Third					***Davidson County – Lower Third***			
State/Area	**Primary (days)**	**Secondary (days)**	**Total (days)**		**State/Area**	**Primary (days)**	**Secondary (days)**	**Total (days)**
North Carolina	8	1	9		North Carolina	9	2	11
South Carolina	2	1	3		South Carolina	1	1	2
Tennessee	4	3	7		Tennessee	0	1	1
Virginia	3	3	6		Virginia	1	3	4
Georgia	0	1	1		Georgia	0	1	1
Kentucky	0	2	2		Kentucky	0	0	0
Ohio Valley	1	1	2		Ohio Valley	1	0	1

Table 6. Total number of hours back trajectories spent in states other than North Carolina for all events for the Davidson County $PM_{2.5}$ monitor. Hours are based on the maximum of all trajectory heights, and therefore do not double count. Percent of total hours based on maximum hours of all events (1224 hours). Average hours based on average of each event, excluding zero hour events.

Davidson County									
Date	***PM2.5***	***SC (hrs)***	***GA (hrs)***	***TN (hrs)***	***VA (hrs)***	***KT (hrs)***	***WV (hrs)***	***OH (hrs)***	***MAX***
1/21/1999	31.0	12	8						36
5/30/1999	29.1	20							36
6/11/1999	29.8								36
7/5/1999	36.6				6	16	12		36
7/8/1999	28.4	23	10	20					36
7/17/1999	38.9	22			22				36
7/20/1999	30.6			22	12	11			36
7/23/1999	40.5			18	13		7	4	36
8/7/1999	33.8				7				36
8/13/1999	44.8	23							36
8/16/1999	30.1								36
8/19/1999	31.1				28		13	8	36
8/28/1999	32.1				25				36
11/11/1999	31.8		15	9					36
1/17/2000	N/A								36
2/9/2000	29.4				13				36
6/2/2000	34.9								36
6/29/2000	34.1	10	16		6	18		6	36
7/2/2000	32.7	21							36
10/18/2000	28.0			25					36
10/21/2000	37.7	16	9	10	6	6			36
10/27/2000	31.1				34				36
11/8/2000	30.7	14	9						36
12/11/2000	38.7				12				36
6/21/2001	41.6	28		10	3	3			36
7/18/2001	37.7	29	11	14					36
8/8/2001	29.0				20	14	18		36
8/14/2001	27.9				20		11		36
8/17/2001	28.5	17	16						36
1/5/2002	39.2			20		4			36
7/1/2002	31.1	23			18				36
7/16/2002	33.1				6		12	12	36
8/12/2002	36.9	20		12	19				36
12/7/2002	43.7			6	5	9			36
Total Hours		**278**	**94**	**166**	**275**	**81**	**73**	**30**	**1224**
% of Total		**22.7**	**7.7**	**13.6**	**22.5**	**6.6**	**6.0**	**2.5**	
Avg. Hours		**19.9**	**11.8**	**15.1**	**14.5**	**10.1**	**12.2**	**7.5**	

Table 7. As in Table 6, except for Catawba County.

Catawba County									
Date	***PM2.5***	***SC (hrs)***	***GA (hrs)***	***TN (hrs)***	***VA (hrs)***	***KT (hrs)***	***WV (hrs)***	***OH (hrs)***	***MAX***
1/21/1999	31.0	12	10						36
1/30/1999	30.0				10		3		36
3/31/1999	30.0	9			6				36
5/30/1999	29.1								36
6/8/1999	31.7				7	25			36
7/5/1999	28.2			25	15	21			36
7/17/1999	32.3	20							36
7/20/1999	30.9			28					36
7/23/1999	36.1			30		12			36
8/4/1999	28.1				17		2		36
8/7/1999	33.1								36
8/10/1999	28.4			10		26			36
8/13/1999	31.0	31							36
8/16/1999	31.1								36
8/19/1999	29.0				6	12	16		36
1/1/2000	33.0								36
2/9/2000	33.5	6	15	12	4				36
5/3/2000	30.8	4			21	7			36
6/2/2000	31.0								36
6/11/2000	28.2	25							36
7/2/2000	29.4	24							36
7/5/2000	29.1			34					36
7/8/2000	32.7								36
7/23/2000	30.6								36
8/7/2000	34.2		26	6					36
8/16/2000	28.2								36
10/18/2000	28.2			31		6			36
10/21/2000	38.0		19	13	3	6			36
10/27/2000	36.7				13	13	10	12	36
11/2/2000	54.7								36
11/8/2000	50.1								36
2/21/2001	32.8		6	9		13			36
6/21/2001	40.0	20							36
7/18/2001	29.3		16	10					36
8/2/2001	32.0								36
8/26/2001	30.2			34					36
9/7/2001	30.4			10					36
9/13/2001	28.1				6	26			36
11/18/2001	29.0				12		15	5	36
6/4/2002	28.4	31							36
7/1/2002	33.5	25			9	16			36
7/7/2002	28.3				8				36
7/16/2002	33.5				11		15	15	36
8/3/2002	30.0								36
8/12/2002	40.7				20	8			36
12/7/2002	29.2			6		10			36
12/31/2002	28.9	12	19						36
Total Hours		**207**	**92**	**258**	**168**	**201**	**61**	**32**	**1656**
% of Total		**12.5**	**5.6**	**15.6**	**10.1**	**12.1**	**3.7**	**1.9**	
Avg. Hours		**18.8**	**15.3**	**18.4**	**10.5**	**14.4**	**10.2**	**10.7**	

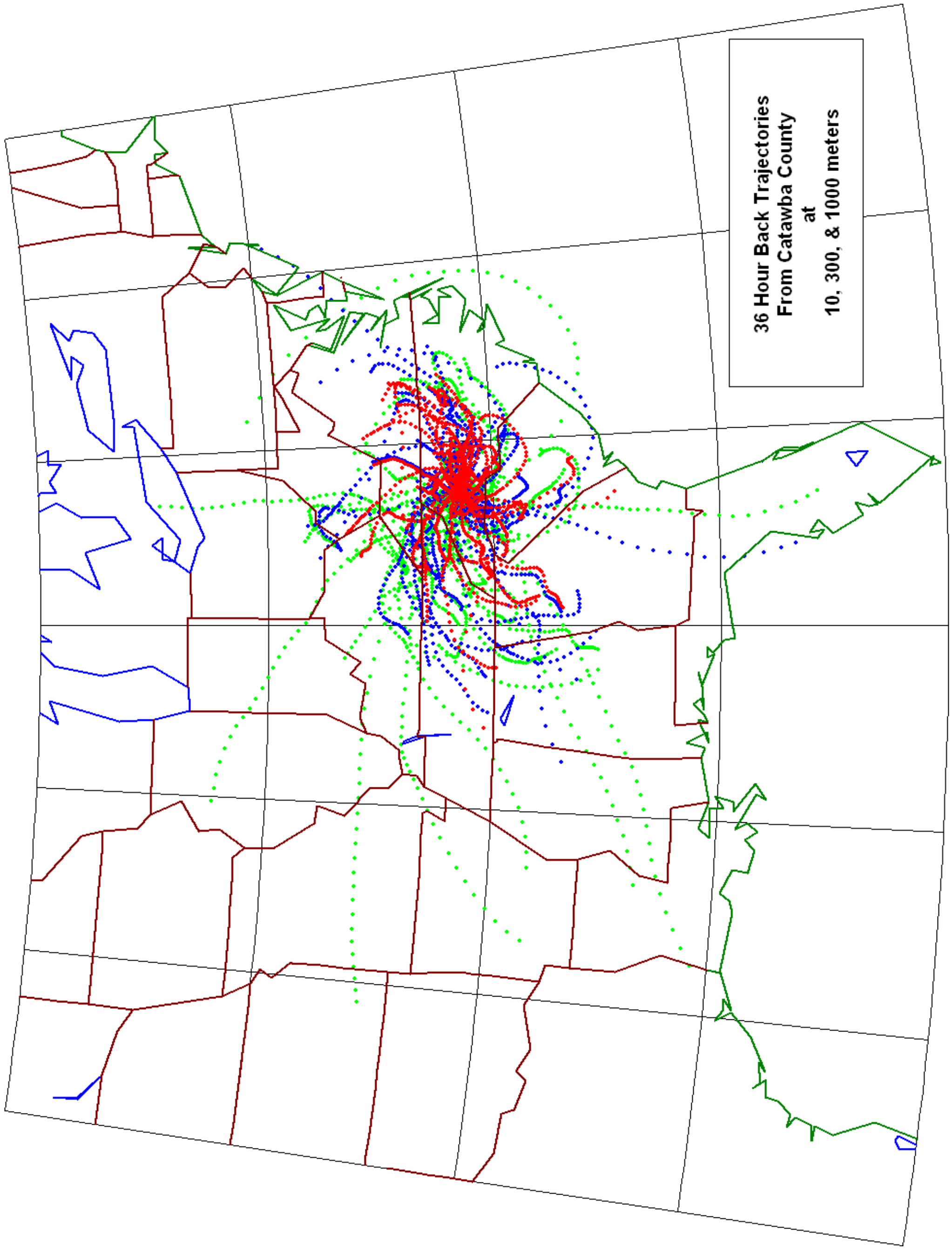

FIG 1. 36-hour back trajectories at 10 meters (red), 300 meters (blue) and 1000 meters (green) from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

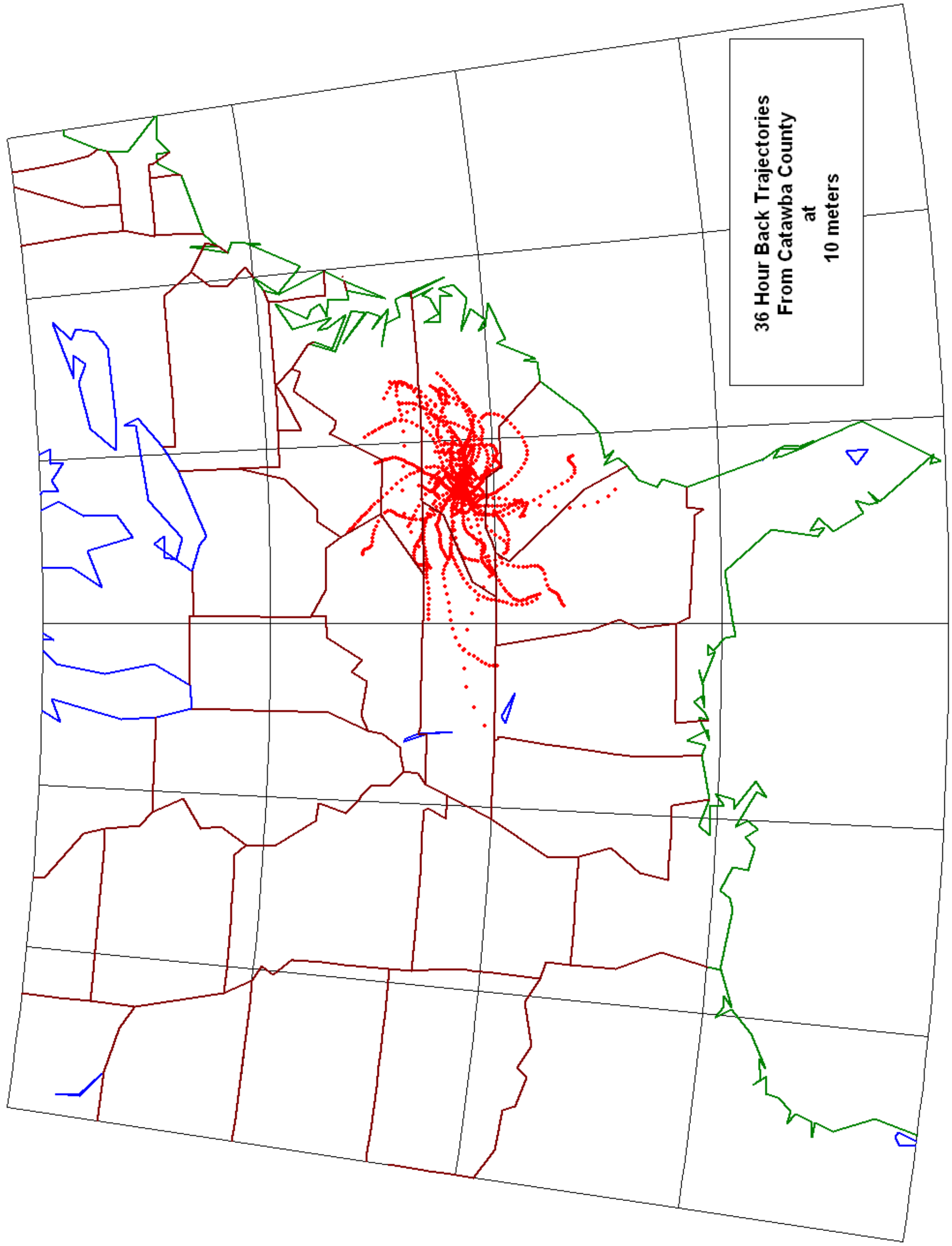

FIG 2. 36-hour back trajectories at 10 meters from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

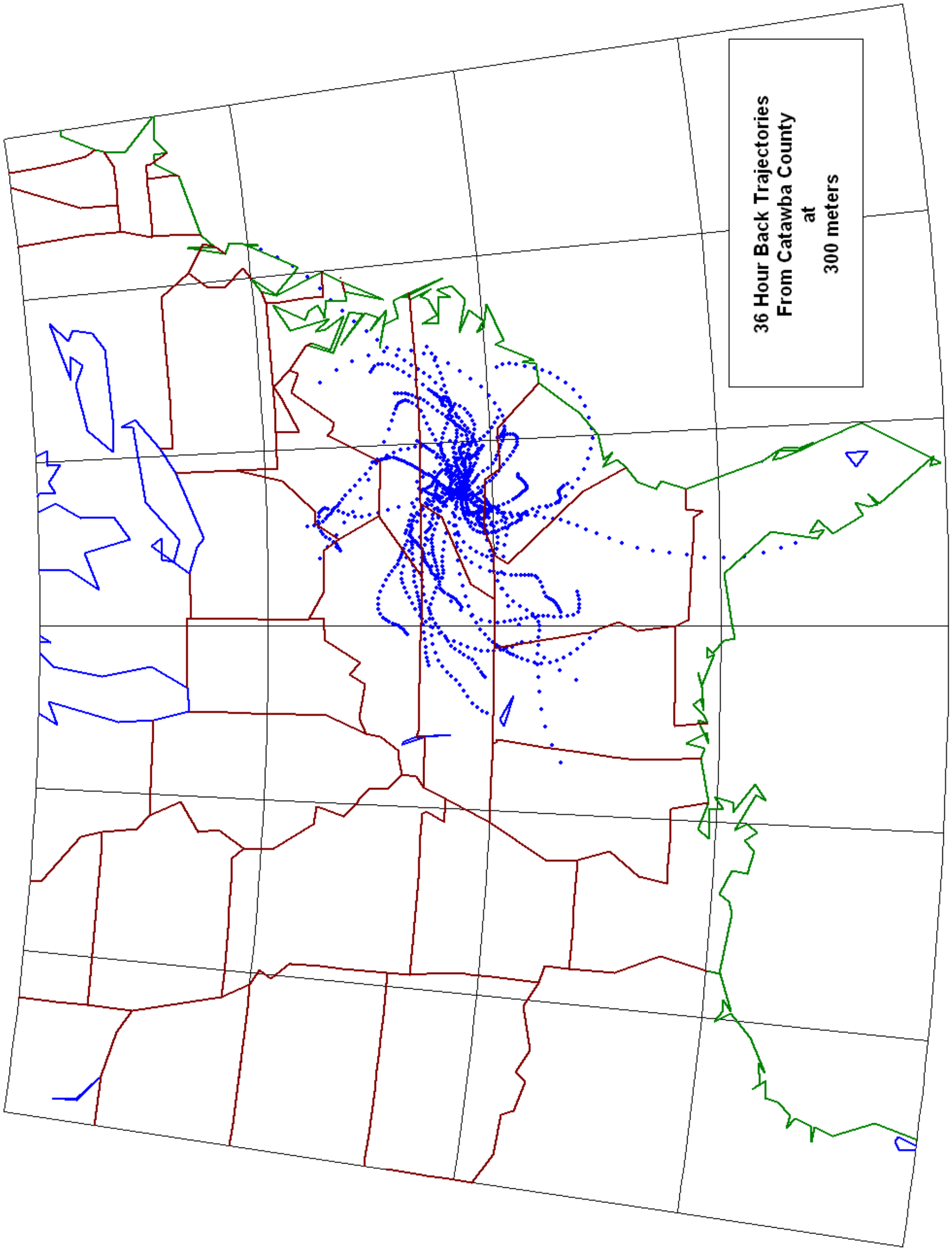

FIG 3. 36-hour back trajectories at 300 meters from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

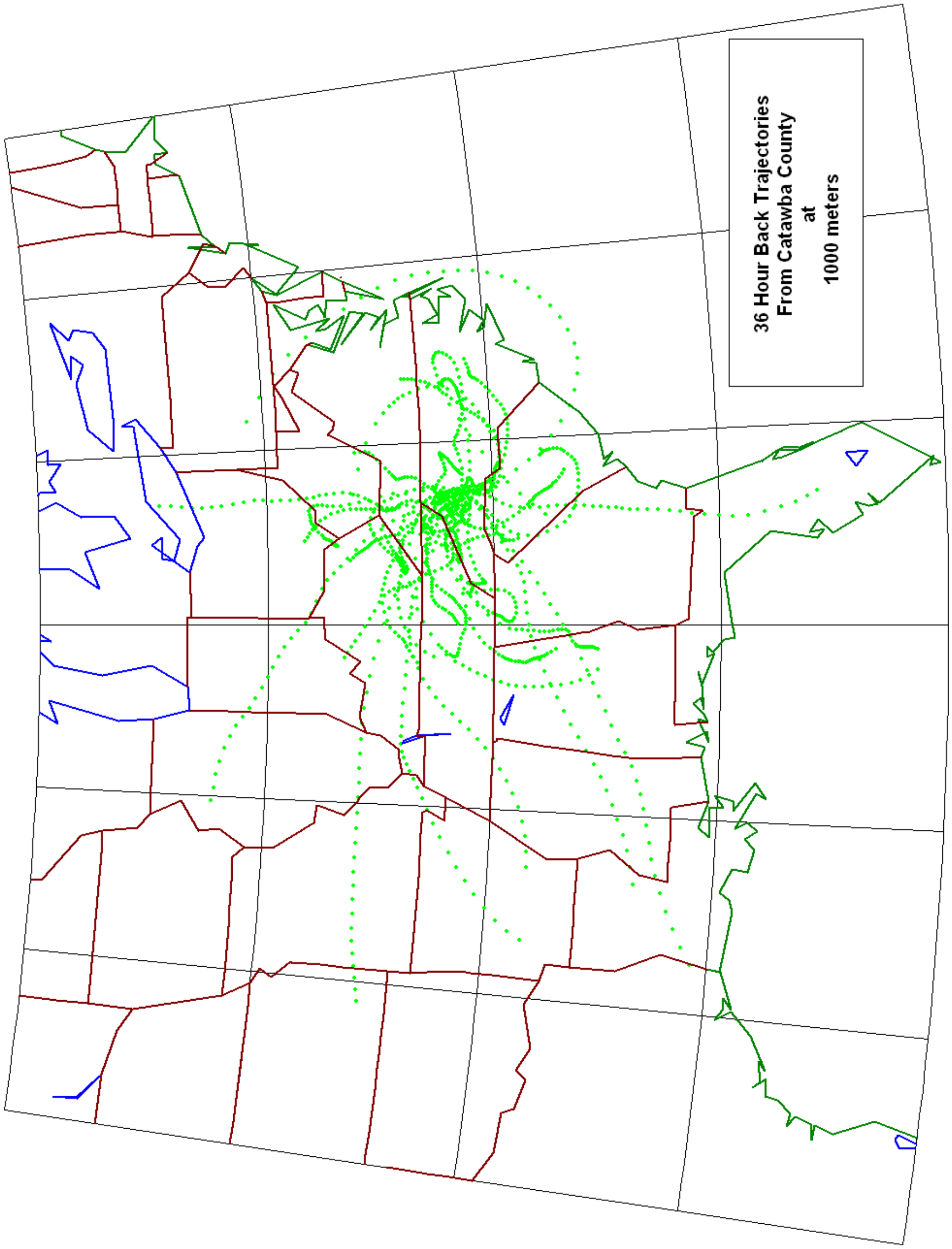

FIG 4. 36-hour back trajectories at 1000 meters from the Catawba County site for days when the $PM_{2.5}$ concentration was high.

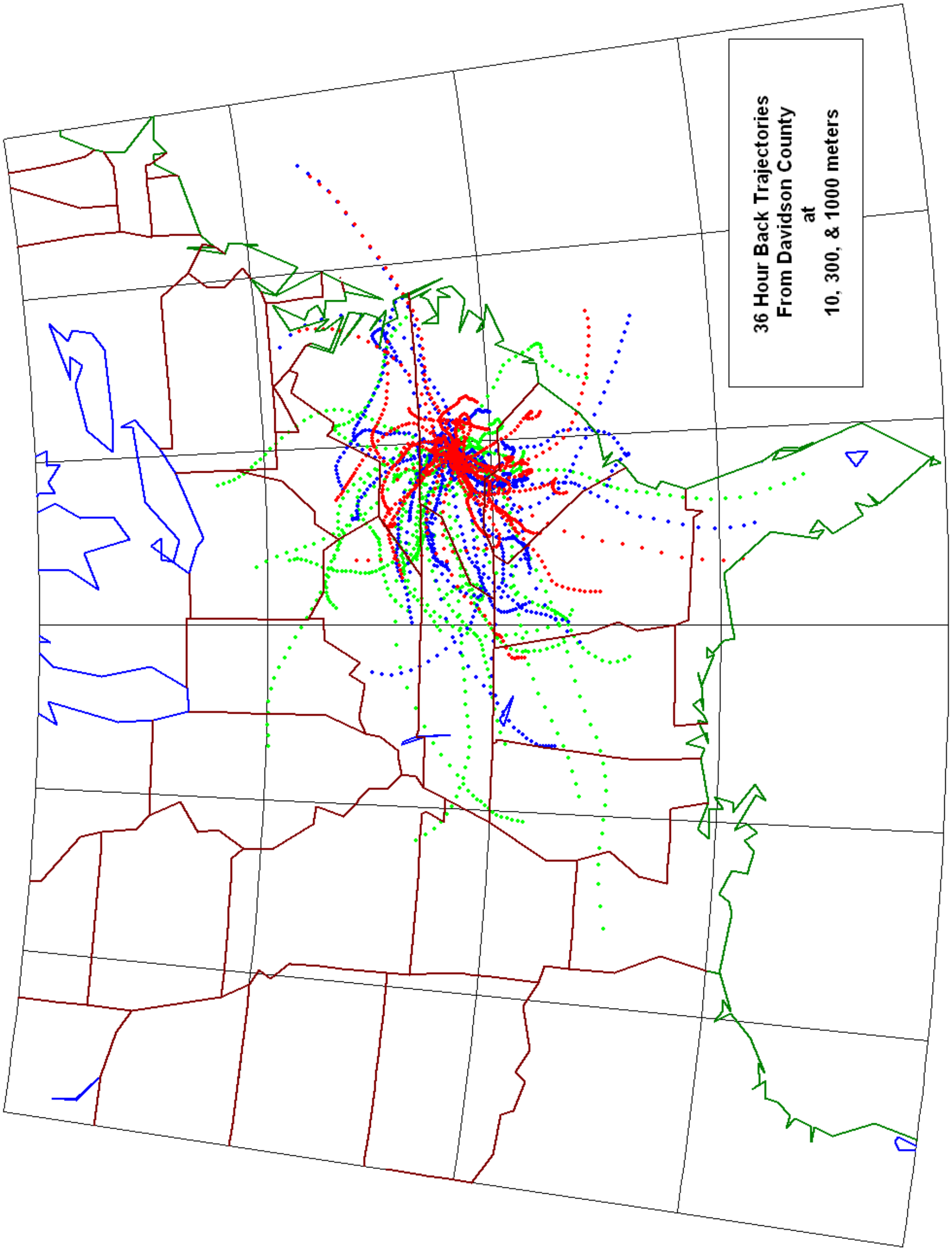

FIG 5. As in Figure 1, except for Davidson County.

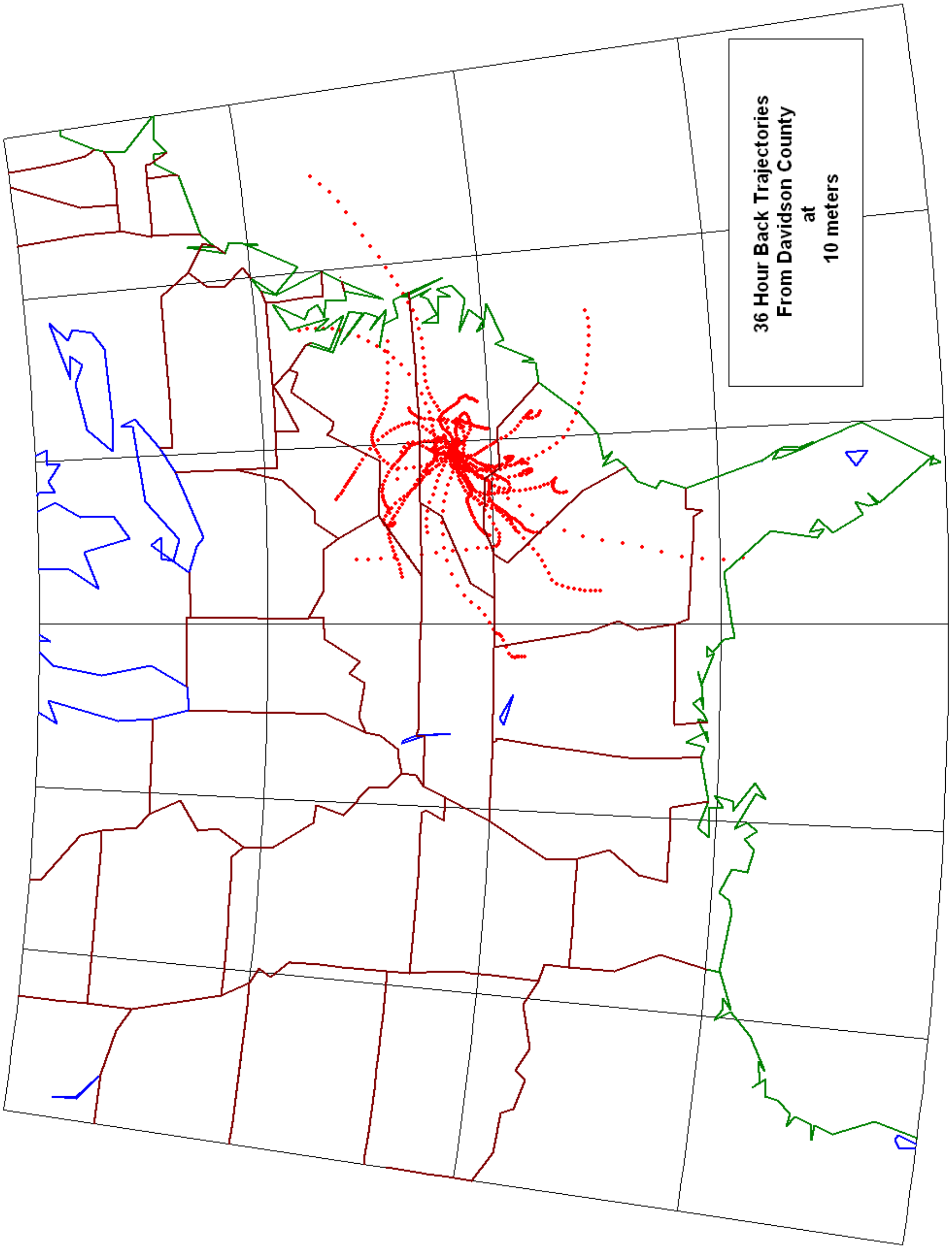

FIG 6. As in Figure 2, except for Davidson County.

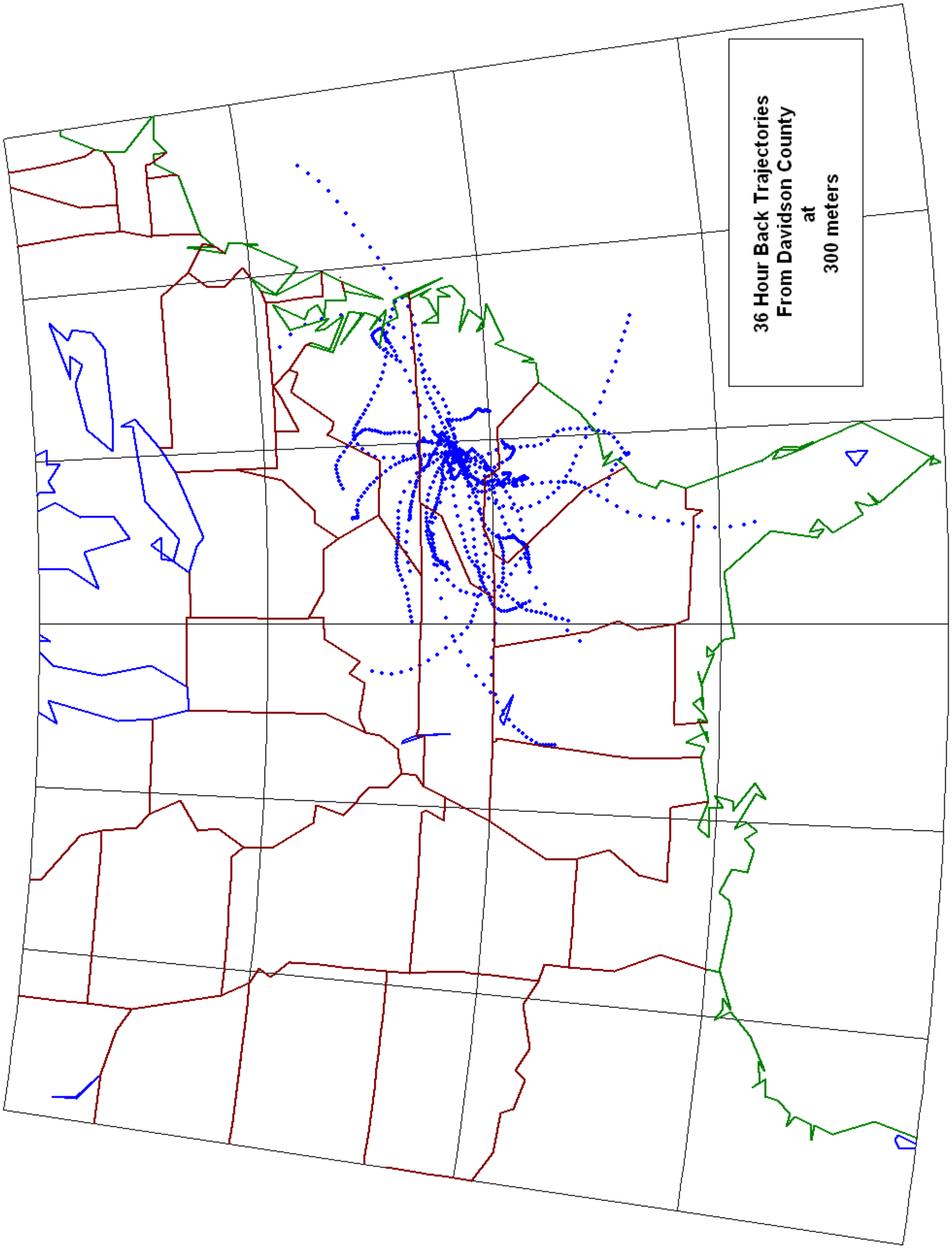

FIG 7. As in Figure 3, except for Davidson County.

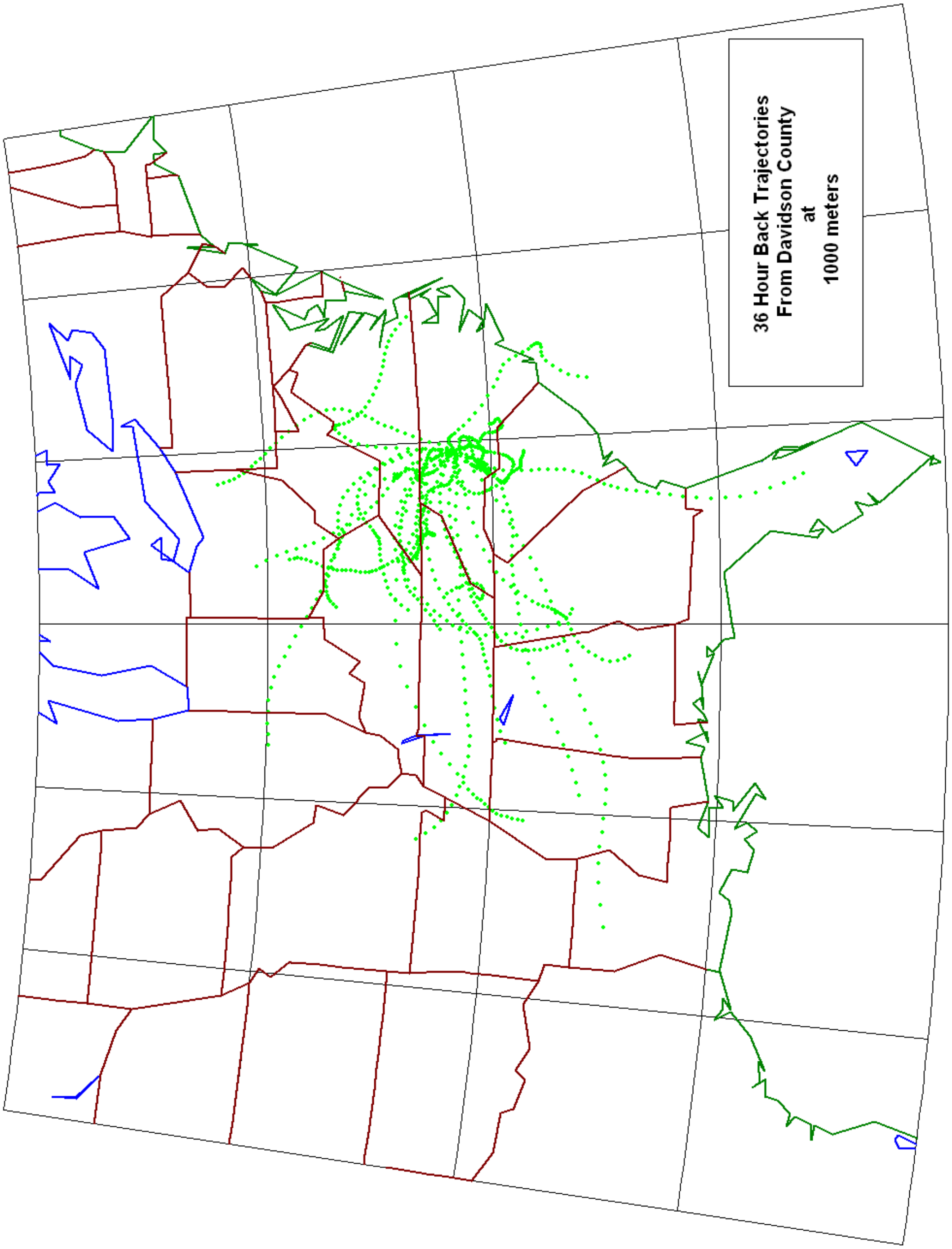

FIG 8. As in Figure 4, except for Davidson County.

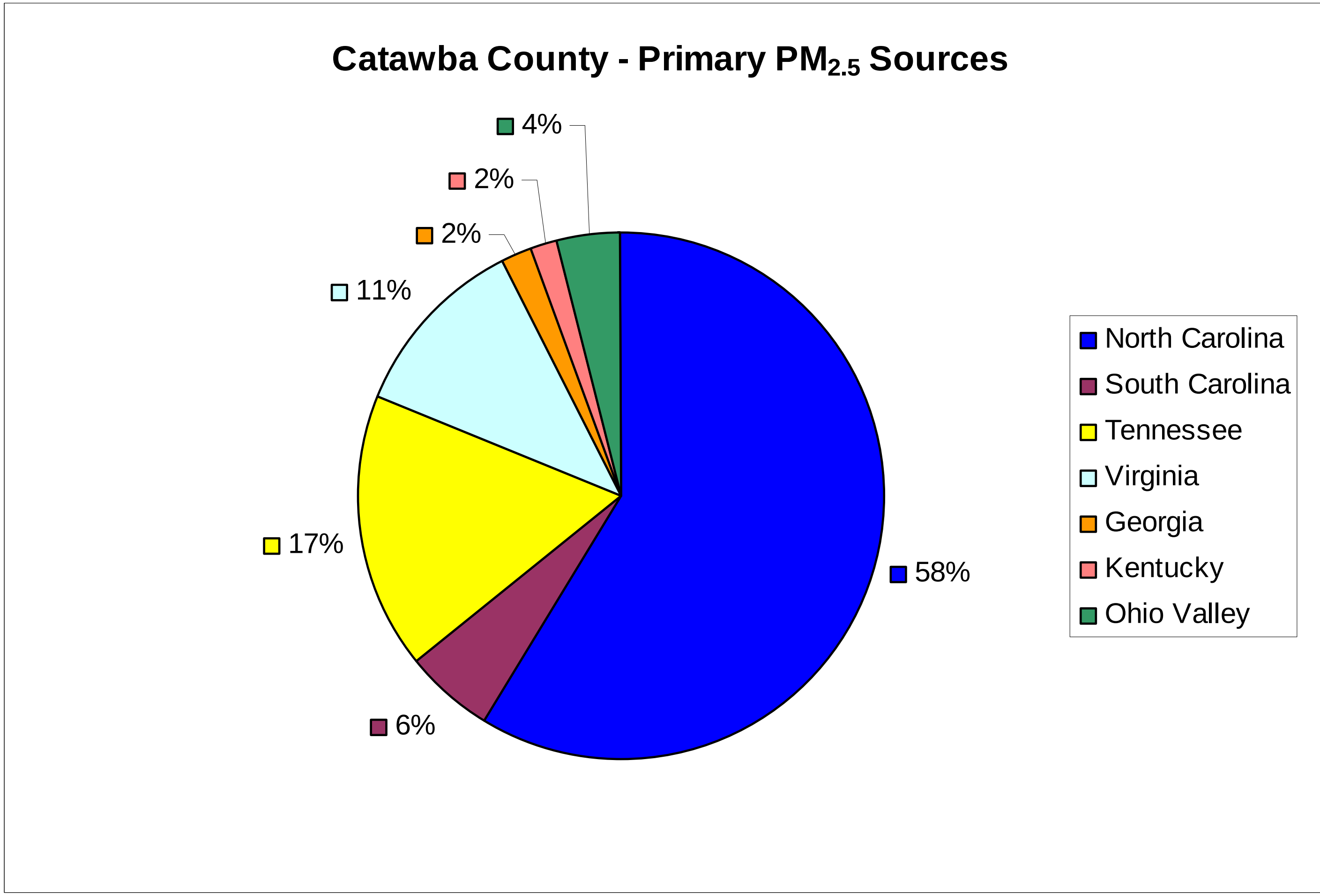

FIG 9. Percent of the days for which HYSPLIT back trajectories were run for the Catawba County $PM_{2.5}$ monitor for which each region was determined to be a primary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

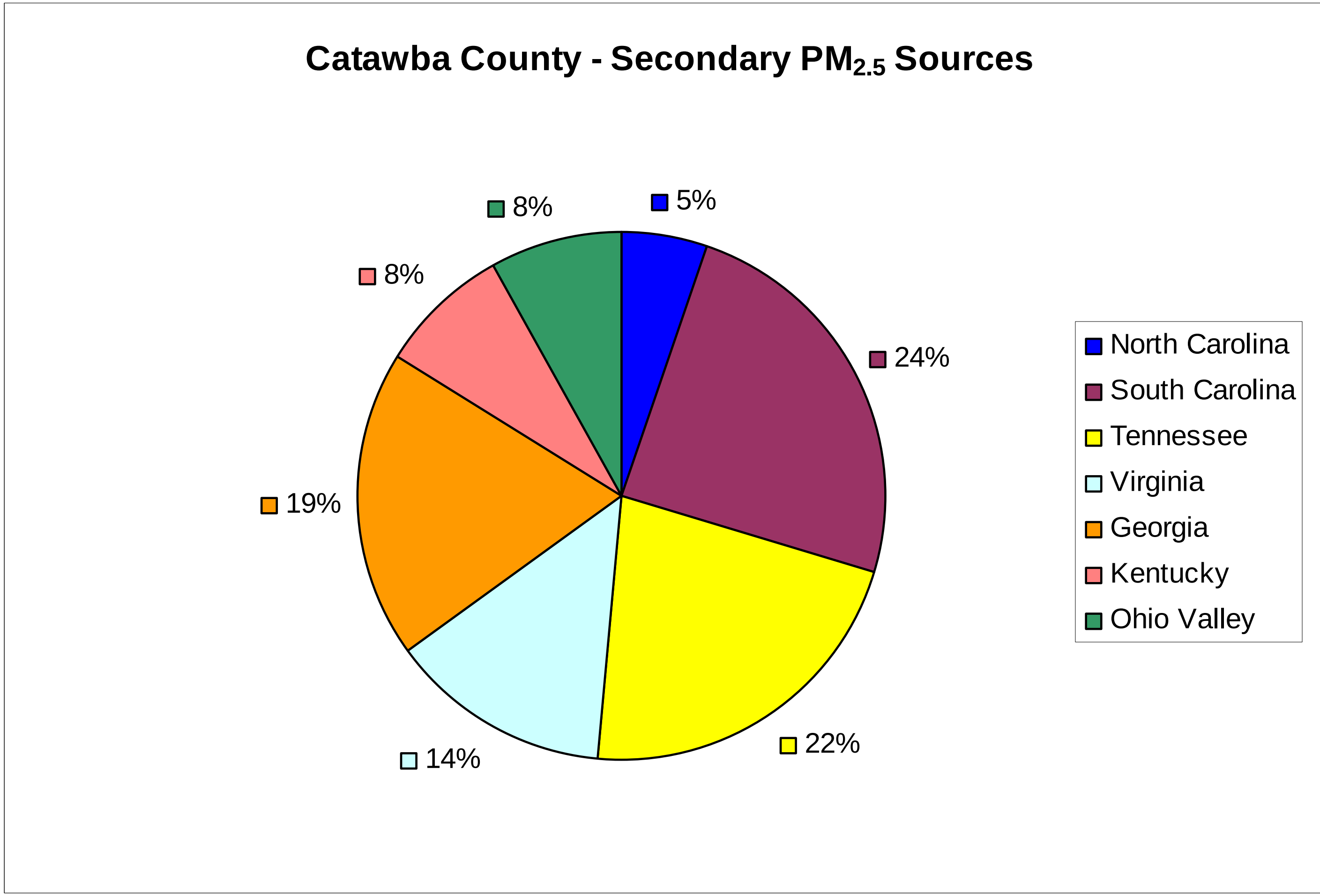

FIG 10. Percent of the days for which HYSPLIT back trajectories were run for the Catawba County $PM_{2.5}$ monitor for which each region was determined to be a secondary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

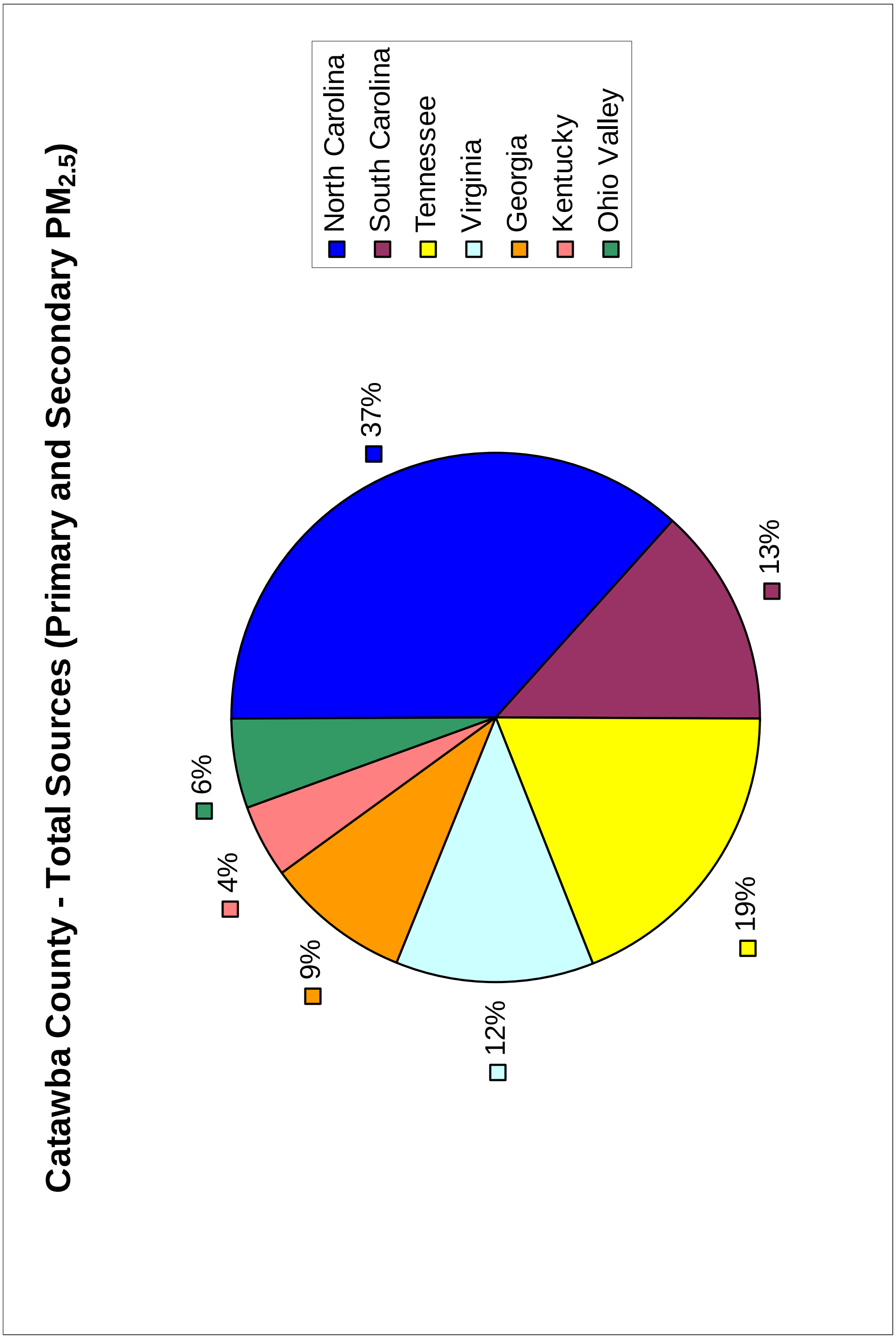

FIG 11. Percent of the days for which HYSPLIT back trajectories were run for the Catawba County $PM_{2.5}$ monitor for which each region was determined to be a primary source, secondary source, or both. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

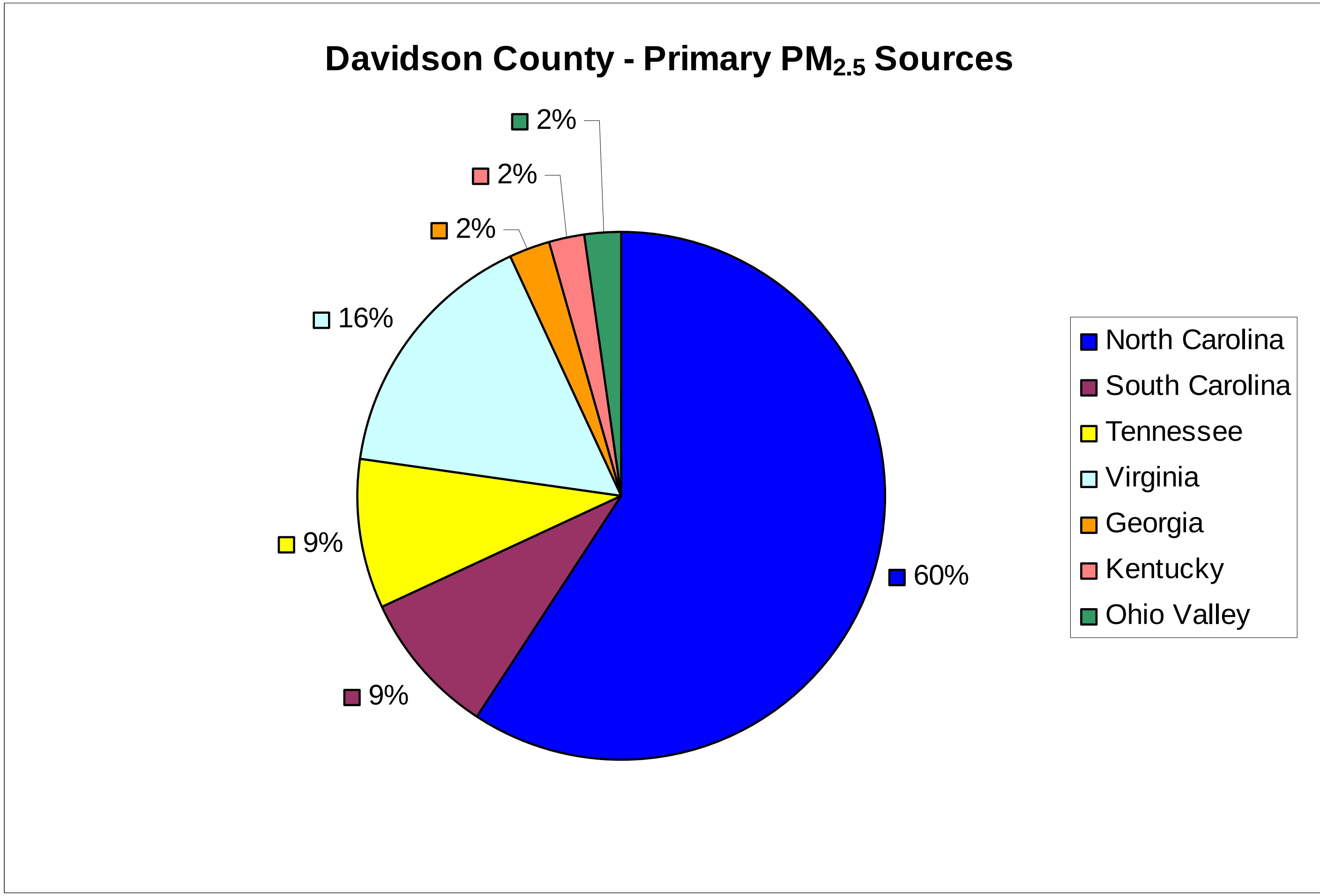

FIG 12. Percent of the days for which HYSPLIT back trajectories were run for the Davidson County $PM_{2.5}$ monitor for which each region was determined to be a primary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

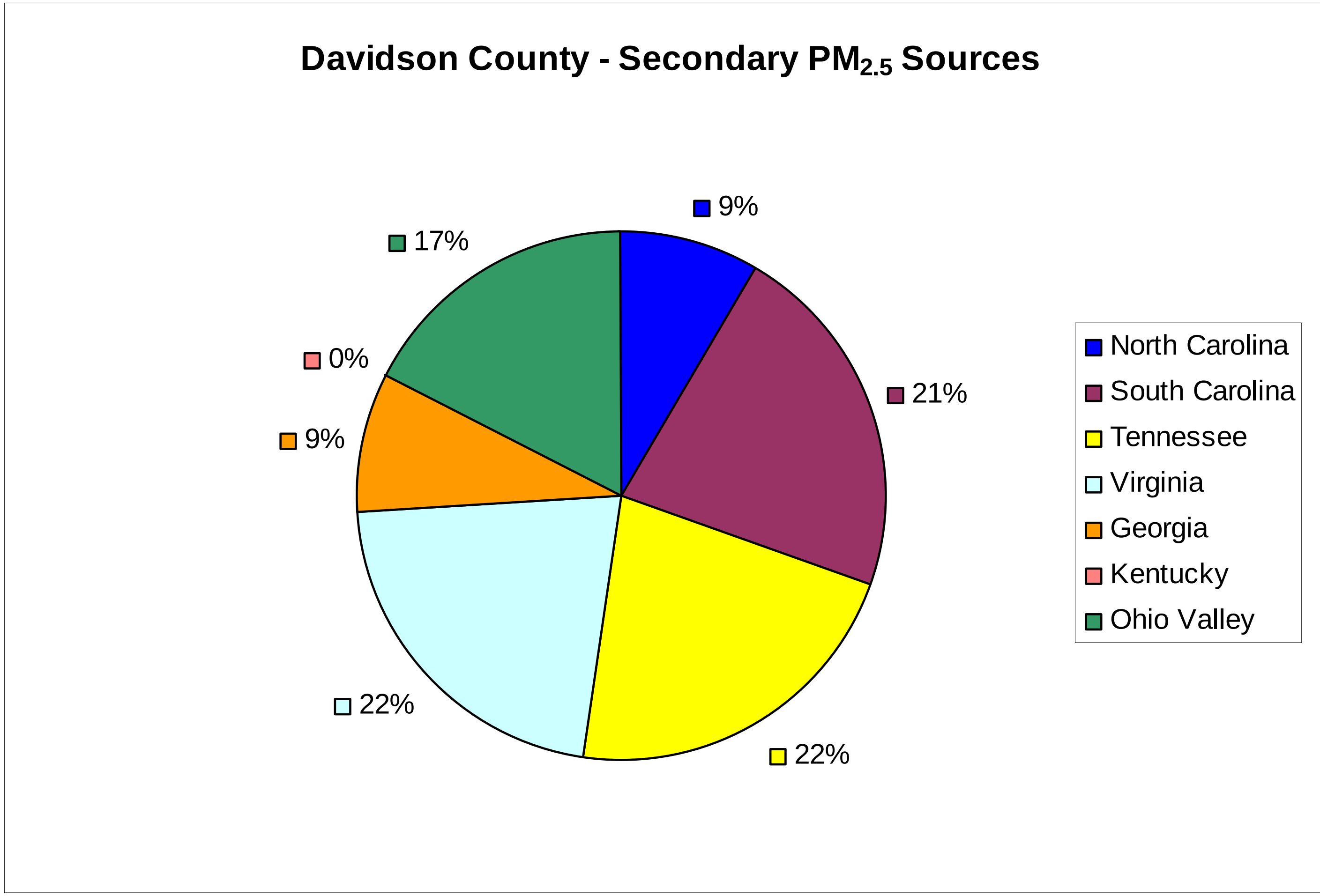

FIG 13. Percent of the days for which HYSPLIT back trajectories were run for the Davidson County $PM_{2.5}$ monitor for which each region was determined to be a secondary source. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

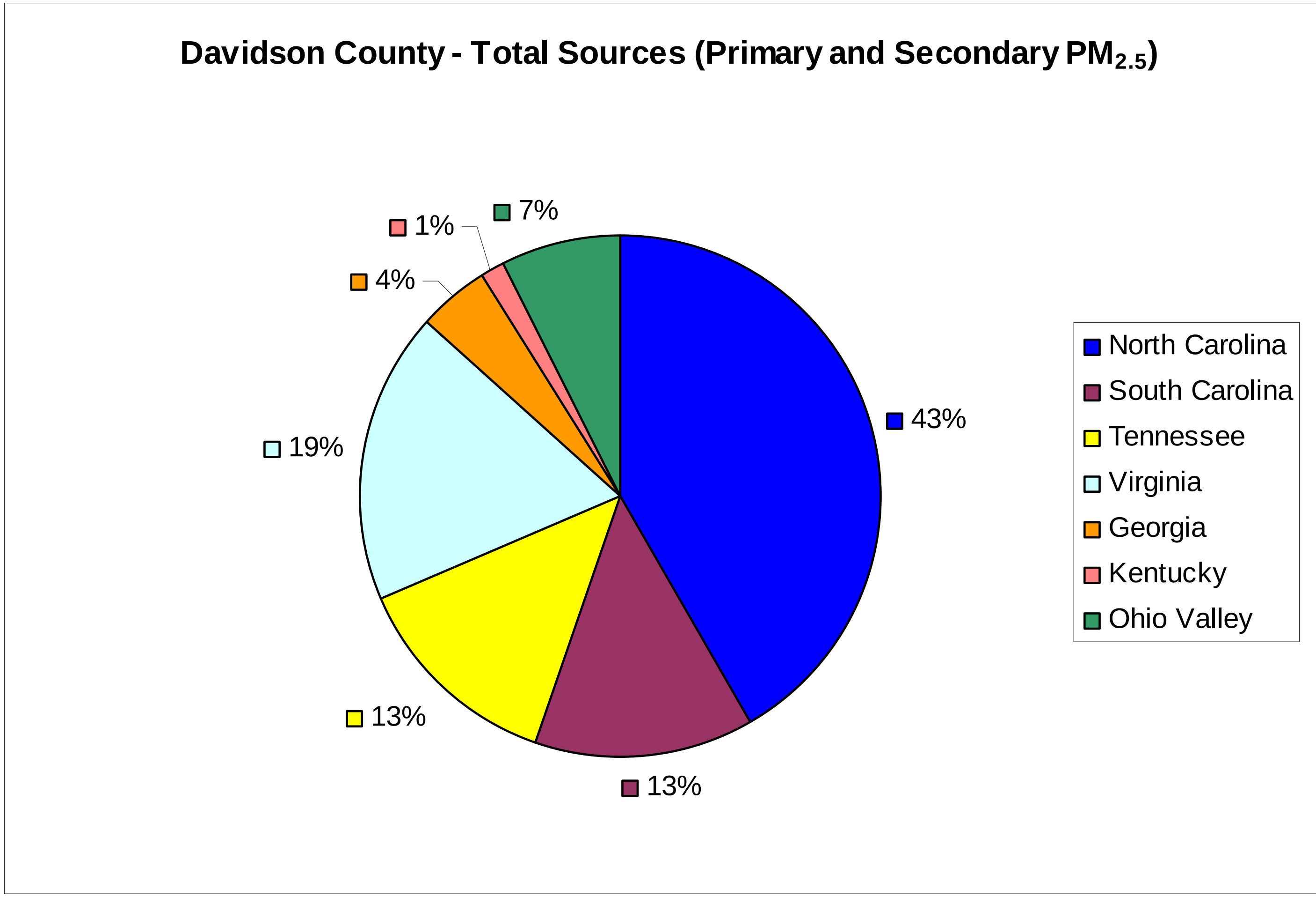

FIG 14. Percent of the days for which HYSPLIT back trajectories were run for the Davidson County $PM_{2.5}$ monitor for which each region was determined to be a primary source, secondary source, or both. Dark Blue: North Carolina; Burgundy: South Carolina; Yellow: Tennessee; Light Blue: Virginia; Orange: Georgia; Pink: Kentucky; Green: Ohio Valley.

Appendix O:

Insignificance of NH_3 and VOCs to PM2.5 Attainment in North Carolina

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1 Significance of Precursors Contributing to Fine Particulate Formation

The United States Environmental Protection Agency (USEPA) revised the National Ambient Air Quality Standards (NAAQS) for particulate matter in 1997 establishing fine particulates (particulate matter with aerodynamic diameter ≤ 2.5 micrometers or PM2.5) as a benchmark. The revised NAAQS for particulate matter set a daily standard of 65 $\mu g/m^3$ and an annual standard of 15.0 $\mu g/m^3$. The daily PM2.5 standard was more recently revised in 2006 by lowering it to 35 $\mu g/m^3$ based on a review of the air quality criteria and the NAAQS, but the annual PM2.5 standard was retained at 15.0 $\mu g/m^3$. Both of these revisions to the NAAQS for particulate matter are published in 40 CFR 50.7 and 40 CFR 50, Appendix N.

Areas designated as "nonattainment" for fine particulates by the USEPA must submit formal implementation plans detailing how attainment will be met as outlined in the Clean Air Act (CAA). These implementation plans must outline the measures that will be taken to curtail the concentrations of various pollutants that are assumed to have significant contributions to fine particulate nonattainment, including sulfur dioxide (SO_2), nitrogen oxides (NOx), and PM2.5.

The USEPA, in 72 FR 20586, requires states to "evaluate and consider control strategies for sources of SO_2, direct PM2.5, and NOx emissions in all nonattainment areas." However, the rule does allow states to make technical demonstrations to reverse the inclusion of NOx as precursor of PM2.5, or deem the precursor insignificant, based on geographical regions, emissions, etc. This then eliminates the need to examine NOx control measures for purposes of reducing PM2.5 concentrations. Although NOx is a relatively minor precursor of PM2.5 in North Carolina, the State of North Carolina is foregoing a technical demonstration of NOx insignificance and will follow the requirements in 72 FR 20586 to include NOx as a precursor for addressing attainment of the 1997 and 2006 revisions of the PM2.5 NAAQS.

The two remaining species that comprise PM2.5, ammonia (NH_3) and volatile organic carbons (VOCs) have been deemed as insignificant contributors to the total mass of PM2.5 by the USEPA. With regards to NH_3, 72 FR 20586 states NH_3 "is presumed not to be a PM2.5 attainment plan precursor, meaning that the State is not required to address [NH_3] in its attainment plan or evaluate sources of [NH_3] emissions for reduction measures." Likewise, the final rule for VOCs states that "States are not required to address VOC in PM2.5 implementation plans and evaluate control measures for such pollutants unless the State or EPA makes a technical demonstration that emissions of VOCs from sources in the State significantly contribute to PM2.5 concentrations in a given nonattainment area."

2 NH_3 and VOC Insignificance

The State of North Carolina agrees with the USEPA's presumptive exclusion of NH_3 and VOCs with regards to the PM2.5 implementation plan. Therefore, emission controls for NH_3 and VOCs are not considered as a part of the North Carolina Division of Air Quality's (NCDAQ's) PM2.5 attainment demonstration plan.

Appendix P
Supporting Documentations
From VISTAS and ASIP

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TABLE OF CONTENTS

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Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)

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February 9, 2004

Pechan Rpt. No. 04.01.002/9440.000

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CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

ATADS	Air Traffic Activity Data System
ATP	anti-tampering program
BTS	Bureau of Transportation Statistics
BTU	British thermal unit
CMV	commercial marine vessels
CNG	compressed natural gas
CO	carbon monoxide
DOT	Department of Transportation
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FIPS	Federal Information Processing Standards
GF	growth factor
HDDV	heavy-duty diesel vehicle
HDGV	heavy-duty gasoline vehicle
HPMS	Highway Performance Monitoring System
I/M	inspection and maintenance
LDDT	light-duty diesel truck
LDDV	light-duty diesel vehicle
LDGT	light-duty gasoline truck
LDGV	light-duty gasoline vehicle
LPG	liquified petroleum gas
LTO	landing and takeoff
MC	motorcycle
mg	milligram
NAPAP	National Acid Precipitation Assessment Program
NEI	National Emission Inventory
NH_3	ammonia
NO_x	oxides of nitrogen
OTAQ	Office of Transportation and Air Quality
Pechan	E.H. Pechan & Associates, Inc.
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
ppmv	parts per million volume
RFG	reformulated gasoline
RVP	Reid vapor pressure
SCC	source classification code
S/L/T	State/Local/Tribal
SO_2	sulfur dioxide
USACE	U.S. Army Corps of Engineers
VISTAS	Visibility Improvement-State and Tribal Association of the Southeast
VMT	vehicle miles traveled
VOC	volatile organic compound

I. INTRODUCTION/BACKGROUND

The Visibility Improvement – State and Tribal Association of the Southeast (VISTAS) has contracted with E.H. Pechan & Associates, Inc. (Pechan) to prepare a 2002 mobile source emissions inventory. The purpose of this emissions inventory is to support the modeling and assessment of speciated particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$). Through this contract, Pechan first prepared an inventory review document. This document summarized several regional and national emission inventory efforts and identified strengths and weaknesses associated with the use of these inventories in regional haze modeling. This document also summarized data submittals by State and local air agencies within the VISTAS region that could be used in the VISTAS 2002 mobile source emissions inventory.

Since that time, the State and local air agencies have updated their submittals for the mobile source sectors, including both onroad vehicles and nonroad engines. In July of 2003, Pechan delivered sets of inputs to the NONROAD model option files and MOBILE6.2 input files and vehicle miles traveled (VMT) data for each State and local agency to review. For the onroad sector, the MOBILE6.2 input files and VMT data represented Pechan's processing of the State and local inputs in a consistent manner for use in calculating the 2002 onroad emissions inventory. The MOBILE6.2 input files and VMT data included as much of the local data supplied by the State and local agencies as possible, with missing information filled in with appropriate default data. The data delivered by Pechan for the State and local agencies to review related to the nonroad sector was primarily in the form of temperature and fuel data that would be used as inputs to the NONROAD model. It should be noted that the nonroad sector inputs were completed first and did not include some of the later temperature and fuel updates that did get incorporated in the onroad data.

The State and local agencies were given a brief period to review, comment upon, and make updated submittals to the onroad and nonroad inputs that were delivered in July 2003. After receiving these comments and updated data, Pechan updated the appropriate MOBILE6.2 input files, VMT data, and nonroad inputs with the revised State and local data. Pechan then calculated 2002 onroad and nonroad emissions from these inputs. Pechan presented the preliminary results of these emission inventories at a VISTAS meeting on August 28, 2003. These draft August 2003 emission estimates, including inputs and methodology, were documented in a draft report circulated to VISTAS in October 2003. This October 2003 report also included documentation of draft 2002 refueling emissions from onroad and nonroad sources. The VISTAS States were asked to review this document, as well as the supporting files provided by Pechan, and provide comments or revisions by December 2003. Onroad and nonroad 2002 emissions for the VISTAS States have since been calculated based on the updates provided by the States. This report documents the inputs and methodologies used in the February 2004 version of the VISTAS 2002 onroad and nonroad mobile source emission inventories.

II. ONROAD METHODS AND DATA

A. 2002 VMT DEVELOPMENT

Table II-1 summarizes the type of VMT data submitted by each agency. Depending upon the data submitted by the individual State or agency, up to three different procedures were performed on the data. First, VMT data that were not provided at the annual level were converted from daily VMT to annual VMT. Second, VMT provided for years other than 2002 were grown from the base year provided. Finally, the VMT were allocated by vehicle type, if not already at that level of detail. The section discusses each of these procedures in more detail.

It should be noted that although the format and content of the VMT provided by the VISTAS State and Local agencies varied significantly from agency to agency, this draft 2002 VISTAS inventory is based at a minimum on county/roadway type specific VMT, as provided by the individual agencies. This is a significant improvement over the spatial allocation methods used in the U.S. Environmental Protection Agency's (EPA's) National Emission Inventory (NEI) for onroad vehicles.

1. Conversion to Annual VMT

For use in the emission calculations, Pechan's ultimate goal with the VMT data was to develop an annual 2002 VMT database by county, roadway type, and vehicle type. As indicated in Table II-1, the VMT data were submitted using three different time periods: annual, average annual day, and summer day. No temporal adjustments were applied to VMT data submitted as annual VMT. VMT data submitted as average annual day VMT were multiplied by 365 to convert from an average day to the annual time period. The Jefferson County, Kentucky VMT were submitted as summer day VMT. All annual VMT values were converted to units of millions of miles per year. Therefore, any VMT values submitted as miles were divided by a factor of 1,000,000 and VMT values submitted in units of 1,000 miles were divided by a factor of 1,000.

The Jefferson County, Kentucky VMT submittal included a single factor for converting the summer day VMT to average annual day VMT. Thus, the Jefferson County summer day VMT data were first multiplied by a factor of 0.97752 (the temporal conversion factor provided by Jefferson County) to obtain average annual day VMT. The VMT data were then multiplied by 365 to obtain the annual VMT.

Table II-1. VMT Data Provided by State/Local Agencies

State/Area	Time Period	2002 Actual VMT by County/Road Type/Vehicle Type	2002 Actual VMT by County/Road Type	2002 Projected VMT by County/Road Type	2002 VMT from TDM by County/Road Type/Vehicle Type	1999 Actual VMT by County/Road Type/Vehicle Type
Alabama	AAD		X			
Florida	AAD		X			
Georgia	AAD		X			
Kentucky	AAD			X		
Jefferson County, KY	SD				X	
Mississippi	ANN	X				
North Carolina	AAD		X			
South Carolina	ANN		X			
Tennessee	AAD		X			
Virginia	ANN					X
West Virginia	ANN	X				X
Time Period Codes: AAD=Average Annual Day, SD=Summer Day, ANN=Annual						

2. Projection to 2002

As indicated in Table II-1, the Virginia VMT submittal was for a base year of 1999 rather than 2002. Thus, these VMT data needed to be projected to 2002 before calculating emissions. For Virginia, growth factors were developed by roadway type for the period from 1999 to 2001 based on historical VMT data by roadway type from Table VM-2 “Functional System Travel” in DOT’s *Highway Statistics* series (DOT, 1999 and 2001). The growth factors, presented in Table II-2, were calculated by dividing Virginia’s 2001 VMT for each of the 12 roadway types from *Highway Statistics 2001* by the corresponding 1999 VMT from *Highway Statistics 1999*. For the period from 2001 to 2002, the growth factors were developed using data obtained from the U.S. Department of Transportation’s Traffic Volume Trends report (DOT, 2002). This monthly publication provides a comparison of preliminary 2002 VMT estimates with comparable 2001 VMT. For several roadway types, these data are provided only at a national level. However, for the combined rural interstates and arterials, these data are presented by State. The resultant data, used to project the 2001 Virginia VMT to 2002, are shown in Table II-2. The 2001 to 2002 growth factors represent the 2002 VMT divided by the 2001 VMT, based on the data Virginia for the rural interstates and arterials and on the national data for the remaining roadway types. Once the growth factors were developed, the Virginia 1999 VMT data were first multiplied by the appropriate 1999 to 2001 growth factor and then by the appropriate 2001 to 2002 growth factor.

Table II-2. VMT Growth Factors Used for Virginia

Roadway Type	Roadway Type Portion of SCC	Virginia 1999 to 2001 VMT Growth Factor	Virginia 2001 to 2002 VMT Growth Factor
Rural Interstate	110	1.043	1.035
Rural Other Principal Arterial	130	1.050	1.035
Rural Major Arterial	150	1.130	1.035
Rural Major Collector	170	0.982	1.011
Rural Minor Collector	190	1.032	1.011
Rural Local	210	0.923	1.011
Urban Interstate	230	1.050	1.024
Urban Other Freeway & Expressway	250	0.984	1.011
Urban Other Principal Arterial	270	1.061	1.011
Urban Minor Arterial	290	0.991	1.011
Urban Collector	310	0.925	1.013
Urban Local	330	0.690	1.013

Sources: U.S. Department of Transportation, Federal Highway Administration, "Traffic Volume Trends, December 2002", (http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.htm); *Highway Statistics 1999*, and *Highway Statistics 2001 (http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm)*

3. Splitting VMT by Road Type

The final step in developing a consistent 2002 VMT data base was to allocate VMT from the county and roadway type level of detail to the county/roadway type/vehicle type level of detail. As shown in Table II-1, the Jefferson County, Kentucky; Mississippi; Virginia; and West Virginia VMT data supplied for these jurisdictions already included the vehicle type level of detail, so this final adjustment was not needed for these areas. For the remaining areas, some provided VMT mix by vehicle type fractions while others provided no information on the allocation of VMT by vehicle. In this latter case, default VMT fraction data from EPA's MOBILE6 model were used.

The States for which MOBILE6 default VMT mix data were used are: Alabama, Florida, Georgia, Kentucky (excluding Boone County, Campbell County, Kenton County, and Jefferson County), and South Carolina. It should be noted that Georgia initially provided VMT fractions based on Georgia's HPMS classification count data, but after review of ten years of these data determined that they are not reflecting the trend towards increasing travel by light trucks. Georgia therefore decided it was more conservative to assume MOBILE6 default VMT fractions.

a. Allocation of VMT to Vehicle Type using Default VMT Mix Data

To calculate 2002 VMT at the county/roadway type/vehicle type level using national default data, the VMT totals by county and roadway type need to be allocated among the 28 MOBILE6 vehicle types. This was done based on the distribution of the 2001 rural and urban VMT among the six Highway Performance Monitoring Systems (HPMS) vehicle types found in Table VM-1 ("Annual Vehicle Distance Traveled in Miles and Related Data - 1999 - by Highway Category and Vehicle Type") of the Federal Highway Administration's (FHWA's) *Highway Statistics*

2001 (http://www.fhwa.dot.gov/ohim/ hs01/index.htm) and a mapping of these HPMS vehicle categories to the 28 MOBILE6 vehicle types. This mapping of the MOBILE6 vehicle types to the HPMS vehicle types was developed by EPA's Office of Transportation and Air Quality (OTAQ) and is used in the development of the NEI. The data first needed to be expanded to the 28 vehicle type level of detail to obtain the proper cross reference between the HPMS and MOBILE6 vehicle types since the eight vehicle types used in the final VISTAS VMT data base cannot be directly mapped to the HPMS vehicle categories. First, the VMT totals for each of the six HPMS vehicle categories were calculated as a fraction of the total VMT. This calculation was performed separately for the rural VMT and the urban VMT. The resulting 2001 VMT fractions for rural VMT and urban VMT are shown in Table II-3. Note that 2002 VMT are not yet available at this level of detail. Using the default MOBILE6 VMT fractions for 2001 (since the HPMS data represents 2001), taken from a MOBILE6 output file for 2001, the MOBILE6 VMT fractions were renormalized among all MOBILE6 vehicle types mapped to a given HPMS vehicle category. This renormalization is shown in the final column of Table II-3.

Table II-3. Allocation of VMT from HPMS Vehicle Categories to MOBILE6 Vehicle Types for 2001

HPMS Vehicle Category	HPMS 2001 Rural VMT Fractions	HPMS 2001 Urban VMT Fractions	MOBILE6 Vehicle Category	MOBILE6 2001 VMT Fractions by HPMS Category
Passenger Cars	0.5454	0.6065	LDGV	0.9980
			LDDV	0.0020
Motorcycles	0.0039	0.0031	MC	1.0000
Other 2-Axle 4-Tire Vehicles	0.3368	0.3375	LDGT1	0.1565
			LDGT2	0.5211
			LDGT3	0.1585
			LDGT4	0.0729
			LDDT12	0.0005
			LDDT34	0.0032
			HDGV2B	0.0658
			HDDV2B	0.0216
Single-Unit 2-Axle 6-Tire or More Trucks	0.0332	0.0212	HDGV3	0.0376
			HDGV4	0.0206
			HDGV5	0.0436
			HDGV6	0.0934
			HDGV7	0.0437
			HDDV3	0.1023
			HDDV4	0.0867
			HDDV5	0.0380
			HDDV6	0.2138
			HDDV7	0.3205
Combination Trucks	0.0770	0.0300	HDGV8A	0.0001
			HDGV8B	0.0000
			HDDV8A	0.2191
			HDDV8B	0.7808
Buses	0.0037	0.0017	HDGB	0.1920
			HDDBT	0.3258
			HDDBS	0.4822
Total	1.0000	1.0000		

To calculate VMT by vehicle type, each VMT value representing a given county and road type was multiplied by the product of the HPMS VMT fraction (selected depending upon whether the road type represent VMT on rural or urban roads) and the corresponding MOBILE6 VMT fraction by HPMS category. This process resulted in 28 VMT values at the county/roadway type/vehicle type level of detail for each county/roadway type VMT value in the original VMT file.

As an example, Table II-3 shows that the HPMS Passenger Car vehicle category accounts for 54.54 percent of the total VMT on rural road types and that the MOBILE6 LDGV category accounts for 99.8 percent of the VMT in the HPMS Passenger Car category. Therefore, a VMT value representing rural interstates would be multiplied by 0.5454 times 0.9980 (0.5443), to obtain the VMT total on rural interstates from LDGVs. Once all county/roadway type VMT values were expanded to the corresponding set of values of VMT at the county/roadway type/28 MOBILE6 vehicle type level of detail, the VMT data base was then totaled at the eight vehicle type level of detail (LDGV, LDGT1, LDGT2, HDGV, LDDV, LDDT, HDDV, MC).

b. Allocation of VMT to Vehicle Type using State-Provided VMT Mix Data

Both North Carolina and Tennessee provided VMT mix data at the eight vehicle type level of detail. The Tennessee data was provided for ten different county groupings, with a VMT mix provided for six aggregated roadway type categories. North Carolina provided statewide VMT mix fractions for each of the 12 roadway types. Since the VMT mix data for these two States were already at the eight vehicle type level, the procedure for allocating VMT by vehicle type was simpler than the procedure described above using the default data. Each county/roadway type VMT value was matched to the corresponding VMT mix for that county and roadway type and then separately multiplied by each of the eight VMT mix fractions to create eight VMT values by county/roadway type/vehicle type that would sum to the original VMT value at the county/roadway type level of detail.

c. Allocation of VMT by Month

The resulting annual county-level, vehicle, and roadway type-specific VMT data were temporally allocated to months during the emission calculations. National Acid Precipitation Assessment Program (NAPAP) temporal allocation factors were used to apportion the VMT to the four seasons. Monthly VMT data were obtained using a ratio between the number of days in a month and the number of days in the corresponding season. These temporal factors are shown in Table II-4. Several States provided some level of information on temporal adjustment factors for their VMT. These data were not used in this draft version of the 2002 VISTAS emission inventory due to time constraints. However, any State or locally supplied temporal adjustment factors will be included in the final version of the 2002 VISTAS onroad emission inventory.

Table II-4. Default VMT Seasonal and Monthly Temporal Allocation Factors

Roadway Seasonal VMT Factors

Vehicle Type	Roadway Type	Winter	Spring	Summer	Fall
LDV,LDT,MC	Rural	0.2160	0.2390	0.2890	0.2560
LDV,LDT,MC	Urban	0.2340	0.2550	0.2650	0.2450
HDV	All	0.2500	0.2500	0.2500	0.2500

Monthly VMT Factors

Vehicle Type	Roadway Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LDV,LDT,MC	Rural	0.0744	0.0672	0.0805	0.0779	0.0805	0.0942	0.0974	0.0974	0.0844	0.0872	0.0844	0.0744
LDV,LDT,MC	Urban	0.0806	0.0728	0.0859	0.0832	0.0859	0.0864	0.0893	0.0893	0.0808	0.0835	0.0808	0.0806
HDV	All	0.0861	0.0778	0.0842	0.0815	0.0842	0.0815	0.0842	0.0842	0.0842	0.0852	0.0824	0.0861

B. 2002 ONROAD EMISSION FACTOR DEVELOPMENT USING MOBILE6.2

The onroad emission factors used in the calculation of the VISTAS 2002 onroad emission inventory were generated using EPA's MOBILE6.2 emission factor model. In the development of the MOBILE6.2 input files, Pechan attempted to include as much of the relevant data supplied by the State and local agencies as possible, while at the same time, maintaining a generally similar overall structure to the MOBILE6.2 input files, such that the output emission factors could easily be matched to the appropriate VMT values. This section first discusses the overall general structure of the MOBILE6.2 input files. This is followed by details explaining how this general structure was adapted to include the State and local agency data and summaries of the types of data provided by each agency.

1. General MOBILE6.2 File Structure

Each MOBILE6.2 input file is divided into three sections: the header section, the run data section, and the scenario section. Information contained in the header section is primarily related to defining the output format and content desired by the user. For the processing of the VISTAS emission calculations, the database output format, aggregated to the daily level, was the desired output format. In addition, for proper modeling of the VOC emissions, it was desired to calculate the exhaust VOC emissions separately from the evaporative VOC emissions. However, within the constraints of MOBILE6.2 in the daily aggregated database output format, it is not possible to obtain evaporative and exhaust VOC emission factors broken out separately within each scenario. It is also not possible to obtain emission factors for both PM_{10} and $PM_{2.5}$ within a single MOBILE6.2 scenario. Therefore, two sets of MOBILE6.2 input files were created—one set to model VOC exhaust, NO_x, CO, SO_2, PM_{10}, and NH_3 emission factors and a second set to model VOC evaporative and $PM_{2.5}$ emission factors. Figure II-1 illustrates the header section of a sample VISTAS MOBILE6.2 input file used to generate the VOC exhaust, NO_x, CO, SO_2, PM_{10}, and NH_3 emission factors. Similarly, Figure II-2 illustrates the header section of a sample VISTAS MOBILE6.2 input file used to generate the VOC evaporative and $PM_{2.5}$ emission factors. The primary difference between these two header sections is in the selection of the emission types included, using the DATABASE EMISSIONS command and in the selection of the pollutants to be included in the output. In Figure II-1, having the first two flags set to "2" following the DATABASE EMISSIONS command indicates that the startup and running exhaust emission factor components will be included in the output emission factor table. In Figure II-2, the last six flags of the DATABASE EMISSIONS command line are set to "2" to obtain the evaporative emission factor components in the emission factor output file. In Figure II-2, the pollutants SO_2 and NH_3 are eliminated from the PARTICULATES command line, as the emission factors for these pollutants will be reported in the output file resulting from the file shown in Figure II-1.

Figure II-1. Header Section of MOBILE6.2 Input File Including VOC Exhaust and PM_{10} Emission Factors

```
MOBILE6 INPUT FILE :
> HEADER 01 0012002 - EXHAUST - PM 10.0

REPORT FILE        : Vistas02/Output02/V0100110.TXT REPLACE
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DAILY OUTPUT       :
DATABASE EMISSIONS : 2211 1111
PARTICULATES       : SO4 OCARBON ECARBON GASPM LEAD SO2 NH3 BRAKE TIRE
AGGREGATED OUTPUT  :
EMISSIONS TABLE    : Vistas02/TB1_02/V0100110.TB1 REPLACE
```

Figure II-2. Header Section of MOBILE6.2 Input File Including VOC Evaporative and $PM_{2.5}$ Emission Factors

```
MOBILE6 INPUT FILE :
> HEADER 01 0012002 - EVAPORATIVE - PM 2.50

REPORT FILE        : Vistas02/Output02/V0100125.TXT REPLACE
DATABASE OUTPUT    :
WITH FIELDNAMES    :
DAILY OUTPUT       :
DATABASE EMISSIONS : 1122 2222
POLLUTANTS         : HC
PARTICULATES       : ECARBON SO4 OCARBON GASPM LEAD BRAKE TIRE
AGGREGATED OUTPUT  :
EMISSIONS TABLE    : Vistas02/TB1_02/V0100125.TB1 REPLACE
```

The next section of the MOBILE6 input files is the run data section. This section includes data that applies to all scenarios in the input file. Figure II-3 shows an example of this section for a county using default data. The only commands included in this example tell MOBILE6 that the HC emission factors should be expressed in terms of VOC and that refueling emission factors should be excluded from the output. It should be noted that refueling emissions were calculated using a separate set of input files, but were excluded from the onroad input files here since refueling emissions are included in the area source inventory rather than the onroad inventory. Chapter IV discusses the onroad refueling MOBILE6 input files and emission calculations. Comments in Figure II-3 indicate that this input file is using default registration distributions and diesel sales fractions. For any input files that represent counties for which registration distribution, diesel sales fractions, or trip length distributions have been provided or that have an inspection and maintenance (I/M) program, anti-tampering program (ATP), or low emission vehicle program in place in 2002, additional inputs are required in the run data section of the MOBILE6.2 input file. Figure II-4 shows an example of an input file including all of these data. Some of these data inputs are included directly in the MOBILE6.2 input file, while other data are contained in external text files that are named by the commands in the run data section. For questions regarding the specifics of any of the MOBILE6 input commands listed, the MOBILE6 User's Guide should be consulted.

Figure II-3. Run Data Section of a MOBILE6.2 Input File

```
RUN DATA           :
>

EXPRESS HC AS VOC  :
NO REFUELING       :

* MOBILE6 Default Registration Distributions Applied
* MOBILE6 Default Diesel Sales Fractions Applied
```

Figure II-4. Run Data Section of a MOBILE6.2 Input File with Significant Local Inputs

```
RUN DATA           :
>

EXPRESS HC AS VOC  :
NO REFUELING       :

REG DIST           : Vistas02\ExtFiles\R02_ARLI.RDT

* Diesel Sales Fractions Source File -
E:\TrendsM6_New\Vistas02\ExtFiles\D02_ARLI.DSF
DIESEL FRACTIONS   :
0.0012 0.0023 0.0026 0.0027 0.0029 0.0015 0.0008 0.0011 0.0001 0.0006
0.0013 0.0015 0.0006 0.0014 0.0006 0.0099 0.0087 0.0446 0.0685 0.0857
0.1922 0.1481 0.1132 0.0959 0.0126
0.0056 0.0221 0.0167 0.0235 0.0126 0.0119 0.0206 0.0136 0.0155 0.0127
0.0246 0.0206 0.0222 0.0184 0.0227 0.0115 0.0310 0.0568 0.0508 0.1211
0.1077 0.2126 0.0711 0.0286 0.0176
0.0056 0.0221 0.0167 0.0235 0.0126 0.0119 0.0206 0.0136 0.0155 0.0127
0.0246 0.0206 0.0222 0.0184 0.0227 0.0115 0.0310 0.0568 0.0508 0.1211
0.1077 0.2126 0.0711 0.0286 0.0176
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0115 0.0111 0.0145
0.0115 0.0129 0.0096 0.0083 0.0072 0.0082 0.0124 0.0135 0.0169 0.0209
0.0256 0.0013 0.0006 0.0011 0.0001
0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0126 0.0115 0.0111 0.0145
0.0115 0.0129 0.0096 0.0083 0.0072 0.0082 0.0124 0.0135 0.0169 0.0209
0.0256 0.0013 0.0006 0.0011 0.0001
0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.1998 0.2578 0.2515 0.3263
0.2784 0.2963 0.2384 0.2058 0.1756 0.1958 0.2726 0.2743 0.3004 0.2918
0.2859 0.0138 0.0000 0.0000 0.0000
0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.6774 0.7715 0.7910 0.8105
0.8068 0.8280 0.8477 0.7940 0.7488 0.7789 0.7842 0.6145 0.5139 0.5032
0.4277 0.0079 0.0000 0.0000 0.0001
0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8606 0.8473 0.8048 0.8331
0.7901 0.7316 0.7275 0.7158 0.5647 0.3178 0.2207 0.1968 0.1570 0.0738
0.0341 0.0414 0.0003 0.0000 0.0000
0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4647 0.4384 0.3670 0.4125
0.3462 0.2771 0.2730 0.2616 0.1543 0.0615 0.0383 0.0333 0.0255 0.0111
0.0049 0.0060 0.0000 0.0000 0.0000
0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6300 0.6078 0.5246 0.5767
```

```
0.5289 0.5788 0.5617 0.4537 0.4216 0.4734 0.4705 0.4525 0.4310 0.3569
0.3690 0.4413 0.3094 0.1679 0.1390
0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8563 0.8443 0.7943 0.8266
0.7972 0.8279 0.8177 0.7440 0.7184 0.7588 0.7567 0.7431 0.7261 0.6602
0.6717 0.7344 0.6107 0.4140 0.3610
0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9992 0.9989 0.9987 0.9989
0.9977 0.9984 0.9982 0.9979 0.9969 0.9978 0.9980 0.9979 0.9976 0.9969
0.9978 0.9982 0.9974 0.9965 0.9964
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000 1.0000
1.0000 1.0000 1.0000 1.0000 1.0000
0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.9585 0.8857 0.8525 0.8795
0.9900 0.9105 0.8760 0.7710 0.7502 0.7345 0.6733 0.5155 0.3845 0.3238
0.3260 0.2639 0.0594 0.0460 0.0291


> ANTI-TAMP PROG     : E:\TrendsM6_New\Vistas02\ExtFiles\VA_ATP2002.ATP
ANTI-TAMP PROG     :
89 68 50 22222 21111111 1 12 098. 22112222

> Exhaust I/M - IDLE test program #1
I/M PROGRAM        : 1 1983 2050 2 TRC 2500/IDLE
I/M MODEL YEARS    : 1 1968 1980
I/M VEHICLES       : 1 22222 21111111 1
I/M STRINGENCY     : 1 35.0
I/M COMPLIANCE     : 1 98.0
I/M WAIVER RATES   : 1 2.0 2.0

> Exhaust I/M - ASM final program #2
I/M PROGRAM        : 2 1983 2050 2 TRC ASM 2525/5015 PHASE-IN
I/M MODEL YEARS    : 2 1981 2050
I/M VEHICLES       : 2 22222 11111111 1
I/M STRINGENCY     : 2 35.0
I/M COMPLIANCE     : 2 98.0
I/M WAIVER RATES   : 2 2.0 2.0
I/M EFFECTIVENESS  : 0.94 0.94 0.94

> Exhaust I/M - IDLE test program #1
I/M PROGRAM        : 3 1983 2050 2 TRC 2500/IDLE
I/M MODEL YEARS    : 3 1981 2050
I/M VEHICLES       : 3 11111 21111111 1
I/M STRINGENCY     : 3 35.0
I/M COMPLIANCE     : 3 98.0
I/M WAIVER RATES   : 3 2.0 2.0

> Evap I/M - Gas Cap test program #3
I/M PROGRAM        : 4 1998 2050 2 TRC GC
I/M MODEL YEARS    : 4 1973 2050
I/M VEHICLES       : 4 22222 21111111 1
I/M COMPLIANCE     : 4 98.0
I/M WAIVER RATES   : 4 2.0 2.0

94+ LDG IMP        : Vistas02\ExtFiles\NLEVNE.D

> WeekDay Trip Length Distribution
WE DA TRI LEN DI   : Vistas02\ExtFiles\WeekTLD2.wdt
```

The third and final section of the MOBILE6.2 input files contains the scenario data. For this VISTAS inventory, each speed and road type combination or speed distribution were modeled in twelve consecutive scenarios representing the temperature and fuel properties applicable in each month. Thus, if a State agency supplied an average speed/road type combination for each of the 12 HPMS road categories, the corresponding MOBILE6.2 input file would have 144 scenarios. The first scenario would represent January temperature and fuel conditions at the speed and MOBILE6 roadway type for the first speed/roadway type provided (typically rural interstates). This would be followed by the February scenario modeled for the same speed and roadway type, and so on through the twelfth scenario representing December conditions for the same speed and roadway type combination.

Figure II-5 illustrates a sample scenario from one of the VISTAS MOBILE6.2 input files. This is the first scenario in the file—therefore, it represents January temperature and fuel conditions. The month of a given scenario in the VISTAS MOBILE6.2 input files can be determined by the last two digits of the SCENARIO RECORD command line. In this case, the last two digits are “01” indicating January. It should be noted that the only options for the EVALUATION MONTH command are “1” indicating January or “7” indicating July. For the VISTAS input files, the EVALUATION MONTH was set to “1” for all months from January through June and to 7 for months from July through December. When this flag is set to “1”, it indicates that MOBILE6 will use a January registration distribution. When the flag is set to “7”, MOBILE6 ages the registration by a half year, applying a half year of fleet turnover to the distribution. The EVALUATION MONTH setting can also affect the reductions from reformulated gas programs. However, by including the SEASON command, as shown in Figure II-5, the EVALUATION MONTH flag setting will not affect reformulated gasoline reductions. With the SEASON flag set to “2”, winter reformulated gasoline rules will be applied in areas with a reformulated gas program modeled (using the FUEL PROGRAM command). Summer reformulated gas rules and reductions will be applied when the SEASON flag is set to “1” if reformulated gas has been modeled. In all of the VISTAS input files, the SEASON flag was included for all areas, whether or not a reformulated gasoline program was modeled. This flag has no effect when the FUEL PROGRAM command is not used. The SEASON flag was set to “1” for the months of May through September and to “2” for the remaining months.

Figure II-5. Sample Scenario for a Typical MOBILE6.2 Input File

```
SCENARIO RECORD    : 010010215.0_M01
>FV FILE:      SCENARIO: 1
CALENDAR YEAR      : 2002
EVALUATION MONTH   : 1
MIN/MAX TEMPERATURE: 38.0 60.0
ALTITUDE           : 1
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV
PMDDR2.CSV
SEASON             : 2
AVERAGE SPEED      : 15.0 Arterial
FUEL RVP           : 12.5
PARTICLE SIZE      : 10.0
DIESEL SULFUR      : 500.0
```

Local speed data were provided by the agencies in Georgia, Kentucky, North Carolina, Tennessee, and Virginia. A set of 12 monthly scenarios was developed for each speed input for these States, with one exception. The Northern Kentucky (Boone County, Campbell County, and Kenton County) and Jefferson County, Kentucky inputs were speed distribution files, rather than average speeds by individual roadway types (one for Northern Kentucky and one for Jefferson County, Kentucky). In this case, only 12 scenarios were modeled in total in the Jefferson County and Northern Kentucky input files, with the Jefferson County or Northern Kentucky speed distribution referenced in each scenario, respectively. No speed information was provided for Alabama, Florida, Mississippi, South Carolina, or West Virginia. The average speeds modeled in these files were the default speeds used in the NEI. These speeds are shown in Table II-5 and vary by both roadway type and vehicle category. It should be noted that several agencies provided speed information for ramps. Since the VMT data file is organized by SCC and no SCC currently exists for ramp VMT, the ramp speed information could not be used directly. In some cases, the fraction of VMT occurring on ramps was provided. In these cases, this information was combined with the freeway speeds, following the guidance in the MOBILE6 user's guide to determine the overall freeway speed including the ramp speed, at 34.6 mph (the assumed value for ramp speeds in MOBILE6), and the fraction of VMT occurring on the ramps.

Table II-5. Default Speeds Modeled by Road Type and Vehicle Type (mph)

	Speed (mph) and MOBILE6 Road Type		
HPMS Road Type	**Light Duty Vehicles**	**Light Duty Trucks**	**Heavy Duty Trucks**
Rural Interstate	60 Freeway	55 Freeway	40 Freeway
Rural Principal Arterial	45 Arterial	45 Arterial	35 Arterial
Rural Minor Arterial	40 Arterial	40 Arterial	30 Arterial
Rural Major Collector	35 Arterial	35 Arterial	25 Arterial
Rural Minor Collector	30 Arterial	30 Arterial	25 Arterial
Rural Local	30 Arterial	30 Arterial	25 Arterial
Urban Interstate	45 Freeway	45 Freeway	35 Freeway
Urban Other Freeway and Expressway	45 Freeway	45 Freeway	35 Freeway
Urban Principal Arterial	20 Arterial	20 Arterial	15 Arterial
Urban Minor Arterial	20 Arterial	20 Arterial	15 Arterial
Urban Collector	20 Arterial	20 Arterial	15 Arterial
Urban Local	Local	Local	Local

Another optional input included in the scenario section of the MOBILE6 input files is the VMT mix by 16 MOBILE6 vehicle categories. These vehicle categories are based on the 28 MOBILE6 vehicle categories, but with gasoline and diesel vehicles of the same weight class combined together. When no information was provided on VMT mix, the MOBILE6 defaults were used. Local VMT mix information provided by Tennessee, Virginia, and Jefferson County, Kentucky were included in the MOBILE6.2 input files. In some cases, the same VMT mix was applied to all scenarios. In other cases, the VMT mixes were specific to roadway type, so the VMT mix would vary according to the roadway type being represented in the scenario.

C. 2002 ONROAD EMISSION INVENTORY CALCULATIONS

Once the MOBILE6.2 input files were set up and run through the MOBILE6.2 model, onroad emissions were calculated by multiplying the monthly VMT for a given county, roadway type, and vehicle type by the emission factor modeled for the same month, county, vehicle type and roadway type. Because the MOBILE6.2 input files were set up to create output files in the form of database tables, the output is provided by each of the 28 MOBILE6 vehicle types. Thus, the emission factors first were aggregated to the eight vehicle categories included in the VMT files. This was done using the VMT Fraction data provided in each of the MOBILE6 output files. For each of the MOBILE6 vehicle types included in one of the eight vehicle types needed, the VMT fractions were renormalized within that category. These eight vehicle categories are sometimes referred to as the MOBILE5 vehicle categories. For example, the LDGT1 and LDGT2 MOBILE6 vehicle categories are both included in the MOBILE5 LDGT1 category. In this case, the MOBILE6 LDGT1 VMT fraction was divided by the sum of the MOBILE6 LDGT1 and LDGT2 VMT fractions. The same was done with the MOBILE6 LDGT2 VMT fraction, so that the renormalized MOBILE6 LDGT1 and LDGT2 VMT fractions should now sum to 1. Next, these normalized VMT fractions were multiplied by the corresponding MOBILE6 emission factor and all of these weighted emission factors for a given scenario, within a MOBILE5 vehicle category were summed to obtain the weighted emission factors at the MOBILE5 vehicle category level. The VMT fractions included in the MOBILE6 output files are affected by the registration distribution, diesel sales fractions, and VMT mixes supplied in the MOBILE6.2 input files. Areas that used the MOBILE6 defaults for each of these inputs should all have the same VMT fractions, although even in these cases, there are two sets of VMT fractions—one for the months from January through June and another for the months July through December. This occurs due to the aging of the registration distribution caused by the use of the EVALUATION MONTH flag, as discussed above. These emission factors, now at the MOBILE5 vehicle category level, were multiplied by the corresponding VMT values to obtain monthly emissions by county, roadway type, and vehicle category.

D. DATA PROVIDED BY STATE AND LOCAL AGENCIES

The sections above describe some of the data that was supplied by the VISTAS State and local agencies for use in the development of the 2002 onroad emission inventory. Tables II-6 through II-15 summarize the data supplied by each agency in a consistent fashion. These tables primarily list the data that were actually used in this analysis. This section provides additional information on the data supplied by these agencies as well discussing why some of the data supplied could not be used.

Table II-6. Summary of Onroad Data Provided by Alabama

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual daily VMT by county/road type
MOBILE6 Input Files	
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	
Monthly Temperatures	Monthly 2002 temperatures by county
RVP Data	March-September RVP values
Speed Data	
Registration Data	
Fuel Information	
I/M Program Information	N/A
Other	

Table II-7. Summary of Onroad Data Provided by Florida

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual daily VMT by county/road type
MOBILE6 Input Files	
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	Supplied counties in each of 3 temperature regions
Monthly Temperatures	
RVP Data	Summer RVP values provided
Speed Data	
Registration Data	
Fuel Information	
I/M Program Information	N/A
Other	

Table II-8. Summary of Onroad Data Provided by Georgia

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual average annual daily VMT by county and functional classification prepared by Georgia DOT
MOBILE6 Input Files	Provided MOBILE6 sample input files
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	
Monthly Temperatures	
RVP Data	Provided summer RVP values
Speed Data	Provided 2002 statewide speeds by road type (speeds based on VMT-weighted average speeds, from a 2002 loaded highway network for the 13-county Atlanta area)
Registration Data	Provided one MOBILE6 registration distribution for 13-county Atlanta area and one MOBILE6 registration distribution for rest-of-state
Fuel Information	Provided information on Georgia gasoline program, applied to 25 counties
I/M Program Information	Provided I/M inputs for 13-county Atlanta area in MOBILE6 format
Other	Provided VMT temporal adjustment factors by month and day of week for each road type (not used in the 01/04 inventory)

Table II-9. Summary of Onroad Data Provided by Kentucky

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual daily VMT by county/road type
MOBILE6 Input Files	Provided sample MOBILE6 input files for several counties
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	Provided temperature stations to be used for several counties
Monthly Temperatures	
RVP Data	Provided summer RVP for several counties
Speed Data	Provided average speed by road type for several county groupings
Registration Data	
Fuel Information	Verified counties in reformulated gasoline program
I/M Program Information	I/M program information provided
Other	
Jefferson County, Kentucky	
Data Element	**Data Supplied by Responsible Agency**
VMT Data	2002 summer day VMT from TDM by county/road type/vehicle type
MOBILE6 Input Files	Provided MOBILE6 input files representing the four different vehicle control combinations found in Jefferson County
MOBILE5 Input Files	
VMT Mix Information	Provided Jefferson County VMT mix in MOBILE6 format
Counties by Temperature Region	
Monthly Temperatures	Provided 2002 actual monthly temperature data for Louisville area
RVP Data	Provided summer and winter RVP values
Speed Data	Provided speed distribution file for Jefferson County
Registration Data	Provided registration distribution for Jefferson County in MOBILE6 format
Fuel Information	Reformulated gasoline modeled
I/M Program Information	I/M program information provided
Other	Provided absolute humidity data
Boone County, Campbell County, and Kenton County, Kentucky	
Data Element	**Data Supplied by Responsible Agency**
VMT Data	2002 actual daily VMT by county/road type
MOBILE6 Input Files	
MOBILE5 Input Files	Provided MOBILE5 input file for Northern Kentucky counties
VMT Mix Information	
Counties by Temperature Region	
Monthly Temperatures	
RVP Data	Provided summer and winter RVP values
Speed Data	Provided speed distribution file for Northern Kentucky
Registration Data	Provided registration distribution for Northern Kentucky in MOBILE6 format—LDGVs and LDGT1s only
Fuel Information	Reformulated gasoline modeled
I/M Program Information	I/M program information extracted from MOBILE5 input file
Other	Provided Northern Kentucky VMT distributions by facility type and by hour in MOBILE6 format

Table II-10. Summary of Onroad Data Provided by Mississippi

Data Element	Data Supplied by Responsible Agency
VMT Data	Provided 2002 actual annual VMT by county/road type/vehicle type
MOBILE6 Input Files	
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	
Monthly Temperatures	
RVP Data	Provided statewide RVP by season
Speed Data	
Registration Data	
Fuel Information	
I/M Program Information	N/A
Other	

Table II-11. Summary of Onroad Data Provided by North Carolina

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual daily VMT by county/road type
MOBILE6 Input Files	
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	Indicated counties within each of several temperature regions in state
Monthly Temperatures	
RVP Data	
Speed Data	Provided average speed data by road type for several groups of counties and rest-of-state
Registration Data	Provided registration data for several groups of counties and rest-of-state based on 2001 data
Fuel Information	
I/M Program Information	Provided written description of I/M program
Other	

Table II-12. Summary of Onroad Data Provided by South Carolina

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual annual VMT by county/road type
MOBILE6 Input Files	
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	Supplied counties in each of 7 temperature regions
Monthly Temperatures	
RVP Data	
Speed Data	
Registration Data	
Fuel Information	
I/M Program Information	N/A
Other	

Table II-13. Summary of Onroad Data Provided by Tennessee

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual daily VMT by county/road type
MOBILE6 Input Files	Provided MOBILE6 input files for groups of counties covering state
MOBILE5 Input Files	
VMT Mix Information	Provided VMT mix fractions by road type
Counties by Temperature Region	
Monthly Temperatures	
RVP Data	Provided summer RVP information
Speed Data	Provided average speed data by road type for groups of counties
Registration Data	Provided registration data for most counties
Fuel Information	
I/M Program Information	Provided in MOBILE6 input files
Other	

Table II-14. Summary of Onroad Data Provided by Virginia

Data Element	Data Supplied by Responsible Agency
VMT Data	1999 actual annual VMT by county/road type/vehicle type
MOBILE6 Input Files	Provided MOBILE6 input files for representative counties
MOBILE5 Input Files	
VMT Mix Information	
Counties by Temperature Region	Provided listing of counties within each of several temperature regions
Monthly Temperatures	
RVP Data	Provided summer RVP data
Speed Data	Speed data provided for each VMT record
Registration Data	2002 county-level registration data provided for nonattainment counties
Fuel Information	Verified counties in reformulated gasoline program
I/M Program Information	I/M and ATP inputs provided in MOBILE6 formats; verified counties that implement I/M
Other	LEV progam modeled statewide; provided diesel sales fractions

Table II-15. Summary of Onroad Data Provided by West Virginia

Data Element	Data Supplied by Responsible Agency
VMT Data	2002 actual annual VMT by county/road type/vehicle type
MOBILE6 Input Files	Supplied several sample MOBILE6 input files
MOBILE5 Input Files	
VMT Mix Information	VMT data included vehicle type splits
Counties by Temperature Region	Supplied counties in each of 4 temperature regions
Monthly Temperatures	
RVP Data	Supplied summer RVP value statewide
Speed Data	Supplied speed data in MOBILE6 input files--speed data determined to be inappropriate for this analysis
Registration Data	
Fuel Information	
I/M Program Information	N/A
Other	

1. Temperature

The default average daily maximum and minimum temperature data for each month used in this analysis was obtained from the National Climatic Data Center. This temperature data was actual 2002 data. It should be noted that a number of agencies provided information on ozone season or summer temperatures. This information could not be used in this analysis, as the ozone season temperature data are based on several years of temperature data and do not represent the average daily minimum and maximum monthly temperatures that were needed for this analysis. Information was provided by Alabama, Kentucky, North Carolina, South Carolina, Virginia, and West Virginia related to monthly temperature. In some cases, this data divided the counties within the State into several temperature regions and listing a city that should be used for obtaining the temperature data. In these cases, a temperature station from the National Climatic Data Center database was selected from the desired city, and this corresponding temperature set was applied to the counties listed by the States. Several of the States provided their own full set of 2002 temperature data either Statewide or by county. These data were included in the analysis, replacing the default temperature data for those States.

2. I/M and ATP Programs

Several agencies provided I/M and ATP inputs in the form of MOBILE5 input files. Pechan converted these inputs to MOBILE6 inputs, following the guidance in the MOBILE6 user's guide. Agencies that provided the data in MOBILE5 format should review the MOBILE6 I/M and ATP inputs carefully to make sure that the conversions fully capture the actual programs as they were implemented in 2002. In addition, from information provided by North Carolina, Tennessee, and Jefferson County, Kentucky, the I/M and ATP programs should only be applied to a portion of the VMT in the corresponding counties. For the North Carolina and Tennessee I/M counties, duplicate MOBILE6.2 input files were created that eliminate the I/M and ATP programs. The VMT from these counties was divided according to the fraction of the VMT subject to I/M and the fraction of the VMT not subject to I/M. These fractions were provided by the corresponding agencies in North Carolina and Tennessee. The VMT data for each I/M county was then divided according to these VMT fractions to obtain one set of VMT for the portion of vehicles subject to I/M and another set for those not subject to I/M. The emission factors from the I/M files were multiplied by the portion of the VMT subject to I/M while the emission factors from the files without the I/M were multiplied by the remaining portion of the VMT. In Jefferson County, Kentucky, a similar procedure was followed. However, in this case, the county also has a significant portion of VMT from vehicles registered in Indiana that are not subject to I/M or that do not have reformulated gasoline. Thus, the Jefferson County VMT was divided into four subsets and four MOBILE6 input files were developed representing the four groups of vehicle types traveling in the county.

3. RVP and Fuel Programs

Default RVP by county and month were obtained from the data used in the 2002 NEI. The NEI fuel data are based on year 2000 fuel survey data for January and July, with data for intermediate months calculated by interpolation. RVP data for July were applied from May through September, the months when Phase II RVP regulations are in effect. For States that supplied

July, summer, or ozone season RVP values, these values were also applied from May through September. If winter RVP values were supplied, these values were applied directly in each of the remaining months. As mentioned above, reformulated gasoline programs were modeled where appropriate. Georgia provided additional fuel inputs to capture the RVP and sulfur content values of its low sulfur gasoline program.

III. NONROAD METHODS AND DATA

A. NONROAD MODEL CATEGORIES

Pechan used EPA's draft NONROAD2002a model to generate 2002 annual emissions for the majority of nonroad engines. To improve the accuracy of these model runs, we asked State/ Local/Tribal (S/L/T) contacts to provide seasonal or monthly gasoline Reid Vapor Pressure (RVP) and temperature; appropriate data on reformulated gasoline (RFG), oxygenated fuel and Stage II programs, and diesel fuel sulfur levels. In addition, to improve the activity data inputs, we asked whether S/L/T agencies had collected information on equipment populations or activity (e.g., hours of use or load factors) to use in place of default populations in the NONROAD model. No S/L/T agencies provided activity data to replace the model defaults.

Seasonal average RVP and average, maximum and minimum temperature values were calculated based on the county-level, monthly RVP and temperature data set prepared for onroad mobile sources. Information on RFG programs and oxygenated fuels programs obtained for the onroad mobile sector was also used. In July 2003, Pechan distributed the input values (RVP, percent O2, temperature, and Stage II control efficiency) to be used for the draft NONROAD model 2002 inventory for review and comment by the VISTAS S/L/T agencies. Pechan obtained comments from the S/L/T agencies listed in Table III-1.

Table III-1. Summary of Comments by S/L/T Agencies on NONROAD Model Input Values Distributed in July 2003

State	Comment
Alabama	Provided region specific data to replace the statewide default values for RVP and ambient temperature
Georgia	Changed oxygen weight percent to zero for all counties
Kentucky	No Stage II programs in Bullitt and Oldham Counties
Tennessee	Revised RVP value for Davidson County
Mississippi	Revised statewide RVP by season
Virginia	No Stage II program in Charles City County

Additional comments on the August 2003 NONROAD model temperature and RVP inputs were incorporated for consistency with data submitted for the onroad mobile modeling (e.g., North Carolina). In addition, the State of West Virginia provided revised geographic allocation files for certain nonroad categories to improve upon the NONROAD model's default county allocation.

Using the inputs shown in the file "VISTAS NONROAD County Inputs.xls," Pechan prepared seasonal option files for each of four seasons (winter, spring, summer, and autumn), and ran the

NONROAD model at the county level. Model default values were used for all other inputs, with the exception of diesel fuel sulfur. A value of 2,500 parts per million volume (ppmv) was used instead of the default 2,318 ppm, since the default represented a national average including California's lower diesel fuel sulfur level. Pechan summed the seasonal results, and then processed the model output to develop a county-level, SCC-level annual emissions inventory for all pollutants except NH_3.

The NH_3 emissions for NONROAD model categories were developed using the following procedures. OTAQ recently reviewed the basis of NH_3 data summarized in a report entitled, "A Study of the Potential Impact of Some Unregulated Motor Vehicle Emissions" (Harvey, 1983). In conducting this review, OTAQ performed an analysis of the available light-duty noncatalyst engine data to develop defensible gasoline nonroad emission factors on a mg/gallon basis (Harvey, 2003). For both gasoline noncatalyst and diesel engines, fuel based emission factors were developed from emission factors expressed on a gram/mile basis by accounting for the reported fuel economy of each tested engine. For gasoline non-catalyst engines, this resulted in a value of 115.8 mg/gallon, which is applied to county-level fuel consumption estimates for 2-stroke gasoline, 4-stroke gasoline and liquified petroleum gas (LPG) equipment. From the diesel engine test data, a value of 83.3 mg/gallon was derived, which is applied to diesel fuel consumption estimates. County-level fuel consumption for these engines, expressed in gallons, is an output from EPA's NONROAD model.

B. AIRCRAFT, COMMERCIAL MARINE VESSELS AND LOCOMOTIVES

For 2002 aircraft, commercial marine vessels (CMVs), and locomotives, Pechan used 1999 emission estimates developed for EPA's 1999 NEI Version 2 as base year estimates for the VISTAS region. These categories are not included in the NONROAD model, and are hereafter referred to as "other nonroad." Pechan then incorporated revised S/L/T estimates summarized in Table III-2, using the replacement procedures summarized in Tables III-3a through III-3d. Pechan tracked changes by labeling the default 1999 NEI records as Version 2 (V2) and the revised S/L/T records as Version 3 (V3). In cases where PM2.5 estimates were not provided, they were developed using the following category-specific fractions applied to the available PM_{10} emission estimates: 1) Aircraft: 0.69; 2) Locomotive: 0.90; and 3) CMV: 0.92 (EPA, 2002). Commercial marine adjustments are described in detail in the following section.

Table III-2. Summary of S/L/T Agency Data Incorporated into the Draft VISTAS 2002 Other Nonroad Inventory

State	Description of Inventory	Pollutants
Alabama	1999 Locomotive emissions for Pickens and Tuscaloosa counties	VOC, NO_x, and CO
Florida	2001 Aircraft, Locomotive and Commercial Marine Vessel emissions for Palm Beach County	VOC, NO_x, CO, PM10, and SO_x
Tennessee	1999 Aircraft and Locomotive emissions for Davidson County	VOC, NO_x, CO, SO_x, and primary PM_{10}
Virginia	1999 Statewide Inventory for Aircraft, Locomotive and Commercial Marine Vessels	VOC, NO_x, CO

Table III-3a. Replacement Procedures for 1999 Locomotive Emissions for Pickens and Tuscaloosa County, Alabama

STATE_ FIPS	COUNTY_ FIPS	SCC	Version	Notes	START_ DATE	END_ DATE	VOC	NOX	CO
01	107	2285002005	V3				7.73	179.7	22.81
01	107	2285002005	V2	Replace VOC, NOx, and CO emissions	19990101	19991231	1962.9	45643	5794.5
01	107	2285002010	V3				5.39	53.48	9.47
01	107	2285002010	V2	Replace VOC, NOx, and CO emissions	19990101	19991231	5.39	53.48	9.48
01	125	2285002005	V3				16.31	379.15	48.13
01	125	2285002005	V2	Replace VOC, NOx, and CO emissions	19990101	19991231	3384.9	78711.4	9992.6
01	125	2285002010	V3				9.29	92.15	16.33
01	125	2285002010	V2	Replace VOC, NOx, and CO emissions	19990101	19991231	9.29	92.15	16.33

Table III-3b. Replacement Procedures for 1999 Aircraft, Locomotive, and Commercial Marine Vessel Emissions for Palm Beach County, Florida

STATE_ FIPS	COUNTY_ FIPS	SCC	Version	Notes	START_ DATE	END_ DATE	VOC	NOX	CO	SO2	PM10-PRI	PM25-PRI
12	099	2275000000	V3	Apply a Growth Factor to 2001 state-supplied aircraft emissions to backcast to 1999 Estimate PM2.5-PRI off PM10-PRI	19990101	19991231	470.39	805.94	4,121.41	1.98	0.00	
12	099	2275001000	V2	Delete all records for this SCC	19990101	19991231	0.44	0.05	9.03	0	0.19	0.13
12	099	2275020000	V2	Delete all records for this SCC	19990101	19991231	79.1	275.5	330.6	26.34		
12	099	2275050000	V2	Delete all records for this SCC	19990101	19991231	13.93	2.37	437.43	0.36	8.62	5.95
12	099	2275060000	V2	Delete all records for this SCC	19990101	19991231	9.23	1.19	212.32	0.11	4.55	3.14
12	099	2280000000	V3	Apply a Growth Factor to 2001 state-supplied cmv emissions to backcast to 1999 Estimate PM2.5-PRI off PM10-PRI	19990101	19991231	10.42	115.60	0.97	9.94	33.91	
12	099	2280002100	V2	Delete all records for this SCC	19990101	19991231	25.5	815.4	107.51	36.95	34.3	31.55
12	099	2280002200	V2	Delete all records for this SCC	19990101	19991231	0.22	7.05	0.93	0.32	0.3	0.27
12	099	2280003100	V2	Delete all records for this SCC	19990101	19991231	6.8	217.5	28.63	115.6	9.48	8.73
12	099	2280003200	V2	Delete all records for this SCC	19990101	19991231	0.06	1.93	0.25	1.43	0.11	0.1
12	099	2285002000	V3	Apply a Growth Factor to 2001 state-supplied locomotive emissions to backcast to 1999 Estimate PM2.5-PRI off PM10-PRI	19990101	19991231	28.19	658.78	83.64	48.09	15.50	
12	099	2285002006	V2	Delete all records for this SCC	19990101	19991231	6.11	164.1	16.17	10.26	4.07	3.66
12	099	2285002008	V2	Delete all records for this SCC	19990101	19991231	0.45	12.15	1.2	0.76	0.3	0.27
12	099	2285002009	V2	Delete all records for this SCC	19990101	19991231	6.78	182.2	17.95	11.39	4.52	4.07
12	099	2285002010	V2	Delete all records for this SCC	19990101	19991231	3.75	64.36	6.77	3	1.64	1.47

[1] Palm Beach County provided emission estimates corresponding to 2001; as such, 2001 emission estimates were backcast to 1999 using growth factors presented in this report before incorporation.

Table III-3c. Replacement Procedures for 1999 Aircraft and Locomotive Emissions for Davidson County, Tennessee

STATE_ FIPS	COUNTY_ FIPS	SCC	Version	Notes	START_ DATE	END_ DATE	VOC	NOX	CO	SO2	PM10-PRI	PM25-PRI
47	037	2275000000	V3	Estimate PM2.5-PRI off PM10-PRI	19990101	19991231	232.125	634.35	1766	32.13	39.25	
47	037	2275001000	V2	Delete all records for this SCC	19990101	19991231	1.7	0.2	35	0.02	0.75	0.52
47	037	2275020000	V2	Delete all records for this SCC	19990101	19991231	187.45	649.92	782.93	62.34		
47	037	2275050000	V2	Delete all records for this SCC	19990101	19991231	4.72	0.8	148.3	0.12	2.92	2.02
47	037	2275060000	V2	Delete all records for this SCC	19990101	19991231	15.22	1.97	349.97	0.19	7.51	5.18
47	037	2285002000	V3	Estimate PM2.5-PRI off PM10-PRI	19990101	19991231	20.803	363.117	50.701	26.36	8.893	
47	037	2285002006	V2	Delete all records for this SCC	19990101	19991231	31.91	857.26	84.46	53.6	21.27	19.15
47	037	2285002010	V2	Delete all records for this SCC	19990101	19991231	19.6	336.23	35.39	15.68	8.54	7.69

Table III-3d. Replacement Procedures for 1999 Aircraft, Locomotive, and Commercial Marine Vessel Emissions for Sample Counties in Virginia

STATE_ FIPS	COUNTY_ FIPS	SCC	Version	Notes	START_ DATE	END_ DATE	VOC	NOX	CO	SO2	PM10- PRI	PM25- PRI
51	001	2275001000	V3		19990101	19991231	3.47	0.78	3.74			
51	001	2275001000	V2	Replace VOC, NOx, and CO emissions Keep SO2, PM10-PRI, and PM2.5-PRI emissions	19990101	19991231	0.31	0.04	6.38	0	0.14	0.09
51	013	2275020000	V3		19990101	19991231	145.821	992.23	1634.2			
51	013	2275020000	V2	Replace VOC, NOx, and CO emissions Keep SO2 emissions	19990101	19991231	271.17	940.36	1132.7	90.2		
51	001	2275050000	V3		19990101	19991231	1.25	0.21	39.34			
51	001	2275050000	V2	Replace VOC, NOx, and CO emissions Keep SO2, PM10-PRI, and PM2.5-PRI emissions	19990101	19991231	0.25	0.04	7.81	0.01	0.15	0.11
51	001	2275060000	V3		19990101	19991231	0.05	0.01	1.26			
51	001	2275060000	V2	Replace VOC, NOx, and CO emissions Keep SO2, PM10-PRI, and PM2.5-PRI emissions	19990101	19991231	1.47	0.19	33.8	0.02	0.72	0.5
51	670	2280002000	V3	Add SCC to the Inventory	19990101	19991231	3.3	18.16	6.94			
51	670	2280002100	V2	Sum up SO2, PM10-PRI, and PM2.5-PRI emissions for SCCs 2280002100 and 2280002200 and add to SCC 280002000. After that, delete all records for SCC 2280002100 and 2280002200	19990101	19991231	10.12	323.52	42.66	14.7	13.61	12.52
51	670	2280002200	V2	Sum up SO2, PM10-PRI, and PM2.5-PRI emissions for SCCs 2280002100 and 2280002200 and add to SCC 2280002000. After that, delete all records for SCC 2280002100 and 2280002200	19990101	19991231	0.17	5.39	0.71	0.24	0.23	0.21
51	670	2280003000	V3	Add SCC to the Inventory	19990101	19991231	0.14	1.64	0			
51	670	2280003100	V2	Sum up SO2, PM10-PRI, and PM2.5-PRI emissions for SCCs 2280003100 and 2280003200 and add to SCC 2280003000. After that, delete all records for SCC 2280003100 and 2280003200	19990101	19991231	2.7	86.31	11.36	45.9	3.76	3.46
51	670	2280003200	V2	Sum up SO2, PM10, and PM2.5 Emissions for SCCs 2280003100 and 2280003200 and add to SCC 2280003000. After that, delete all records for SCC 2280003100 and 2280003200	19990101	19991231	0.05	1.48	0.19	1.09	0.08	0.08
51	199	2283002000	V3		19990101	19991231	8.46	53.47	15.51			
51	199	2283002000	V2	Replace VOC, NOx, and CO emissions	19990101	19991231	7.43	47.26	13.63			
51	740	2285002005	V3	Add SCC to the Inventory	19990101	19991231	3.76	100.99	9.95			
51	740	2285002006	V2	Sum up SO2, PM10-PRI, and PM2.5-PRI emissions for SCCs 2285002006 and 2285002007 and add to SCC 285002005. After that, delete all records for SCC 2285002006 and 2285002007.[1]	19990101	19991231	0.7	18.77	1.85	1.17	0.47	0.42
51	740	2285002007	V2	Sum up SO2, PM10-PRI, and PM2.5-PRI emissions for SCCs 2285002006 and 2285002007 and add to SCC 285002005. After that, delete all records for SCC 2285002006 and 2285002007.[1]	19990101	19991231	0.08	2.26	0.22	0.14	0.06	0.05
51	036	2285002010	V3		19990101	19991231	0.59	10.13	1.06			
51	036	2285002010	V2	Replace VOC, NOx, and CO emissions Keep SO2, PM10-PRI, and PM2.5-PRI emissions	19990101	19991231	1.99	34.15	3.59	1.59	0.87	0.78

[1] Other counties may also have emissions for SCCs 2285002008 and 2285002009. In these cases, sum up SO2, PM10-PRI, and PM2.5-PRI emissions for SCCs 2285002006, 2285002007, 2285002008, and 2285002009 and add to SCC 2285002005. After that, delete all records for SCC 2285002006, 2285002007, 2285002008, and 2285002009.

2. CMV Improvements

This section describes procedures for improving the spatial distribution of CMV emission estimates for the VISTAS region. States that share borders with non-VISTAS States along the Mississippi and Ohio Rivers have expressed concern about the representativeness of port emission estimates at a county-level. Revising the county-level emissions estimates would allow more accurate modeling of emissions in the VISTAS States.

Ideally, CMV emission estimates would be developed using local activity data that account for vessel type, engine type and mode of operation (cruise, maneuvering, and hotelling). Creating this type of "bottom-up" emission inventory requires a large amount of effort. Therefore, Pechan utilized port-specific emission estimates developed for the 1999 NEI, distributed using a revised allocation methodology, which incorporates information on the number of port facilities in each county.

a. Current Allocation Method

The current 2002 VISTAS commercial marine inventory is based on EPA's 1999 NEI Version 2.0, projected to 2002 using appropriate growth factors. State-supplied data were incorporated by EPA or by Pechan for some VISTAS States for this category, including Alabama, Virginia, West Virginia, and Palm Beach County, Florida.

The 1999 NEI estimated emissions for these categories according to the following SCCs:

SCC	Descriptor 1	Descriptor 3	Descriptor 6	Descriptor 8
2280002100	Mobile Sources	Marine Vessels, Commercial	Diesel	Port emissions
2280002200	Mobile Sources	Marine Vessels, Commercial	Diesel	Underway emissions
2280003100	Mobile Sources	Marine Vessels, Commercial	Residual	Port emissions
2280003200	Mobile Sources	Marine Vessels, Commercial	Residual	Underway emissions

For the 1999 NEI, commercial marine diesel emissions were developed by obtaining 2000 emission estimates for all pollutants except SO_2 from OTAQ's marine diesel regulatory background documentation (*Draft Regulatory Impact Analysis - Control of Emissions from Compression-Ignition Marine Engines*). To estimate emissions for 1999, 2000 estimates were backcast using growth factors obtained from the draft RIA cited above. Steam-powered residual CMV emission estimates were developed by obtaining fuel usage data from OTAQ and applying fuel-based emission factors (EPA, 1989). A similar method was used for diesel SO_2 emissions. National diesel usage was estimated assuming a sulfur content of 0.25 percent and EPA emission factors (EPA, 2002).

National diesel emissions were disaggregated into port and underway emissions estimates based on the assumption that 75 percent of distillate fuel is consumed within the port, while the remaining fuel is consumed while underway, consistent with EPA guidance. National residual emissions were disaggregated into port and underway emissions estimates based on the assumption that 25 percent of residual fuel is consumed within the port, while the remaining fuel is consumed while underway (EPA, 1989).

To allocate to counties, port emissions were assigned to the 150 largest U.S. ports based on activity obtained from the U.S. Army Corps of Engineers (USACE). The percentage of total traffic for each port was calculated by dividing the port-level traffic by the total traffic. Emissions for each port were then assigned to a single county.

Underway emissions are assigned to counties based on a county=s shipping lane traffic. The Bureau of Transportation Statistics' (BTS=) *National Transportation Atlas Databases-1999* contains data on the thousand tons per mile traveled for each shipping lane link in the United States (BTS-CD26). Where navigable rivers form a county or State boundary, the shipping lane traffic is proportioned to individual counties based on the length of shoreline that is shared. For example, if two counties share a navigable river, and both counties have the same length of shoreline, the shipping traffic is split evenly between the two counties. Shipping lanes that are not within counties, for example in the ocean, are associated to States based on BTS assignments. These waterway weights are then evenly distributed among the counties within these States that have navigable waterways. All shipping activity is summed at the county-level and compared with national shipping activity to determine what portion of activity can be attributed to individual counties. These proportions were used in disaggregating the national CMV emission estimates to the county level.

b. Revised Port Allocation Method

Figures III-1 and III-2 present emission maps for CMV port and underway NO_x emissions created from the 1999 NEI Version 2.0 data. For underway emissions, Pechan believes that the allocation procedure results in a reasonable distribution of county-level emissions. However, the methodology to allocate port emissions results in all the emissions being assigned to a single county. For example, Cabell County in West Virginia is assigned all emissions for Huntington Port, but no emissions are allocated to Lawrence County in Ohio, the county on the opposite river bank.

Port areas encompass multiple States and counties and in some cases, multiple waterways. Therefore, the emissions allocation process must incorporate all counties in the vicinity of the port where activity is occurring. This is especially true for inland rivers where activity takes place on both riverbanks and for 10 river miles or more outside the port city. The revised methodology allocates port emissions based on a surrogate for port-related activity in each county, rather than using a single county to define the port.

Figure III-1. VISTAS Region and Surrounding States, *Underway NO_x Emissions*

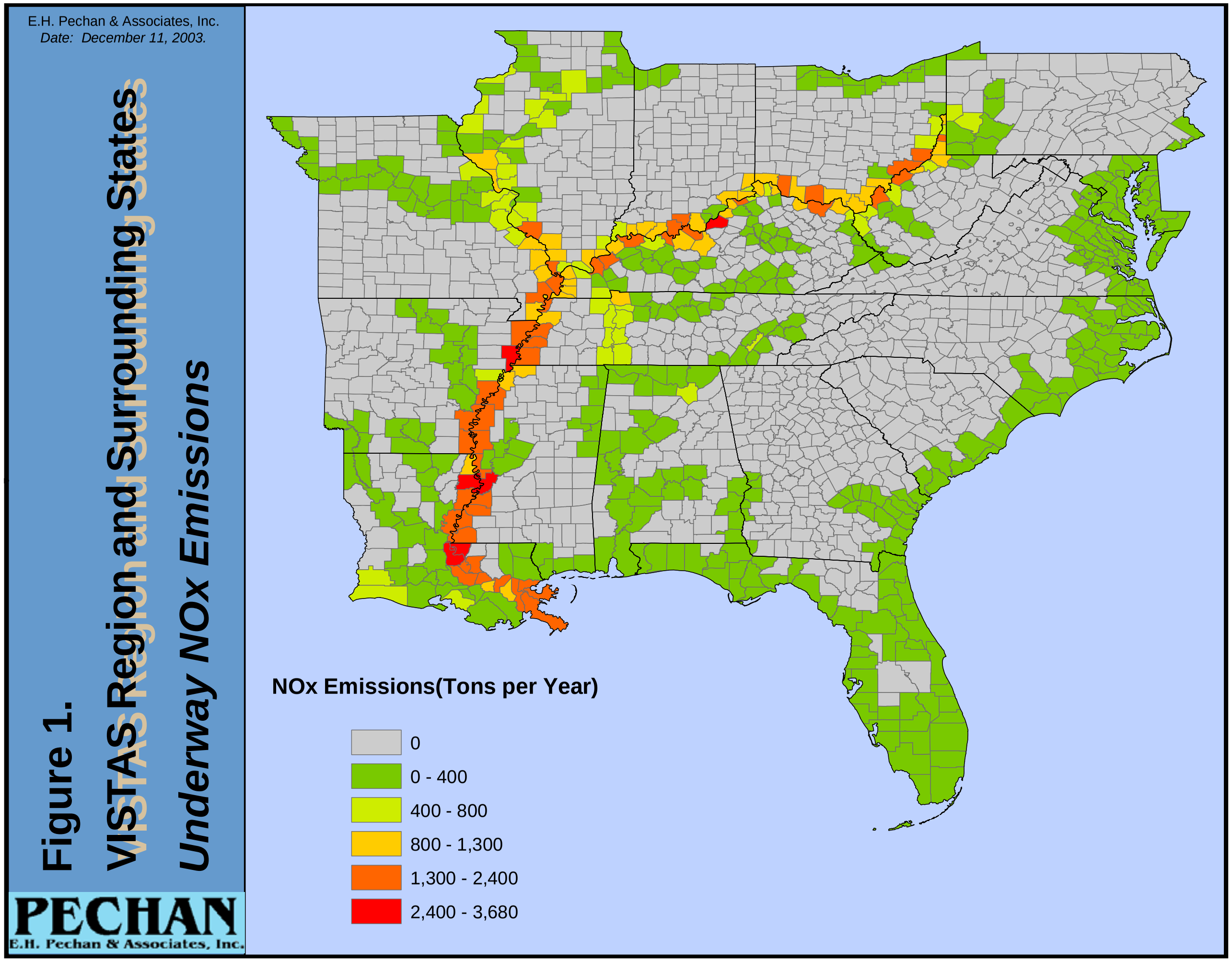

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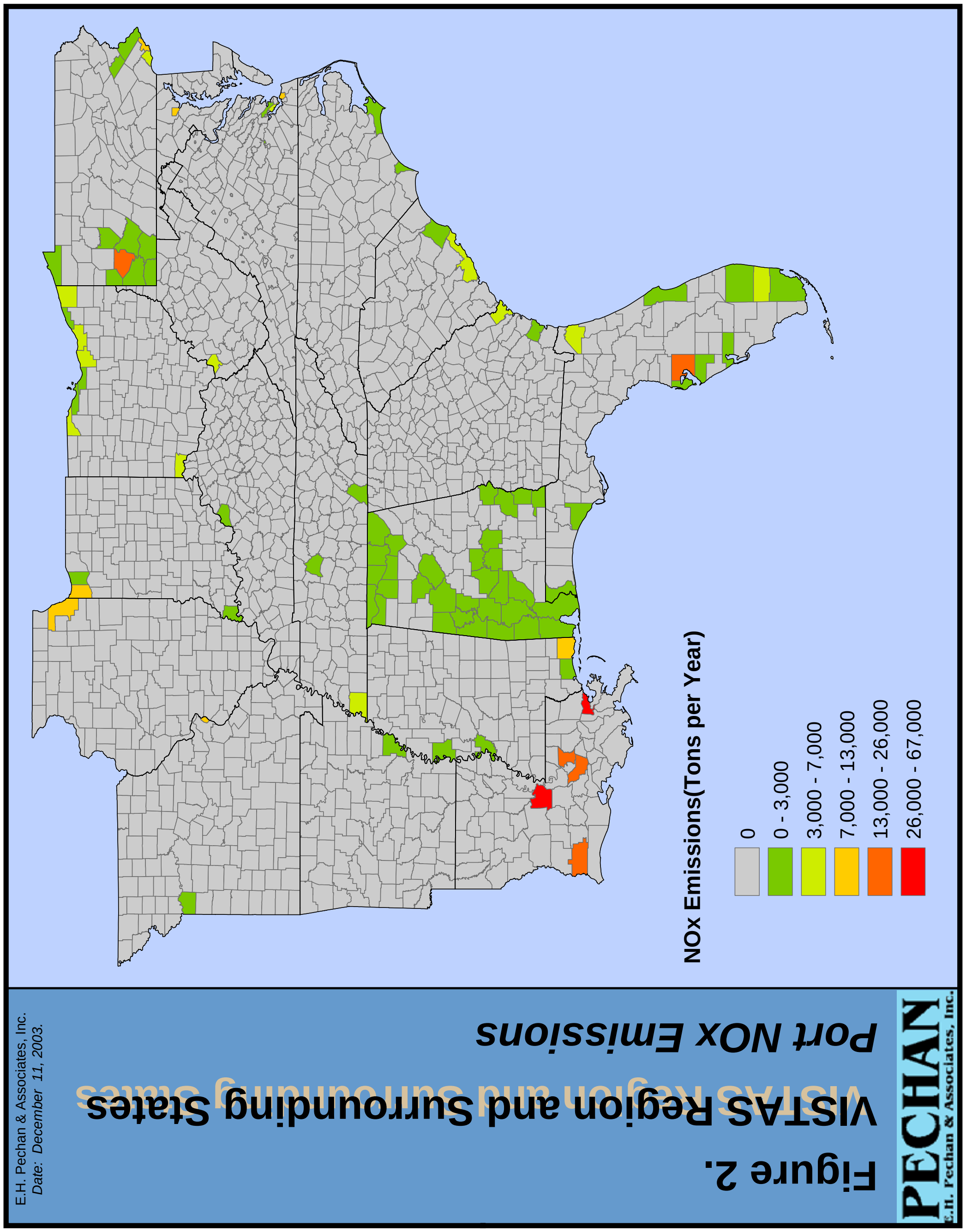
Figure III-2. VISTAS Region and Surrounding States, *Port NO_x Emissions*



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The report, *Waterborne Commerce of the United States, Calendar Year 1999* (USACE, 2000), hereafter referred to as *Waterborne Commerce*, presents the cargo tonnage and number of vessel trips in major waterways of the United States. The report defines port areas, which USACE uses to develop the Top 150 Ports in the United States by amount of cargo tonnage. As discussed in the previous section, the 1999 NEI allocates all the port emissions to these 150 ports based on the cargo tonnage handled by the port.

Pechan uses this allocation of emissions to each port area as the starting point of its revised allocation process. Table III-4 presents the ports that are located in VISTAS and adjoining States, which are part of the Top 150 Ports.

Table III-4. Port Areas Located in VISTAS and Adjoining States

Port	State	Port	State
Mobile	AL	Pascagoula	MS
Guntersville	AL	Vicksburg	MS
Helena	AR	Biloxi	MS
Port Everglades	FL	Greenville	MS
Jacksonville	FL	Gulfport	MS
Miami	FL	Wilmington	NC
Port Canaveral	FL	Morehead City	NC
Palm Beach	FL	Cincinnati	OH
Panama City	FL	Pittsburgh	PA
Pensacola	FL	Charleston	SC
Tampa	FL	Georgetown	SC
Port Manatee	FL	Memphis	TN
Weedon Island	FL	Nashville	TN
Savannah	GA	Chattanooga	TN
Brunswick	GA	Norfolk Harbor	VA
Mount Vernon	IN	Newport News	VA
Louisville	KY	Hopewell	VA
New Orleans	LA	Huntington	WV
Baton Rouge	LA		

The next step was to develop a list of counties that make up the port area. Port area definitions were obtained from *Waterborne Commerce*. Table III-6 presents the port definitions for the VISTAS States and adjoining States. Using the port definitions by river mile, Pechan established which counties are included in each port area. In many cases, these port areas encompass multiple counties. For example, Pittsburgh is defined in *Waterborne Commerce* as:

> Ohio River from Pittsburgh, PA to mile 40 (Pennsylvania/Ohio State Line);
> Allegheny River from Pittsburgh, PA to mile 72 (to head of project);
> Monongahela River from Pittsburgh, PA to mile 91 (to head of project).

Therefore, the Port of Pittsburgh includes the following counties in Pennsylvania; Allegheny, Westmoreland, Armstrong, Washington, Fayette, Greene, Beaver. This process was repeated for all the port areas listed in Table III-4.

The next step in allocating emissions is to develop a surrogate for the amount of CMV activity in each county of the port area. Pechan assumed that the activity of vessels in each county is related to the number of port facilities operating in a given county. Port facilities include terminals, piers, wharves, and docks that are involved in all types of commercial activity and support services. Pechan obtained the number of port facilities in each county from *The Port Series Reports* (USACE, 2003). The USACE periodically surveys the commercial marine industry to obtain information on port facilities and publishes it in *The Port Series Reports*. The reports give the name, location, operations, and describe the physical and inter-modal characteristics of the facilities. The data includes the location of the facility by river mile, State, and county.

For each port area, Pechan calculated the ratio between the number of port facilities in each county to the total number of facilities in all counties that make up the port area. This ratio was used to allocate emissions for each port area to the county-level. Table III-5 presents the allocation ratios for each county in the port areas. Some port areas were still encompassed by one county using the definition of the port from *Waterborne Commerce*. However, a number of port areas include multiple counties. Note that New Orleans and Pittsburgh do not include any counties in VISTAS States.

Table III-5. List of VISTAS Ports and Ports of Adjoining States

Port	State	County	Ratio	Port	State	County	Ratio	Port	State	County	Ratio
Port Everglades	FL	Broward	1.0	Helena	AR	Phillips	0.7778	Chattanooga	TN	Hamilton	0.7692
Jacksonville	FL	Duval	1.0		MS	Coahoma	0.2222		TN	Marion	0.2308
Miami	FL	Miami-Dade	1.0	Charlotte	FL	Charlotte	0.7500	Norfolk	VA	Norfolk City	0.5568
Port Canaveral	FL	Brevard	1.0		FL	Lee	0.2500		VA	Chesapeake City	0.3068
Palm Beach	FL	Palm Beach	1.0	Mount Vernon	IN	Vanderburgh	0.3182		VA	Portsmouth	0.1364
Panama City	FL	Bay	1.0		IN	Posey	0.4773	Newport News	VA	Newport News	0.6500
Pensacola	FL	Escambia	1.0		KY	Henderson	0.2045		VA	Hampton	0.3500
Tampa	FL	Hillborough	1.0	Louisville	KY	Jefferson	0.6596	Hopewell	VA	Hopewell	0.5000
Port Manatee	FL	Manatee	1.0		IN	Clark	0.3404		VA	Charles City	0.5000
Weedon Island	FL	Pinellas	1.0	New Orleans	LA	St. Bernard	0.0858	Pittsburgh	PA	Allegheny	0.5206
Savannah	GA	Chatham	1.0		LA	Plaquemines	0.1231		PA	Westmoreland	0.0412
Brunswick	GA	Glynn	1.0		LA	Orleans	0.3284		PA	Armstrong	0.0309
Pascagoula	MS	Jackson	1.0		LA	Jefferson	0.4366		PA	Washington	0.1340
Vicksburg	MS	Warren	1.0		LA	St. Tammany	0.0224		PA	Fayette	0.0412
Biloxi	MS	Harrison	1.0		LA	Tangipahoa	0.0037		PA	Greene	0.0567
Greenville	MS	Washington	1.0	Wilmington	NC	New Hanover	0.8974		PA	Beaver	0.1753
Gulfport	MS	Harrison	1.0		NC	Brunswick	0.1026	Huntington	KY	Greenup	0.0795
Morehead City	NC	Carteret	1.0	Cincinnati	OH	Hamilton	0.7931		KY	Boyd	0.1023
Georgetown	SC	Georgetown	1.0		KY	Kenton	0.0862		OH	Gallia	0.1136
Nashville	TN	Davidson	1.0		KY	Boone	0.1207		OH	Lawrence	0.2273
Mobile	AL	Mobile	1.0	Charleston	SC	Charleston	0.7097		OH	Scioto	0.1364
Guntersville	AL	Marshall	1.0		SC	Berkeley	0.2903		WV	Wayne	0.1136
				Memphis	TN	Shelby	0.9123		WV	Cabell	0.0795
					AR	Crittenden	0.0877		WV	Mason	0.1477

Pechan was directed to perform the reallocation for all VISTAS ports. Figure III-3 presents the reallocation of port emissions in all States except Alabama. Alabama's CMV data were provided to EPA and already incorporated into the 1999 NEI Version 2, and Pechan did not have access to the default 1999 NEI estimates for this State and category. Since State data take precedence, the inventory prepared by Pechan reflects the incorporation of State data for those areas that developed independent CMV emission estimates, including Virginia and Palm Beach County, Florida. In addition, West Virginia provided their own county fractions to allocate emissions for the Port of Huntington, using District-level data from the Army Corps of Engineers on tonnage of freight shipped and received. West Virginia also requested that residual-fueled CMV activity/emissions be zeroed out for their State. States providing their own data are encouraged to review the allocations Pechan developed for their port areas, and to provide further comment or direction as needed.

Figure III-3. VISTAS Region and Surrounding States, *Revised Port Emissions of NO_X*

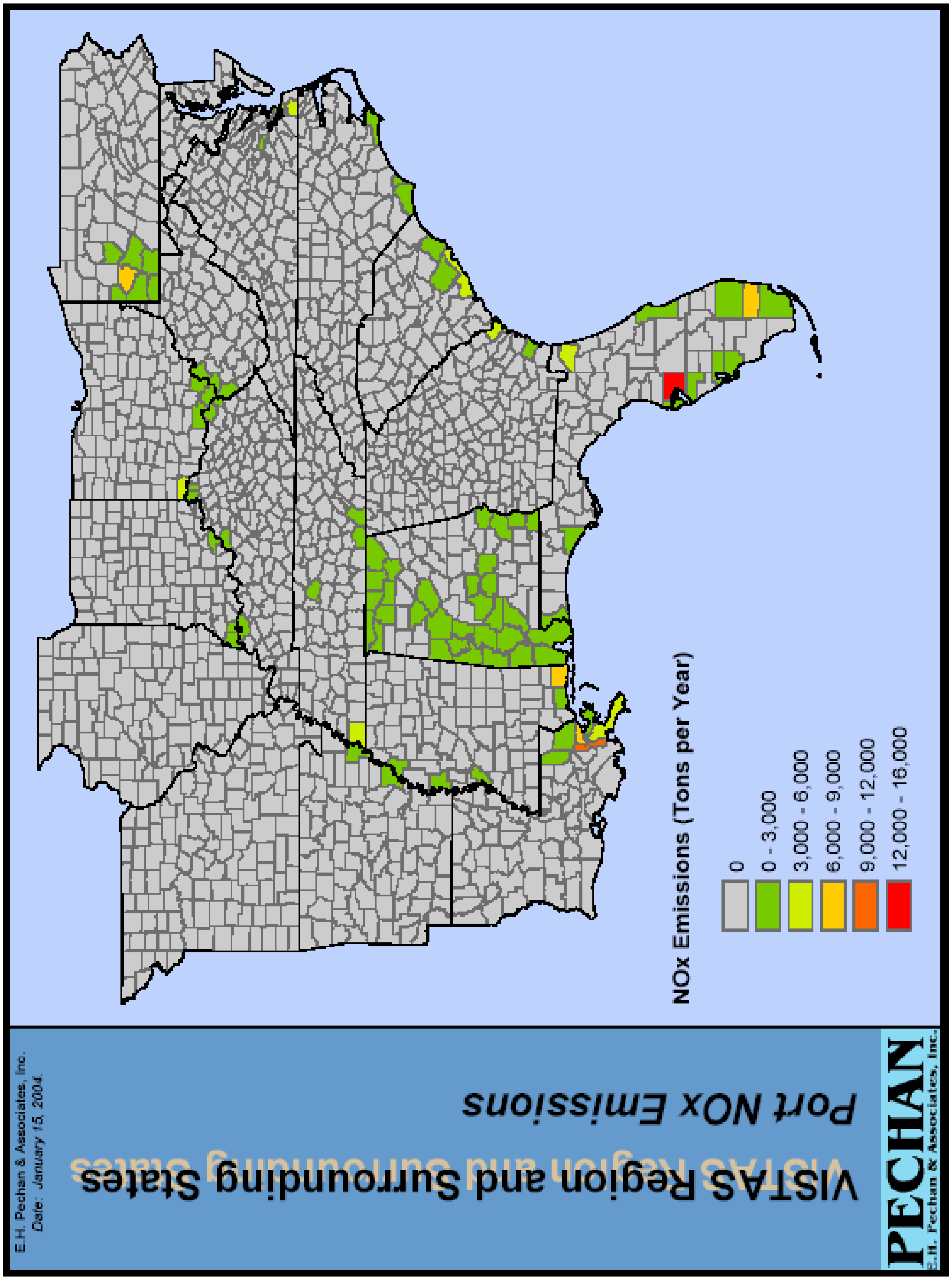

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Table III-6. Definition of Port Areas Obtained from Waterborne Commerce (USACE, 2000)

VISTAS PORTS
MOBILE, AL Entrance. bay and river channels, and channels into Chickasaw and Three Mile Creeks; Branch Channels; Theodore Ship Channel.
GUNTERSVILLE, AL Both banks of the Tennessee River at mile 358 to mile 363.
JACKSONVILLE HARBOR, FL Atlantic Ocean to the Florida East Coast Railway Bridge at Jacksonville, 26.8 miles.
TAMPA, FL Gulf of Mexico to and including the channels of upper Tampa Harbor, 49.8 miles; Channel to Port Tampa and thence to Courtney Campbell Parkway, 17.5 miles; Natural channel leading from Port Tampa Channel toward St. Petersburg, 1.8 miles; Alafia River Channel, 3.6 miles; Hillsborough River to City Waterworks Dam, 10 miles; Channels in "Little Manatee River, Fl; Port Manatee, Fl Harbor."
MIAMI HARBOR, FL Atlantic Ocean to inner end of turning basin at Miami, 6 miles; Meloy Channel and thence natural channels along the easterly side of Biscayne Bay to Bakers Haulover Inlet, FL, about 11 miles; channel from turning basin to mouth of Miami River, 1.1 miles; existing Florida East Coast Railway Channel, Fishermans Channel from mouth of Miami River to Government Cut, 3.8 miles; and the channels reported under "Miami River, FL."
EVERGLADES HARBOR, COLLIER COUNTY, FL - No definition given
CANAVERAL HARBOR, FL Entrance Channel (Atlantic Ocean) to Barrier Beach inner channel and Turning Basins, thence a Barge canal through a lock in the perimeter dike and continuing to the Intracoastal Waterway, Jacksonville to Miami.
CHARLOTTE HARBOR, FL Gulf of Mexico to Municipal Terminal at Punta Gorda, about 29.5 miles; waterfront on Gasparilla Island from Port Boca Grande to Boca Grande, 4.5 miles; and Myakka River to El Jobean, 4 miles.
PALM BEACH HARBOR, FL Atlantic Ocean to Port of Palm Beach Terminals, 1.7 miles; Lake Worth from Riviera Bridge to Southern Boulevard Bridge at West Palm Beach, 7.5 miles; and "Palm Beach, FL side channel and basin."
PORT MANATEE, FL 40 feet deep by 400 feet wide entrance channel and basin. The entrance channel extends approximately 3 miles in length from the turning basin to its intersection with Tampa Harbor main channel. Controlling Depth: 40 feet in entrance channel and turning basin.
PANAMA CITY HARBOR, FL Entrance channel, inside bay and Watson Bayou. Project Depth: Approach channel, 34 feet; across Lands End, 32 feet; Watson Bayou, 10 feet.

Table III-6. Definition of Port Areas Obtained from Waterborne Commerce (USACE, 2000)

PENSACOLA HARBOR, FL Entrance channel and entire harbor, including Bayou Chico. Project Depth: entrance, 35 feet; Inner Harbor, 33 feet; Bayou Chico, 15 and 14 feet.
WEEDON ISLAND, FL – no definition
BRUNSWICK HARBOR, GA From 32-foot contour in the ocean across the Barthrough St. Simon Sound, Brunswick River, and Turtle River to the upper end of the Allied Chemical Company's Wharf, formerly Atlantic Refining Company Wharf, 20.4 miles; from Brunswick River through East River, to the upper end of the project in Academy Creek, 2.7 miles; from St. Simon Sound through Back River to Mill Creek, the upper end of Back River improvement, 2.9 miles; from Back River through Terry Creek to the Glynn Canning Company's Wharf, 1.8 miles; a total distance of 27.8 miles.
SAVANNAH HARBOR, GA From the 40-foot contour in the ocean to the Continental Can Company Plant, 32.15 miles.
LOUISVILLE, KY Both banks of the Ohio River from mile 606 to mile 616 Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.
BILOXI HARBOR, MS Mississippi Sound, Biloxi Bay, Back Bay, and land cut to Gulfport Lake. Project Depth: East entrance channel, Mississippi Sound to Gulfport Lake, 12 feet: West entrance channel, Mississippi Sound to Biloxi Harbor, 10 feet; Ott Bayou, 12 feet.
GREENVILLE, MS From Mississippi River mile 537 AHP left descending bank in an easterly direction, an entrance channel, 8,000 feet long and 250 feet wide transitioning into the harbor and port area 10,000 feet long and 500 feet wide, then transitioning into Lake Ferguson, a channel 5,700 feet long and 250 feet wide.
GULFPORT HARBOR, MS Mississippi Sound Channel, Ship Island Pass Channel, and Small Craft Harbor about 4,300 feet long west of the anchorage basin. Project Depth: Mississippi Sound, 30 feet; Ship Island Pass, 32 feet; Small Craft Harbor, 8 feet.
PASCAGOULA HARBOR, MS Lower 4 miles of Dog River and lower 6.8 miles of Pascagoula River, Mississippi Sound, Bayou Casotte, and Horn Island Pass Channels.
VICKSBURG, MS From Mississippi River mile 437 AHP on left descending bank in a northerly direction, a channel 14,500 feet long by 150 feet wide in the Yazoo Diversion Canal, thence a dredged entrance channel 4,800 feet long and 150 feet wide, transitioning into a 300-foot wide dredged slack water harbor and turning basin 10,700 feet long.
MOREHEAD CITY HARBOR, NC Morehead City Harbor, NC.

Table III-6. Definition of Port Areas Obtained from Waterborne Commerce (USACE, 2000)

PORT OF WILMINGTON, NC (see also Wilmington Harbor NC for waterway data) Both banks of the Cape Fear River extending from a point about 18 miles below the foot of Castle St. in Wilmington to a point about 2 miles above the Railroad Bridge at Navassa, and both banks of Northeast (Cape Fear) River from its mouth to a point about 1.67 miles above the Hilton Railroad Bridge.
CHARLESTON HARBOR, SC (Including Ashley River, Cooper River, Shem Creek And Shipyard River, SC) Ocean to Goose Creek via Cooper River and Town Creek; to the Standard Wharf on Ashley River; to the Mount Pleasant Memorial Highway Bridge on Shem Creek; to the Airco Alloys Wharf on Shipyard River; Wando River to Cainhoy.
GEORGETOWN HARBOR, SC (Winyah Bay) Atlantic Ocean Entrance to Winyah Bay, SC, to and including turning basin in Sampit River at the City of Georgetown, SC.
MEMPHIS, TN Section Inlcuded: From mile 715.5 to mile 741.0 on Lower Mississippi River and includes Memphis Harbor (McKellar Lake) and Wolf River Harbor, Tennessee. Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.
PORT OF NASHVILLE, TN (included in traffic of Cumberland River, TN and KY) Both banks of Cumberland River, mile 182 to mile 194 Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.
CHATTANOOGA, TN Section Included: Both banks of the Tennessee River at mile 454 to 471. Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.
PORT OF RICHMOND, VA (Included in James River, VA Consolidated Report)
PORT OF NEWPORT NEWS, VA (Including Newport News Creek, VA) Lower east shore of James River from mouth to 1.8 miles, and portion of north shore of Hampton Roads covering approximately 15,000 linear feet of waterfront at Newport News; and Newport News Creek.
PORT OF HOPEWELL, VA (Included In James River VA Consolidated Report) South side of James River, from City Point, at mouth of Appomattox River, 2 miles downstream to the mouth of Baileys Creek. Controlling Depth: 25 feet at mean low water. Project Depth: 35 feet, maintained to 25 feet.
NORFOLK HARBOR, VA From 55-foot contour in Hampton Roads to Norfolk & Western (formerly Virginia) Railway Bridge Crossing Southern Branch of Elizabeth River, 14.78 miles; thence upstream in Southern Branch, 4.61 miles. In Eastern Branch, 2.54 miles upstream from the mouth of that branch; in Western Branch, 1.78 miles upstream from the mouth of that branch; and 0.73 miles in Scotts Creek.
HUNTINGTON, WV Both banks of the Ohio River from mile 303 to mile 317 Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.

Table III-6. Definition of Port Areas Obtained from Waterborne Commerce (USACE, 2000)

NON-VISTAS PORTS
HELENA, AR Mile 659 through mile 663 on the Lower Mississippi River. The project provides for maintenance of an off-river harbor with dimensions of 9 feet deep and 450 feet wide for a length of 3,200 feet.
MOUNT VERNON, IN Section Included: Right Bank of Ohio River from mile 151 to mile 154. Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.
CINCINNATI, OH Both banks of the Ohio River from mile 465 to mile 491. Controlling Depth: 9 feet. Project Depth: 9 feet at low water stages.
PORT OF PITTSBURGH, PA Ohio River from Pittsburgh, PA to mile 40 (Pennsylvania/Ohio State Line); Allegheny River from Pittsburgh, PA to mile 72(to head of project); Monongahela River from Pittsburgh, PA to mile 91(to head of project). Includes Aliquippa-Rochester, Pittsburgh, Clairton-Elizabeth. Controlling Depth: 9 feet. Project Depth: 9 feet.
PORT OF PLAQUEMINES, LA Both banks of Mississippi River from mile 0 A.H.P. through mile 81.2 A.H.P Controlling and Project Depths: 45 feet.
PORT OF BATON ROUGE, LA Both banks of Mississippi River from mile 168.5 A.H.P. through mile 253 A.H.P; including the Baton Rouge Barge Canal from a point on the east bank of the Mississippi River at mile 234.5 A.H.P., for a distance of 5 miles.
PORT OF NEW ORLEANS, LA Both banks of the Mississippi River from mile 81.2 A.H.P. through mile 114.9 A.H.P.; Innerharbor Navigation Canal, 5.5 miles; Mississippi River-Gulf Outlet from its junction with the Innerharbor Navigation Canal to Bayou Bienvenue, 7 miles; and Harvey Canal, 5.5 miles.
PORT OF SOUTH LOUISIANA (LA) Both banks of Mississippi River from mile 114.9 A.H.P. through mile 168.5 A.H.P. Controlling and Project Depths: 45 feet.

3. Projection Methods

Pechan then projected the revised 1999 inventory to 2002 using surrogate growth indicators. For the aircraft category, 1999 and 2002 approach operations by airport and aircraft type were compiled from the Federal Aviation Administration's Air Traffic Activity Data System (ATADS). The airport-level landing and takeoffs (LTOs) were assigned to counties and summed for the county. For counties with aircraft emissions without a county match in ATADS, State-average growth factors were calculated and applied. The county-level growth factors are not presented in this report, but could be provided to VISTAS S/L/Ts if requested.

For locomotives, projected emissions were developed in two steps as described below. For 1999 to 2001, State-level vessel bunkering and rail fuel consumption was obtained from the Energy Information Administration's (EIA's) *Fuel Oil and Kerosene Sales.* For 2001 to 2002, Pechan applied national growth factors developed from fuel consumption projections in EIA's *Annual Energy Outlook.* Table III-7a lists the growth factors for locomotives that were applied to the 1999 emissions to first develop 2001 emissions. Table III-7b lists the growth factors used to generate 2002 emissions. Locomotive emissions were not revised from the August 2003 draft VISTAS 2002 inventory.

Table III-7a. Growth Factors for Railroad Distillate Fuel Oil Use

FIPSST	State	Rail Distillate Fuel Oil Sales (Thousand Gallons)		Growth Factor (GF)
		1999	2001	
01	Alabama	42,137	55,777	**1.3**
12	Florida	127,269	107,084	**0.8**
13	Georgia	73,494	70,538	**1.0**
21	Kentucky	98,941	99,812	**1.0**
28	Mississippi	14,267	24,812	**1.7**
37	North Carolina	53,900	77,762	**1.4**
45	South Carolina	13,051	15,936	**1.2**
47	Tennessee	44,083	91,363	**2.1**
51	Virginia	32,202	61,154	**1.9**
54	West Virginia	9,160	8,787	**1.0**

Source: Department of Energy, Energy Information Administration Fuel Oil and Kerosene Sales 1999 & Fuel Oil and Kerosene Sales 2001 Table 23. Adjusted Sales for Transportation Use: Distillate Fuel Oil and Residual Fuel Oil (http://tonto.eia.doe.gov/FTPROOT/pertroleum/053599.pdf), (http://tonto.eia.doe.gov/FTPROOT/pertroleum/053501.pdf)

Table III-7b. 2002 National Rail Transportation Energy Use by Fuel Type (Trillion BTU)

	2001	2002	Growth Factor (GF)
Intercity Rail (Electric)	10.17	10.40	1.0226
Intercity Rail (Diesel)	16.60	16.88	1.0169
Transit Rail (Electric)	46.36	47.40	1.0224
INTERCITY/TRANSIT RAIL AVERAGE (SCC 2285002008)			**1.0206**
Commuter Rail (Electric)	16.13	16.49	1.0223
Commuter Rail (Diesel)	26.31	26.76	1.0171
COMMUTER RAIL AVERAGE (SCC 2285002009)			**1.0197**
Freight Rail (Distillate) (SCCs 2285002000, 2285002005, 2285002006, 2285002007, 2285002010)	512.81	492.32	**0.9600**

Source: Department of Energy, Energy Information Administration, Annual Energy Outlook 2003: Table 34. Transportation Sector Energy Use by Fuel Type Within a Mode (http://www.eia.doe.gov/oiaf/aeo/supplement/sup_tran.pdf)

Since the CMV emissions were revised for the 1999 base year, these emissions were projected using 2002 *Fuel Oil and Kerosene Sales* data, which became available in November 2003. Table III-8 lists the growth factors for CMVs that were applied to 1999 emissions to generate 2002 emissions. The same regional growth factor that accounts for an average regional growth rate was applied to CMV emissions for all VISTAS States. Because the State-level data represents sales and not use, and CMV activity spans State borders, a regional growth factor was deemed more appropriate. Pechan could make a similar adjustment for the locomotive growth factors, which are also based on fuel sales for 1999 to 2001, if requested by VISTAS.

Table III-8. Growth Factors for Commercial Marine Vessel Distillate and Residual Fuel Oil Use

FIPSST	State	Fuel Oil Sales (Thousand Gallons)		Growth Factor (GF)
		1999	2002	
DISTILLATE				
01	Alabama	67,455	73,400	**1.1**
12	Florida	139,809	143,577	**1.0**
13	Georgia	17,697	22,327	**1.3**
21	Kentucky	81,811	56,169	**0.7**
28	Mississippi	12,749	68,668	**5.4**
37	North Carolina	11,279	10,057	**0.9**
45	South Carolina	12,732	19,782	**1.6**
47	Tennessee	43,867	112,364	**2.6**
51	Virginia	29,444	28,235	**1.0**
54	West Virginia	54,560	46,981	**0.9**
Regional Distillate GF		**471,403**	**581,560**	**1.2**
RESIDUAL				
01	Alabama	46,093	93,487	**2.0**
12	Florida	404,228	460,600	**1.1**
13	Georgia	40,117	79,191	**2.0**
21	Kentucky[1]		69	**1.2**
28	Mississippi	48,644	54,031	**1.1**
37	North Carolina	6,989	35,210	**5.0**
45	South Carolina	20,056	22,758	**1.1**
47	Tennessee[1]		124	**1.2**
51	Virginia	60,090	36,445	**0.6**
54	West Virginia			**1.2**
Regional Residual GF		**626,217**	**781,915**	**1.2**

[1] For Kentucky, Tennessee and West Virginia, Pechan summed the 1999 and 2002 CMV residual fuel oil use to develop a total VISTAS State growth factor, which was then applied to the three States.
Source: Department of Energy, Energy Information Administration, Fuel Oil and Kerosene Sales 1999 & Fuel Oil and Kerosene Sales 2002, Table 23. Adjusted Sales for Transportation Use: Distillate Fuel Oil and Residual Fuel Oil.

IV. ONROAD REFUELING METHODS

Emissions were separately calculated from onroad refueling, also known as Stage II emissions. Since refueling is a category of evaporative rather than exhaust emissions, VOC is the only criteria pollutant of concern for this category. This chapter discusses the controls modeled for this emission category and the methods used to calculate these emissions. Refueling emissions for onroad sources were updated in February 2004 to account for the VMT updates provided by several States.

A. CONTROLS

Based on default information from the NEI as well as some information provided by VISTAS agencies, portions of five of the VISTAS States have onroad Stage II refueling controls in place. These States, along with the specific counties with onroad Stage II controls, are listed in Table IV-1. This table also shows information about the Stage II control program in each State including the year a Stage II program began, the number of years that the program was phased-in over, and the control efficiency of the program in reducing VOC emissions from Stage II refueling for the LDGV, LDGT, and HDGV vehicle categories. These are the inputs required for modeling a Stage II control program using MOBILE6. States with Stage II programs should review this information and provide any corrections for the next round of emissions modeling.

Table IV-1. Onroad Stage II Control Programs

State	Start Year	Phase-In Years	Control Efficiency	Counties
Florida	1993	2	95%	Broward, Miami-Dade, Palm Beach
Georgia	1992	3	81%	Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, Rockdale
Kentucky	1999	2	86%	Boone, Campbell, Kenton
Kentucky	1992	2	95%	Jefferson
Tennessee	1993	3	95%	Davidson, Rutherford, Sumner, Williamson, Wilson
Virginia	1993	2	95%	Counties: Arlington, Chesterfield, Fairfax, Hanover, Henrico, Loudoun, Prince William, Stafford Independent Cities: Alexandria, Colonial Heights, Fairfax, Falls Church, Hopewell, Manassas, Manassas Park, Richmond

B. METHODS

A simplified set of MOBILE6.2 input files was created to simulate the onroad refueling emission factors. These input files were simplified because several of the inputs used for calculating the onroad exhaust and evaporative emission factors do not affect the refueling emission factors. For example, the refueling emission factors are unaffected by vehicle speed or I/M program. Thus, for each group of counties in a State with the same fuel parameters, temperature parameters, fleet characteristics (registration distribution, diesel sales fractions), and Stage II control program parameters, a MOBILE6.2 input file was created to model the onroad refueling emission factors. As mentioned above, speed does not affect the refueling emission factors, so each input file contained only 12 scenarios—one for each month of the year. Within each scenario, the temperature and fuel parameters were varied, using the same temperature and fuel data modeled in the onroad exhaust and evaporative MOBILE6.2 input files. Other fleet characteristics, such as registration distributions and diesel sales fractions, were included in the input files where applicable. The inputs shown in Table IV-1 were included for the input files representing counties with Stage II control programs. The header section of the MOBILE6.2 input files was set up so that only refueling emission factors would be included in the tabular output file.

After the MOBILE6.2 input files were generated, they were run through the MOBILE6.2 model to obtain refueling VOC emission factors in the database table format. These emission factors are produced for the 28 MOBILE6 vehicle types. The emission factors were then weighted using the VMT fraction information included in the MOBILE6 output tables to obtain VOC refueling emission factors for the 8 vehicle types included in the VISTAS VMT database. The VMT fraction information contained in the MOBILE6 input files is based on the default MOBILE6 registration distributions, diesel sales fractions, and VMT fractions, or, when this information is provided in the input files, based on area-specific fleet parameters. A database of emission factors by month, county, and 8 vehicle types was then prepared. In calculating monthly onroad refueling emissions, the VISTAS annual VMT data were temporally allocated by month in the same manner as described in Chapter II for the onroad exhaust and evaporative emission calculations. These VMT were then multiplied by the corresponding monthly emission factor (in terms of grams per mile) to obtain refueling emissions from onroad vehicles. The monthly emissions for each county were then summed to obtain annual refueling emissions. Also, since refueling emissions are included in the area source inventory and are not distinguished by vehicle type, all refueling emissions from onroad vehicles were summed for each county in the VISTAS region. Summaries of the refueling emissions from onroad vehicles are presented in Chapter VI.

V. NONROAD REFUELING METHODS

The NONROAD model accounts for refueling emissions from nonroad equipment under two separate components, vapor displacement and spillage. Vapor displacement emissions result when new liquid fuel being added to a fuel tank displaces fuel vapors already present in the tank. Spillage emissions result when fuel is spilled during the refueling process.

Nonroad equipment may be fueled from a gasoline pump or a portable container. Refueling nonroad equipment from a portable container results in different emissions for both spillage and vapor displacement compared to refueling from a gasoline pump. In addition, the use of portable containers also results in extra refueling events. Both spillage and displacement emissions will also occur when the container is filled from a gasoline pump. However, due to lack of data, the NONROAD2002 model does not attempt to quantify this set of refueling emissions. As such, the NONROAD model refueling emissions associated with nonroad equipment being filled directly at the gasoline pumps will be used to represent the nonroad Stage II emission component. Stage II control factors listed in Table IV-1 were input in the county-specific NONROAD model option files. Once the model runs were performed, Pechan extracted the refueling and spillage emissions corresponding only to those engines (typically the larger horsepower engines) within each SCC assumed to be refueled at the pump. The list of SCC and horsepower ranges associated with pump versus container refueling is specified in the model since different emission rates are assumed for these two types of refueling.

Table V-1 presents draft annual Stage II VOC emission estimates by State. These emissions were combined with the onroad vehicle Stage II estimates described in Section IV of this report.

Table V-1. 2002 Draft Stage II Refueling Emissions by State

FIPSST	NAME	VOC Emissions, tpy
01	Alabama	167.25
12	Florida	842.60
13	Georgia	209.01
21	Kentucky	112.65
28	Mississippi	147.18
37	North Carolina	298.49
45	Tennessee	197.81
47	South Carolina	155.33
51	Virginia	174.70
54	West Virginia	39.33

VI. SUMMARY OF RESULTS

This chapter presents the emission results from the February 2004 draft version of the 2002 mobile source emissions inventory for the VISTAS region. These emissions result from the data and procedures described in the preceding chapters of this report.

A. ONROAD RESULTS

Table VI-1 summarizes the latest 2002 VISTAS onroad emissions inventory by State. This table also summarizes the total VMT for each State. Tables VI-2 and VI-3 are provided here for the purpose of comparing this inventory with another existing onroad inventory. The emissions shown in Table VI-2 are taken from Version 2 of EPA's 1999 NEI. Table VI-3 then shows the percentage change from the 1999 NEI to the 2002 draft VISTAS inventory. If the two inventories had been developed using comparable data, one would generally expect to see reductions in the onroad emissions from 1999 to 2002 due to fleet turnover resulting in the replacement of older, dirtier vehicles with vehicles meeting more stringent emission standards. However, this reduction in per-vehicle emissions also needs to overcome increases in VMT for the overall emissions to decrease. All of the VISTAS States show increases in VMT from 1999 to 2002, except North Carolina. This decrease in VMT needs to be further investigated by the State agency. States that were modeled with significant State or locally supplied inputs in the VISTAS modeling, such as Virginia and Georgia, would be expected to have more significant differences from the NEI data than States with no State-supplied information other than VMT. Some of the State inputs that cause significant deviations from the NEI estimates are registration distributions, VMT mixes by vehicle type, and speeds by road type. In addition, some of the pollutants are more affected by these inputs, while others (such as NH_3) are minimally affected by these inputs. The 2002 VISTAS onroad emissions will continue to undergo review. Any comments or questions on these emissions by the State or local agencies will be investigated as part of this review.

Table VI-1. 2002 VISTAS Onroad Emissions and VMT by State (February 2004 Version)

State	2002 Annual Emissions (tons per year)							2002 Annual VMT
	VOC	NOx	CO	SO2	PM10	PM2.5	NH3	(million miles)
Alabama	99,650	154,908	1,275,969	6,515	4,344	3,231	5,619	55,723
Florida	457,309	463,419	4,678,471	19,739	12,666	9,232	18,240	178,681
Georgia	215,035	311,125	2,601,785	11,487	8,038	5,942	10,612	106,785
Kentucky	79,110	164,231	1,196,211	5,718	4,083	3,048	5,103	51,020
Mississippi	68,508	107,047	845,990	4,354	3,152	2,399	3,603	36,278
North Carolina	147,977	278,265	2,116,829	9,953	6,374	4,741	7,868	80,166
South Carolina	92,491	136,569	1,192,894	5,647	3,825	2,867	4,719	47,074
Tennessee	126,959	255,090	1,785,136	8,115	5,445	4,059	6,855	68,316
Virginia	115,044	182,513	1,858,629	6,110	4,413	3,032	7,937	76,566
West Virginia	34,197	57,941	512,592	2,361	1,550	1,155	1,947	19,544
VISTAS Total	***1,436,279***	***2,111,108***	***18,064,506***	***79,999***	***53,890***	***39,705***	***72,504***	***720,153***

Table VI-2. 1999 NEI Version 2 Onroad Emissions and VMT by State

State	1999 Annual Emissions (tons per year)							1999 Annual VMT
	VOC	NOx	CO	SO2	PM10	PM2.5	NH3	(million miles)
Alabama	121,201	163,024	1,412,343	6,280	4,712	3,599	5,249	52,914
Florida	328,412	424,969	3,379,563	16,581	12,259	9,318	14,162	141,903
Georgia	207,562	313,568	2,526,592	12,028	9,263	7,139	9,787	98,859
Kentucky	97,286	162,160	1,225,414	6,006	4,772	3,715	4,703	47,816
Mississippi	74,579	126,344	830,477	4,478	3,908	3,106	3,406	34,955
North Carolina	187,346	285,380	2,252,671	10,829	8,462	6,552	8,663	87,759
South Carolina	98,010	153,346	1,207,336	5,616	4,515	3,527	4,330	44,146
Tennessee	138,629	211,133	1,697,778	7,876	6,108	4,716	6,392	64,570
Virginia	150,528	238,515	1,861,417	8,972	6,892	5,307	7,320	73,904
West Virginia	40,060	68,580	539,578	2,471	2,023	1,589	1,859	19,033
VISTAS Total	***1,443,613***	***2,147,019***	***16,933,170***	***81,137***	***62,913***	***48,567***	***65,871***	***665,859***

Table VI-3. Change in Onroad Emissions and VMT from 1999 NEI Version 2 to VISTAS 2002 Inventory (February 2004 Version)

	Change from 1999 NEI V2 to 2002 VISTAS Draft Inventory							
State	**VOC**	**NOx**	**CO**	**SO2**	**PM10**	**PM2.5**	**NH3**	**VMT**
Alabama	-18%	-5%	-10%	4%	-8%	-10%	7%	5%
Florida	39%	9%	38%	19%	3%	-1%	29%	26%
Georgia	4%	-1%	3%	-4%	-13%	-17%	8%	8%
Kentucky	-19%	1%	-2%	-5%	-14%	-18%	9%	7%
Mississippi	-8%	-15%	2%	-3%	-19%	-23%	6%	4%
North Carolina	-21%	-2%	-6%	-8%	-25%	-28%	-9%	-9%
South Carolina	-6%	-11%	-1%	1%	-15%	-19%	9%	7%
Tennessee	-8%	21%	5%	3%	-11%	-14%	7%	6%
Virginia	-24%	-23%	0%	-32%	-36%	-43%	8%	4%
West Virginia	-15%	-16%	-5%	-4%	-23%	-27%	5%	3%
VISTAS Total	-1%	-2%	7%	-1%	-14%	-18%	10%	8%

Table VI-4 presents the latest 2002 VISTAS onroad refueling emission estimates by State. These refueling emissions are NOT included in the emissions shown in Tables VI-1 through VI-3.

Table VI-4. 2002 VISTAS Annual Onroad Refueling Emissions

State	2002 Annual Onroad VOC Refueling Emissions (tons per year)
Alabama	8,408
Florida	28,367
Georgia	12,329
Kentucky	6,885
Mississippi	6,057
North Carolina	15,320
South Carolina	8,926
Tennessee	9,901
Virginia	8,657
West Virginia	3,383
VISTAS Total	***108,233***

B. NONROAD RESULTS

Table VI-5 provides a summary of draft 2002 nonroad sector annual emissions by State, including Stage II refueling emission estimates. Table VI-6 provides a summary of the draft 2002 NONROAD model emission estimates by State, and compares the values to 2001 NONROAD model NEI Version 2 estimates by showing the percent difference. A similar comparison is shown in Table VI-7 for other nonroad emission estimates compared to the 1999 NEI Version 2.

For the NONROAD model categories, SO_2, PM_{10}, $PM_{2.5}$, and NH_3 decrease consistently across all States. SO_2 emissions decrease due in part to a lower diesel fuel sulfur content input for the NONROAD model runs, which also contributes to decreases in particulate emissions. The decrease in NH_3 is due primarily to corrections made to compresses natural gas (CNG) engine NH_3 emissions, which involved zeroing out the estimates. The 1999 NEI erroneously applied emission factors on a grams per gallon basis to CNG fuel consumption. Although reported as uncompressed gallons in the NONROAD model, the CNG fuel consumption estimates represent a gaseous, not liquid, volume. Based on OTAQ's recommendations, CNG NH_3 emissions are now reported as zero. CO and NO_x show little change for all States, and changes in VOC vary by State and are dependent on the contribution of specific equipment categories (detail not shown).

For other nonroad categories, the increase in PM_{10} and $PM_{2.5}$ is due to the addition of commercial aircraft PM emissions. Commercial aircraft PM_{10} and $PM_{2.5}$ emissions were zero in the 1999 NEI; hence, the large percent increase. To gap fill this portion of the inventory, Pechan calculated and applied an average air taxi PM/NO_x emission ratio to commercial aircraft NO_x emissions. States with a higher proportion of commercial aircraft show significant PM increases (e.g., FL, TN, VA). In addition, NO_x emissions decrease due to new State data for other nonroad from AL and VA.

Table VI-5. Summary of Draft 2002 Nonroad Sector Annual Emissions by State, tons per year

FIPSST	STATE	VOC	NOX	CO	PM10-PRI	PM25-PRI	SO2	NH3
01	Alabama	46,788	64,367	373,634	5,504	4,895	7,529	32
12	Florida	211,006	153,396	1,765,539	61,426	45,849	17,453	109
13	Georgia	66,712	87,053	712,159	10,411	8,666	7,914	55
21	Kentucky	35,537	100,989	294,929	8,538	7,249	13,771	28
28	Mississippi	33,443	90,190	217,407	5,795	5,194	11,537	23
37	North Carolina	75,020	81,264	742,822	12,814	10,379	7,281	62
45	South Carolina	43,231	46,518	375,469	4,115	3,678	4,465	29
47	Tennessee	52,333	118,690	461,976	14,727	11,692	12,478	41
51	Virginia	61,655	69,668	614,958	21,580	16,497	11,068	44
54	West Virginia	15,497	36,613	120,029	2,293	2,034	2,388	10

Table VI-6. Summary of Draft 2002 NONROAD Model Emission Estimates by State

2002 DRAFT VISTAS NONROAD Model Inventory, tpy								
FIPSST	**STATE**	**VOC_ANN**	**NOX_ANN**	**CO_ANN**	**PM10_ANN**	**PM25_ANN**	**SO2_ANN**	**NH3_ANN**
01	Alabama	44,501.18	28,635.48	365,161.12	3,306.84	3,044.48	2,729.32	31.92
12	Florida	205,489.66	86,654.40	1,730,125.77	12,890.06	11,862.13	9,113.26	109.02
13	Georgia	65,054.02	51,452.93	705,292.75	5,493.33	5,057.34	5,025.11	54.97
21	Kentucky	32,836.91	28,253.72	283,488.53	3,152.29	2,901.82	2,777.69	28.00
28	Mississippi	31,097.14	23,549.89	207,824.23	2,761.65	2,542.05	2,375.53	23.37
37	North Carolina	73,610.93	58,667.62	734,496.85	6,095.96	5,613.11	5,442.35	62.06
45	South Carolina	41,652.41	26,212.76	366,737.16	3,028.92	2,788.66	2,461.79	29.29
47	Tennessee	48,626.66	39,833.95	446,461.43	4,240.53	3,904.21	3,810.11	41.22
51	Virginia	56,973.85	40,914.48	594,020.13	4,739.47	4,362.61	4,103.01	44.22
54	West Virginia	14,498.68	9,502.33	115,652.49	1,038.29	955.70	980.17	10.31
2001 NONROAD Model NEI Version 2, tpy								
FIPSST	**STATE**	**VOC_ANN**	**NOX_ANN**	**CO_ANN**	**PM10_ANN**	**PM25_ANN**	**SOX_ANN**	**NH3_ANN**
01	Alabama	43,602.83	28,786.95	360,439.36	3,422.60	3,150.91	3,110.79	581.69
12	Florida	188,868.96	86,835.32	1,713,539.62	13,243.04	12,186.78	10,456.05	1,305.25
13	Georgia	63,927.85	51,521.66	698,868.77	5,678.55	5,227.63	5,749.47	989.31
21	Kentucky	31,662.34	28,350.32	279,283.79	3,274.35	3,014.06	3,127.88	463.74
28	Mississippi	29,037.96	23,671.70	205,664.64	2,877.28	2,648.40	2,668.55	359.21
37	North Carolina	69,671.36	58,742.13	724,908.46	6,300.02	5,800.72	6,196.92	1,223.82
45	South Carolina	39,310.79	26,304.57	363,112.01	3,130.17	2,881.75	2,817.02	507.81
47	Tennessee	47,193.97	39,916.38	440,915.76	4,395.90	4,047.06	4,337.42	749.51
51	Virginia	55,459.80	41,082.63	585,850.58	4,887.90	4,499.09	4,677.52	627.60
54	West Virginia	13,912.53	9,568.82	113,766.38	1,076.32	990.67	1,113.21	179.75
Percent Difference								
FIPSST	**STATE**	**VOC_ANN**	**NOX_ANN**	**CO_ANN**	**PM10_ANN**	**PM25_ANN**	**SOX_ANN**	**NH3_ANN**
01	Alabama	2.06%	-0.53%	1.31%	-3.38%	-3.38%	-12.26%	-94.51%
12	Florida	8.80%	-0.21%	0.97%	-2.67%	-2.66%	-12.84%	-91.65%
13	Georgia	1.76%	-0.13%	0.92%	-3.26%	-3.26%	-12.60%	-94.44%
21	Kentucky	3.71%	-0.34%	1.51%	-3.73%	-3.72%	-11.20%	-93.96%
28	Mississippi	7.09%	-0.51%	1.05%	-4.02%	-4.02%	-10.98%	-93.50%
37	North Carolina	5.65%	-0.13%	1.32%	-3.24%	-3.23%	-12.18%	-94.93%
45	South Carolina	5.96%	-0.35%	1.00%	-3.23%	-3.23%	-12.61%	-94.23%
47	Tennessee	3.04%	-0.21%	1.26%	-3.53%	-3.53%	-12.16%	-94.50%
51	Virginia	2.73%	-0.41%	1.39%	-3.04%	-3.03%	-12.28%	-92.95%
54	West Virginia	4.21%	-0.69%	1.66%	-3.53%	-3.53%	-11.95%	-94.26%

Table VI-7. Summary of Draft 2002 Other Nonroad* Emission Estimates by State

FIPSST	STATE	VOC_ANN	NOX_ANN	CO_ANN	PM10_ANN	PM25_ANN	SO2_ANN
2002 DRAFT VISTAS Other Nonroad Inventory, tpy							
FIPSST	**STATE**	**VOC_ANN**	**NOX_ANN**	**CO_ANN**	**PM10_ANN**	**PM25_ANN**	**SO2_ANN**
01	Alabama	2,286.81	35,731.80	8,473.33	2,196.87	1,850.82	4,799.75
12	Florida	5,516.71	66,741.52	35,413.13	48,536.33	33,987.28	8,340.05
13	Georgia	1,657.99	35,599.76	6,865.94	4,917.40	3,609.14	2,889.06
21	Kentucky	2,699.92	72,735.57	11,440.23	5,385.61	4,346.83	10,992.91
28	Mississippi	2,345.96	66,640.48	9,582.89	3,033.69	2,652.14	9,161.66
37	North Carolina	1,409.01	22,596.53	8,325.56	6,718.49	4,766.12	1,838.68
45	South Carolina	1,578.34	20,304.80	8,732.26	1,086.01	889.24	2,002.78
47	Tennessee	3,706.17	78,855.60	15,514.17	10,486.01	7,787.92	8,667.84
51	Virginia	4,681.39	28,753.43	20,938.22	16,840.30	12,134.84	6,965.04
54	West Virginia	998.41	27,110.49	4,376.64	1,254.86	1,077.93	1,408.05
1999 Other Nonroad NEI Version 2, tpy							
FIPSST	**STATE**	**VOC_ANN**	**NOX_ANN**	**CO_ANN**	**PM10_ANN**	**PM25_ANN**	**SO2_ANN**
01	Alabama	7,309.83	152,338.93	25,075.50	1,315.93	1,176.15	3,854.54
12	Florida	3,945.18	56,197.72	25,350.10	2,110.74	1,881.95	6,878.28
13	Georgia	2,594.07	39,245.14	12,198.09	1,072.08	953.43	3,070.41
21	Kentucky	2,676.93	62,930.31	12,388.06	2,370.31	2,153.93	8,965.67
28	Mississippi	1,755.99	48,927.22	8,072.51	1,917.16	1,747.89	7,051.91
37	North Carolina	1,447.95	17,999.44	8,739.21	540.09	470.85	1,508.40
45	South Carolina	2,470.03	18,034.10	13,291.47	561.99	503.60	1,858.19
47	Tennessee	2,426.97	51,133.47	11,127.02	1,786.06	1,616.72	6,266.91
51	Virginia	2,682.78	51,592.64	13,083.30	1,632.38	1,462.82	4,769.97
54	West Virginia	1,133.03	30,991.75	4,858.71	1,151.55	1,048.38	4,097.15
Percent Difference							
FIPSST	**STATE**	**VOC_ANN**	**NOX_ANN**	**CO_ANN**	**PM10_ANN**	**PM25_ANN**	**SO2_ANN**
01	Alabama	-69%	-77%	-66%	67%	57%	25%
12	Florida	40%	19%	40%	2199%	1706%	21%
13	Georgia	-36%	-9%	-44%	359%	279%	-6%
21	Kentucky	1%	16%	-8%	127%	102%	23%
28	Mississippi	34%	36%	19%	58%	52%	30%
37	North Carolina	-3%	26%	-5%	1144%	912%	22%
45	South Carolina	-36%	13%	-34%	93%	77%	8%
47	Tennessee	53%	54%	39%	487%	382%	38%
51	Virginia	74%	-44%	60%	932%	730%	46%
54	West Virginia	-12%	-13%	-10%	9%	3%	-66%

*Includes emissions from aircraft, commercial marine and locomotive SCCs

VII. OBSERVATIONS AND RECOMMENDATIONS FOR IMPROVEMENT

This chapter lists several areas where the onroad and nonroad emission inventories could be improved. Some of these improvements require a long lead-time for the States and would not likely be available for the final 2002 VISTAS modeling, but could improve future State and regional inventory efforts.

A. ONROAD SECTOR IMPROVEMENTS

In the onroad sector, significant improvements have been made to the inventory due to the State and local agencies providing 2002 VMT data by county and roadway type. For this February 2004 version of the VISTAS onroad inventory, only the Virginia VMT were projected by Pechan. It is anticipated that this States will be able to provide 2002 VMT data for use in the next revision of the inventory.

Local registration distribution data were provided by fewer than half of the VISTAS States. In many cases, registration data can be obtained from State Departments of Motor Vehicles. States that do not already do so should request a download of the data summarizing registrations by model year and vehicle class from their appropriate motor vehicle agency. Although it is probably too late in many cases to obtain 2002 data, 2003 registration data could be used with some adjustments in developing the 2002 emission inventories. Registration data will become even more important as VISTAS prepares to project a 2018 onroad emission inventory, since the 2018 projections will be affected by the number of vehicles that are subject to the Tier 2 emission standards and the new heavy duty vehicle standards. The registration distributions directly determine the proportion of vehicles subject to these new emission standards.

A relatively small amount of data was obtained regarding the distribution of VMT by season or month. Many State Departments of Transportation collect data that could be used to better distribute VMT by season or month. States should check to see what is available. These distributions will affect the episodic modeling that will be conducted by VISTAS. Pechan is currently performing a VMT scoping study for VISTAS to determine what data are available for better allocating VMT and emissions by month, day, and hour. These temporal improvements are expected to be incorporated into the next update of the VISTAS onroad emission inventory.

Due to the direct relationship between the VMT mix by vehicle type and the overall emissions, States should investigate potential sources of information for this data to replace the default data used here in most States.

EPA is currently in the process of preparing guidance on estimating emissions from heavy duty vehicles during long-term idling (sometimes referred to as hotelling). While these emissions are theoretically included in the MOBILE6 HDDV emission factors, they are not currently accounted for in the appropriate locations. For example, these emissions would typically occur at rest stops, trucking centers, and warehouse and distribution centers. With the current modeling, these emissions are spread over all counties, based on the VMT traveled by HDDVs in each county. If significant sources of truck idling emissions occur in or near Class I areas, the current modeling may be underestimating the effect of these emissions. If States are able to obtain data on the locations and utilization of truck rest stops, some of this emissions effect could be more appropriately accounted for in future versions of VISTAS modeling.

B. NONROAD SECTOR IMPROVEMENTS

NH_3 emissions for aircraft, commercial marine and locomotives are still reported as zero. As a result of recent communications with OTAQ, Pechan would suggest applying the updated nonroad diesel NH_3 emission factors used for the NONROAD model categories to activity data for commercial marine vessels and locomotives. To develop ammonia from commercial marine vessels and locomotives, Pechan would need to obtain or compile the county-level fuel consumption estimates used as the basis for 1999 emissions for these categories to use as the activity data for calculating updated NH_3 emissions. The presence of State or local data in the 1999 NEI does not allow for this to be determined easily by backing out the reported emission factors, and in some cases (e.g., diesel commercial marine), actual emissions (instead of activity) were obtained at a national level and allocated to counties (EPA, 2002). Alternatively, Pechan could use county level fuel consumption estimates developed for these categories for 2000 or 2001. These activity data were used by Pechan to estimate dioxin/furan emission estimates for the 2000 and 2001 NEI. Pechan could normalize the 2000 or 2001 county distribution to national level fuel consumption estimates for 1999. Due to the characteristics of aircraft jet and piston engines, Pechan does not recommend estimating aircraft NH_3 emissions using the available NH_3 emission factors.

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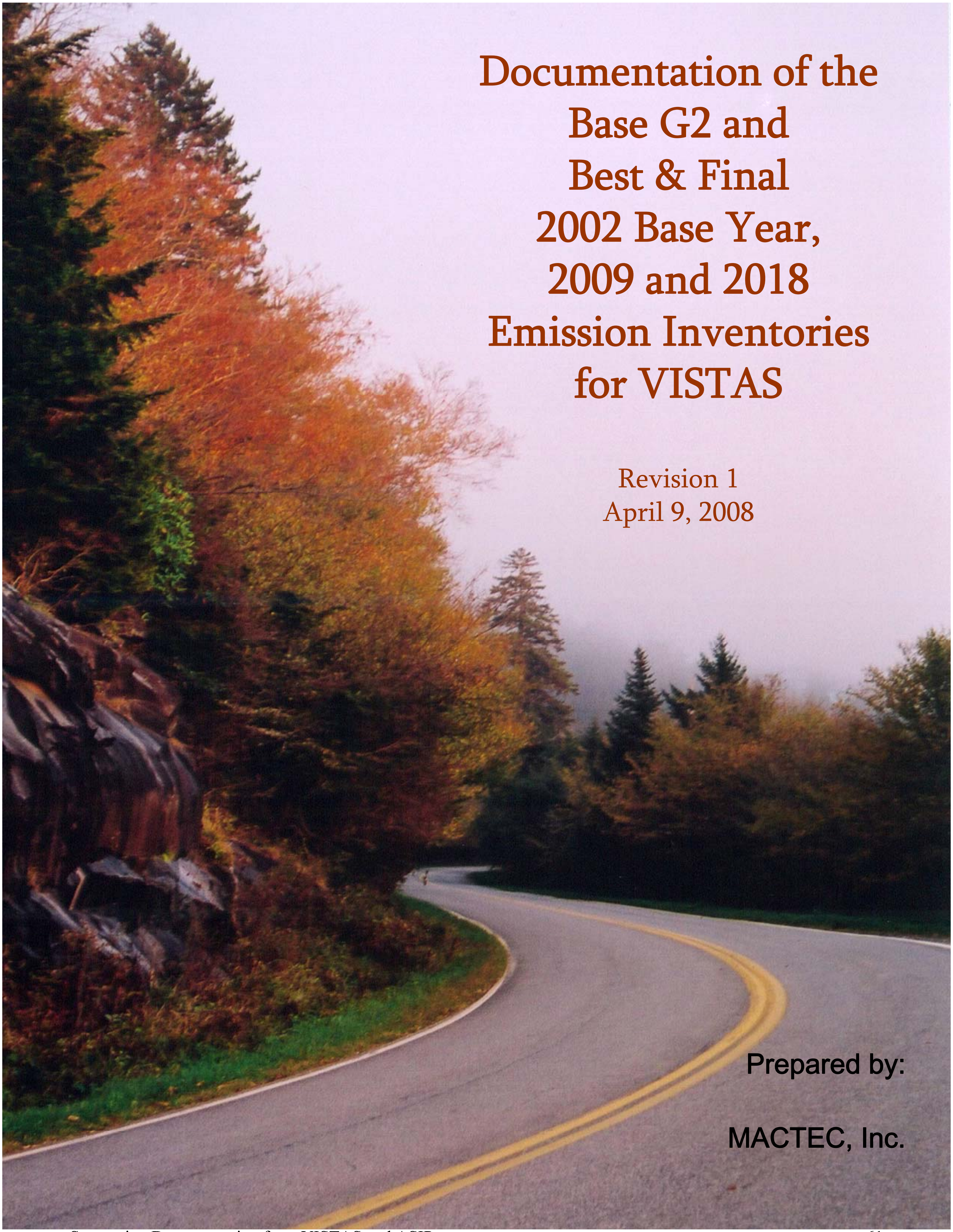

Documentation of the Base G2 and Best & Final 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS

Revision 1
April 9, 2008

Prepared by:

MACTEC, Inc.

Documentation of the

Base G2 and Best & Final

2002 Base Year, 2009 and 2018

Emission Inventories for VISTAS

Revision 1

Prepared for:

Visibility Improvement State and Tribal Association of the Southeast (VISTAS)

April 9, 2008

Prepared by:

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Acronyms and Abbreviations

AEO	Annual Energy Outlook
AF&PA	American Forest and Paper Association
APCD	Air Pollution Control District
ATP	Anti-Tampering Program
BLRID	Boiler Identification (Boiler ID)
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CEM	Continuous Emissions Monitoring
CAMD	Clean Air Markets Division
CERR	Consolidated Emissions Reporting Rule
CMU	Carnegie Mellon University
CMV	commercial marine vessels
CE	Control Efficiency
CO	carbon monoxide
DENR	North Carolina Department of Environment and Natural Resources
DHEC	South Carolina Department of Health and Environmental Control
EDMS	Emissions Data Management Systems
ESD	Emissions Standards Division
EPA	Environmental Protection Agency
EGU	Electric Generating Unit
ICF	ICF International, Inc.
FIP	Federal Implementation Plan
FLM	Federal Land Manager
FTP	File transfer protocol
FR	Federal Register
FS	Forest Service
HDD	Heavy Duty Diesel
HDD RULE	Heavy Duty Diesel Rule
ICF	ICF International, Inc.
ID	Identification
I/M	Inspection and Maintenance
IPM®	Integrated Planning Model®
IAQTR	Interstate Air Quality Transport Rule
LTO	Landing and take off
MACT	Maximum achievable control technology

Acronyms and Abbreviations (continued)

MACTEC	MACTEC Engineering and Consulting, Inc.
MOBILE 6	MOBILE emissions estimation model version 6
MRPO	Midwest Regional Planning Organization
NH_3	Ammonia
NEI	National Emission Inventory
NIF	National Emission Inventory Format
NLEV	National Low Emission Vehicle regulation
NMIM	National Mobile Inventory Model
NONROAD	no acronym (model name)
NO_x	Oxides of nitrogen
NWR	National Wildlife Refuge
OTB	On the books
OTW	On the way
ORIS	Office of Regulatory Information Systems
OTAQ	Office of Transportation and Air Quality
OTC	Ozone Transport Commission
PFC	Portable fuel containers
PM	Particulate matter
PM_{10}-FIL	Particulate matter less than or equal to 10 microns in diameter that can be captured on a filter
PM_{10}-PRI	Particulate matter less than or equal to 10 microns in diameter that includes both the filterable and condensable components of particulate matter
$PM_{2.5}$-FIL	Particulate matter less than or equal to 2.5 microns in diameter that can be captured on a filter
$PM_{2.5}$-PRI	Particulate matter less than or equal to 2.5 microns in diameter that includes both the filterable and condensable components of particulate matter
PM-CON	Particulate matter created by the condensation of hot materials to form particulates, usually less than 2.5 microns in diameter
ppmW	parts per million by weight
PRI	Primary
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
REMI	Regional Economic Models, Inc.
RFG	Reformulated gasoline
RVP	Reid Vapor Pressure

Acronyms and Abbreviations (continued)

SCC	Source Classification Code
SIP	State Implementation Plan
SIWG	Special Interest Workgroup
S/L/T	State/Local/Tribal
SMOKE	Sparse Matrix Operator Kernel Emissions Modeling System
S/L	State and Local
SO_2	Oxides of Sulfur
T4	Tier 4
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VMT	Vehicle Miles Traveled
VOC	Volatile organic compounds
WRAP	Western Regional Air Partnership

Documentation of the Base G2 and Best & Final 2002 Base Year, 2009 and 2018, Emission Inventories for VISTAS

Introduction

Base G2 document was delivered final in Aug (?) 2007. In fall 2007 states updated specific point source EGU and non-EGU facility record in Best and Final (B&F) inventories for 2009 and 2018 to account for BART controls, consent decrees, corrections to Base G2, and source specific controls. Only EGU and non-EGU point source records were changed. Area, non-road, on-road remained the same as Base G2. In this report all records for area, non-road, and on-road were used in B&F modeling the same as Base G2. This report has been updated from the Base G2 report submitted in July 2007 just for B&F changes to EGU and non-EGU sources. A history of the development of the VISTAS inventory follows. Specific sections of the document detail the modifications made as the inventory progressed from Base F through B&F.

The Base G2 inventory included changes in 2018 controls on specific electric generating units in GA, FL, NC, and WV. There were no changes in 2009 controls for EGU and no changes between the Base G and Base G2 inventories for non-EGU point, on-road, non-road, or area sources in 2009 or 2018. The Base G2 modeling run included changes for 2018 EGU controls plus corrections in 2002 typical, 2009, and 2018 for errors in emissions processing in Base G. These corrections in emissions processing are not seen when comparing the Base G and G2 inventory files.

Base G and Base G2 inventories represent two separate model runs, as does the B&F. Since Base G2 supersedes Base G, VISTAS will maintain only the Base G2 and B&F model files since both were used in State Implementation Plan submittals.

History of VISTAS Base and Projection Year Emission Inventory Development

This section is provided to supply the history behind the development of the base and projection year inventories provided to the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the Association for Southeast Integrated Planning (ASIP). Through the various iterations, the inventories that have been developed have typically had version numbers provided by the contractors who developed the inventories and to a certain extent these were also based on their purpose. Different components of the 2002 base year inventories have been supplied by E.H. Pechan and Associates, Inc. (Pechan), MACTEC Engineering and Consulting, Inc.

(MACTEC), and by Alpine Geophysics, Inc. (AG). The projection year inventories were developed by MACTEC and AG.

The initial 2002 base year inventory was jointly developed by Pechan and MACTEC. Pechan developed the on-road and non-road mobile source components of the inventory while MACTEC developed the point and area source component of the inventory. This version of the inventory included updates to on-road mobile that incorporated information from the 1999 NEI Version 2 final along with updated information on VMT, fuel programs, and other inputs to the MOBILE6 model to produce a draft version of the 2002 inventory. For non-road sources, a similar approach was used. Updated State information on temperatures and fuel characteristics were obtained from VISTAS States and used with the NONROAD 2002 model to calculate 2002 emissions for NONROAD model sources. These estimates were coupled with data for commercial marine vessels, locomotives and airplanes projected to 2002 using appropriate growth surrogates. A draft version of these inventories was prepared in late 2003, with a final version in early 2004. An overview of the development of the on-road component can be found at: http://www.vistas-sesarm.org/documents/Pechan_drafton-roadinventory_082803.ppt while an overview of the non-road component can be found at: http://www.vistas-sesarm.org/documents/Pechan_Non-roadInventory_082803.ppt.

Similarly, draft versions of the 2002 point and area source base year inventories were prepared by MACTEC in the same timeframe (late 2003 for the draft, final in early 2004). The point source component was based on data submitted by the VISTAS States or on the 1999 NEI. The data submitted by the States ranged from 1999 to 2001 and was all projected to 2002 using appropriate growth surrogates from Economic Growth Analysis System (EGAS) version 4. Toxic Release Inventory (TRI) data were used to augment the inventory for NH_3. Continuous Emissions Monitor (CEM) data from the U.S. EPA's Clean Air Markets Division was used to supply emissions for electric generating utilities (EGUs). Particulate matter emissions were augmented (when missing) by using emission factor ratios. Details on all these calculations are discussed in Section 1.1.1.3 of this document.

The area source component of the 2002 draft base year emissions was prepared similarly to the point sources, using State submittals and the 1999 NEI Version 2 final as the basis for projecting emissions to 2002 using EGAS growth factors. For ammonia area sources the Carnegie Mellon University (CMU) ammonia model was used to calculate emissions. Finally, data on acreage burned on a fire by fire basis was solicited from State forestry agencies in order to calculate fire emissions on a fire by fire basis. Virtually all VISTAS State forestry agencies provided data for these calculations at least for wild and

prescribed fires. An overview of the point and area source development methods can be found at:
http://www.vistas-sesarm.org/documents/MACTEC_draftpointareainventory_82803.ppt.

Three interim versions of the 2002 base year inventory were developed. The first was delivered in August of 2003, the second in April of 2004 and the final one in October of 2004. The August 2003 and April 2004 inventories were prepared by MACTEC and Pechan. A draft version of the revised 2002 base year inventory was released in June of 2004, with a final version released in October 2004. That 2002 base year inventory was solely prepared by MACTEC. The October 2004 inventory incorporated 2002 Consolidated Emissions Reporting Rule (CERR) data into the inventory along with some updated data from the VISTAS States. This inventory is typically referred to as version 3.1 of the VISTAS inventory.

Closely following the version 3.1 2002 base year inventory, a "preliminary" 2018 projection inventory was developed. This "preliminary" 2018 inventory was developed in late 2004 (Oct/Nov) and was designed solely for use in modeling sensitivity runs to provide a quick and dirty assessment of what "on the books" and "on the way" controls could be expected to provide in terms of improvements to visibility and regional haze impairment. A brief overview of the history of the three versions of the 2002 base year and the 2018 preliminary inventory use can be found at: http://www.vistas-sesarm.org/documents/STAD1204/2002and2018Emissions14Dec2004.ppt.

Following preparation of the final 3.1 version of the 2002 base year inventory, States were asked to review and provide comments on that inventory to MACTEC for update and revision. At the same time MACTEC prepared a revised draft version of the 2018 projection inventory (January 2005) and a draft version of a 2009 projection inventory (April 2005). All of these were known as version 3.1 and were provided to the VISTAS States for review and comment. Comments were received and updates to the inventories based on these comments were prepared. The revised inventories were provided to the VISTAS States. At that time to be consistent with the modeling nomenclature being used by AG in performing their modeling runs, the inventory became the Base F VISTAS inventory. The Base F inventory was delivered for review and comment in August of 2005. In addition, MACTEC delivered a report entitled *Documentation of the Revised 2002 Base Year, Revised 2018, and Initial 2009 Emission Inventories for VISTAS* on August 2, 2005 that described the methods used to develop the Base F inventories. For the Electric Generating Utilities (EGU) different versions of the Integrated Planning Model were used between Base D and Base F, resulting in different projections of future EGU emissions.

Over the period from August 2005 until June/July 2006 MACTEC received comments and updates to some categories from VISTAS States, particularly EGU. In addition, a new NONROAD model (NONROAD05) was released. Thus additional updates to the inventory were prepared based on the comments received along with revised NONROAD emission estimates from NONROAD05. The resultant inventory became the Base G inventory.

Following release of the Base G inventory in early 2007, four States specified additional changes to reflect their best estimates of EGU emission levels and controls in 2018. The resulting 2018 EGU emission inventory is referred to as Base G2, which was released in July 2007.

The current version of the VISTAS inventory is referred to as the “Best and Final (B&F)” inventory. States specified additional changes to the point source inventory to reflect improved knowledge of EGU emission levels and controls in 2009 and 2018. States also specified changes to nonEGU sources reflecting new information on anticipated controls and shutdowns. No changes to any other source sector (e.g., area, fire, nonroad, onroad) were made for the B&F inventory. The 2018 B&F inventory was released in October 2007, and the 2009 B&F inventory was released in December 2007.

This document details the development of the Base G/G2/B&F inventories for 2002, 2009 and 2018. The information that follows describes the development of the VISTAS inventory by sector from Base F forward. Unless specific updates were made to an inventory sector, the methods used for Base F were retained. Table I-1 through Table I-3 indicate roughly which version of the inventory is in use for each sector of the inventory as of the B&F inventory.

Under a separate contract, AG was asked to obtain and convert emission inventory data for the five states that make up the Midwest Regional Planning Organization (MRPO) for use by VISTAS/ASIP modelers. Details of this effort are documented in an Appendix to this report.

Table I-1 Inventory Version in Use by Year and Source Sector Through B&F - 2002

Source	AL	FL	GA	KY	MS	NC	SC	TN	VA	WV
EGU	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G
Non-EGU Point	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G	Base F with some source specific revisions in Base G
Area[1]	Base F for ammonia sources (CMU Model) and for some area sources, Base G for selected sources updated by the State with State supplied data	Base F except for some emissions zeroed out (and records removed) for some southern FL counties for Base G.	Base F	Base F	Base F	Base F for ammonia sources (CMU Model) and for some area sources, Base G for selected sources updated by the State with State supplied data. Some corrections applied by MACTEC to correct PM values	Base F	Base F	Base F for ammonia Sources (CMU Model) and for some area sources, Base G for selected sources updated by the State with State supplied data.	Base F
On-road	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G
Non-road	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources, except aircraft and locomotives updated for Base G.	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources except for aircraft in Cincinnati/N. KY Int. Airport, which are Base G.	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources	Base G for all sources included in the NONROAD model. NC moved from Southern to Mid-Atlantic State in seasonal adjustment file. Base F for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources, except for aircraft emissions which are Base G.	Base G for all sources included in the NONROAD model. Base F for non-NONROAD model sources
Fires	Base F Typical	Base F Typical	Base F Typical	Base F Typical	Base F Typical	Base F Typical	Base F Typical	Base F Typical	Base F Typical	Base F Typical

Notes:

Base G global Area Source changes that apply to ALL States: A) removal of Stage II refueling from area source file to non-road and on-road; B) modification of PM2.5 ratio for several fugitive dust sources per WRAP methodology; C) addition of portable fuel container (PFC) emissions to all States based on OTAQ report.

Table I-2 Inventory Version in Use by Year and Source Sector Through B&F - 2009

Source	AL	FL	GA	KY	MS	NC	SC	TN	VA	WV
EGU[1]	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final
Non-EGU Point[2]	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F
Area	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model. Some specific source categories updated using State supplied file to override projected values.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.
On-road	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G
Non-road	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources.	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources except for aircraft in Cincinnati/N. KY Int. Airport, which are Base G using State supplied growth factors.	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources
Fires	Base F typical except for Rx fires	Base F typical	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires

Notes:

1. All EGU emissions updated with new IPM runs in Base G; additional EGU-specific changes specified by States for Best & Final.
2. Revised growth factors from DOE AEO2006 fuel use projections

Table I-3 Inventory Version in Use by Year and Source Sector Through B&F - 2018

Source	AL	FL	GA	KY	MS	NC	SC	TN	VA	WV
EGU[1]	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final	Best & Final
Non-EGU Point[2]	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in Base G2 and B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in Base G2 and B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in Base G2 and B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in B&F	Base F methodology but with revised growth factors for fuel fired sources in Base G and source-specific changes in Base G2 and B&F
Area	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model. Some specific source categories updated using State supplied file to override projected values.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.	Base F with updated AEO growth factors for fuel fired sources. Agricultural ammonia sources from CMU model.
On-road	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G	Base G
Non-road	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources.	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources except for aircraft in Cincinnati/N. KY Int. Airport, which are Base G using State supplied growth factors.	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources	Base G for all sources included in the NONROAD model. Base F projection methodology used for non-NONROAD model sources
Fires	Base F typical except for Rx fires	Base F typical	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires	Base F typical except for Rx fires

Notes:
1. All EGU emissions updated with new IPM runs in Base G; additional EGU-specific changes specified by States for Base G2 and B&F.
2. Revised growth factors from DOE AEO2006 fuel use projections

1.0 2002 Base Year Inventory Development

1.1 Point Sources

This section details the development of the 2002 base year inventory for point sources. There were two major components to the development of the point source sector of the inventory. The first component was the incorporation of data submitted by the Visibility Improvement State and Tribal Association of he Southeast (VISTAS) States and local (S/L) agencies to the United States Environmental Protection Agency (EPA) as part of the Consolidated Emissions Reporting Rule (CERR) requirements Work on incorporating the CERR data into the revised base year involved: 1) obtaining the data from EPA or the S/L agency, 2) evaluating the emissions and pollutants reported in the CERR submittals, 3) augmenting CERR data with annual emission estimates for PM_{10}-PRI and $PM_{2.5}$-PRI; 4) evaluating the emissions from electric generating units, 5) completing quality assurance reviews for each component of the point source inventory, and 6) updating the database with corrections or new information from S/L agencies based on their review of the 2002 inventory. The processes used to perform those operations are described in the first portion of this section.

The second component was the development of a "typical" year inventory for electric generating units (EGUs). VISTAS determined that a typical year electric generating units (EGU) inventory was necessary to smooth out any anomalies in emissions from the EGU sector due to meteorology, economic, and outage factors in 2002. The typical year EGU inventory is intended to represent the five year (2000-2004) period that will be used to determine the regional haze reasonable progress goals. The second part of this section discusses the development of the typical year EGU inventory.

1.1.1 Development of 2002 Point Source Inventory

MACTEC developed a draft 2002 emission inventory in June 2004 (*Development of the Draft 2002 VISTAS Emission Inventory for Regional Haze Modeling – Point Sources*, MACTEC, June 18, 2004). The starting point for the draft 2002 emission inventory was EPA's 1999 National Emission Inventory (NEI), Version 2 Final (NEI99V2). For several states, we replaced the NEI99V2 data with more recent inventories for either calendar year 1999, 2000, or 2001 as submitted by the S/L agencies. We also performed several other updates, including updating emission estimates for selected large source of ammonia, incorporating 2002 Continuous Emissions Monitoring-(CEM)-based SO_2 and NO_x emissions for electric utilities, adding PM_{10} and $PM_{2.5}$ emissions when they were missing from an S/L submittal, and performing a variety of additional Quality assurance/Quality control (QA/QC) checks.

The next version of the 2002 inventory (referred to as Base F) was released in August 2005 (*Documentation of the Revised 2002 Base Year, Revised 2018, and Initial 2009 Emission Inventories for VISTAS*, MACTEC, August 2, 2005). The primary task in preparing the Base F 2002 base year inventory was the replacement of NEI99V2 data with data submitted by the VISTAS S/L agencies as part of the CERR submittal and included in EPA's 2002 NEI.

The next version of the 2002 inventory (referred to as Base G) was released in August 2006 and is documented in this report. The primary task in preparing the Base G 2002 base year inventory was the incorporation of corrections and new information as submitted by the S/L agencies based on their review of the Base F inventory. Note that no changes to the Base G 2002 point source inventory were made during the Base G2 and B&F update cycles (in other words, for the 2002 actual and typical inventories, Base G = Base G2 = B&F).

The following subsections document the data sources for the Base G/B&F inventory, the checks made on the CERR submittals, the process for augmenting the inventory with PM_{10} and $PM_{2.5}$ emissions, the evaluation of EGU emissions, other QA/QC checks, and other Base G updates. The final subsection summarizes the Base G/B&F 2002 inventory by state, pollutant, and sector (EGU and non-EGU).

1.1.1.1 Data Sources

Several data sources were used to compile the Base F point source inventory: 1) the inventories that the S/L submitted to EPA from May through July 2004 as required by the CERR; 2) supplemental data supplied by the S/L agencies that may have been revised or finalized after the CERR submittal to EPA, and 3) the draft VISTAS 2002 inventory in cases where S/L CERR data were not available. For the Base G inventory, we replaced data from Hamilton County, Tennessee, using data from Hamilton County's CERR submittal as contained in EPA's 2002 NEI inventory (in Base F, the inventory for Hamilton County was based on the draft VISTAS 2002 inventory, which in turn was based on the 1999 NEI).

Table 1.1-1 summarizes the data used as the starting point for the Base F 2002 inventory. Once all of the files were obtained, MACTEC ran the files through the EPA National Emission Inventory Format (NIF) Basic Format and Content checking tool to ensure that the files were submitted in standard NIF format and that there were no referential integrity issues with those files. In a couple of cases small errors were found. For example, in one case non-standard pollutant designations were used for particulate matter (PM) and ammonia emissions. MACTEC contacted each VISTAS State point source contact person to resolve the issues with the files and corrections were made. Once all corrections to the native files were made, MACTEC continued with the incorporation of the data into the VISTAS point source files. S/L agencies completed a detailed review of the Base F inventory. Additional updates and corrections to the Base F inventory were requested by S/L agencies and incorporated into the Base G inventory. The Base G changes are documented in more detail in Section 1.1.1.6. No additional changes to the Base G inventory were made as part of the Base G2/B&F round of updates.

Table 1.1-1 State Data Submittals Used for the Base F 2002 Point Source Inventory.

State / Local Program	Point Source Emissions Data Source
AL	C
FL	B
GA	B
KY	C
MS	B
NC	C
SC	C
TN	C
VA	B
WV	B
Davidson County, TN	B
Hamilton County, TN	D
Memphis/Shelby County, TN	B
Knox County, TN	B
Jefferson County, AL	B
Jefferson County, KY	B
Buncombe County, NC	B
Forsyth County, NC	B
Mecklenburg County, NC	B

Key
A = Draft VISTAS 2002
B = CERR Submittal from EPA's file transfer protocol (FTP) site
C = Other (CERR or other submittal sent directly from S/L agency to MACTEC)
D = CERR Submittal from EPA's NEI 2002 Final Inventory

1.1.1.2 Initial Data Evaluation

For the Base F inventory, we conducted an initial review of the 2002 point source CERR data in accordance with the QA procedures specified in the Quality Assurance Project Plan (QAPP) for this project. The following evaluations were completed to identify potential data quality issues associated with the CERR data:

- Compared the number of sites in the CERR submittal to the number of sites in the VISTAS draft 2002 inventory; for all States, the number of sites in the CERR submittal was less than in the VISTAS draft 2002 inventory, since the CERR data was limited to major sources, while the VISTAS draft 2002 inventory contained data for both major and minor sources; verified with S/L contacts that minor sources not included in the CERR point source inventory were included in the CERR area source inventory.

- Checked for correct pollutant codes and corrected to make them NIF-compliant; for example, some S/L agencies reported ammonia emissions using the CAS Number or as "ammonia", rather than the NIF-compliant "NH_3" code.
- Checked for types of particulate matter codes reported (i.e., PM-FIL, PM-CON, PM-PRI, PM_{10}-PRI, PM10-FIL, $PM_{2.5}$-PRI, $PM_{2.5}$-FIL); corrected codes with obvious errors (i.e., changed PMPRI to PM-PRI). (The PM augmentation process for filling in missing PM pollutants is discussed later in Section 1.1.1.3)
- Converted all emission values that weren't in tons to tons to allow for preparation of emission summaries using consistent units.
- Checked start and end dates in the PE and EM tables to confirm consistency with the 2002 base year.
- Compared annual and daily emissions when daily emissions were reported; in some cases, the daily value was non-zero (but very small) but the annual value was zero. This was generally the result of rounding in an S/L agency's submittal.
- Compared ammonia emissions as reported in the CERR submittals and the 2002 Toxics Release Inventory; worked with S/L agencies to resolve any outstanding discrepancies.
- Compared SO_2 and NO_x emissions for EGUs to EPA's Clean Air Markets Division CEM database to identify any outstanding discrepancies. (A full discussion of the EGU emissions analysis is discussed later in Section 1.1.1.4)
- Prepared State-level emission summaries by pollutant for both the EGU and non-EGU sectors to allow S/L agencies to compare emissions as reported in the 1999 NEI Version 2, the VISTAS draft 2002 inventory, and the CERR submittals.
- Prepared facility-level emission summaries by pollutant to allow S/L agencies to review facility level emissions for reasonableness and accuracy.

We communicated the results of these analyses through email/telephone exchanges with the S/L point source contacts as well as through Excel summary spreadsheets. S/L agencies submitted corrections and updates as necessary to resolve any QA/QC issues from these checks.

1.1.1.3 PM Augmentation

Particulate matter emissions can be reported in many different forms, as follows:

PM Category	Description
PM-PRI	Primary PM (includes filterable and condensable)

PM-CON	Primary PM, condensable portion only (all less than 1 micron)
PM-FIL	Primary PM, filterable portion only
PM_{10}-PRI	Primary PM_{10} (includes filterable and condensable)
PM_{10}-FIL	Primary PM_{10} filterable portion only
$PM_{2.5}$ -PRI	Primary $PM_{2.5}$ (includes filterable and condensable)
$PM_{2.5}$ -FIL	Primary $PM_{2.5}$ filterable portion only

S/L agencies did not report PM emissions in a consistent manner. The State/local inventories submitted for VISTAS included emissions data for either PM-FIL, PM-PRI, PM_{10}-FIL, PM_{10}-PRI, $PM_{2.5}$ -FIL, $PM_{2.5}$ -PRI, and/or PM-CON. From any one of these pollutants, EPA has developed augmentation procedures to estimate PM_{10}-PRI, PM_{10}-FIL, $PM_{2.5}$ -PRI, $PM_{2.5}$ -FIL, and PM-CON. If not included in a State/local inventory, PM_{10}-PRI and $PM_{2.5}$ -PRI were calculated by adding PM_{10}-FIL and PM-CON or $PM_{2.5}$ -FIL and PM-CON, respectively.

The procedures for augmenting point source PM emissions are documented in detail in Appendix C of *Documentation for the Final 1999 National Emissions Inventory {Version 3} for Criteria Air Pollutants and Ammonia – Point Sources*, January 31, 2004). Briefly, the PM data augmentation procedure includes the following five steps:

- Step 1: Prepare S/L/T PM and PM_{10} Emissions for Input to the PM Calculator
- Step 2: Develop and Apply Source-Specific Conversion Factors
- Step 3: Prepare Factors from PM Calculator
- Step 4: Develop and Apply Algorithms to Estimate Emissions from S/L/T Inventory Data
- Step 5: Review Results and Update the NEI with Emission Estimates and Control Information.

Please refer to the EPA documentation for a complete description of the PM augmentation procedures.

Table 1.1-2 compares the original PM emission estimates from the S/L CERR submittals and the revised 2002 VISTAS emissions estimates calculated using the above methodology. This table is intended to show that we took whatever States provided in the way of PM and filled in gaps to add in PM-CON where emissions were missing in order to calculate PM_{10}-PRI and $PM_{2.5}$ -PRI for all processes to get a complete set of particulate data. We did not compare any other pollutants besides PM, since for other pollutants CERR emissions equal VISTAS emissions. As noted in Table 1.1-2, we made significant revisions to the PM emissions for Kentucky in the Base F inventory and for South Carolina in the Base G inventory.

Table 1.1-2 Comparison of Particulate Matter Emissions from the S/L Data Submittals and the Base G 2002 VISTAS Point Source Inventory

State	Database	PM-PRI	PM-FIL	PM-CON	PM_{10}-PRI	PM_{10}-FIL	$PM_{2.5}$ -PRI	$PM_{2.5}$ -FIL
AL	CERR	28,803	9,174	0	16,522	6,548	8,895	4,765
	VISTAS	43,368	33,336	10,129	32,791	22,661	23,290	13,328
FL	CERR	0	33,732	0	0	32,254	0	0
	VISTAS	61,728	37,325	24,403	57,243	32,840	46,147	21,744
GA	CERR	42,846	0	0	27,489	0	15,750	0
	VISTAS	44,835	37,088	7,799	33,202	25,403	22,777	15,085
KY	CERR	0	3,809	0	19,748	1,360	0	0
	VISTAS	27,719	22,349	5,329	21,326	15,963	14,173	8,749
MS	CERR	23,925	0	0	20,968	0	10,937	0
	VISTAS	23,928	17,632	6,296	21,089	14,793	11,044	5,739
NC	CERR	48,110	0	0	36,222	0	24,159	0
	VISTAS	48,114	41,407	6,708	36,992	30,284	27,512	21,113
SC	CERR	0	43,837	0	0	32,656	0	21,852
	VISTAS	43,844	38,633	5,210	34,799	29,588	26,418	21,207
TN	CERR	1,660	25,500	21,482	43,413	22,164	34,167	12,140
	VISTAS	56,797	32,085	24,715	50,937	26,269	41,442	16,774
VA	CERR	0	0	0	17,065	0	12,000	0
	VISTAS	40,856	36,414	4,442	17,065	12,623	12,771	8,607
WV	CERR	0	29,277	0	0	14,778	0	8445
	VISTAS	36,188	29,392	6,795	22,053	15,258	15,523	8,733

Note 1: CERR refers to data as submitted by S/L agencies; VISTAS refers to data calculated by MACTEC using the PM augmentation methodologies described in this document.

Note 2: KY DEP's initial CERR submittal reported particulate matter emissions using only PM-PRI pollutant code. MACTEC used this pollutant code during the initial PM augmentation routine. In February 2005, KY DEP indicated that data reported using the PM-PRI code should actually have been reported using the PM_{10}-PRI code. MACTEC performed a subsequent PM augmentation in April 2005 using the PM_{10}-PRI code. These changes were reflected in the Base F emission inventory.

Note 3: South Carolina Department of Health and Environmental Control (SC DHEC) initial CERR submittal reported particulate matter emissions using the PM-FIL, PM_{10}-FIL, and $PM_{2.5}$ -FIL pollutant codes. MACTEC used these pollutant codes during the initial PM augmentation routine. In August 2005, SC DHEC indicated that data reported using the PM-FIL, PM_{10}-FIL, and $PM_{2.5}$ -FIL pollutant codes should actually have been reported using the PM-PRI, PM_{10}-PRI, and $PM_{2.5}$ _PRI codes. MACTEC performed a subsequent PM augmentation in April 2006 using the revised pollutant codes. These changes were reflected in the Base G emission inventory.

Note 4: The emission values in the VISTAS emission rows above differ slightly from the final values in the Base G inventory. This is due to several corrections and updates to the 2002 inventory submitted by S/L agencies after the PM augmentation was performed as discussed in Section 1.1.1.6.

After the PM augmentation process was performed, we executed a series of checks to identify potential inconsistencies in the PM inventory. These checks included:

- PM-PRI less than PM_{10}-PRI, $PM_{2.5}$ -PRI, PM_{10}-FIL, $PM_{2.5}$ -FIL, or PM-CON;
- PM-FIL less than PM_{10}-FIL, $PM_{2.5}$ -FIL;
- PM_{10}-PRI less than $PM_{2.5}$ -PRI, PM_{10}-FIL, $PM_{2.5}$ -FIL or PM-CON;
- PM_{10}-FIL less than $PM_{2.5}$ -FIL;
- PM25-PRI less than $PM_{2.5}$ -FIL or PM-CON;
- The sum of PM_{10}-FIL and PM-CON not equal to PM_{10}-PRI; and
- The sum of $PM_{2.5}$ -FIL and PM-CON not equal to $PM_{2.5}$ -PRI.

S/L agencies were asked to review this information and provide corrections where the inconsistencies were significant. In general, corrections (or general directions) were provided in the case of the potential inconsistency issues. In other cases, the agency provided specific process level pollutant corrections.

Note that for the Base G inventory, only the PM_{10}-PRI and $PM_{2.5}$ -PRI emission estimates were retained since they are the only two PM species that are included in the air quality modeling. Other PM species were removed from the Base G inventory to facilitate emissions modeling.

1.1.1.4 EGU Analysis

We made a comparison of the annual SO_2 and NO_x emissions for EGUs as reported in the S/L agencies CERR submittals and EPA's Clean Air Markets Division (CAMD) CEM database to identify any outstanding discrepancies. Facilities report hourly CEM data to EPA for units that are subject to CEM reporting requirements of the NO_x State Implementation Plan (SIP) Call rule and Title IV of the Clean Air Act (CAA). EPA sums the hourly CEM emissions to the annual level, and we compared these annual CEM emissions to those in the S/L inventories. The 2002 CEM inventory containing NO_x and SO_2 emissions and heat input data were downloaded from the EPA CAMD web site (www.epa.gov/airmarkets).

The first step in the EGU analysis involved preparing a crosswalk file to match facilities and units in the CAMD inventory to facilities and units in the S/L inventories. In the CAMD inventory, the Office of Regulatory Information Systems (ORIS) identification (ID) code identifies unique facilities and the unit ID identifies unique boilers and internal combustion engines (i.e., turbines and reciprocating engines). In the S/L inventories, the State and county FIPS and State facility ID together identify unique facilities and the emission unit ID identifies unique boilers or internal combustion engines. In most cases, there is a one-to-one correspondence between the CAMD identifiers and the S/L identifiers. However, in some of the S/L inventories, the emissions for multiple emission units are summed and reported under one emission unit ID. We created an Excel spreadsheet that contained an initial crosswalk with the ORIS ID and unit ID in the CEM inventory matched to the State and county Federal

Implementation Plan (FIPS), State facility ID, and emission unit ID in the S/L inventory. The initial crosswalk contained both the annual emissions summed from the CAMD database as well as the S/L emission estimate. It should be noted that the initial matching of the IDs in both inventories was based on previous crosswalks that had been developed for the preliminary VISTAS 2002 inventory and in-house information compiled by MACTEC and Alpine Geophysics. The matching at the facility level was nearly complete. In some cases, however, S/L agency or stakeholder assistance was needed to match some of the CEM units to emission units in the S/L inventories.

The second step in the EGU analysis was to prepare an Excel spreadsheet that compared the annual emissions from the hourly CAMD inventory to the annual emissions reported in the S/L inventory. The facility-level comparison of CEM to emission inventory NO_x and SO_2 emissions found that for most facilities, the annual emissions from the S/L inventory equaled the CAMD CEM emissions. Minor differences could be explained because the facility in the S/L inventory contained additional small or emergency units that were not included in the CAMD database.

The final step was to compare the SO_2 and NO_x emissions for select Southern Company units in the VISTAS region. Southern Company is a super-regional company that owns EGUs in four VISTAS States – Alabama, Florida, Georgia, and Mississippi – and participates in VISTAS as an industry stakeholder. Southern Company independently provided emission estimates for 2002 as part of the development of the preliminary VISTAS 2002 inventory. In most cases, these estimates were reviewed by the States and incorporated into the States CERR submittal. The exception to this was a decision made by Georgia's Department of Environmental Protection (GDEP) to utilize CEM-based emissions for the actual 2002 emissions inventory for sources within the State when Southern Company also provided data. There were no major inconsistencies between the Southern Company data, the CAMD data, and the S/L CERR data.

The minor inconsistencies included small differences (<2 percent) in emission estimates, exclusion/inclusion of small gas-fired units in the different databases, and grouping of emission units in S/L CERR submittals where CAMD listed each unit individually. We compared SO_2 and NO_x emissions on a unit by unit basis and did not find any major inconsistencies.

1.1.1.5 QA Review of Base F Inventory

QA checks were run on the Base F point source inventory data set to ensure that all corrections provided by the S/L agencies and stakeholders were correctly incorporated into the S/L inventories and that there were no remaining QA issues. After exporting the inventory to ASCII text files in NIF 3.0, the EPA QA program was run on the ASCII files and the QA output was reviewed to verify that all QA issues that could be addressed were resolved.

Throughout the inventory development process, QA steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for VISTAS. QA was an important component to the inventory development process and MACTEC performed the following QA steps on the point source component of the VISTAS revised 2002 base year inventory:

1. Facility level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.
2. State-level EGU and non-EGU comparisons (by pollutant) were developed between the Base F 2002 base year inventory, the draft VISTAS 2002 inventory, and the 1999 NEI Version 2 inventory.
3. Data product summaries and raw NIF 3.0 data files were provided to the VISTAS Emission Inventory Technical Advisor and to the Point Source, EGU, and non-EGU Special Interest Work Group representatives for review and comment. Changes based on these comments were reviewed and approved by the S/L point source contact prior to implementing the changes in the files.
4. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from Base F1 to Base F2.

1.1.1.6 Additional Base G Updates and Corrections

S/L agencies completed a detailed review of the Base F inventory. Table 1.1-3 summarizes the updates and corrections to the Base F inventory that were requested by S/L agencies and incorporated into the Base G inventory.

There was a discrepancy between the base year 2002 and 2009/2018 emissions for PM_{10}-PRI, $PM_{2.5}$-PRI, and NH_3. The 2002 emissions were provided directly by the S/L agencies and were estimated using a variety of techniques (i.e., EPA emission factors, S/L emission factors, site-specific emission factors, and source test data). The 2009/2018 emissions, on the other hand, were estimated by Pechan (see Section 2.1.1.3) using an emission factor file based solely on AP-42 emission factors. An adjustment was made for 2002 EGU PM and NH_3 emissions to reconcile these differences. The post-processed Integrated Planning Model® (IPM®) 2009/2018 output uses a set of PM and NH_3 emission factors that are “the most recent EPA approved uncontrolled emission factors” – these are most likely not the same emission factors used by States and emission inventory preparation contractors for estimating these emissions in 2002 for EGUs in the VISTAS domain. VISTAS performed a set of modifications to replace 2002 base year PM and NH_3 emission estimates with estimates derived from the most recent EPA-approved emission factors. For further details of the methodology used to make this adjustment, see *EGU Emission Factors and Emission Factor Assignment*, memorandum from Greg Stella to VISTAS State Point Source Contacts and VISTAS EGU Special Interest Workgroup, June 13, 2005.

Table 1.1-3 Summary of Updates and Corrections to the Base F 2002 Inventory Incorporated into the 2002 Base G Inventory.

Affected State(s)	Nature of Update/Correction
TN, WV	The latitude and longitude values for TN (except the four local programs) and WV were truncated to two decimal places in the Base F inventory. MACTEC re-exported the NIF ER tables in a manner that so that the latitude and longitude were not truncated in the Base G inventory.
AL	Corrected the latitude and longitude for two facilities: Ergon Terminalling (Site ID: 01-073-010730167) and Southern Power Franklin (Site ID: 01-081-0036).
	Corrections to stack parameters at 10 facilities for stacks with parameters that do not appear to fall into the ranges typically termed "acceptable" for AQ modeling.
FL	Corrected emission values for the Miami Dade RRF facility (Site ID: 12-086-0250348).
GA	Hercules Incorporated (12-051-05100005) had an erroneous process id (#3) within emission unit id SB9 and was deleted. This removes about 6,000 tons of SO_2 from the 2002 inventory.
	Provided a revised file of location coordinates at the stack level that was used to replace the location coordinated in the ER file.
NC	Made several changes to Base F inventory to correct the following errors: 1. Corrected emissions at Hooker Furniture (Site ID: 37-081-08100910), release point G-29, 9211.38 tons volatile organic compounds (VOC's) should be 212.2 tons, 529.58 tons PM_{10} should be 17.02 tons, 529.58 tons PM2.5 should be 15.79 tons in 2002 inventory. 2. Identified many stack parameters in the ER file that were unrealistic. Several have zero for height, diameter, gas velocity, and flow rate. NC used the procedures outlined in Section 8 of the document ""National Emission Inventory QA and Augmentation Report" to correct unrealistic stack parameters. 3. Identified truncated latitude and longitude values in Base F inventory. NC updated all Title V facility latitude and longitude that was submitted to EPA for those facilities in 2004. Smaller facilities with only two decimal places were not corrected. 4. Corrected emissions for International Paper (3709700045) Emission Unit ID, G-12, should be 1.8844 tons VOCs instead of 2819.19 tons in 2002
SC	Corrected PM species emission values. SC DHEC's initial CERR submittal reported particulate matter emissions using the PM-FIL, PM_{10}-FIL, and PM25-FIL pollutant codes. In August 2005, SC DHEC indicated that data reported using the PM-FIL, PM_{10}-FIL, and PM25-FIL pollutant codes should actually have been reported using the PM-PRI, PM_{10}-PRI, and PM25_PRI codes. MACTEC performed a subsequent PM augmentation in April 2006 using the revised pollutant codes. These changes were reflected in the Base G emission inventory.
TN	Identified six facilities that closed in 2000/2001 but had non-zero emissions in the 2002 Base F inventory. MACTEC changed emissions to zero for all pollutants in the Base G 2002 inventory.
	Supplied updated emission inventory for the Bowater facility (47-107-0012) based on the facility's updated 2002 emission inventory update.
	Replaced data from Hamilton County, Tennessee, using data from Hamilton County's CERR submittal as contained in EPA's 2002 NEI (in Base F, the inventory for Hamilton County was based on the draft VISTAS 2002 inventory, which in turn was based on the 1999 NEI).
	Updated emissions for PCS Nitrogen Fertilizer LP (Site ID: 47-157-00146)
WV	Updated emissions for Steel of West Virginia (Site ID: 54-011-0009)
	Made changes to several Site ID names due to changes in ownership
	Made corrections to latitude/longitude and stack parameters at a few facilities for stacks with parameters that do not appear to fall into the ranges typically termed "acceptable" for AQ modeling.

1.1.1.7 Summary of B&F 2002 Inventory

Tables 1.1-4 through 1.1-10 summarize the B&F 2002 base year inventory. All values are in tons. Note that no changes to the Base G 2002 point source inventory were made during the Base G2 and B&F update cycles (in other words, Base G = Base G2 = B&F). Note also that Alabama suggested additional changes to the 2002 inventory resulting from their $PM_{2.5}$ modeling for the Birmingham area; however, these changes were identified too late to be incorporated in the VISTAS B&F inventory and ASIP modeling.

For the purposes of Tables 1.1-4 through 1.1-10, EGU emissions include the emissions from all processes with a Source Classification Code (SCC) of either 1-01-xxx-xx (External Combustion Boilers – Electric Generation) or 2-01-xxx-xx (Internal Combustion Engines – Electric Generation). Emissions for all other SCCs are included in the non-EGU column. Note that aggregating emissions into EGU and non-EGU sectors based on the above SCCs causes a minor inconsistency with the EGU emissions reported in EPA's CAMD database. The EGU emissions summarized in these tables may include emissions from some smaller electric generating units in the VISTAS inventory that are not in CAMD's 2002 CEM database or the IPM forecasted emissions. The minor inconsistencies result in a less than 2 percent difference between the summary tables below and the data from CAMD's CEM database.

Table 1.1-4 Base G / B&F 2002 VISTAS Point Source Inventory for SO_2 (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	544,309	447,828	96,481
FL	518,721	453,631	65,090
GA	568,731	514,952	53,778
KY	518,086	484,057	34,029
MS	103,388	67,429	35,960
NC	522,113	477,990	44,123
SC	259,916	206,399	53,518
TN	413,755	334,151	79,604
VA	305,106	241,204	63,903
WV	570,153	516,084	54,070
Total	**4,324,278**	**3,743,725**	**580,556**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

Table 1.1-5 Base G / B&F 2002 VISTAS Point Source Inventory for NO_x (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	244,348	161,038	83,310
FL	302,834	257,677	45,156
GA	196,767	147,517	49,251
KY	237,209	198,817	38,392
MS	104,661	43,135	61,526
NC	196,782	151,854	44,928
SC	130,394	88,241	42,153
TN	221,652	157,307	64,344
VA	147,300	86,886	60,415
WV	277,589	230,977	46,612
Total	**2,059,536**	**1,523,449**	**536,087**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

Table 1.1-6 Base G / B&F 2002 VISTAS Point Source Inventory for VOC (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	49,332	2,295	47,037
FL	40,995	2,524	38,471
GA	34,952	1,244	33,709
KY	46,321	1,487	44,834
MS	43,852	648	43,204
NC	62,170	988	61,182
SC	38,927	470	38,458
TN	85,254	926	84,328
VA	43,906	754	43,152
WV	15,775	1,180	14,595
Total	**461,484**	**12,516**	**448,970**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

Table 1.1-7 Base G / B&F 2002 VISTAS Point Source Inventory for CO (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	185,550	11,279	174,271
FL	139,045	57,113	81,933
GA	140,561	9,712	130,850
KY	122,555	12,619	109,936
MS	59,871	5,303	54,568
NC	64,461	13,885	50,576
SC	63,305	6,990	56,315
TN	122,348	7,084	115,264
VA	70,688	6,892	63,796
WV	100,220	10,341	89,879
Total	**1,068,604**	**141,218**	**927,388**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

Table 1.1-8 Base G / B&F 2002 VISTAS Point Source Inventory for PM_{10}-PRI (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	32,886	7,646	25,240
FL	57,243	21,387	35,857
GA	32,834	11,224	21,610
KY	21,326	4,701	16,626
MS	21,106	1,633	19,472
NC	36,592	22,754	13,838
SC	35,542	21,400	14,142
TN	49,814	14,640	35,174
VA	17,211	3,960	13,252
WV	22,076	4,573	17,503
Total	**326,630**	**113,918**	**212,714**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

Table 1.1-9 Base G / B&F 2002 VISTAS Point Source Inventory for $PM_{2.5}$ -PRI (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	23,291	4,113	19,178
FL	46,148	15,643	30,504
GA	22,401	4,939	17,462
KY	14,173	2,802	11,372
MS	11,044	1,138	9,906
NC	26,998	16,498	10,500
SC	27,399	17,154	10,245
TN	39,973	12,166	27,807
VA	12,771	2,606	10,165
WV	15,523	2,210	13,313
Total	**239,721**	**79,269**	**160,452**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

Table 1.1-10 Base G / B&F 2002 VISTAS Point Source Inventory for NH_3 (tons/year).

State	All Point Sources	EGUs	Non-EGUs
AL	2,200	317	1,883
FL	1,657	234	1,423
GA	3,697	83	3,613
KY	1,000	326	674
MS	1,359	190	1,169
NC	1,234	54	1,180
SC	1,553	142	1,411
TN	1,817	204	1,613
VA	3,230	127	3,104
WV	453	121	332
Total	**18,200**	**1,798**	**16,402**

Note: EGU emissions include SCCs 1-01-xxx-xx and 2-01-xxx-xx; non-EGU has all other SCCs.

1.1.2 Development of Typical Year EGU inventory

VISTAS developed a typical year 2002 emission inventory for EGUs to avoid anomalies in emissions due to variability in meteorology, economic, and outage factors in 2002. The typical year inventory represents the five year (2000-2004) period and was used to determine the regional haze reasonable progress goals. Actual 2002 emissions were used when comparing the CMAQ modeling results to the 2002 measurements in the model performance evaluation. A detailed discussion of how the actual and typical year EGU inventories were used for modeling is contained in the *Technical Support Document for VISTAS Emissions and Air Quality Modeling to Support Regional Haze State Implementation Plans* located on the VISTAS web site (http://www.vistas-sesarm.org)

Data from EPA's CAMD were used to develop normalization factors for producing a 2002 typical year inventory for EGUs. We used the ratio of the 2000-2004 average heat input and the 2002 actual heat input to normalize the 2002 actual emissions. MACTEC obtained data from EPA's CAMD for utilities regulated by the Acid Rain program. Annual data for the period 2000 to 2004 were obtained from the CAMD web site (www.epa.gov/airmarkets). The parameters available were the SO_2 and NO_x emission rates, heat input, and operating hours. We used the actual 2002 heat input and the average heat input for the 5-year period from 2000-2004 as the normalization factor, as follows:

$$\text{Normalization Factor:} \quad \frac{\text{2000-2004 average heat input}}{\text{2002 actual heat input}}$$

If the unit did not operate for all five years, then the 2000-2004 average heat input was calculated for the one or two years in which the unit did operate. For example, if the unit operated only during 2002, then the normalization factor would be 1.0. The annual actual emissions were multiplied by the normalization factor to determine the typical emissions for 2002, as follows:

$$\text{Typical Emissions} = \text{2002 actual emissions} \times \text{Normalization Factor}$$

After applying the normalization factor, some adjustments were needed for special circumstances. For example, a unit may not have operated in 2002 and thus have zero emissions. If the unit had been permanently retired prior to 2002, then we used zero emissions for the typical year. If the unit had not been permanently retired and would normally operate in a typical year, then we used the 2001 (or 2000) heat input and emission rate to calculate the typical year emissions.

The Southern Company provided typical year data for their sources. Hourly emissions data for criteria pollutants were provided. MACTEC aggregated the hourly emissions into annual values. Further documentation of how Southern Company created the typical year inventory for their units can be found in *Developing Southern Company Emissions and Flue Gas Characteristics for VISTAS Regional Haze Modeling (April 2005, presented at 14th International Emission Inventory Conference* http://www.epa.gov/ttn/chief/conference/ei14/session9/kandasamy.pdf). Since Southern Company only supplied filterable particulate emissions, we ran the $PM_{10}/PM_{2.5}$ augmentation routine to calculate annual emission estimates for PM_{10}-PRI and $PM_{2.5}$-PRI. The Southern Company typical year data were used for Southern Company sources in Alabama, Florida, and Mississippi. Georgia EPD elected to use the typical year normalization factor derived from the CAMD data instead of the Southern Company typical year data (as was used in the Base F inventory).

The final step was to replace the 2002 actual emissions with the 2002 typical year data described above. MACTEC provided the raw data and results of the typical year calculations in a spreadsheet for S/L agency review and comment. Any comments made were incorporated into the Base G inventory.

Table 1.1-11 summarizes emissions by State and pollutant for the actual 2002 EGU inventory and the typical year EGU inventory. For the entire VISTAS region, actual 2002 SO_2 emissions were about 1.6 percent higher than the typical year emissions. The differences on a state-be-state basis ranged from actual emissions being 2.3 percent lower in Kentucky to 10.9 percent higher in Mississippi. For the entire VISTAS region, actual 2002 NO_x emissions were about 1.7 percent lower than the typical year emissions. The differences on a state-be-state basis ranged from actual emissions being 1.6 percent lower in Kentucky to 6.3 percent higher in Mississippi.

Table 1.1-11 Comparison of SO_2 and NO_x Emissions (tons/year) for EGUs.

	SO_2 Emissions (tons/year)			NO_x Emissions (tons/year)		
State	**Actual 2002**	**Typical 2002**	**Percentage Difference**	**Actual 2002**	**Typical 2002**	**Percentage Difference**
AL	447,828	423,736	5.4	161,038	154,704	3.9
FL	453,631	444,383	2.0	257,677	255,678	0.8
GA	514,952	517,633	-0.5	147,517	148,126	-0.4
KY	484,057	495,153	-2.3	198,817	201,928	-1.6
MS	67,429	60,086	10.9	43,135	40,433	6.3
NC	477,990	478,489	-0.1	151,854	148,812	2.0
SC	206,399	210,272	-1.9	88,241	88,528	-0.3
TN	334,151	320,146	4.2	157,307	152,137	3.3
VA	241,204	233,691	3.1	86,886	85,081	2.1
WV	516,084	500,381	3.0	230,977	222,437	3.7
Total	**3,743,725**	**3,683,968**	**1.6**	**1,523,449**	**1,497,864**	**1.7**

Note: a negative percentage difference indicates actual emissions are less than the typical year emissions.

1.2 Area Sources

This section details the development of the Base G 2002 base year inventory for area sources. There are three major components of the area source sector of the inventory. The first component is the "typical" year fire inventory. Version 3.1 of the VISTAS base year fire inventory provided actual 2002 emissions estimates. Since fire emissions are not easily grown or projected, in order to effectively represent fires in both the base and future year inventories, VISTAS determined that a typical year fire inventory was necessary. Development of the "typical" year fire inventory covered wildfire, prescribed burning, agricultural fires and land clearing fires. The first part of this section of the report discusses the development of the typical year fire inventory. The methodology provided in that section is identical to the documentation provided for Base F since the "typical" year inventory was developed as part of the Base F development effort. The major change in Base G for the fire component of the inventory was the development of projection year inventories that represent alternatives to the "typical" year inventory. These alternative projections incorporated projected changes in the acreage burned for prescribed fires on Federal lands. These projections are an augmentation of the "typical" year inventory.

The second component of the area source inventory was the incorporation of data submitted by the VISTAS States to the United States Environmental Protection Agency (EPA) as part of the CERR. Work on incorporating the CERR data into the revised base year involved: 1) obtaining the data from EPA, 2) evaluating the emissions and pollutants reported in order to avoid double counting and 3) backfilling from the existing VISTAS 2002 base year inventory for missing sources/pollutants. The processes used to perform those operations are described in the second portion of this section. That work was performed as part of the Base F inventory effort. In general no changes to that method were made as part of the Base G inventory updates. The methods used for the Base F inventory development effort using the CERR submittals have been maintained in this document. Where necessary, additional documentation has been added to 1) reflect changes that resulted from VISTAS States review of the Base F inventory and the incorporation of those changes into Base G, 2) changes made to how certain sources were estimated or 3) addition of new sources not found in Base F.

The final component of the area source inventory was related to the development of NH_3 emission estimates for livestock and fertilizers and paved road PM emissions. For the NH_3 emission estimates for livestock and fertilizers we used version 3.6 of the Carnegie Mellon University (CMU) NH_3 model. For the paved road PM emissions, we used the most recent estimates developed by EPA as part of the National Emission Inventory (NEI) development effort. EPA had developed an improved methodology for estimating paved road emissions so those values were substituted directly into the inventory after receiving consensus from all of the VISTAS States to perform the replacement. Details on these methods are provided in the third portion of this section of the document. That section is virtually identical to that from the Base F inventory document as there were only a couple of changes to the ammonia portion of the inventory and some updates to all fugitive dust categories including paved roads on a global basis between Base F and Base G.

Finally, quality assurance steps for each component of the area source inventory are discussed.

1.2.1 Development of a "typical" year fire inventory

Typical year fire emissions were developed starting from the actual fire acreage data and emission calculated for each VISTAS State. The table below shows the data submitted by each State in the VISTAS region indicating what data was received from each State for the purposes of calculating actual fire emissions.

Fire Type	AL	FL	GA	KY	MS	NC	SC	TN	VA	WV
Land Clearing	✓	✓	✓				✓			
Ag Burning	✓	✓	✓				✓			
Wildfires	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Prescribed	✓	✓	✓	✓	✓	✓	✓	✓		✓

In order to effectively characterize fire emissions in the VISTAS region, a typical (as opposed to strictly 2002 year based inventory) was required. Development of a typical year fire inventory provided the capability of using a comparable data set for both the base year and future years. Thus fire emissions would remain the same for air quality and visibility modeling in both the base and any future years. MACTEC originally proposed five different methods for developing the typical fire year to the VISTAS Fire Special Interest Work Group (SIWG) and requested their feedback and preference for developing the final typical year inventory. The method that was selected by SIWG members was to use a method similar to that used to develop an early version of a 2018 projection inventory. For that early 2018 inventory, State level ratios of acres over a longer term record (three or more years) developed for each fire type relative to 2002. The 2002 acreage was then scaled up or down based on these ratios to develop a typical year inventory. For Base F and G, the decision of the VISTAS Fire SIWG was to base the ratio on county level data for States that supplied long term fire-by-fire acreage data rather than State-level ratios. Where States did not supply long term fire-by-fire acreage data, MACTEC reverted to using State-level ratios. With one broad exception (wildfires) this method was implemented for all fires. MACTEC solicited long term fire-by-fire acreage data by fire type from each VISTAS State. A minimum of three or more years of data were used to develop the ratios. Those data were then used to develop a ratio for each county based on the number of acres burned in each county for each fire type relative to 2002.

Thus if we had long term county prescribed fire data from a State, we developed a county acreage ratio of:

$$Ratio = \frac{\text{Long term average county level Rx acres}}{\text{2002 actual county level Rx acreage}}$$

This ratio was then multiplied times the actual 2002 acreage to get a typical value (basically the long term average county level acres). Wherever possible this calculation was performed on a fire by fire basis. The acreage calculated using the ratio was then used with the fuel loading and emission factor values that we already had (and had been reviewed by the SIWG) to calculate emissions using the same method used for the 2002 actual values (which were previously documented). The following lists indicate which counties used the State ratios by fire type.

Land Clearing		Agricultural Fires		Prescribed Burning	
FIPS	**COUNTY**	**FIPS**	**COUNTY**	**FIPS**	**COUNTY**
12086	Miami-Dade County	13063	Clayton County	13059	Clarke County
12037	Franklin County	13083	Dade County	13083	Dade County
12043	Glades County	13089	Dekalb County	13089	Dekalb County
12045	Gulf County	13097	Douglas County	13097	Douglas County
12049	Hardee County	13121	Fulton County	13121	Fulton County
12057	Hillsborough County	13135	Gwinnett County	13123	Gilmer County
12073	Leon County	13137	Habersham County	13135	Gwinnett County
12077	Liberty County	13215	Muscogee County	13139	Hall County
12081	Manatee County	13227	Pickens County	13215	Muscogee County
12095	Orange County	13241	Rabun County	13241	Rabun County
12097	Osceola County	13247	Rockdale County	13247	Rockdale County
12103	Pinellas County	13311	White County		
12115	Sarasota County				
13015	Bartow County				
13021	Bibb County				
13045	Carroll County				
13047	Catoosa County				
13057	Cherokee County				
13059	Clarke County				
13063	Clayton County				
13073	Columbia County				
13077	Coweta County				
13083	Dade County				
13089	Dekalb County				
13097	Douglas County				
13117	Forsyth County				
13121	Fulton County				
13129	Gordon County				
13135	Gwinnett County				
13137	Habersham County				
13143	Haralson County				
13147	Hart County				

Land Clearing		Agricultural Fires		Prescribed Burning	
FIPS	COUNTY	FIPS	COUNTY	FIPS	COUNTY
13151	Henry County				
13169	Jones County				
13215	Muscogee County				
13237	Putnam County				
13241	Rabun County				
13291	Union County				
13311	White County				

There were three exceptions to this method.

Exception 1: Use of State Ratios for Wildfires

The first exception was that wildfires estimates were developed using State ratios rather than county ratios. This change was made after initial quality assurance of the draft estimates revealed that some counties were showing unrealistic values created by very short term data records or missing data that created unrealistic ratios. In addition, exceptionally large and small fires were removed from the database since they were felt to be atypical. For example the Blackjack Complex fire in Georgia was removed from the dataset because the number of acres burned was "atypical" in that fire. We also removed all fires less than 0.1 acres from the dataset.

Exception 2: Correction for Blackened Acres on Forest Service Lands

Following discussions with the United States Forest Service (Forest Service) (memo from Cindy Huber and Bill Jackson, dated August 13, 2004), it was determined that the acres submitted by the Forest Service for wildfires and prescribed fires represented perimeter acres rather than "blackened" acres. Thus for wildfires and prescribed fires on Forest Service lands, a further correction was implemented to correct the perimeter acre values to blackened acres. The correction was made based on the size of the fire. For prescribed fires over 100 acres in size the acreage was adjusted to be 80 percent of the initial reported value. For prescribed fires of 100 acres or less the acreage values were maintained as reported. For wildfires, all reported acreage values were adjusted to be 66 percent of their initially reported values. These changes were made to all values reported for Forest Service managed lands.

Exception 3: Missing/Non-reported data

When we did not receive data from a VISTAS State for a particular fire type, a composite average for the entire VISTAS region was used to determine the typical value for that type fire. For example, if no agricultural burning long term acreage data was reported for a particular State, MACTEC determined an overall VISTAS regional average ratio that was used to multiply times the 2002 values to produce the "typical" values. This technique was applied to all fire types when data was missing.

In addition, for wildfires and prescribed burning, ratios were developed for "northern" and "southern" tier States within the VISTAS region and those ratios were applied to each State with missing data depending upon whether they were considered a "northern" or "southern" tier State. Development of "southern" and "northern" tier data was an attempt to account for a change from a predominantly pine/evergreen ecosystem (southern) to a pine/deciduous ecosystem (northern). States classified as "southern" included: AL, FL, GA, MS, and SC. States classified as "northern" included: KY, NC, TN, VA, and WV.

Finally for land clearing and agricultural fires, there are no NH_3 and SO_2 emissions. This is due to the lack of emission factors for these pollutants for these fire types.

Table 1.2-1 shows fire emissions from the original base year emission inventory (VISTAS 3.1), the actual 2002 emissions and the typical year emissions for the entire VISTAS region. The actual 2002 and typical fire emissions represent the Base F and Base G 2002 emissions. The typical emissions also represent the 2009 and 2018 emissions for all fire types with the exception of prescribed burning. Revisions made to the typical year prescribed fire emissions for 2009 and 2018 are detailed in the projection section. Also, State level Base G emissions from fires for all years can be found in the tables in Appendix A. Values for fires in those tables are "typical" year values.

Figures 1.2-1 through 1.2-4 show the State by State changes in emissions between the original 2002 base year fire inventories, the actual 2002 and the typical year inventories for carbon monoxide (CO) by fire type. Due to the relative magnitude of CO emissions compared to other criteria and PM pollutants from fires; this pollutant is normally chosen to represent the distribution of fires in the example plots.

Table 1.2-1 Emissions from Fires in the VISTAS Region – Comparison between Original Base Year 2002 (VISTAS 3.1), 2002 Actual and Typical Year Base G Emissions.

		CO	NH_3	NO_X	PM_{10}-FIL	PM_{10}-PRI	$PM_{2.5}$-FIL	$PM_{2.5}$-PRI	SO_2	VOC
Total LC	Actual (Base G)	492,409	0	14,568	62,146	62,146	62,146	62,146	0	33,799
	Typical (Base G)	675,838	0	19,995	80,598	80,598	80,598	80,598	0	46,389
	VISTAS 3.1	484,240	0	14,327	61,325	61,325	61,325	61,325	0	33,238
Total Ag	Actual (Base G)	164,273	0	903	30,958	30,958	30,385	30,385	0	21,946
	Typical (Base G)	161,667	0	903	30,465	30,465	29,892	29,892	0	21,595
	VISTAS 3.1	331,073	0	903	41,480	41,480	40,192	40,192	0	41,875
Total WF	Actual (Base G)	298,835	1,333	6,628	28,923	28,923	24,926	24,926	1,611	16,804
	Typical (Base G)	547,174	2,451	11,955	53,070	53,070	45,635	45,635	3,072	28,491
	VISTAS 3.1	275,766	1,230	6,133	26,680	26,680	23,002	23,002	1,476	15,718
Total RX	Actual (Base G)	1,678,216	7,616	36,561	168,938	168,938	145,175	145,175	9,839	78,988
	Typical (Base G)	1,635,776	7,425	35,650	164,811	164,811	141,636	141,636	9,590	76,990
	VISTAS 3.1	1,724,940	7,822	37,556	173,590	173,590	149,181	149,181	10,101	81,188

Key: LC = Land Clearing; Ag = Agricultural burning; WF = wildfires; RX = prescribed burning. Actual and Typical represent Base F and Base G (e.g., no change in methodology for Base F and Base G) for 2002.

Figure 1.2-1 CO Emissions from Agricultural Burning for the Original Base Year, 2002 Actual Base G, and 2002 Typical Base G Inventories.

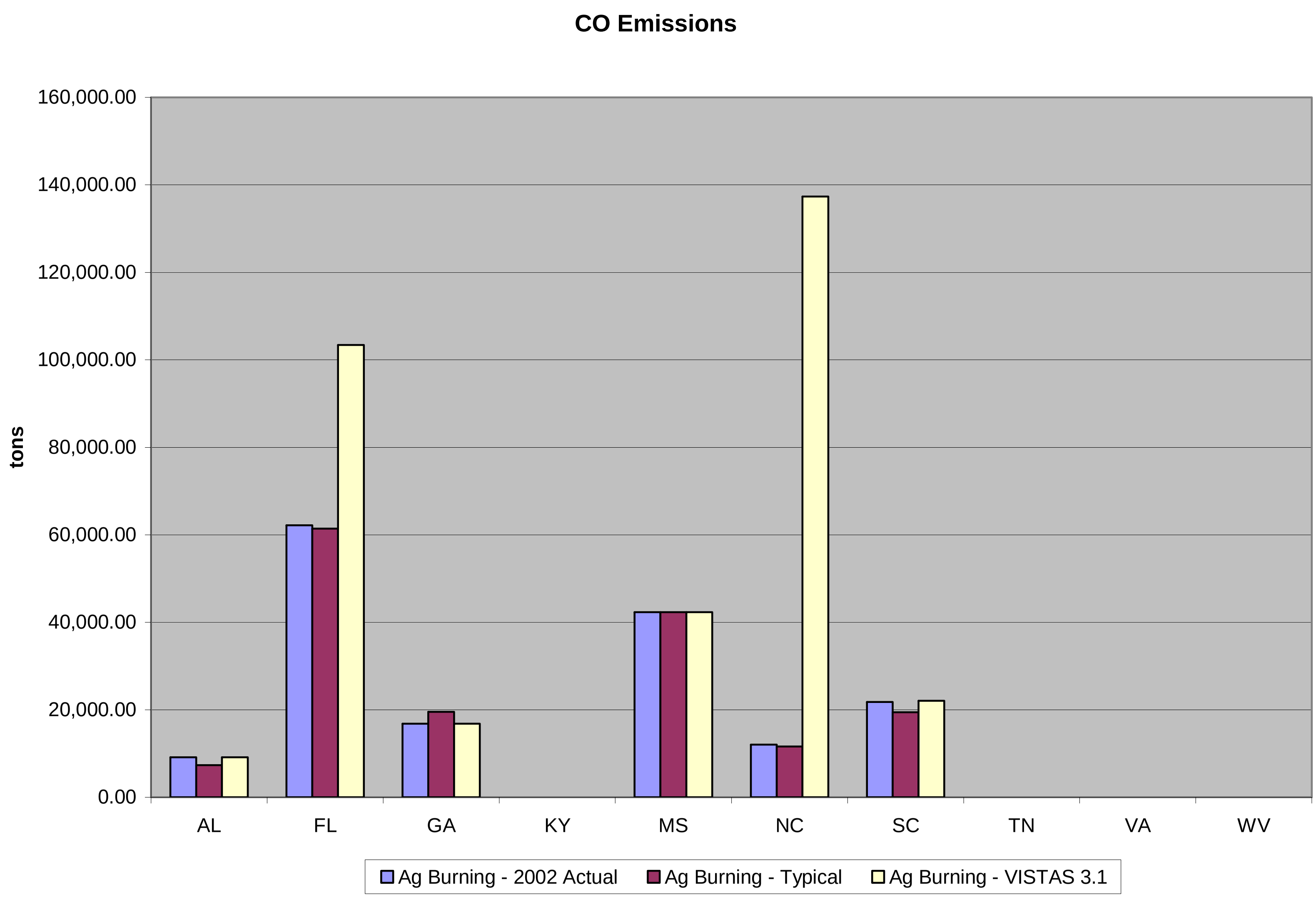


Figure 1.2-2 CO Emissions from Land Clearing Burning for the Original Base Year, 2002 Actual Base G and 2002 Typical Base G Inventories.

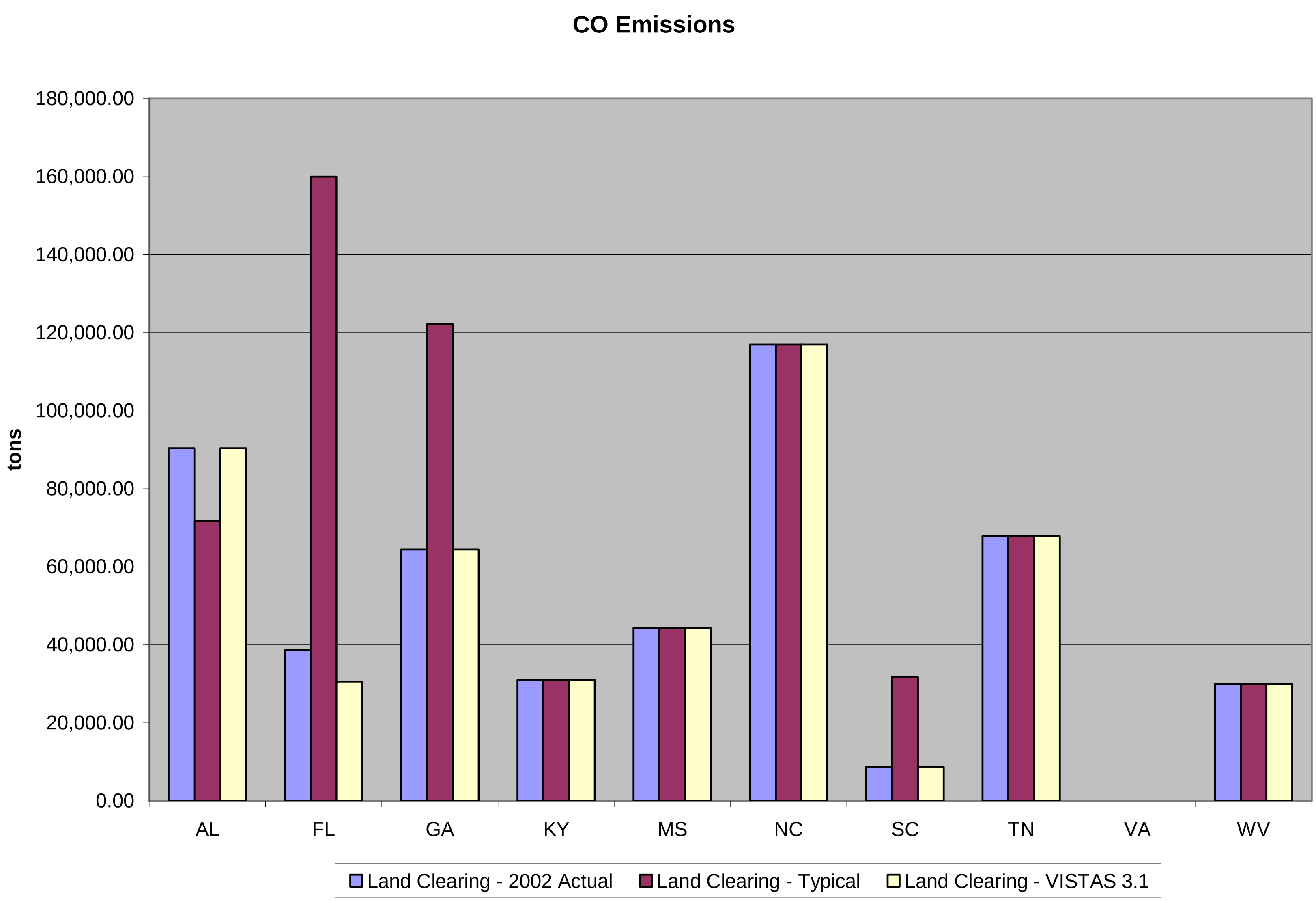


Figure 1.2-3 CO Emissions from Prescribed Burning for the Original Base Year, 2002 Actual Base G and 2002 Typical Base G Inventories.

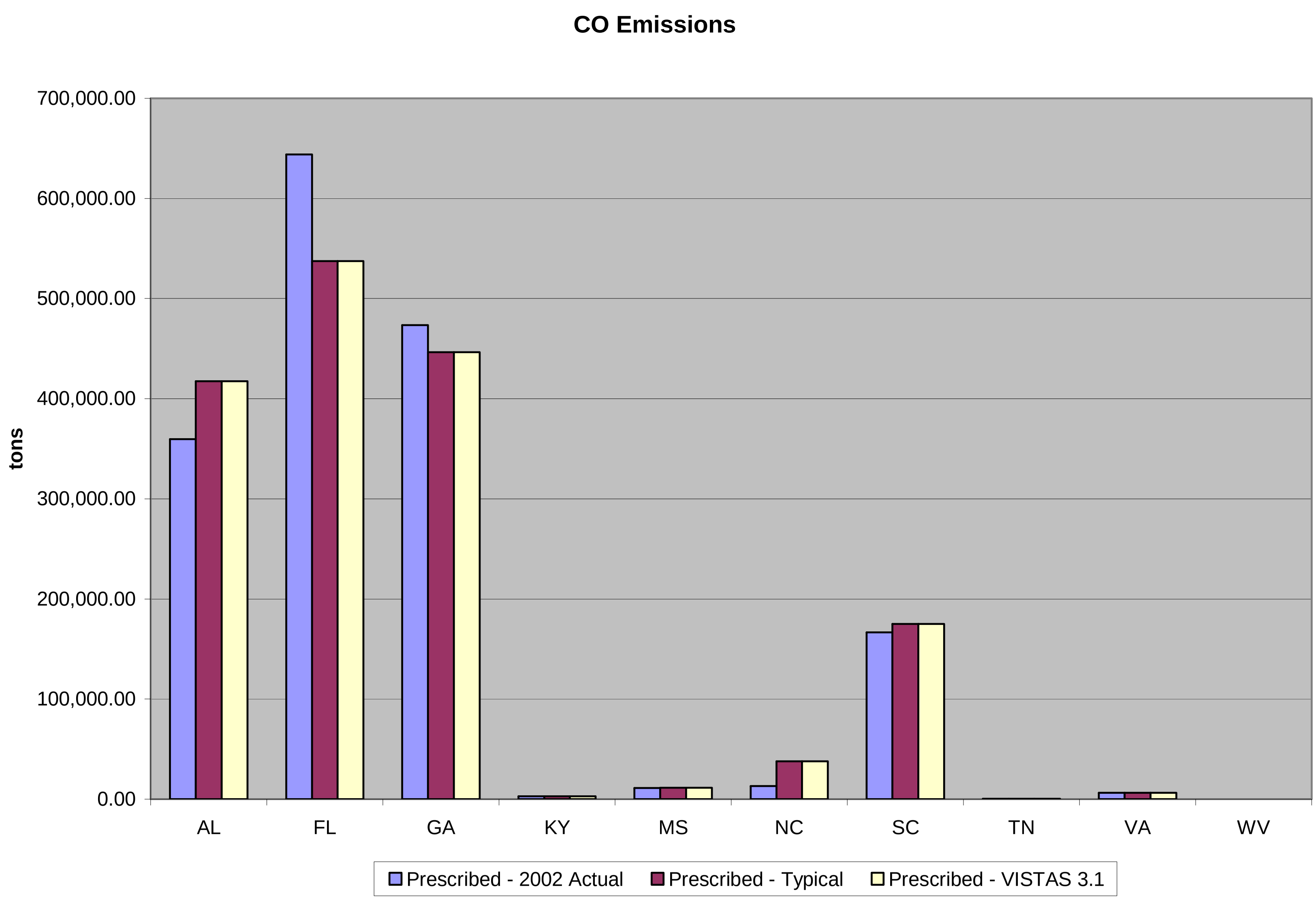
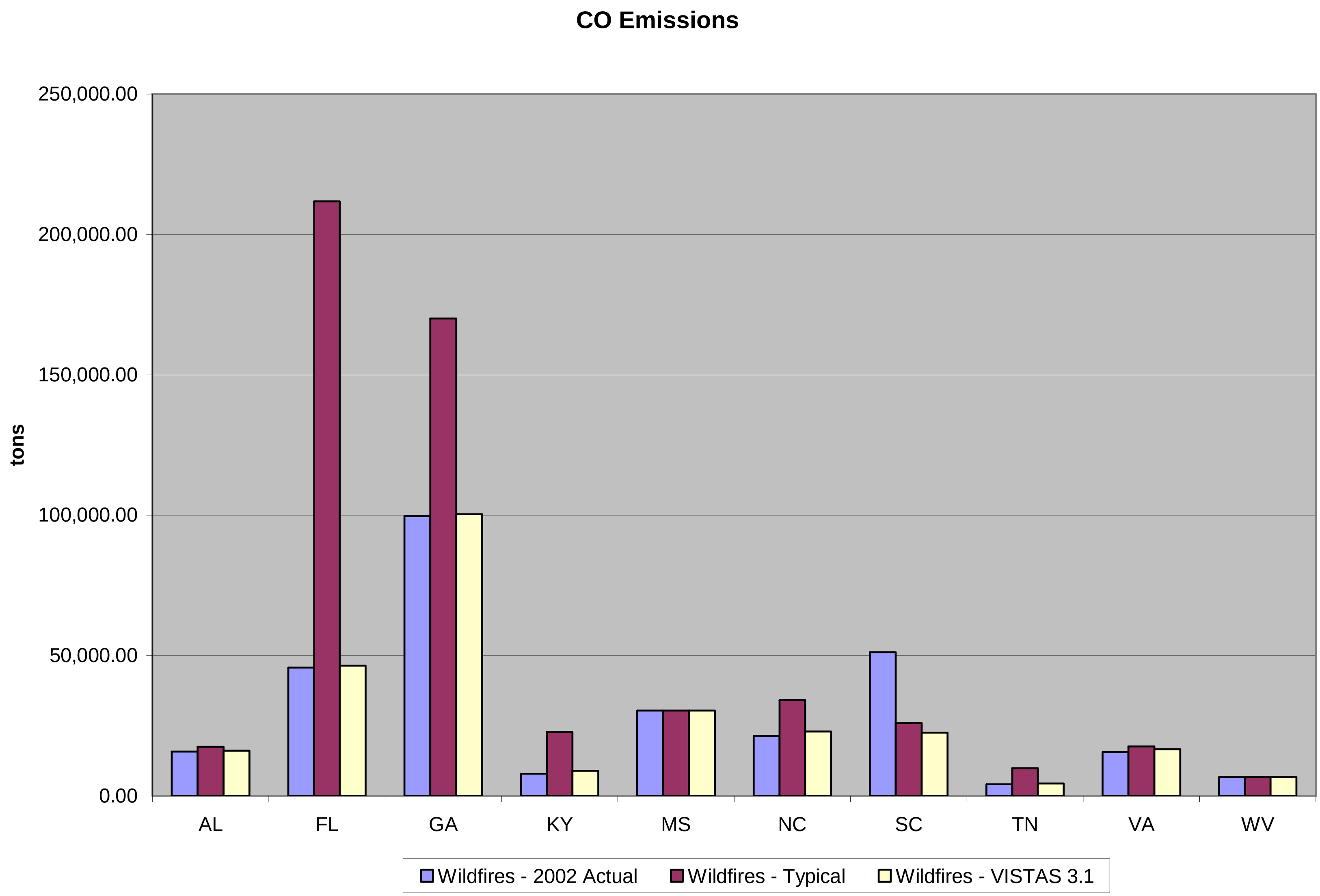


Figure 1.2-4 CO Emissions from Wildfire Burning for the Original Base Year, 2002 Actual Base G and 2002 Typical Base G Inventories.



1.2.2 Development of non-fire inventory

The second task in preparing the area source component of the Base F and Base G 2002 base year inventory was the incorporation of data submitted by the VISTAS States to the EPA as part of the CERR. With few exceptions, Base F and Base G inventories for this component of the inventory are identical. Modifications to the Base F methodology (described below) only resulted from modifications from the VISTAS States during review of the Base F inventory. The changes made to the inventory based on these reviews are described in the last portion of this section of the report. The information presented below describes the method used to incorporate CERR data as part of Base F.

Work on incorporating the CERR data into the 2002 Base F inventory involved: 1) obtaining the data from EPA, 2) evaluating the emissions and pollutants reported in order to avoid double counting and 3) backfilling from the earlier version of the VISTAS 2002 base year inventory for missing sources/pollutants. The processes used to perform those operations are described below. This work did not include any of the fire emission estimates described above. In addition it did not include emission estimates for ammonia from agricultural and fertilizer sources. Finally it did not include PM emissions from paved roads. Each of those categories was estimated separately.

Data on the CERR submittals was obtained from EPA’s Draft NEI download file transfer protocol (FTP) site where the data are stored after they’ve been processed for review. The data submitted in National Emission Inventory Format (NIF) was downloaded from that site. Once all of the files were obtained, MACTEC ran the files through the EPA NIF Format and Content checking tool to ensure that the files were submitted in standard NIF format and that there were no issues with those files. In a couple of cases small errors were found. For example, in one case a county FIPs code that was no longer in use was found. MACTEC contacted each VISTAS State area source contact person to resolve the issues with the files and corrections were made. Once all corrections to the native files were completed, MACTEC continued with the incorporation of the data into the VISTAS area source files.

Our general assumption was that unless we determined otherwise, the CERR submittals represented full and complete inventories. Where a State submitted a complete inventory, our plan was to simply delete the previous 2002 base year data and replace it with the CERR submittal. Prior to this replacement however, we stripped out the following emissions:

1. All wildfire, prescribed burning, land clearing and agricultural burning emissions submitted to EPA by the States as part of the CERR process were removed since they were to be replaced with emissions estimated using methods described earlier.
2. All fertilizer and agricultural ammonia emission records submitted to EPA by the States as part of the CERR process were removed. These were replaced with the estimates developed using the CMU Ammonia model.

3. All emissions from paved roads submitted to EPA by the States as part of the CERR process were removed. These emissions were replaced with updated emissions developed by U.S. EPA as part of their 2002 NEI development effort.

This approach was used for most State and Local emission submittals to prepare the Base F inventory. There were a few cases where alternative data were used to prepare the Base F inventory. In general, these alternatives involved submittal of alternative files to the CERR data by S/L agencies. Table 1.2-2 below summarizes the data used to prepare the Base F inventory. In general the data were derived from one of the following sources:

1. CERR submittal obtained from EPA FTP site as directed by VISTAS States;
2. State submitted file (either revised from CERR submittal or separate format);
3. VISTAS original 2002 base year (VISTAS version 3.1 base year file); or
4. EPA's preliminary 2002 NEI.

Table 1.2-2 Summary of State Data Submittals for the 2002 VISTAS Area Source Base F Inventory

State / Local Program	Area Source Emissions Data Source
AL	B
FL	B
GA	C
KY	A
MS	B
NC	C
SC	B
TN	B
VA	B
WV	A/C
Davidson County, TN	B
Hamilton County, TN	C
Memphis/Shelby County, TN	A
Knox County, TN	B
Jefferson County, AL	* so B from State
Jefferson County, KY	B
Buncombe County, NC	* so C from State
Forsyth County, NC	* so C from State
Mecklenburg County, NC	* so C from State

A = VISTAS 2002 (version 3.1)
B = CERR Submittal from EPA's ftp site
C = Other (CERR or other submittal sent directly from State to MACTEC)
* = No response

In order to track the sources of data in the final Base F and Base G NIF files, a field was added to the NIF format files developed for VISTAS to track each data source. A field named Data_Source was added to the EM table. A series of codes were added to this field to mark the source of each emissions value in the Base F and Base G inventories. Values in this field are detailed in Table 1.2-3.

Table 1.2-3 Data Source Codes and Data Sources for VISTAS 2002 Base F Area Source Emissions Inventory.

Data Source Codes	Data Source
Base F Codes	
CMU Model	CMU Ammonia model v 3.6
E-02-X or E-99-F or L-02-X or S-02-X	EPA CERR submittal (from FTP site)
EPA Paved	EPA Paved Road emissions estimates
EPAPRE02NEI	EPA Preliminary 2002 NEI
STATEFILE	State submitted file
VISTBASYR31	VISTAS 2002 Base Year version 3.1
VISTRATIO	Developed from VISTAS Ratios (used only for missing pollutants)
Additional Base G Codes	
ALBASEGFILE	Base G update file provided by AL
NCBASEGFILE	Base G update file provided by NC
OTAQRPT	Portable Fuel Container Emissions from OTAQ Report
STELLA	Revised data provided by VISTAS EI Advisor Greg Stella
VABASEGFILE	Base G update file provided by VA
VAStateFile	Revisions/additions to Base G update file provided by VA

Most States submitted complete inventories for Base F. Virginia's inventory required a two stage update. Virginia's CERR submittal only contained ozone precursor pollutants (including CO). For Virginia, MACTEC's original plan was to maintain the previous 2002 VISTAS base year emissions for non-ozone pollutants and then do a simple replacement for ozone pollutants. However during the QA phase of the work, MACTEC discovered that there were categories that had ozone precursor or CO emissions in the submittal that weren't in the original 2002 VISTAS base year inventory that should have PM or SO_2 emissions. For those records, MACTEC used an emissions ratio to build records for emissions of these pollutants. Data for Virginia PM and SO_2 emissions were generated by developing SCC level ratios to NO_x from the VISTAS 2002 base year inventory (version 3.1) or from emission factors and then calculating the emissions based on that ratio.

1.2.3 2002 Base G inventory updates

After the Base F inventory was submitted and used for modeling, VISTAS States were provided an opportunity for further review and comment on the Base F inventory. As a result of this review and comment period, several VISTAS States provided revisions to the Base F inventory.

In addition to and as an outgrowth of some of the comments provided by the States during the review process, some of the changes made to the inventory were made globally across the entire VISTAS region. This section discusses the specific State changes followed by the global changes made to the area source component of the inventory for all VISTAS States.

1.2.3.1 Changes resulting from State review and comment

Alabama

Alabama suggested several changes and had questions concerning a few categories in the Base F inventory. The changes/questions were:

1. For Source Classification Code (SCC) 2102005000 (Industrial Boilers: Residual Oil) and SCC 2103007000 (Institutional/Commercial Heating: Liquefied Petroleum Gas) the Alabama noted that the Base F VISTAS inventory had values for NO_x, VOC and CO for the State, but no values for SO_2, PM_{10} or $PM_{2.5}$.

MACTEC evaluated this information and found that there were actually emissions for two counties in AL for that SCC that had either SO_2 and/or PM emissions. The data used to develop the 2002 Base F inventory for AL came from the preliminary 2002 CERR submittals (see above) which should have included SO_2 and PM but did not except for two counties. According to MACTEC's protocol for use of these files, the files received from EPA were to be used "as is" unless the States provided comments during the Base F comment period to correct the CERR submittal. No comments were received from AL on the CERR submittal used for Base F. For 2002 Base G, AL provided an updated database file for these SCCs for all counties in the State that provided revised values for emissions and included SO_2 and PM. The revised file was used to update the Base F data for Base G.

2. AL noted that the Base F inventory included SCC 2401002000 (Solvent Utilization, Surface Coating, Architectural Coatings - Solvent-based, Total: All Solvent Types) and 2401003000 (Solvent Utilization, Surface Coating,

Architectural Coatings - Water-based, Total: All Solvent Types) as well as SCC 2401001000 (Solvent Utilization, Surface Coating, Architectural Coatings, Total: All Solvent Types). This resulted in double counting of the emissions for this category. AL suggested removal of the breakdown SCCs and use of the total SCC.

MACTEC deleted records for the breakdown SCCs and retained the total all solvents SCC emissions.

3. AL found the SCCs listed below missing from the Base F VISTAS inventory.

SCC	VOC Emissions	SCC Description
2401025000	1139.91	Surface Coatings: Metal Furniture, all coating types
2401030000	425.27	Surface Coatings: Paper, all coating types
2401065000	344.08	Surface Coatings: Electronic and Other Electrical, all coating types
2430000000	504.29	Solvent Utilization, Rubber/Plastics, All Processes, Total: All Solvent Types
2440020000	3043.78	Solvent Utilization, Miscellaneous Industrial, Adhesive (Industrial) Application, Total: All Solvent Types
Total for AL	5457.32	

MACTEC found that the emissions for these SCCs were included in the Base F inventory, but with slightly different total emissions. AL provided an updated county-level emissions file for use in updating the Base G inventory. That file was used to update the NIF records for AL for those SCCs.

4. AL noted that emissions in the Base F inventory were found for SCC 2465000000 and SCCs 2465100000, 2465200000, 2465400000, 2465600000, and 2465800000. These last five SCCs represent a subset of the emissions in the 246500000 SCC resulting in potential double counting of emissions.

MACTEC deleted all emissions associated with the Total SCC 2465000000 and retained the subset SCCs for the Base G inventory.

Florida

Florida provided comments indicating that they felt that emissions from the following sources and counties were too high, especially for CO and PM and were likely zero:

- motor vehicle fire - Palm Beach County
- woodstoves - Miami Dade, Hillsborough, Orange, Polk, Ft Myers, Pasco and Sarasota Counties
- fireplaces - Miami Dade and Hillsborough Counties

Emissions from these sources in the counties specified were set to zero by MACTEC for the Base G inventory.

North Carolina

North Carolina provided corrected emission files for 2002 Base F. A text file with emission values was provided and used to update the Base F emissions to Base G. The updated emissions were applied directly to the Base F NIF file. The file provided was similar to the "EM" NIF table. An update query was used to update the data supplied in the text file to the Access database NIF file. All changes were implemented.

South Carolina

South Carolina had two issues concerning the Base F inventory. These issues related to 1) additional SCCs that were in BASE F 2009 and 2018, but not in 2002 Base F and 2) SCCs that were in the U.S. EPA 2002 NEI inventory, but not in the VISTAS 2002, 2009, or 2018 Base F inventory.

MACTEC investigated the additional SCCs found in 2009 and 2018 Base F and found that the SCCs actually were not missing in the 2002 Base F inventory but only had emissions for PM. Thus the emissions were maintained as they were provided in Base F.

With respect to the SCCs that were found in the U.S. EPA 2002 NEI, MACTEC investigated and found that they were not included in the Base F inventory because they were not included in the 2002 CERR submittal used to produce the Base F updates. The SCCs were apparently added by EPA later in the NEI development process. In addition, MACTEC also evaluated whether or not the SCCs were found in other VISTAS States Base F inventories. MACTEC found that some States included them and some did not, there was no consistency between the States. MACTEC also found that typically emissions for these SCCs were low in emissions, generally with emissions of only a few tons to tens of tons per year. The decision was made with South Carolina concurrence not to add these SCCs to the Base G inventory. These SCCs were: 210205000, 2102011000, 2103007000, 2103011000, 2104007000, 2104011000, 2302002100, 2302002200, 2302003100, 2302003200, 2610000500, 2810001000, and 281001500.

Virginia

Virginia provided an updated 2002 base year emissions file. The data in that file were used to update the Base F inventory emission values to those for Base G. In addition, Virginia provided information on several source categories that required controls for future year projections since the sources were located in counties/cities in northern Virginia and were subject to future year Ozone Transport Commission (OTC) regulations. MACTEC added in the base year control levels to the Base G inventory file for these categories so that they could be estimated correctly in future years. The controls added were for mobile equipment repair/refinishing sources, architectural and industrial maintenance coating sources, consumer products sources, and solvent metal cleaning sources. Minor errors were found in some entries for the initial file provided and VA provided a revised file with corrections and minor additions.

Jefferson County, KY

In December 2007, KY Division of Air Quality staff identified that Jefferson County, KY was showing zero area source SO_2 emissions. MACTEC was asked to investigate why there were zero emissions. MACTEC's investigation showed that some of the surrounding counties had area source SO_2 emissions, but that Jefferson County's were indeed zero. MACTEC determined that there were emissions in pre-Base F inventories which would have originated from the 1999 NEI grown to 2002. However under our Base F update procedure, we obtained a CERR submittal from Jefferson County. That file contained only emissions for Jefferson County including a limited number of non-ozone pollutant records. Thus under our procedure for processing CERR submittals (see above), the file was considered to be full and complete for purposes of inclusion in the Base F inventory and was processed as if it contained more than just ozone pollutant records (i.e., supplemental pollutant records were not required). The file provided, however did not have any SO_2 records. The lack of area source SO_2 emissions was not discovered during the normal State/local review process or during MACTEC's QA process performed on the initial version of the Base F inventory and was thus carried forward into the Base G2 (and thus the Best and Final) inventory and modeling effort where it remained undiscovered until December 2007.

After discovery of the lack of SO_2 records, MACTEC recovered the SO_2 (and some PM) records from the pre-Base F inventories and prepared updated records for 2002, 2009 and 2018. However, because of the timing of the release of these data (December 2007) and the fact that VISTAS could not rerun 2002 and 2009 in time for the final modeling needs with these data, these changes were not included in the final files (Base G2/Best and Final). Therefore, the summaries provided in this document do not reflect those emissions, nor do the Best and Final inventory files include them.

1.2.4 Ammonia and paved road emissions

The final component of the Base F inventory development was estimation of NH_3 emission estimates for livestock and fertilizers and paved road PM emissions. For the NH_3 emission estimates for livestock and fertilizers we used version 3.6 of the CMU NH_3 model (http://www.cmu.edu/ammonia/). Results from this model were used for all VISTAS States. The CMU model version 3.6 was used in large part because it had been just recently been updated to include the latest (2002) Census of Agriculture animal population statistics. Prior to inclusion of the CMU model estimates, MACTEC removed any ammonia records for agricultural livestock or fertilizer emissions from the VISTAS 2002 initial base year inventory. MACTEC also generated emissions from human perspiration and from wildlife using the CMU model and added those emissions for each State.

For the Base G ammonia inventory, MACTEC removed all wildlife and human perspiration emissions. VISTAS decided to remove these emissions from the inventory. Human perspiration was dropped due to a discrepancy in the units used for the emission factor that was not resolved prior to preparing the estimates and wildlife was dropped because VISTAS felt the activity data was too uncertain. Thus all emissions from these two categories were deleted in the Base G 2002 inventory.

For the paved road PM Base F emissions, we used the most recent estimates developed by EPA as part of the NEI development effort (Roy Huntley, U.S. EPA, email communication, 8/30/2004). EPA had developed an improved methodology for estimating paved road emissions for 2002 and had used that method to calculate emissions for that source category. MACTEC obtained those emissions from EPA and those values were substituted directly into the inventory after receiving consensus from all of the VISTAS States to perform the replacement. These files were obtained in March of 2005 in NIF format from the EPA FTP site.

For the Base G emissions, modifications were made to the emissions estimates based on changes suggested by work of the Western Regional Air Partnership and U.S. EPA. Details of these changes are provided below in the section on global changes made as part of the Base G inventory updates.

1.2.5 Global Changes Made for Base G

There were three global changes made between the Base F and the Base G inventory (beyond the removal of wildlife and human perspiration NH_3 emissions). These changes were:

1. Removal of Stage II emissions from the area source inventory and inclusion in the mobile sector of the inventory,

2. Adjustment of fugitive dust $PM_{2.5}$ emissions, and

3. Addition of emissions from portable fuel containers.

As part of the Base F review process, several VISTAS States had expressed surprise that the Stage II refueling emission estimates were in the area source component of the inventory. This decision had been made with SIWG agreement early on in the inventory development process because 1) some States had included it in their CERR submittals and 2) because the non-road and on-road mobile estimates had differing activity factor units and could not be easily combined. However for Base G, the VISTAS States all agreed, especially in light of the different ways in which the emissions were reported in the CERR, to remove the Stage II refueling emissions from the area source inventory and include them in the non-road and on-road sectors. Thus all records related to Stage II refueling were removed from the area source component of the Base G inventory.

$PM_{2.5}$ emissions from several fugitive dust sources were also updated for Base G. The Western Regional Air Partnership (WRAP) and U.S. EPA had been investigating overestimation of the $PM_{2.5}$ / PM_{10} ratio in several fugitive dust categories and U.S. EPA was in the process of making revisions to AP-42 for several categories during preparation of the Base G inventory. Based on data received from U.S. EPA, VISTAS decided to revise the $PM_{2.5}$ emissions from construction, paved roads and unpaved road sources. $PM_{2.5}$ emissions in Base F were multiplied by 0.67, 0.6, and 0.67 for construction, paved roads and unpaved roads respectively to produce the values found in Base G. No changes were made to PM_{10}, only to $PM_{2.5}$.

Finally, as part of Virginia's comments on the Base F inventory, emissions from portable fuel containers were mentioned as being absent from the inventory. MACTEC was tasked with developing a methodology that could be used to add these emissions to the Base G area source inventory. In investigating options for a method of estimating emissions, MACTEC found that the U.S. EPA had prepared a national inventory of emissions by State for portable fuel containers. Data on emissions from this source prepared by U.S. EPA were presented in, "Estimating Emissions Associated with Portable Fuel Containers (PFCs), Draft Report, Office of Transportation and Air Quality, United States Environmental Protection Agency, Report # EPA420-D-06-003, February 2006".

State-level emission estimates for 2005 derived from Appendix Table B-2 of the PFCs report were used as the starting point for developing 2002 county-level emissions estimates. State emissions were derived from that table by using all of the emission estimates in that table with the exception of values for vapor displacement and spillage from refueling operations. Those components of the State emissions were left out of the State-level emissions to avoid double counting refueling emissions in the non-road sector. For the purposes of 2002 emission estimates for Base G, the 2005 values were assumed equal to 2002 values.

The 2005 State-level estimates minus the refueling component from Appendix Table B-2 of the report were summed for each State and then allocated to the county-level. The county-level allocation was based on the fuel usage information obtained from the NONROAD 2005 model runs conducted as part of the Base G inventory development effort (see the 2002 base year Base G non-road section below). MACTEC used the spillage file from the NONROAD model (normally located in the DATA\EMSFAC directory in a standard installation of NONROAD) to determine the SCCs that used containers for refueling. The spillage file contains information by SCC and horsepower indicating whether or not the refueling occurs using a container or a pump. All SCC and horsepower classes using containers were extracted from the file and cross-referenced with the fuel usage by county for those SCC/horsepower combinations from the appropriate year model runs (2002, 2009 or 2018). Then the fuel usages by county from the NONROAD 2005 runs prepared for VISTAS were summed for those SCCs by county. The county level fuel use was then divided by the State total fuel use for the same SCCs to determine the fraction of total State fuel usage and that fraction was used to allocate the State-level emissions to the county.

1.2.6 Quality Assurance steps

Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for VISTAS. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the area source component of the 2002 Base F inventory:

1. All CERR and NIF format State supplied data submittals were run through EPA's Format and Content checking software.
2. SCC level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.
3. Tier comparisons (by pollutant) were developed between the revised 2002 base year inventory and the previous (version 3.1) base year inventory.
4. Fields were either added or used within each NIF data table to track the sources of data for each emission record.
5. Data product summaries were provided to both the VISTAS Emission Inventory Technical Advisor and to Area Source and Fires SIWG representatives for review and comment. Changes based on these comments were implemented in the files.
6. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For

example, a major change would result in a version going from 1.0 to 2.0. A minor change would cause a version number to go from 1.0 to 1.1. Minor changes resulting from largely editorial changes would result in a change from 1.00 to 1.01.

In addition, for the fires inventory, data related to fuel loading and fuel consumption was reviewed and approved by the VISTAS Fire SIWG to ensure that values used for each type of fire and each individual fire were appropriate. Members of the VISTAS Fire SIWG included representatives from most State Divisions of Forestry (or equivalent) as well as U.S. Forest Service and National Park Service personnel.

For Base G, similar QA steps to those outlined above for Base F were undertaken. In addition, all final NIF files were checked using the EPA Format and Content checking software and summary information by State and pollutant were prepared comparing the Base F and Base G inventories.

1.3 Mobile Sources

This section describes the revisions made to the initial 2002 VISTAS Base Year emission inventory on-road mobile source input files. For this work actual emission estimates were not made, rather data files consistent with Mobile Emissions Estimation Model Version 6 (MOBILE6) were developed and provided to the VISTAS modeling contractor. These input data files were then run during the VISTAS modeling to generate on-road mobile source emissions using episodic and meteorological specific conditions configured in the sparse matrix operator Kernel Emissions modeling system (SMOKE) emissions processor.

During initial discussions with the VISTAS Mobile Source SIWG, some States indicated a desire to use CERR mobile source emissions data in place of the VISTAS 2002 inventories generated by E.H. Pechan and Associates, Inc. (the initial VISTAS 2002 Base Year inventory files).

However, the CERR emissions data by itself were not sufficient for an inventory process that includes both base and future year inventories. MACTEC needed to be able to replicate the CERR data rather than simply obtain CERR emissions estimates. The reason for this is that only input files were being prepared to provide revised 2002 estimates during the VISTAS modeling process, rather than the actual emission estimates and that the 2002 input data files would be used as a starting point for the projected emission estimates. This meant that the appropriate vehicle miles traveled (VMT), MOBILE6, and/or NONROAD model input data needed to be provided. If these data were provided with the CERR emissions estimates we used it as the starting point for revision of the 2002 Base Year inventory. However MACTEC did not have access to the on-road mobile CERR submissions from EPA, so re-submittal of these data directly to MACTEC was requested in order to begin compiling the appropriate input file data.

In those cases where States did not provide CERR on-road mobile source input data files, our default approach was to maintain the data input files and VMT estimates for the initial 2002 Base Year inventory prepared by Pechan.

1.3.1 Development of on-road mobile source input files and VMT estimates

Development of the 2002 on-road input files and VMT was a multi-step process depending upon what the State mobile source contacts instructed us to use as their data. Information provided below provides incremental revisions made to on-road mobile source inventories or inputs in series from one inventory version to the next. In general the process involved one of three steps from the original 2002 on-road mobile source data.

Base F Revisions

1. The first step was to evaluate the initial 2002 base year files and make any non-substantive changes (i.e., changes only to confirm that the files posted for 2002 by Pechan were executable and that all the necessary external files needed to run MOBILE6 were present). This approach was taken for AL, FL, GA, MS, SC, and WV. For these States the determination was made that the previous files would be okay to use as originally prepared. For SC, the VMT file was updated, but that did not affect the MOBILE6 input files.

2. For other States, modification to the input files was required. The information below indicates what changes were made for other States in the VISTAS region.

KY – For Kentucky, the Inspection and Maintenance (I/M) records in the input files for Jefferson County were updated in order to better reflect the actual I/M program in the Louisville metropolitan area.

NC - Substantial revisions were implemented to these input files based on input from the State. The modifications necessary to reflect the desires of the State led to complete replacement of the previous input files. Among the changes made were:

- The regrouping of counties (including the movement of some counties from one county group to another and the creation of new input files for previously grouped counties). There were originally 32 input files; after the changes there were 49. The pointer file was corrected to reflect these changes.
- Travel speeds were updated in over 3000 scenarios.
- All I/M records were updated.
- All registration distributions were updated.

- I/M VMT fractions were updated (which only affected the pointer file).
- VMT estimates were updated (which has no direct effect on the MOBILE6 input files but does ultimately affect emissions).

3. VA and TN – For these States, new input files were provided due to substantive changes that the State wanted to make relative to the 2002 initial base year input files. In addition, revised VMT data were developed for each State.

Base G Revisions

For the production of the VISTAS 2002 Base G inventory, VISTAS states reviewed the Base F inputs, and provided corrections, updates and supplemental data.

For all states modeled, the Base G updates include:

Adding Stage II refueling emissions calculations to the SMOKE processing.

Revised the HDD compliance for all states. (REBUILD EFFECTS = .1)

In addition to the global changes, individual VISTAS states made the following updates:

KY – updated VMT and M6 input values for selected counties.

NC – revised VMT and registration distributions.

TN - revised VMT and vehicle registration distributions for selected counties.

VA – revised winter RFG calculations in Mobile 6 inputs.

WV – revised VMT input data.

AL, FL, and GA did not provide updates for Base G and therefore the Base F inputs were used for these States.

1.3.1.1 Emissions from on-road mobile sources

The MOBILE6 module of the Sparse Matrix Operator Kernel Emissions (SMOKE) model was used to develop the on-road mobile source emissions estimates for CO, NO_X, NH_3, SO_2, PM, and VOC emissions. The MOBILE6 parameters, vehicle fleet descriptions, and VMT estimates are combined with gridded, episode-specific temperature data to calculate the gridded, temporalized emission estimates. The MOBILE6 emissions factors are based on episode-specific temperatures predicted by the meteorological model. Further, the MOBILE6 emissions factors model accounts for the following:

- Hourly and daily minimum/maximum temperatures;

- Facility speeds;
- Locale-specific inspection/maintenance (I/M) control programs, if any;
- Adjustments for running losses;
- Splitting of evaporative and exhaust emissions into separate source categories;
- VMT, fleet turnover, and changes in fuel composition and Reid vapor pressure (RVP).

The primary input to MOBILE6 is the MOBILE shell file. The MOBILE shell contains the various options (e.g. type of inspection and maintenance program in effect, type of oxygenated fuel program in effect, alternative vehicle mix profiles, RVP of in-use fuel, operating mode) that direct the calculation of the MOBILE6 emissions factors. The shells used in these runs were based on VISTAS Base F modeling inputs as noted in the previous section.

For this analysis, the on-road mobile source emissions were produced using selected weeks (seven days) of each month and using these days as representative of the entire month. This selection criterion allows for the representation of day-of-the-week variability in the on-road motor vehicles, and models a representation of the meteorological variability in each month. The modeled weeks were selected from mid-month, avoiding inclusion of major holidays.

The parameters for the SMOKE runs are as follows:

Episodes:
2002 Initial Base Year, and
2009 and 2018 Future years, using 2009/2018 inventories and modeled using the same meteorology and episode days as 2002.

Episode represented by the following weeks per month:
January 15-21
February 12-18
March 12-18
April16-22
May 14-20
June 11-17
July 16-22
August 13-19
September 17-23
October 15-21
November 12-18
December 17-23

Days modeled as holidays for annual run:

New Year's Day - January 1

Good Friday – March 29

Memorial Day – May 27

July 4th

Labor Day – September 2

Thanksgiving Day – November 28, 29

Christmas Eve – December 24

Christmas Day – December 25

Output time zone:

Greenwich Mean Time (zone 0)

Projection:

Lambert Conformal with Alpha=33, Beta=45, Gamma=-97, and center at (-97, 40).

Domain:

36 Kilometer Grid: Origin at (-2736, -2088) kilometers with 148 rows by 112 columns and 36-km square grid cells.

12 Kilometer Grid: Origin at (108, -1620) kilometers with 168 rows by 177 columns and 12-km square grid cells.

CMAQ model species:

The CMAQ configuration was CB-IV with PM. The model species produced were: CO, NO, NO_2, ALD_2, ETH, FORM, ISOP, NR, OLE, PAR, TERPB, TOL, XYL, NH_3, SO_2, SULF, PEC, PMFINE, PNO_3, POA, PSO_4, and PMC.

Meteorology data:

Daily (25-hour). SMOKE requires the following five types of MCIP outputs: (1) Grid cross 2-d, (2) Grid cross 3-d, (3) Met cross 2-d, (4) Met cross 3-d, and (5), Met dot 3-d.

The reconstructed emissions based on the representative week run were calculated by mapping each day of week (Mon, Tue, Wed, etc.) from the modeled month to the same day of week generated in the representative week run. In the case of holidays, these days were mapped to representative week Sundays. An example of this mapping for the January episode is presented in Table 1.3-1 below. Note that although the emissions were generated for individual calendar years (2002, 2009 and 2018) the meteorology is based on 2002.

Table 1.3-1 Representative day mapping for January episode

(Highlighted representative week)

Modeled Date	Representative Day	Modeled Date	Representative Day	Modeled Date	Representative Day
1/1/2002*	1/20/2002	1/11/2002	1/18/2002	1/22/2002	1/15/2002
1/2/2002	1/16/2002	1/12/2002	1/19/2002	1/23/2002	1/16/2002
1/3/2002	1/17/2002	1/13/2002	1/20/2002	1/24/2002	1/17/2002
1/4/2002	1/18/2002	1/14/2002	1/21/2002	1/25/2002	1/18/2002
1/5/2002	1/19/2002	1/15/2002	1/15/2002	1/26/2002	1/19/2002
1/6/2002	1/20/2002	1/16/2002	1/16/2002	1/27/2002	1/20/2002
1/7/2002	1/21/2002	1/17/2002	1/17/2002	1/28/2002	1/21/2002
1/8/2002	1/15/2002	1/18/2002	1/18/2002	1/29/2002	1/15/2002
1/9/2002	1/16/2002	1/19/2002	1/19/2002	1/30/2002	1/16/2002
1/10/2002	1/17/2002	1/20/2002	1/20/2002	1/31/2002	1/17/2002
		1/21/2002	1/21/2002		

* Modeled holiday

1.3.2 Development of non-road emission estimates

Emissions from non-road sources were estimated in two steps. First, emissions for non-road sources that are included in the NONROAD model were developed. Second, emissions from sources not included in the NONROAD model were estimated. The sections below detail the procedures used for each group of sources.

1.3.2.1 Emissions from NONROAD model sources

An initial 2002 base year emissions inventory for non-road engines and equipment covered by the EPA NONROAD model was prepared for VISTAS in early 2004. The methods and assumptions used to develop the inventory are presented in a February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" as prepared by E.H. Pechan & Associates, Inc. Except as otherwise stated below, all aspects of the preparation methodology documented in that report continue to apply to the revised NONROAD modeling discussed in this section.

Revisions to the initial 2002 NONROAD emissions inventory were implemented to ensure that the latest State and local data were considered, as well as to more accurately reflect gasoline sulfur contents for 2002 and correct other State-specific discrepancies. Those revisions comprise the Base F VISTAS non-road inventory. This section details the specific revisions made to the NONROAD model input files for the Base F and Base G VISTAS base year inventories, and provides insight into some key differences between the versions of the NONROAD model employed for the Base F and Base G inventories and the previous version employed for the initial 2002 base year inventory prepared by Pechan.

Revisions to the initial 2002 emissions inventory prepared by Pechan were actually implemented in two stages. An initial set of revisions was implemented in the fall of 2004. Those revisions resulted in the Base F inventory. These were followed by a second set of revisions in the spring of 2006. Those estimates produced the Base G base year inventory. To accurately document the combined effects of both sets of revisions, each set is discussed separately below. Unless otherwise indicated, all revisions implemented in Base F were carried directly into the Base G revision process without change. Thus, the inventories that resulted from the Base F revisions served as the starting point for the Base G revisions.

For Base F, three VISTAS States provided detailed data revisions for consideration in developing revised model inputs. These States were:

1. North Carolina
2. Tennessee (including a separate submission for Davidson County), and
3. Virginia.

The remaining seven VISTAS States indicated that the initial 2002 VISTAS input files prepared by Pechan continued to reflect the most recent data available. These States were:

1. Alabama,
2. Florida,
3. Georgia,
4. Kentucky,
5. Mississippi,
6. South Carolina, and
7. West Virginia.

However, it should be recognized that the NONROAD input files for *all* ten VISTAS States were updated to reflect gasoline sulfur content revisions for the Base F 2002 base year inventory (as discussed below). The original files prepared by Pechan are available on their FTP site in the /pub/VISTAS/MOB_0104/ directory.

Before presenting the specific implemented revisions, it is important to note that the Base F 2002 base year inventory utilized a newer release of the NONROAD model than was used for the initial 2002 base year inventory (prepared by Pechan). The Base F 2002 base year inventory, as developed in spring 2004, was based on the Draft NONROAD2004 model, which was released by the EPA in May of 2004. This model is no longer available on EPA's website. The initial 2002 base year inventory (prepared by Pechan) was based on the Draft NONROAD2002a version of the model (which is also no longer available on EPA's website). Key differences between the models are as follows:

- Draft NONROAD2004 included the effects of the Tier 4 non-road engine and equipment standards (this did not impact the Base F 2002 inventory estimates, but did affect Base F future year forecasts).

- Draft NONROAD2004 included the *exhaust* emission impacts of the large spark-ignition engine standards; the evaporative impacts of these standards are *not* incorporated (this does not impact 2002 inventory estimates, but does affect future year forecasts).
- Draft NONROAD2004 included revised equipment population estimates.
- The $PM_{2.5}$ fraction for *diesel* equipment in Draft NONROAD2004 had been updated from 0.92 to 0.97.
- Draft NONROAD2004 included revisions to recreational marine activity, useful life, and emission rates.

To the extent that these revisions affect 2002 emissions estimates, they will be reflected as differentials between the initial and Base F 2002 VISTAS base year inventories. It is perhaps important to identify that, at the time of the Base F inventory revisions; the EPA recognized the Draft NONROAD2004 model as an appropriate mechanism for SIP development. Although the model was designated as a draft update, it reflected the latest and most accurate NONROAD planning data at that time, as evidenced by the EPA's use of that version for the Tier 4 Final Rulemaking.

Prior to the Base G inventory revisions implemented in 2006, the EPA released another updated version of the NONROAD model, designated as Final NONROAD2005 (which can be downloaded from: http://www.epa.gov/OMSWWW/nonrdmdl.htm#model). This version ostensibly represents the final version of the model, although certain components of it have been updated since its first release in December 2005. For the Base G inventory developed in the first half of 2006, all updates of the Final NONROAD2005 model through March 2006 are included. Key differences between Final NONROAD2005 and Draft NONROAD2004 are as follows:

- Final NONROAD2005 reflects the latest basic emission rate and deterioration data.
- Final NONROAD2005 includes emission estimates for a range of evaporative emissions categories not included in Draft NONROAD2004 (tank and hose permeation, hot soak, and running loss emissions).
- Final NONROAD2005 includes a revised diurnal emissions algorithm.
- Final NONROAD2005 includes a revised equipment scrappage algorithm.
- Final NONROAD2005 includes revised state and county equipment allocation data.
- Final NONROAD2005 allows separate sulfur content inputs for marine and land-based diesel fuel.
- Final NONROAD2005 includes revised conversion factors for hydrocarbon emissions.

- Final NONROAD2005 includes the evaporative emission impacts of the large spark-ignition engine standards (this does not impact 2002 inventory estimates, but does affect future year forecasts).

Unfortunately, due to the extensive revisions associated with Final NONROAD2005, input files created for use with Draft NONROAD2004 (e.g., Base F input files) and earlier versions of the model cannot be used directly with Final NONROAD2005 (used for Base G). This created a rather significant impact in that the VISTAS NONROAD modeling process involves the consideration of over 200 unique sets of input data. To avoid creating new input files for each of these datasets, a conversion process was undertaken wherein each of the Draft NONROAD2004 (Base F) input data files were converted into the proper format required for proper execution in Final NONROAD2005 (Base G).[1] This process consisted of the following steps:

- Revise the Draft NONROAD2004 (Base F) input files to include the following two line EPA-developed comment at the end of the input file header (this is a nonsubstantive change implemented solely for consistency with input files produced directly using Final NONROAD2005):

```
9/2005 epa: Add growth & tech years to OPTIONS packet
 and Counties & Retrofit files to RUNFILES packet.
```

- Revise the Draft NONROAD2004 (Base F) input files to include the following two command lines after the "Weekday or weekend" command in the PERIOD packet:

```
Year of growth calc:
Year of tech sel  :
```

- Revise the Draft NONROAD2004 (Base F) input files to include the following command line after the "Diesel sulfur percent" command in the OPTIONS packet:

```
Marine Dsl sulfur %: 0.2638
```

  Note that the value 0.2638 (2638 parts per million by weight [ppmW]) is applicable only for 2002 modeling and was accordingly revised (as described below) for both the 2009 and 2018 Base G forecast inventories. The 2638 ppmW sulfur value for 2002 marine diesel fuel was taken from the 48-State (excludes Alaska and Hawaii) tabulation presented in the April 27, 2004 EPA document "*Diesel Fuel Sulfur Inputs for the Draft*

[1] The necessary conversions where developed by comparing substantively identical input files created using the graphical user interfaces for both Draft NONROAD2004 and Final NONROAD2005. The differences between the input files indicated the specific revisions necessary to convert existing VISTAS input files into Final NONROAD2005 format.

NONROAD2004 Model used in the 2004 Non-road Diesel Engine Final Rule." It should also be noted that this value differs by about 5 percent from the 2500 ppmW value previously used for the initial 2002 VISTAS modeling (performed by Pechan). Prior to Final NONROAD2005 (used for Base G), the NONROAD model allowed only a single diesel fuel sulfur input that was applied to both land-based and marine equipment. As documented in the February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" as prepared by E.H. Pechan & Associates, Inc., a value of 2500 ppmW sulfur was used for all 2002 VISTAS NONROAD modeling. Given the ability of Final NONROAD2005 to distinguish a separate sulfur content for marine equipment and the existing EPA guidance document suggesting an appropriate marine sulfur value of 2638 ppmW for 2002, the existing modeling value of 2500 ppmW was modified (for marine equipment only).

- Replace the Draft NONROAD2004 (Base F) input files RUNFILES packet command line:

```
TECHNOLOGY     : c:\non-road\data\tech\tech.dat
```

  with the command lines:

```
EXH TECHNOLOGY   : c:\non-road\data\tech\tech-exh.dat
EVP TECHNOLOGY   : c:\non-road\data\tech\tech-evp.dat
```

- Revise the Draft NONROAD2004 (Base F) input files to include the following two command lines after the "EPS2 AMS" command in the RUNFILES packet:

```
US COUNTIES FIPS  : c:\non-road\data\allocate\fips.dat
RETROFIT      :
```

- Revise the Draft NONROAD2004 (Base F) input files to include the following command line after the "Rec marine outbrd" command in the ALLOC FILES packet:

```
Locomotive NOx   : c:\non-road\data\allocate\XX_rail.alo
```

  Where "XX" varies across input files. For any given file, "XX" is the two digit abbreviation of the state associated with the scenario being modeled (e.g., for Alabama modeling, XX=AL).

- Replace the Draft NONROAD2004 (Base F) input files EMFAC FILES packet command line:

```
Diurnal      : c:\non-road\data\emsfac\diurnal.emf
```

with the eight command lines:

```
Diurnal      : c:\non-road\data\emsfac\evdiu.emf
TANK PERM     : c:\non-road\data\emsfac\evtank.emf
NON-RM HOSE PERM  : c:\non-road\data\emsfac\evhose.emf
RM FILL NECK PERM : c:\non-road\data\emsfac\evneck.emf
RM SUPPLY/RETURN  : c:\non-road\data\emsfac\evsupret.emf
RM VENT PERM    : c:\non-road\data\emsfac\evvent.emf
HOT SOAKS     : c:\non-road\data\emsfac\evhotsk.emf
RUNINGLOSS     : c:\non-road\data\emsfac\evrunls.emfEVP
```

- Revise the Draft NONROAD2004 (Base F) input files to include the following command line after the "PM exhaust" command in the DETERIORATE FILES packet:

```
Diurnal      : c:\non-road\data\detfac\evdiu.det
```

Once revised in this format, the VISTAS non-road input files developed for use with Draft NONROAD2004 (Base F) were executable under the Final NONROAD2005 model (Base G).

The only additional revisions implemented to develop a Final NONROAD2005-based inventory (Base G) involved elimination of non-default equipment allocation files for North Carolina and West Virginia. Due to concerns about improper equipment allocation across counties under the Draft NONROAD2004 model (used for Base F), as well as for earlier versions of the NONROAD model, North Carolina had produced alternative allocation data files indicating the number of employees in air transportation by county, the number of wholesale establishments by county, and the number of employees in landscaping services by county. For the same reason, West Virginia had produced alternative equipment allocation files indicating the number of employees in air transportation by county, the tonnage of underground coal production by county, the number of golf courses and country clubs by county, the number of wholesale establishments by county, the number of employees in logging operations by county, the number of employees in landscaping services by county, the number of employees in manufacturing operations by county, the number of employees in oil and gas drilling and extraction operations by county, and the number of recreational vehicle parks and campgrounds by county. These alternative equipment allocation files were used for all VISTAS inventory modeling conducted prior to the release of Final NONROAD2005 (i.e., through Base F). However, both North Carolina and West Virginia determined that the default allocation file revisions associated with the release of Final NONROAD2005 were appropriate to address the concerns that led to the development of the alternative allocation files. As a result, all alternative allocation file commands were removed from VISTAS NONROAD2005 (Base G) input files for North Carolina and West Virginia, so that the entire region under the Base G inventory is now modeled using the default allocation files provided with NONROAD2005.

In addition to the alternative equipment allocation files, North Carolina had previously developed an alternative seasonal adjustment file that was used for the Base F inventory in place of the default file provided with Draft NONROAD2004 (and earlier model versions). The alternative data file implemented a single change, namely reclassifying North Carolina as a southeastern state rather than a mid-Atlantic state (as identified in the default data file). Since Final NONROAD2005 continues to identify North Carolina as a mid-Atlantic state, North Carolina requested that the southeastern reclassification be continued for all NONROAD2005 modeling (Base G). To ensure that any other revisions associated with the seasonal adjustment file released with NONROAD2005 were not overlooked, the previously developed alternative seasonal adjustment file for North Carolina was scrapped and a new alternative file was created from the default seasonal adjustment file provided with Final NONROAD2005 for Base G inventory development. The alternative file, which was used for all North Carolina modeling, reclassifies North Carolina from a mid-Atlantic to a southeastern state. This represents the only non-default data file used for VISTAS NONROAD2005-based (Base G) modeling.

The remainder of this section documents all changes to the originally established VISTAS input file values as documented in the February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" as prepared by E.H. Pechan & Associates, Inc. Unless specifically stated below, all values from that report continue to be used without change in the latest VISTAS modeling.

Base F Revisions:

For the initial 2002 base year inventory (developed by Pechan), all NONROAD modeling runs for VISTAS were performed utilizing a gasoline sulfur content of 339 ppmW and a diesel sulfur content of 2,500 ppmW. Although the EPA-recommended non-road diesel fuel sulfur content for 2002 is 2,283 ppmW, the 2,500 ppmW sulfur content used for the initial 2002 base year VISTAS inventory was designed to remove the effect of lower non-road diesel fuel sulfur limits applicable only in California. (The EPA recommended inputs can be found in "*Diesel Fuel Sulfur Inputs for the Draft NONROAD2004 Model used in the 2004 Non-road Diesel Engine Final Rule*," EPA, April 27, 2004.) This correction is appropriate and was retained for the Base F 2002 inventory. Thus, the Base F inventory continued to assume a diesel fuel sulfur content of 2,500 ppmW across the VISTAS region.

However, 339 ppmW is not the EPA recommended 2002 gasoline sulfur content for either eastern conventional gasoline areas or Federal Reformulated Gasoline (RFG) areas. The recommended sulfur content for eastern conventional gasoline is 279 ppmW year-round, while the recommended sulfur content for RFG areas is 129 ppmW during the summer season and 279 ppmW during the winter season. (Conventional gasoline and RFG sulfur contents for 2002 can be found in "*User's Guide to MOBILE6.1 and MOBILE6.2, Mobile Source Emission Factor*

Model," EPA420-R-03-010, U.S. EPA, August 2003 [pages 149-155] (available at link at http://www.epa.gov/otaq/m6.htm) and in the source code for MOBILE6.2 at Block Data BD05.) Given the differences in the EPA-recommended values and the value used to generate the initial 2002 base year inventory, the input files for Base F for *all* VISTAS areas were updated to reflect revised gasoline sulfur content assumptions.

Since the VISTAS NONROAD modeling is performed on a seasonal basis, and since gasoline sulfur content in RFG areas varies with the RFG season, seasonally-specific gasoline sulfur content values were estimated for use in RFG area modeling. In addition, 25 counties in Georgia are subject to a summertime gasoline sulfur limit of 150 ppmW, so that seasonal sulfur content estimates were also estimated for these counties. The initial 2002 base year NONROAD inventory (prepared by Pechan) for these Georgia counties was based on a year-round 339 ppmW gasoline sulfur content, but that oversight was corrected in the Base F 2002 base year inventory. Based on the seasonal definitions employed in the NONROAD model, monthly sulfur contents were averaged to estimate seasonal gasoline sulfur contents as follows:

Month/Season	RFG Areas	Conventional Gasoline Areas	Georgia Gasoline Control Areas
March	279 ppmW	279 ppmW	279 ppmW
April	279 ppmW	279 ppmW	279 ppmW
May	129 ppmW	279 ppmW	150 ppmW
Spring	229 ppmW	279 ppmW	236 ppmW
June	129 ppmW	279 ppmW	150 ppmW
July	129 ppmW	279 ppmW	150 ppmW
August	129 ppmW	279 ppmW	150 ppmW
Summer	129 ppmW	279 ppmW	150 ppmW
September	129 ppmW	279 ppmW	150 ppmW
October	279 ppmW	279 ppmW	279 ppmW
November	279 ppmW	279 ppmW	279 ppmW
Fall	229 ppmW	279 ppmW	236 ppmW
December	279 ppmW	279 ppmW	279 ppmW
January	279 ppmW	279 ppmW	279 ppmW
February	279 ppmW	279 ppmW	279 ppmW
Winter	279 ppmW	279 ppmW	279 ppmW

Note that the seasonal data are based on simple arithmetic averages and do not consider any monthly variation in activity (and fuel sales), and that the transition between summer and winter seasons is also not considered. Additionally, the summer fuel control season is treated as though it applies from May through September, while the summer RFG season actually ends on September 15 and the Georgia fuel control season does not officially begin until June 1. This treatment is consistent with the treatment of both fuel control programs in the VISTAS on-road vehicle modeling. Each of these influences will result in some error in the estimated sulfur content estimates, but it is expected that this error is small relative to the overall correction from a year-round sulfur content estimate of 339 ppmW.

All NONROAD modeling revisions made as part of the Base F inventory preparation process are presented in Table 1.3-2. Due to more involved updates in several areas, the number of NONROAD input files as well as sequence numbers used to represent these files was also updated in a few instances (as compared to the files used to create the initial 2002 VISTAS non-road inventory, as documented in the February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" as prepared by E.H. Pechan & Associates, Inc. These structural revisions are presented in Table 1.3-3, and are provided solely for the benefit of NONROAD modelers as the indicated revisions have no impact on generated emission estimates.

Table 1.3-2 Summary of Base F NONROAD Modeling Revisions

State	Revisions Implemented
AL	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas).
FL	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas).
GA	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all seasons for conventional gasoline counties. (2) Gasoline sulfur content changed from 339 ppmW to 150 ppmW in the summer for all gasoline control counties. (3) Gasoline sulfur content changed from 339 ppmW to 236 ppmW in the spring and fall for all gasoline control counties. (4) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in the winter for all gasoline control counties. *Gasoline control counties: Barrow, Bartow, Butts, Carroll, Cherokee (a), Clayton (a), Cobb (a), Coweta (a), Dawson, De Kalb (a), Douglas (a), Fayette (a), Forsyth (a), Fulton (a), Gwinnett (a), Hall, Haralson, Henry (a), Jackson, Newton, Paulding (a), Pickens, Rockdale (a), Spalding, and Walton*
KY	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all seasons for conventional gasoline counties. (2) Gasoline sulfur content changed from 339 ppmW to 129 ppmW in the summer for all gasoline control counties. (3) Gasoline sulfur content changed from 339 ppmW to 229 ppmW in the spring and fall for all gasoline control counties. (4) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in the winter for all gasoline control counties. *Gasoline control counties: Boone, Bullitt (b), Campbell, Jefferson, Kenton, and Oldham (b)*
MS	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas).
NC	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas). (2) Utilize revised (i.e., local) allocation files for three equipment categories. (3) Utilize revised (i.e., local) seasonal activity data.
SC	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas).
TN	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas). (2) Gasoline Reid Vapor Pressure (RVP) values changed in accordance with local recommendations. (3) Temperature data changed in accordance with local recommendations. (4) Counties regrouped in accordance with local recommendations.

Table 1.3-2. Summary of Base F NONROAD Modeling Revisions (continued)

State	Revisions Implemented
VA	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all seasons for conventional gasoline counties. (2) Gasoline sulfur content changed from 339 ppmW to 129 ppmW in the summer for all gasoline control counties. (3) Gasoline sulfur content changed from 339 ppmW to 229 ppmW in the spring and fall for all gasoline control counties. (4) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in the winter for all gasoline control counties. (5) Gasoline RVP values changed in accordance with local recommendations. (6) Counties regrouped in accordance with local recommendations. (7) The control effectiveness for counties subject to Stage II controls revised to 77 percent in accordance with local recommendations. *Gasoline control counties: Arlington Co., Fairfax Co., Loudoun Co., Prince William Co., Stafford Co., Alexandria City, Fairfax City, Falls Church City, Manassas City, Manassas Park City, Chesterfield Co., Hanover Co., Henrico Co., Colonial Heights City, Hopewell City, Richmond City, James City, York Co., Chesapeake City, Hampton City, Newport News City, Norfolk City, Poquoson City, Portsmouth City, Suffolk City, Virginia Beach City, and Williamsburg City (c)*
WV	(1) Gasoline sulfur content changed from 339 ppmW to 279 ppmW in all counties and all seasons (all are conventional gasoline areas). (2) Continue to utilize local allocation files for nine equipment categories.

Notes:

(a) County is subject to local control currently, but is scheduled to join the RFG program in January 2005.
(b) Control area is a portion of the county, but modeling is performed as though the control applies countywide.
(c) The EPA also lists Charles City County as an RFG area, but local planners indicate that Charles City County is a conventional gasoline area and it is modeled as such.

Table 1.3-3 Base F NONROAD Input File Sequence and Structural Revisions

State	Initial 2002 Base Year Inventory Input File Sequence Numbers	Revised 2002 Inventory Input File Sequence Numbers	Reason(s) for Change	Number of Revised 2002 Inventory NONROAD Input Files
AL	01-08	01-08	No Structural Changes	32 (at 8 per season)
FL	09-10	09-10	No Structural Changes	8 (at 2 per season)
GA	11-13	11-13	No Structural Changes	12 (at 3 per season)
KY	14-22	14-22	No Structural Changes	36 (at 9 per season)
MS	48	48	No Structural Changes	4 (at 1 per season)
NC	23-25	23-25	No Structural Changes	12 (at 3 per season)
SC	26-32	26-32	No Structural Changes	28 (at 7 per season)
TN	33-34	33-34, 49-52	Counties Regrouped	24 (at 6 per season)
VA	35-43	35-38, 40-43	Counties Regrouped	32 (at 8 per season)
WV	44-47	44-47	No Structural Changes	16 (at 4 per season)
All	**01-48**	**01-38, 40-52**		**204 (at 51 per season)**

Note: (1) All files include internal revisions to reflect the data changes summarized in Table 1.3-3 above. This table is intended to present structural revisions that are of interest in assembling the NONROAD model input files into a complete VISTAS region inventory. The indicated revisions do not (in and of themselves) result in emission estimate changes.

(2) The NONROAD model imposes an eight digit input file name limit, so all input files for the revised 2002 base year inventory follow a modified naming convention to allow each to be distinguished from the input files for the initial 2002 base year inventory. For the initial 2002 base year inventory, the naming convention was:

ss02aaqq, where: ss = the two character State abbreviation,
aa = a two character season indicator as follows: AU = autumn, WI = winter, SP = spring, and SU = summer, and
qq = the two digit sequence number indicated above.

For the revised 2002 inventory, the naming convention was modified to:

ss02aFqq, where: ss = the two character State abbreviation,
a = a one character season indicator as follows: A = autumn, W = winter, S = spring, and X = summer, and
qq = the two digit sequence number indicated above.

Base G Revisions:

As described above, the primary modeling revision implemented for the Base G 2002 inventory was the use of the Final NONROAD2005 model (in place of the Base F use of Draft NONROAD2004). However, there were other minor revisions implemented for 13 Georgia counties and somewhat more significant revisions implemented for Tennessee. In Georgia, Stage II refueling control was assumed for 13 counties that previously were modeled as having no refueling control under Base F. In addition, to accommodate this Stage II change as well as forecast year changes in gasoline vapor pressure, corresponding changes in the structure and sequence of Georgia NONROAD input files were made. With the exception of the minor Stage II impacts, these structural and sequence changes have no impact on 2002 emission estimates, but allow for consistency between 2002 and forecast year input file structure and sequence. In Tennessee, more significant changes were implemented to gasoline vapor pressure assumptions, as well as similar minor changes in Stage II refueling control assumptions.

In accordance with instructions from Georgia regulators, Stage II refueling control was assumed in the following 13 Georgia counties at a control efficiency value of 81 percent for the Base G inventory:

> Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale.

No Stage II control was assumed in these counties in prior inventories.

Tennessee regulators provided revised monthly values for gasoline vapor pressure. Based on the seasonal definitions employed in the NONROAD model, monthly vapor pressures were averaged to estimate seasonal vapor pressures as follows:

Month/Season	Nashville Area	Memphis Area	Remainder of Tennessee
March	13.5 psi	13.5 psi	13.5 psi
April	13.5 psi	13.5 psi	13.5 psi
May	9.0 psi	9.0 psi	9.0 psi
Spring	12.0 psi	12.0 psi	12.0 psi
June	7.8 psi	7.8 psi	9.0 psi
July	7.8 psi	7.8 psi	9.0 psi
August	7.8 psi	7.8 psi	9.0 psi
Summer	7.8 psi	7.8 psi	9.0 psi
September 1-15	7.8 psi	7.8 psi	9.0 psi
September 16-30	11.5 psi	11.5 psi	11.5 psi
October	13.5 psi	13.5 psi	13.5 psi
November	13.5 psi	13.5 psi	13.5 psi
Fall	12.2 psi	12.2 psi	12.4 psi
December	15.0 psi	15.0 psi	15.0 psi
January	15.0 psi	15.0 psi	15.0 psi
February	13.5 psi	13.5 psi	13.5 psi
Winter	14.5 psi	14.5 psi	14.5 psi

Note: The Nashville area consists of Davidson, Rutherford, Sumner, Williamson and Wilson counties, the Memphis area consists of Shelby County.

As with the Base F revisions, the seasonal data are based on simple arithmetic averages and do not consider any monthly variation in activity (and fuel sales), nor is the transition between summer and winter seasons considered. Additionally, a monthly average of the September 1-15 and September 16-30 data is calculated prior to averaging the September-November data to estimate a fall average vapor pressure, so that the month of September is weighted identically to the months of October and November.

Tennessee regulators also indicated that Stage II vapor recovery was not in effect in Shelby County, so the Base F NONROAD input files for the county (which assumed Stage II was in place) were revised accordingly.

All Base G NONROAD modeling revisions are presented in Table 1.3-4. As indicated above, the differentiation of inputs across previously grouped counties also required revision to the overall number and sequence of VISTAS NONROAD input files (as compared to the files used to create both the initial VISTAS non-road inventory, as documented in the February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" as prepared by E.H. Pechan & Associates, Inc., and the Base F revised inventory as documented above. These structural revisions are presented in Table 1.3-5, and are provided solely for the benefit of NONROAD modelers as the indicated revisions have no impact on generated emission estimates.

Table 1.3-4 Summary of Base G NONROAD Modeling Revisions

State	Revisions Implemented
AL	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons.
FL	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons.
GA	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons. (2) Stage II refueling vapor recovery implemented in 13 counties at an efficiency of 81 percent. (3) Counties regrouped to accommodate base and forecast year data differentiations. *Stage II control counties: Cherokee, Clayton, Cobb, Coweta, De Kalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale*
KY	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons.
MS	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons.
NC	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons. (2) Revert to default equipment allocation files for all equipment categories. (3) Utilize revised (i.e., local) seasonal activity data.
SC	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons.
TN	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons. (2) Gasoline RVP values changed in accordance with local recommendations. (3) Stage II vapor recovery eliminated from Shelby County modeling.
VA	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons.
WV	(1) Marine diesel sulfur content changed from 2500 ppmW to 2638 ppmW in all counties and seasons. (2) Revert to default equipment allocation files for all equipment categories.

Table 1.3-5 Spring 2006 NONROAD Input File Sequence and Structural Revisions

State	2002 Inventory Input File Sequence Numbers (Fall 2004)	2002 Inventory Input File Sequence Numbers (Spring 2006)	Reason(s) for Change	Number of Final 2002 Inventory NONROAD Input Files
AL	01-08	01-08	No Structural Changes	32 (at 8 per season)
FL	09-10	09-10	No Structural Changes	8 (at 2 per season)
GA	11-13	11-13, 53-54	Counties Regrouped	20 (at 5 per season)
KY	14-22	14-22	No Structural Changes	36 (at 9 per season)
MS	48	48	No Structural Changes	4 (at 1 per season)
NC	23-25	23-25	No Structural Changes	12 (at 3 per season)
SC	26-32	26-32	No Structural Changes	28 (at 7 per season)
TN	33-34, 49-52	33-34, 49-52	No Structural Changes	24 (at 6 per season)
VA	35-38, 40-43	35-38, 40-43	No Structural Changes	32 (at 8 per season)
WV	44-47	44-47	No Structural Changes	16 (at 4 per season)
All	**01-38, 40-52**	**01-38, 40-54**		**212 (at 53 per season)**

Note: (1) All files include internal revisions to reflect the data changes summarized in Table 1.3-5 above. This table is intended to present structural revisions that are of interest in assembling the NONROAD model input files into a complete VISTAS region inventory. The indicated revisions do not (in and of themselves) result in emission estimate changes.

(2) The NONROAD model imposes an eight digit input file name limit, so all input files for the revised 2002 base year inventory follow a modified naming convention to allow each to be distinguished from the input files for the initial 2002 and fall 2004-revised 2002 base year inventory. For the initial 2002 base year inventory, the naming convention was:

ss02aaqq, where: ss = the two character State abbreviation,
aa = a two character season indicator as follows: AU = autumn, WI = winter, SP = spring, and SU = summer, and
qq = the two digit sequence number indicated above.

For the fall 2004-revised 2002 inventory, the naming convention was modified to:

ss02aFqq, where: ss = the two character State abbreviation,
a = a one character season indicator as follows: A = autumn, W = winter, S = spring, and X = summer, and
qq = the two digit sequence number indicated above.

For the spring 2006-revised 2002 inventory, the naming convention was modified to:

ss02aCqq, where: ss = the two character State abbreviation,
a = a one character season indicator as follows: A = autumn, W = winter, S = spring, and X = summer, and
qq = the two digit sequence number indicated above.

1.3.2.2 Emissions from Commercial Marine Vessels, Locomotives, and Airplanes

An initial 2002 base year emissions inventory for aircraft, locomotives, and commercial marine vessels (CMV) was prepared for VISTAS in early 2004. The methods and data used to develop the inventory are presented in a February 9, 2004 report "*Development of the VISTAS Draft 2002 Mobile Source Emission Inventory (February 2004 Version)*" as prepared by E.H. Pechan & Associates, Inc. A summary of the initial 2002 base year emissions inventory is presented in Table 1.3-6. Except as otherwise stated below, all aspects of the preparation methodology continue to apply to the Base F and Base G emission inventories.

Revisions to the initial 2002 emissions inventory (prepared by Pechan) were implemented to ensure that the latest State and local data were incorporated as well as to correct an overestimation of PM emissions from aircraft. Revisions were actually implemented in two stages. An initial set of revisions was implemented in the fall of 2004. Those revisions constitute the Base F inventory. These were followed by a second set of revisions in 2006, which constitute the Base G inventory. To accurately document the combined effects of both sets of revisions, each set is discussed separately below. Unless otherwise indicated, all revisions implemented for Base F were carried directly into the Base G revision process without change. Thus, the inventories that resulted from the Base F revisions served as the starting point for the Base G revisions.

<u>Base F Revisions:</u>

Revisions to the initial 2002 base year emissions inventory were implemented to ensure that the latest State and local data were incorporated as well as to correct an overestimation of PM emissions from aircraft. Seven of the ten VISTAS States provided revised inventory data in the form of emissions reported to the EPA under the CERR. States providing CERR data were Alabama, Georgia, Mississippi, North Carolina, Tennessee (excluding Davidson, Hamilton, Knox, and Shelby Counties), Virginia, and West Virginia.

In many cases, the CERR data were only marginally different than the initial 2002 base year inventory data, but there were several instances where significant updates were evident. The remaining three VISTAS States (Florida, Kentucky, and South Carolina), plus Davidson, Hamilton, Knox, and Shelby counties in Tennessee, indicated that the initial 2002 VISTAS inventory continued to reflect the most recent data available. Florida did provide updated aircraft emissions data for one county (Miami-Dade) and these data were incorporated into the Base F 2002 inventory as described below.

Since several States recommended retaining the initial 2002 base year inventory data for Base F, the initial step toward revising the 2002 inventory consisted of modifying the estimated aircraft PM emissions of the initial inventory. The overestimation of aircraft PM became evident shortly after the release of the initial 2002 base year inventory, when it was determined that VISTAS region airports would constitute the top seven, and 11 of the top 15, PM sources in the nation. Moreover, PM emissions for one airport (Miami International) were a full order of magnitude larger than *all* other modeled elemental carbon PM emission sources. In addition, unexpected relationships across airports were also observed, with emissions for Atlanta's Hartsfield International being substantially less than those of Miami International, even though Atlanta handles over twice as many aircraft operations annually. Given the pervasiveness of this problem, and since the CERR data submitted by States was based on the initial 2002 VISTAS inventory data, aircraft PM emissions for the entire VISTAS region were recalculated.

Table 1.3-6 Initial 2002 Base Year Aircraft, Locomotive, and Non-Recreational Marine Emissions as Reported in February 2004 Pechan Report (annual tons)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	3,787	175	688	475	17	196
	FL	28,518	11,955	46,352	31,983	1,050	3,703
	GA	3,175	992	3,919	2,704	94	353
	KY	2,666	657	2,597	1,792	63	263
	MS	1,593	140	553	381	13	96
	NC	6,088	1,548	6,115	4,219	148	613
	SC	6,505	515	452	312	88	863
	TN	6,854	2,665	7,986	5,510	225	920
	VA	17,676	5,607	14,476	9,988	234	3,229
	WV	1,178	78	310	214	8	66
	Total	**78,040**	**24,332**	**83,448**	**57,578**	**1,940**	**10,302**
Commercial Marine (2280)	AL	1,195	9,217	917	843	3,337	736
	FL	5,888	44,817	1,936	1,781	6,683	1,409
	GA	1,038	7,874	334	307	1,173	246
	KY	6,607	50,267	2,246	2,066	9,608	1,569
	MS	5,687	43,233	1,903	1,750	7,719	1,351
	NC	599	4,547	193	178	690	142
	SC	1,067	8,100	343	316	1,205	253
	TN	4,129	31,397	1,390	1,278	5,753	980
	VA	1,198	3,426	929	855	3,258	596
	WV	2,094	15,882	668	614	720	497
	Total	**29,503**	**218,760**	**10,858**	**9,989**	**40,146**	**7,779**
Military Marine (2283)	VA	136	387	28	26	30	59
	Total	**136**	**387**	**28**	**26**	**30**	**59**
Locomotives (2285)	AL	3,490	26,339	592	533	1,446	1,354
	FL	1,006	9,969	247	222	605	404
	GA	2,654	26,733	664	598	1,622	1,059
	KY	2,166	21,811	542	488	1,321	867
	MS	2,302	23,267	578	520	1,429	899
	NC	1,638	16,502	410	369	1,001	654
	SC	1,160	11,690	291	261	710	462
	TN	4,530	44,793	1,110	999	2,689	1,805
	VA	1,928	19,334	1,407	1,266	3,443	798
	WV	1,105	11,150	277	249	681	436
	Total	**21,980**	**211,588**	**6,118**	**5,505**	**14,947**	**8,738**
Grand Total		**129,659**	**455,067**	**100,452**	**73,099**	**57,062**	**26,877**

Aircraft do emit PM while operating. However, official EPA inventory procedures for aircraft generally do not include PM emission factors and, therefore, aircraft PM is generally erroneously reported as zero. In an effort to overcome this deficiency, the developers of the initial VISTAS 2002 base year aircraft inventory (Pechan) estimated PM emission rates for aircraft using estimated NO_x emissions and an unreported PM-to-NO_x ratio (i.e., PM = NO_x times a PM-to-NO_x ratio). According to the initial 2002 base year inventory documentation, this approach was applied only to commercial aircraft NO_x, but a review of that inventory indicates that the technique was also applied to military, general aviation, and air taxi aircraft in many, but not all, instances. Although there is nothing inherently incorrect with this approach, the accuracy and inconsistent application of the assumed PM-to-NO_x ratio results in grossly overestimated aircraft PM.

Through examination of the initial 2002 base year aircraft inventory (prepared by E.H. Pechan and Associates, Inc.), it is apparent that the commercial aircraft PM-to-NO_x ratio used to generate PM emission estimates was approximately equal to 3.95 (i.e., PM = NO_x times 3.95). While the majority of observed commercial aircraft PM-to-NO_x ratios in that inventory are equal to 3.95, a few range as low as 3.00. If all aircraft estimates are included (i.e., commercial plus military, general aviation, and air taxi), observed PM-to-NO_x ratios range from 0 to 123.0, and average 3.43 as illustrated in Table 1.3-7

Table 1.3-7 PM-to-NO_x Ratios by Aircraft Type In Initial 2002 Base Year Inventory.

Aircraft Type	Average PM-to-NO_x	Range of PM-to-NO_x	Average $PM_{2.5}$ / PM_{10}	Range of $PM_{2.5}$ / PM_{10}
Undefined (1)	0.046	0-0.062	0.690	0.690-0.690
Military	0.073	0-92.3	0.688	0.333-1.000
Commercial	3.953	3.00-3.953	0.690	0.667-0.696
General Aviation	2.059	0-9.00	0.689	0.500-1.000
Air Taxi	2.734	0-123.0	0.690	0.500-1.000
Aggregate	3.427	0-123.0	0.690	0.333-1.000

Note: (1) Two counties report aircraft emissions as SCC 2275000000 “all aircraft.”

As indicated, the aggregate PM-to-NO_x ratio is similar in magnitude to the ratio for commercial aircraft. This results from the dominant nature of commercial aircraft NO_x emissions relative to NO_x from other aircraft types. It is surmised that ratios that deviate from 3.95 are based on PM emission estimates generated by local planners, which were retained without change in the PM estimation process (although a considerable number of unexplained “zero PM” records also exist in the initial 2002 base year inventory dataset). Regardless, based on previous statistical analyses performed in support of aircraft emissions inventory development outside the VISTAS region, a PM-to-NO_x ratio of 3.95 is too large by over an order of magnitude.

In analyses performed for the Tucson, Arizona planning area, PM-to-NO_x ratios for aircraft over a standard aircraft landing and takeoff (LTO) cycle are shown in Table 1.3-8. Data for this table is taken from "Emissions Inventories for the Tucson Air Planning Area, Volume I., Study Description and Results," prepared for the Pima Association of Governments, Tucson, AZ, November 2001. Pages 4-40 through 4-42 of that report, which document the statistical derivation of these ratios, are included in this report as Appendix E.

Table 1.3-8 Tucson, AZ PM-to-NO_x Ratios by Aircraft Type.

Aircraft Type	PM-to-NO_x
Commercial Aircraft	0.26
Military Aircraft	0.88
Air Taxi Aircraft	0.50
General Aviation Aircraft	1.90

Note:

The PM and NO_x emission estimates presented in the Tucson study are for local aircraft operating mode times. For this work, emission estimates for Tucson were recalculated for a standard LTO cycle, so that the ratios presented are applicable to the standard LTO cycle and not a Tucson-specific cycle. Thus, the ratios presented herein vary somewhat from those associated with the emission estimates presented in the Tucson study report.

In reviewing these data, it should be considered that they apply to a standard (i.e., EPA-defined) commercial aircraft LTO cycle.[2] Aircraft PM-to-NO_x ratios vary with operating mode, so that aircraft at airports with mode times that differ from the standard cycle will exhibit varying ratios. However, conducting an airport-specific analysis for all airports in the VISTAS region was beyond the scope of this work. While local PM-to-NO_x ratios could vary somewhat from the indicated standard cycle ratios, any error due to this variation will be significantly less than the order of magnitude error associated with the 3.95 commercial aircraft ratio used for the initial 2002 base year inventory.

It should be recognized that while the Tucson area is far removed from the VISTAS region, the data analyzed to generate the PM-to-NO_x ratios is standard aircraft emission factor data routinely employed for inventory purposes throughout the United States (as encoded in models such as the

[2] As defined in *AP-42, Compilation of Air Pollutant Emission Factors, Volume II, Mobile Sources, a standard commercial aircraft LTO cycle consists of 4 minutes of approach time, 26 minutes of taxi (7 minutes in plus 19 minutes out), 0.7 minutes of takeoff, and 2.2 minutes of climbout time (approach and climbout times being based on a 3000 foot mixing height).*

Federal Aviation Administration's Emissions Data Management Systems [EDMS]). With the exception of aircraft operating conditions, there are no inherent geographic implications associated with the use of data from the Tucson study. As indicated above, issues associated with local operating conditions have been eliminated by recalculating the Tucson study ratios for a standard LTO cycle.

To implement the revised PM-to-NO_x ratios in the Base F inventory, *all* aircraft PM records were removed from the initial 2002 base year inventory (prepared by Pechan). This includes records for which local planners may have estimated PM emissions. This approach was taken for two reasons. First, there is no way to distinguish which records may have been generated by local planners. Second, the data available to local planners may be no better than that used to generate the presented PM-to-NO_x ratio data, so the consistent application of these data to the entire VISTAS region was determined to be the most appropriate approach to generating consistent inventories throughout the region. In undertaking this removal, it became apparent that there was an imbalance in the aircraft NO_x and PM records in the initial 2002 base year inventory. Whereas there were 1,531 NO_x records in the NIF emission data sets for this source category, there were only 1,212 PM records. The imbalance was distributed between three States, South Carolina, Tennessee, and Virginia as follows:

Table 1.3-9 Non-Corresponding Aircraft Emissions Records

Aircraft NO_x records with no corresponding PM record:

Aircraft Type	South Carolina	Virginia	Total
Military Aircraft	8	100	108
General Aviation Aircraft	14	94	108
Air Taxi Aircraft	5	99	104
Aggregate	27	293	320

Aircraft PM records with no corresponding NO_x record:

Aircraft Type	Tennessee	Total
Air Taxi Aircraft	1	1
Aggregate	1	1

The unmatched PM record was for Hamilton County (Chattanooga), Tennessee and when removed, was not replaced since there was no corresponding NO_x record with which to estimate revised PM emissions. It is unclear how this orphaned record originated, but clearly there can be no air taxi PM emissions without other combustion-related emissions. Thus, the removal of the PM_{10} and $PM_{2.5}$ records for Hamilton County permanently reduced the overall size of the 2002 initial base year inventory database used as a starting point for Base F by two records.

Of the 320 unmatched NO_x records, 269 were records for which the reported emission rate was zero. Therefore, even though associated PM records were missing, the overall inventory was not affected. However, the 51 missing records for which NO_x emissions were non-zero, did impact PM estimates for the overall inventory.

Replacement PM_{10} records were calculated for all aircraft NO_x records using the PM-to-NO_x ratios presented above. Aircraft type-specific ratios were utilized in all cases, except for two counties where aircraft emissions were reported under the generic aircraft SCC 2275000000. For these counties (Palm Beach County, Florida and Davidson County, Tennessee), the commercial aircraft PM-to-NO_x ratio was applied since both contain commercial airports (Palm Beach International and Nashville International).

Replacement aircraft $PM_{2.5}$ records were also developed. The initial 2002 base year inventory assumed that aircraft $PM_{2.5}$ was 69 percent of aircraft PM_{10}. The origin of this fraction is not clear, but it is very low for combustion related PM. The majority of internal combustion engine related PM is typically 1 micron or smaller ($PM_{1.0}$), so that typical internal combustion engine $PM_{2.5}$ fractions approach 100 percent. For example, the EPA NONROAD model assumes 92 percent for gasoline engine particulate and 97 percent for diesel engine particulate. Based on recent correspondence from the EPA, it appears that the agency is preparing to recommend a $PM_{2.5}$ fraction of 98 percent for aircraft. (August 12, 2004 e-mail correspondence from U.S. EPA to Gregory Stella of Alpine Geophysics.) This is substantially more consistent with expectations based on emissions test data for other internal combustion engine sources and was used as the basis for the recalculated aircraft $PM_{2.5}$ emission estimates in the Base F inventory.

Although a substantial portion of the initial 2002 base year inventory was ultimately replaced with data prepared by State and local planners under CERR requirements in developing the Base F inventory, it was necessary to first revise the initial 2002 base year aircraft inventory as described so that records extracted from the inventory for areas not supplying CERR data for the Base F update would be accurate. Therefore, in *no case* is the aggregated State data reported for the Base F inventory identical to that of the initial 2002 base year inventory. Even areas relying on the initial 2002 base year inventory will reflect updates in Base F due to changes in emissions of PM_{10} and $PM_{2.5}$ from aircraft.

Table 1.3-10 presents the updated initial 2002 base year inventory estimates. These estimates do not reflect any changes related to modifications made to incorporate the CERR data, but instead indicate the impacts associated solely with the recalculation of aircraft PM emissions alone to apply the more appropriate PM to NO_x ratios. Table 1.3-11 presents a summary of the net impacts of these changes, where an over 90 percent reduction in aircraft PM is observed for all VISTAS areas except South Carolina and Virginia. The reasons for the lesser changes in these two States is that the overall aircraft NO_x inventories for both include a large share of military aircraft NO_x to which no (or very low) particulate estimates were assigned in the initial 2002 base year inventory. Since these operations are assigned non-zero PM emissions under the revised approach, the increase in military aircraft PM offsets a portion of the reduction in commercial aircraft PM. In Virginia, zero (or near zero) PM military operations were responsible for about 35 percent of total aircraft NO_x, while the corresponding fraction in South Carolina was almost 70 percent. As indicated, aggregate aircraft, locomotive, and commercial marine vessel PM is 70-75 percent lower in the updated 2002 base year inventory.

Table 1.3-10 Initial 2002 Base Year Aircraft, Locomotive, and Non-Recreational Marine Emissions with Modified Aircraft PM Emission Rates (annual tons)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	3,787	175	64	62	17	196
	FL	28,518	11,955	3,193	3,129	1,050	3,703
	GA	3,175	992	269	264	94	353
	KY	2,666	657	179	175	63	263
	MS	1,593	140	44	43	13	96
	NC	6,088	1,548	419	411	148	613
	SC	6,505	515	409	401	88	863
	TN	6,854	2,665	707	692	225	920
	VA	17,676	5,607	2,722	2,667	234	3,229
	WV	1,178	78	25	24	8	66
	Total	**78,040**	**24,332**	**8,030**	**7,870**	**1,940**	**10,302**
Commercial Marine (2280)	AL	1,195	9,217	917	843	3,337	736
	FL	5,888	44,817	1,936	1,781	6,683	1,409
	GA	1,038	7,874	334	307	1,173	246
	KY	6,607	50,267	2,246	2,066	9,608	1,569
	MS	5,687	43,233	1,903	1,750	7,719	1,351
	NC	599	4,547	193	178	690	142
	SC	1,067	8,100	343	316	1,205	253
	TN	4,129	31,397	1,390	1,278	5,753	980
	VA	1,198	3,426	929	855	3,258	596
	WV	2,094	15,882	668	614	720	497
	Total	**29,503**	**218,760**	**10,858**	**9,989**	**40,146**	**7,779**
Military Marine (2283)	VA	136	387	28	26	30	59
	Total	136	387	28	26	30	59
Locomotives (2285)	AL	3,490	26,339	592	533	1,446	1,354
	FL	1,006	9,969	247	222	605	404
	GA	2,654	26,733	664	598	1,622	1,059
	KY	2,166	21,811	542	488	1,321	867
	MS	2,302	23,267	578	520	1,429	899
	NC	1,638	16,502	410	369	1,001	654
	SC	1,160	11,690	291	261	710	462
	TN	4,530	44,793	1,110	999	2,689	1,805
	VA	1,928	19,334	1,407	1,266	3,443	798
	WV	1,105	11,150	277	249	681	436
	Total	**21,980**	**211,588**	**6,118**	**5,505**	**14,947**	**8,738**
Grand Total		**129,659**	**455,067**	**25,034**	**23,390**	**57,062**	**26,877**

Table 1.3-11 Change in Initial 2002 Base Year Emissions due to Aircraft PM Emission Rate Modifications.

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	0%	0%	-91%	-87%	0%	0%
	FL	0%	0%	-93%	-90%	0%	0%
	GA	0%	0%	-93%	-90%	0%	0%
	KY	0%	0%	-93%	-90%	0%	0%
	MS	0%	0%	-92%	-89%	0%	0%
	NC	0%	0%	-93%	-90%	0%	0%
	SC	0%	0%	-9%	+29%	0%	0%
	TN	0%	0%	-91%	-87%	0%	0%
	VA	0%	0%	-81%	-73%	0%	0%
	WV	0%	0%	-92%	-89%	0%	0%
	Total	**0%**	**0%**	**-90%**	**-86%**	**0%**	**0%**
Commercial Marine (2280)	AL	0%	0%	0%	0%	0%	0%
	FL	0%	0%	0%	0%	0%	0%
	GA	0%	0%	0%	0%	0%	0%
	KY	0%	0%	0%	0%	0%	0%
	MS	0%	0%	0%	0%	0%	0%
	NC	0%	0%	0%	0%	0%	0%
	SC	0%	0%	0%	0%	0%	0%
	TN	0%	0%	0%	0%	0%	0%
	VA	0%	0%	0%	0%	0%	0%
	WV	0%	0%	0%	0%	0%	0%
	Total	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Military Marine (2283)	VA	0%	0%	0%	0%	0%	0%
	Total	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Locomotives (2285)	AL	0%	0%	0%	0%	0%	0%
	FL	0%	0%	0%	0%	0%	0%
	GA	0%	0%	0%	0%	0%	0%
	KY	0%	0%	0%	0%	0%	0%
	MS	0%	0%	0%	0%	0%	0%
	NC	0%	0%	0%	0%	0%	0%
	SC	0%	0%	0%	0%	0%	0%
	TN	0%	0%	0%	0%	0%	0%
	VA	0%	0%	0%	0%	0%	0%
	WV	0%	0%	0%	0%	0%	0%
	Total	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Grand Total		**0%**	**0%**	**-75%**	**-68%**	**0%**	**0%**

As indicated above, for the Base F 2002 base year inventory, data for all or portions of seven VISTAS States were replaced with corresponding data from recent (as of the fall of 2004) CERR submissions for 2002. Before replacing these data, however, an analysis of the CERR data was performed to ensure consistency with VISTAS inventory methods. It should perhaps also be noted that three of the CERR datasets provided for the Base F 2002 base year inventory (specifically those for Tennessee, Virginia, and West Virginia) included both annual and daily emissions data. Only the annual data were used. Daily values were removed.

Several important observations resulted from this analysis. First, it was clear that all of the CERR data continued to rely on the inaccurate aircraft PM estimation approach employed for the initial 2002 base year inventory. Therefore, an identical aircraft PM replacement procedure as described above for updating the initial 2002 base year inventory was undertaken for CERR supplied data. As a result, the CERR data for *all* VISTAS States has been modified for inclusion in the Base F 2002 VISTAS base year inventory due to PM replacement procedures.

As was the case with the initial VISTAS 2002 base year inventory, there were a substantial number of aircraft NO_x records without corresponding PM records, so that the number of recalculated PM records added to the CERR dataset is greater than the number of PM records removed. The aggregated CERR inventory data, reflecting data for all or parts of seven States, consisted of 13,656 records, of which 1,211 were aircraft NO_x records. However, the number of corresponding aircraft PM records was 662 (662 PM_{10} records and 662 $PM_{2.5}$ records). This imbalance was distributed as follows:

Table 1.3-12 CERR Aircraft NO_x Records with No Corresponding PM Record.

Aircraft Type	Georgia	Tennessee	Virginia	Total
Military Aircraft			136	136
Commercial Aircraft		4	136	140
General Aviation Aircraft	1		136	137
Air Taxi Aircraft			136	136
Aggregate	**1**	**4**	**544**	**549**

From this tabulation, it is clear that virtually the entire imbalance is associated with the Virginia CERR submission, with minor imbalances in Georgia and Tennessee. Of the 549 unmatched NO_x records, 461 were records for which the reported emission rate was zero. Therefore, even though the associated PM records were missing, the overall inventory was not affected. However, the 88 missing records for which NO_x emissions were non-zero do impact PM emission estimates for the overall inventory.

Replacement aircraft PM records (both PM_{10} and $PM_{2.5}$) were generated for the CERR dataset using procedures identical to those described above for the updated initial 2002 base year inventory.

Further analysis revealed that the CERR data for Virginia included only VOC, CO, and NO_x emissions for all aircraft, locomotives, and non-recreational marine vessels. Since SO_2, PM_{10}, and $PM_{2.5}$ records are included in the 2002 VISTAS inventory, an estimation method was developed for these emission species and applied to the Virginia CERR data. For PM, the developed methodology was only employed for locomotive and marine vessel data since aircraft PM was estimated using the PM-to-NO_x ratio methodology described above.

Consideration was given to simply adding the Virginia SO_2 and non-aircraft PM records from the initial 2002 VISTAS inventory dataset, but it is very unlikely that either the source distribution or associated emission rates are identical across the CERR and initial VISTAS inventories. This was confirmed through a comparative analysis of dataset CO records. Therefore, an estimation methodology was developed using Virginia source-specific SO_2/CO, PM_{10}/CO, and $PM_{2.5}$/PM_{10} ratios from the initial 2002 base year VISTAS inventory. The calculated ratios were then applied to the source-specific CERR CO emission estimates to derive associated source-specific SO_2, PM_{10}, and $PM_{2.5}$ emissions for the Base F inventory.

Initially, the development of the emissions ratios from the initial 2002 base year inventory was performed at the State (i.e., Virginia), county, and SCC level of detail. However, it readily became clear that there were substantial inconsistencies in ratios for identical SCCs across counties. For example, in one county, the SO_2/CO ratio might be 0.2, while in the next county it would be 2.0. Since the sources in question are virtually identical (e.g., diesel locomotives) and since the fueling infrastructure for these large non-road equipment sources is regional as opposed to local in nature, such variations in emission rates are not realistic. Therefore, a more aggregated approach was employed in which SCC-specific emission ratios were developed for the State as a whole. Through this approach county-to-county variation in emission ratios is eliminated, but the underlying variation in CO emissions does continue to influence the resulting aggregate emission estimates. The applied emission ratios are as follows:

Table 1.3-13 Calculated Emission Ratios for VA.

Source	SCC	SO_2/CO	PM_{10}/CO	$PM_{2.5}$/CO	$PM_{2.5}$/PM_{10}
Military Aircraft	2275001000	0.0215	*Emissions estimated using PM-to-NO_x ratios as described previously.*		
Commercial Aircraft	2275020000	0.3292			
General Aviation Aircraft	2275050000	0.0002			
Air Taxi Aircraft	2275060000	0.0015			
Aircraft Refueling	2275900000	0.0000	0.0000	0.0000	
Diesel Commercial Marine	2280002000	0.3697	0.3434	0.3157	0.92
Residual Commercial Marine	2280003000	0.3697	0.3434	0.3157	0.92
Diesel Military Marine	2283002000	0.2422	0.2248	0.2068	0.92
Line Haul Locomotives	2285002005	3.2757	1.2999	1.1696	0.90
Yard Locomotives	2285002010	2.2908	1.2461	1.1205	0.90

It is important to recognize that the inconsistency of emissions ratios across Virginia counties for sources of virtually identical design, which utilize a regional rather than local fueling infrastructure, has potential implications for other VISTAS States. There is no immediately obvious reason to believe that such inconsistencies would be isolated to Virginia.

One final revision to the CERR dataset was undertaken as part of the Base F effort, and that was the removal of two records for unpaved airstrip particulate (SCC 2275085000) in Alabama. Otherwise identical records for these emissions were reported both in terms of filterable and primary particulate. The filterable particulate records were removed as all other particulate emissions in the VISTAS inventories are in terms of primary particulate. It is also perhaps worth noting that a series of aircraft refueling records (SCC 2275900000) for Virginia were left in place, even through typically such emissions would be reported under SCC 2501080XXX in the area source inventory. If additional VISTAS aircraft refueling emissions are reported under SCC 2501080XXX, then it may be desirable to recode these records.

Finally, data for areas of the VISTAS region not represented in the CERR dataset were added to the CERR data by extracting the appropriate records from the initial 2002 base year inventory (with revisions for aircraft PM to NO_x ratios). Specifically, records applicable to the States of Florida, Kentucky, South Carolina, and the Tennessee counties of Davidson, Hamilton, Knox, and Shelby were extracted from the revised initial 2002 inventory and added to the CERR dataset to establish the 2002 Base F inventory.

Following this aggregation, one last dataset revision was implemented to complete the development of the 2002 Base F inventory. As indicated in the introduction of this section, the initial 2002 base year emission estimates for Miami International Airport were determined to be excessive. Although the reason for this inaccuracy was not apparent, revised estimates for aircraft emissions in Miami-Dade County were obtained from Florida planners and used to overwrite the erroneous estimates. (Aircraft emission estimates were provided in an August 10, 2004 e-mail transmittal from Bruce Coward of Miami-Dade County to Martin Costello of the Florida Department of Environmental Protection.)

Table 1.3-14 presents a summary of the resulting Base F VISTAS 2002 base year inventory estimates for aircraft, locomotives, and non-recreational marine vessels. Table 1.3-15 provides a comparison of the Base F 2002 base year inventory estimates to those of the initial 2002 base year inventory. As indicated, total emissions for VOC, CO, NO_x, and SO_2 are generally within 10 percent, but final PM emissions are reduced by 70-80 percent due to the approximate 90 percent reductions in aircraft PM estimates. In addition, the significant changes in Georgia aircraft emissions are due to the CERR correction of Atlanta Hartsfield International Airport emissions, which were significantly underestimated in the initial 2002 base year inventory. The reduction in Florida aircraft emissions due to the correction of Miami International estimates is also apparent.

Lastly, Table 1.3-16 provides a direct comparison of emission estimates from the initial and Base F 2002 base year inventories for all 16 VISTAS region airports with estimated annual aircraft NO_x emissions of 200 tons or greater (as identified at the conclusion of the Base F revisions).[3] The table entries are sorted in order of decreasing NO_x and once again, the dramatic reduction in PM emissions is evident. However, in addition, the appropriate reversal of the relationship between Atlanta's Hartsfield and Miami International Airport is also depicted. As a rough method of quality assurance, Table 1.3-15 also includes a *gross* estimate of expected airport NO_x emissions using detailed NO_x estimates developed for Tucson International Airport in conjunction with the ratio of local to Tucson LTOs. (The Tucson NO_x estimates are revised to reflect a standard LTO cycle rather than the Tucson-specific LTO cycle. This should provide for a more realistic comparison to VISTAS estimates.) This is not meant to serve as anything other than a crude indicator of the propriety of the developed VISTAS estimates, and it is clear that the range of estimated-to-expected NO_x emissions has been substantially narrowed in the Base F 2002 base year inventory. Whereas estimated-to-expected ratios varied from about 0.2 to over 3.5 in the initial 2002 base year inventory, the range of variation is tightened on both ends, from about 0.5 to 1.75 for the Base F 2002 base year inventory. In effect, all estimates are now within a factor of two of the expected estimates, which is quite reasonable given likely variation in local and standard LTO cycles and variations in aircraft fleet mix across airports.

It is perhaps important to note that some shifting in county emissions assignments is evident between the initial and Base F 2002 base year aircraft inventories. For example, for the initial 2002 base year inventory, Atlanta Hartsfield estimates were assigned to Fulton County (FIP 13121), while they are assigned to Clayton County (FIP 13063) for the Base F 2002 base year inventory. Similarly, Dulles International Airport emissions were assigned solely to Fairfax County, Virginia (FIP 51059) in the initial 2002 base year inventory, but are split between Fairfax and Loudoun County (FIP 51107) for Base F. Such shifts reflect local planner decision-making and are not an artifact of the revisions described above.

[3] Subsequent revisions performed for Base G result in the addition of the Cincinnati/Northern Kentucky International Airport to the group of airports with aircraft operations generating at least 200 tons of NO_x. These revisions are discussed below, including the addition of an appropriately modified version of the aircraft emissions table.

Table 1.3-14 Base F 2002 Base Year Aircraft, Locomotive, and Non-Recreational Marine Emissions (tons/year)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	3,787	175	226	87	17	196
	FL	25,431	8,891	2,424	2,375	800	3,658
	GA	6,622	5,372	1,475	1,446	451	443
	KY	2,666	657	179	175	63	263
	MS	1,593	140	44	43	13	96
	NC	6,088	1,548	419	411	148	613
	SC	6,505	515	409	401	88	863
	TN	7,251	2,766	734	719	235	943
	VA	9,763	2,756	1,137	1,115	786	2,529
	WV	1,178	78	25	24	8	66
	Total	**70,884**	**22,899**	**7,072**	**6,797**	**2,607**	**9,670**
Commercial Marine (2280)	AL	1,196	9,218	917	844	3,337	737
	FL	5,888	44,817	1,936	1,781	6,683	1,409
	GA	1,038	7,875	334	307	1,173	246
	KY	6,607	50,267	2,246	2,066	9,608	1,569
	MS	5,688	43,233	1,903	1,751	7,719	1,351
	NC	599	4,547	193	178	690	142
	SC	1,067	8,100	343	316	1,205	253
	TN	3,624	27,555	1,217	1,120	4,974	860
	VA	972	2,775	334	307	359	483
	WV	1,528	11,586	487	448	525	362
	Total	**28,207**	**209,972**	**9,911**	**9,118**	**36,275**	**7,413**
Military Marine (2283)	VA	110	313	25	23	27	48
	Total	**110**	**313**	**25**	**23**	**27**	**48**
Locomotives (2285)	AL	3,490	26,339	592	533	1,446	1,354
	FL	1,006	9,969	247	222	605	404
	GA	2,725	27,453	682	614	1,667	1,086
	KY	2,166	21,811	542	488	1,321	867
	MS	2,302	23,267	578	520	1,429	899
	NC	1,638	16,502	410	369	1,001	654
	SC	1,160	11,690	291	261	710	462
	TN	2,626	25,627	633	570	1,439	1,041
	VA	1,186	11,882	1,529	1,375	3,641	492
	WV	1,311	13,224	329	296	808	517
	Total	**19,611**	**187,764**	**5,833**	**5,248**	**14,066**	**7,777**
Grand Total		**118,812**	**420,948**	**22,841**	**21,186**	**52,976**	**24,908**

Table 1.3-15 Change in 2002 Emissions, Base F Inventory Relative to Initial Inventory

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	0%	0%	-67%	-82%	0%	0%
	FL	-11%	-26%	-95%	-93%	-24%	-1%
	GA	+109%	+442%	-62%	-47%	+379%	+26%
	KY	0%	0%	-93%	-90%	0%	0%
	MS	0%	0%	-92%	-89%	0%	0%
	NC	0%	0%	-93%	-90%	0%	0%
	SC	0%	0%	-9%	+29%	0%	0%
	TN	+6%	+4%	-91%	-87%	+4%	+2%
	VA	-45%	-51%	-92%	-89%	+236%	-22%
	WV	0%	0%	-92%	-89%	0%	0%
	Total	**-9%**	**-6%**	**-92%**	**-88%**	**+34%**	**-6%**
Commercial Marine (2280)	AL	+0%	+0%	+0%	+0%	+0%	+0%
	FL	0%	0%	0%	0%	0%	0%
	GA	+0%	+0%	+0%	+0%	+0%	+0%
	KY	0%	0%	0%	0%	0%	0%
	MS	+0%	+0%	+0%	+0%	+0%	+0%
	NC	+0%	+0%	+0%	+0%	+0%	+0%
	SC	0%	0%	0%	0%	0%	0%
	TN	-12%	-12%	-12%	-12%	-14%	-12%
	VA	-19%	-19%	-64%	-64%	-89%	-19%
	WV	-27%	-27%	-27%	-27%	-27%	-27%
	Total	**-4%**	**-4%**	**-9%**	**-9%**	**-10%**	**-5%**
Military Marine (2283)	VA	-19%	-19%	-12%	-12%	-12%	-19%
	Total	**-19%**	**-19%**	**-12%**	**-12%**	**-12%**	**-19%**
Locomotives (2285)	AL	0%	0%	0%	0%	0%	0%
	FL	0%	0%	0%	0%	0%	0%
	GA	+3%	+3%	+3%	+3%	+3%	+3%
	KY	0%	0%	0%	0%	0%	0%
	MS	0%	0%	0%	0%	0%	0%
	NC	0%	0%	0%	0%	0%	0%
	SC	0%	0%	0%	0%	0%	0%
	TN	-42%	-43%	-43%	-43%	-46%	-42%
	VA	-38%	-39%	+9%	+9%	+6%	-38%
	WV	+19%	+19%	+19%	+19%	+19%	+19%
	Total	**-11%**	**-11%**	**-5%**	**-5%**	**-6%**	**-11%**
Grand Total		**-8%**	**-7%**	**-77%**	**-71%**	**-7%**	**-7%**

Table 1.3-16 Base F Comparison of Aircraft Emissions (Airports with Aircraft NO_x > 200 tons per year)

Airport	FIP	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	Approx. LTOs	Predicted NO_x	VISTAS to Predicted
Initial 2002 Base Year Inventory										
Miami	12086	9,757	5,997	23,706	16,357	525	1,641	150,000	1,680	3.57
Orlando	12095	3,456	2,170	8,578	5,919	204	642	150,000	1,680	1.29
Memphis	47157	3,462	1,934	7,645	5,275	185	603	125,000	1,400	1.38
Reagan	51013	3,892	1,806	7,138	4,925	164	302	100,000	1,120	1.61
Hampton	51650	2,690	1,705	0	0	0	611	Military		
Dulles	51059	2,032	1,330	5,246	3,620	0	272	75,000	840	1.58
Orlando-Sanford	12117	3,615	1,225	4,837	3,337	100	351			
Atlanta	13121	1,457	913	3,608	2,490	86	274	420,000	4,704	0.19
Fort Lauderdale	12011	1,930	809	3,196	2,206	75	257	75,000	840	0.96
Charlotte	37119	1,643	788	3,113	2,148	75	255	150,000	1,680	0.47
Tampa	12057	1,399	785	3,101	2,140	74	240	75,000	840	0.93
Nashville	47037	1,819	653	40	28	33	239	60,000	672	0.97
Raleigh	37183	1,584	592	2,338	1,613	56	204	75,000	840	0.70
Louisville	21111	1,073	468	1,851	1,277	45	155	60,000	672	0.70
Jacksonville	12031	871	325	1,284	886	31	112	30,000	336	0.97
Palm Beach	12099	1,156	226	0	0	1	132	30,000	336	0.67
Aggregate		41,836	21,724	75,682	52,220	1,655	6,290			0.19-3.57
Base F 2002 Base Year Inventory										
Atlanta	13063	4,121	5,288	1,435	1,406	443	337	420,000	4,704	1.12
Miami	12086	6,670	2,933	805	789	274	1,596	150,000	1,680	1.75
Orlando	12095	3,456	2,170	568	556	204	642	150,000	1,680	1.29
Memphis	47157	3,462	1,934	506	495	185	603	125,000	1,400	1.38
Orlando-Sanford	12117	3,615	1,225	338	332	100	351			
Fort Lauderdale	12011	1,930	809	217	212	75	257	75,000	840	0.96
Charlotte	37119	1,643	788	206	202	75	255	150,000	1,680	0.47
Tampa	12057	1,399	785	206	202	74	240	75,000	840	0.93
Nashville	47037	1,819	653	170	166	33	239	60,000	672	0.97
Reagan	51013	1,269	635	171	168	193	97	100,000	1,120	0.57
Dulles 1	51107	1,807	595	164	161	252	153	37,500	420	1.42
Raleigh	37183	1,584	592	156	153	56	204	75,000	840	0.70
Dulles 2	51059	1,095	591	156	153	252	115	37,500	420	1.41
Hampton	51650	858	535	471	461	18	305	Military		
Louisville	21111	1,073	468	123	121	45	155	60,000	672	0.70
Jacksonville	12031	871	325	87	85	31	112	30,000	336	0.97
Palm Beach	12099	1,156	226	59	58	1	132	30,000	336	0.67
Aggregate		37,829	20,550	5,838	5,721	2,312	5,793			0.47-1.75
Net Change		**-10%**	**-5%**	**-92%**	**-89%**	**+40%**	**-8%**			

Note: For the Base F inventory, Dulles International Airport emissions are split between two Virginia counties.
Predicted NO_x is based on the ratio of airport LTOs to test airport (Tucson International Airport) LTOs and NO_x.
This is not a rigorous comparison, but rather an approximate indicator of expected magnitude.

Base G Revisions:

Further revisions to the 2002 base year emissions inventory were implemented in response to additional state data submittals in the spring of 2006. The inventories developed through the Base F revision process (as described above) served as the starting point for the 2006 revisions. Thus, unless otherwise indicated below, all documented Base F revisions continue to apply to the Base G-revised 2002 base year inventory.

As part of the Base G review and update process, Virginia regulators provided 443 updated emission records for aircraft. These records reflected revisions to aircraft VOC, CO, and NO_x, and in a few cases SO_2, emissions records that were already in the Base F VISTAS 2002 inventory (as opposed to the addition of previously unreported data). The specific revisions broke down as follows:

Table 1.3-17 Base G VA Aircraft Records Updates

Aircraft Type	VOC	CO	NO_x	SO_2	Total
Military Aircraft	9	9	9	1	28
Commercial Aircraft	12	12	12	17	53
General Aviation Aircraft	65	66	66	0	197
Air Taxi Aircraft	56	56	53	0	165
Aggregate	142	143	140	18	443

Emissions values for each of the 443 records in the Base F 2002 VISTAS inventory were updated for Base G to reflect the revised data. However, as described above for the Base F revisions, all aircraft SO_2, PM_{10}, and $PM_{2.5}$ emissions in Virginia are estimated on the basis of CO (in the case of SO_2) and NO_x emissions (in the cases of PM_{10} and $PM_{2.5}$). Therefore, since Virginia regulators did not provide updated SO_2 emissions for all updated CO emissions records, or updated PM_{10} or $PM_{2.5}$ emissions for all updated NO_x emissions records, it was necessary to re-estimate aircraft SO_2, PM_{10}, and $PM_{2.5}$ emissions in all cases where updated CO or NO_x emissions were provided for Base G (and explicit SO_2 and/or PM_{10} and $PM_{2.5}$ emissions were not).

The procedure used to estimate the SO_2, PM_{10}, and $PM_{2.5}$ emissions revisions was identical to that described above for the Base F inventory revisions, except that revised SO_2-to-CO emissions ratios were calculated for commercial aircraft, where 12 pairs of revised CO and SO_2 emissions estimates were available. Although a single pair of revised CO and SO_2 emissions records was available for military aircraft, this was deemed an insufficient sample with which to replace the military aircraft SO_2-to-CO emissions ratios previously calculated in Base F. However, it is worth noting that the SO_2-to-CO emissions ratio for the revised military aircraft emissions pair was within 16 percent of the previously calculated ratio, so any error associated with retention of the Base F ratio will be minor. Table 1.3-18 presents the emissions ratios.

Table 1.3-18 Calculated Base G Emission Ratios for VA.

Source	SCC	SO_2/CO (fall 2004)	SO_2/CO (spring 2006)	SO_2/CO (used in 2006)	PM_{10}/NO_x	$PM_{2.5}/PM_{10}$
Military Aircraft	2275001000	0.0215	0.0180	0.0215	0.88	0.98
Commercial Aircraft	2275020000	0.3292	0.0696	0.0696	0.26	0.98
General Aviation Aircraft	2275050000	0.00016	n/a	0.00016	1.9	0.98
Air Taxi Aircraft	2275060000	0.0015	n/a	0.0015	0.5	0.98

Application of the SO_2-to-CO emissions ratios to the 130 revised aircraft CO records, for which no corresponding SO_2 emission revisions were provided, resulted in an additional 130 aircraft SO_2 emission records updates for Virginia. Similarly, application of the PM_{10}-to-NO_x emissions ratios to the 140 revised aircraft NO_x records for which no corresponding PM_{10} emission revisions were provided, resulted in an additional 140 aircraft PM_{10} emission records updates for Virginia. Application of the $PM_{2.5}$-to-PM_{10} emissions ratios to the 140 revised aircraft PM_{10} records resulted in an additional 140 aircraft $PM_{2.5}$ emission records updates for Virginia. Thus, in total, 853 (443+130+140+140) Virginia aircraft emissions records were updated for Base G.

Also as part of the Base G review and update process, Alabama regulators provided 178 updated PM emission records for aircraft (89 records for PM_{10} and 89 records for $PM_{2.5}$), 42 additional emissions records for locomotives (14 records for VOC, 14 records for CO, and 14 records for NO_x), and 179 additional emission records for aircraft (30 records for VOC, 30 records for CO, 30 records for NO_x, 29 records for SO_2, 30 records for PM_{10}, and 30 records for $PM_{2.5}$). After review, it was determined that the 178 updated PM emission records for aircraft actually reflected the original (overestimated) aircraft PM data that was replaced universally throughout the VISTAS region for Base F. Implementing these latest revisions would, in effect, “undo” the Base F aircraft PM revisions. Following discussions with Alabama regulators, it was determined that the 178 aircraft PM records would not be updated for the Base G revisions.

The 42 additional emissions records for locomotives were determined to correspond exactly to existing SO_2, PM_{10}, and $PM_{2.5}$ emissions records already in the Base F VISTAS 2002 inventory. It is not clear why these existing records contained no corresponding data for VOC, CO, and NO_x, but those data are now reflected through the additional 42 records that have now been added to the Base G 2002 VISTAS inventory for Alabama.

After examining the 179 additional aircraft emissions records in conjunction with Alabama regulators, it was determined that 17 of the records (commercial aircraft records in Dale, Limestone, and Talladega counties) were erroneous and should be excluded from the update. The remaining 162 records reflected additional general aviation, air taxi, and military aircraft activity in 20 counties and were specifically comprised of 27 records each for VOC, CO, NO_x, SO_2, PM_{10}, and $PM_{2.5}$. There were no further issues with the VOC, CO, NO_x, and SO_2 records and these were added to the Base G 2002 VISTAS inventory without change. It was, however, apparent that the PM_{10} and $PM_{2.5}$ records reflected an overestimation of aircraft PM similar to that which was previously corrected throughout the VISTAS region for Base F (as documented above). To overcome this overestimation, the additional aircraft PM_{10} and $PM_{2.5}$ records provided by Alabama regulators were replaced with revised emission estimates developed on the basis of the PM_{10}-to-NO_x and $PM_{2.5}$-to-PM_{10} ratios documented under the Base F revisions above. So although 27 aircraft PM_{10} records and 27 aircraft $PM_{2.5}$ records were added to the 2002 Alabama inventory, they reflected different emissions values than those provided directly by Alabama regulators.

In total, 204 additional emissions records (42 for locomotives and 162 for aircraft) were added to the Base G 2002 Alabama inventory.

Finally, as part of the Base G review and update process, Kentucky regulators provided 12 updated aircraft emission records for Boone County, to correct previously underestimated aircraft emissions associated with the Cincinnati/Northern Kentucky International Airport. VOC, CO, and NO_x emissions data were provided for military, commercial, general aviation, and air taxi aircraft. No associated updates for SO_2, PM_{10}, or $PM_{2.5}$ emissions were provided. Corresponding PM_{10} emission estimates were developed by applying the PM_{10}-to-NO_x ratios presented in Table 1.3-17 above to the updated NO_x emission estimates. $PM_{2.5}$ emission estimates were developed by applying the $PM_{2.5}$-to-PM_{10} ratios from that same table to the estimated PM_{10} emissions. SO_2 emission estimates were developed by applying the SO_2-to-PM_{10} ratios developed from the older data (i.e., the data being replaced) for Boone County aircraft to the updated PM_{10} emissions. Thus, a total of 24 inventory records for Kentucky were updated (VOC, CO, NO_x, SO_2, PM_{10}, and $PM_{2.5}$ for four aircraft types).

Upon implementation of the universe of updates, 877 existing emission records were revised (853 in Virginia and 24 in Kentucky) and 204 additional emission records (all in Alabama) were added to the 2002 VISTAS inventory. The total number of aircraft, locomotive, and commercial marine inventory records thus changed from 22,838 records in Base F to 23,042 records in Base G.

Table 1.3-19 presents a summary of the resulting Base G VISTAS 2002 base year inventory estimates for aircraft, locomotives, and non-recreational marine vessels. Table 1.3-20 provides a comparison of the Base G 2002 base year inventory estimates to those of the Base F 2002 base year inventory. As indicated, total emissions for VOC, CO, NO_x, and SO_2 are generally within about 5 percent, with changes restricted to the states of Alabama, Kentucky, and Virginia.

Lastly, Table 1.3-21 provides an updated comparison of emission estimates from the Base F and Base G 2002 base year inventories for all 17 VISTAS region airports with estimated annual aircraft NO_x emissions of 200 tons or greater. As compared to Table 1.3-16, the table reflects the Base G addition of the Cincinnati/Northern Kentucky International Airport. Aircraft emission estimates for the other 16 airports are unchanged from their Base F values.

Table 1.3-19 Base G-Revised 2002 Base Year Aircraft, Locomotive, and Non-Recreational Marine Emissions (tons/year)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	5,595	185	238	99	18	276
	FL	25,431	8,891	2,424	2,375	800	3,658
	GA	6,620	5,372	1,475	1,446	451	443
	KY	5,577	925	251	246	88	397
	MS	1,593	140	44	43	13	96
	NC	6,088	1,548	419	411	148	613
	SC	6,505	515	409	401	88	863
	TN	7,251	2,766	734	719	235	943
	VA	11,873	3,885	2,010	1,970	272	2,825
	WV	1,178	78	25	24	8	66
	Total	**77,712**	**24,305**	**8,029**	**7,734**	**2,121**	**10,179**
Commercial Marine (2280)	AL	1,196	9,218	917	844	3,337	737
	FL	5,888	44,817	1,936	1,781	6,683	1,409
	GA	1,038	7,875	334	307	1,173	246
	KY	6,607	50,267	2,246	2,066	9,608	1,569
	MS	5,688	43,233	1,903	1,751	7,719	1,351
	NC	599	4,547	193	178	690	142
	SC	1,067	8,100	343	316	1,205	253
	TN	3,624	27,555	1,217	1,120	4,974	860
	VA	972	2,775	334	307	359	483
	WV	1,528	11,586	487	448	525	362
	Total	**28,207**	**209,972**	**9,911**	**9,118**	**36,275**	**7,413**
Military Marine (2283)	VA	110	313	25	23	27	48
	Total	**110**	**313**	**25**	**23**	**27**	**48**
Locomotives (2285)	AL	3,518	26,623	592	533	1,446	1,365
	FL	1,006	9,969	247	222	605	404
	GA	2,654	26,733	664	598	1,622	1,059
	KY	2,166	21,811	542	488	1,321	867
	MS	2,302	23,267	578	520	1,429	899
	NC	1,638	16,502	410	369	1,001	654
	SC	1,160	11,690	291	261	710	462
	TN	2,626	25,627	633	570	1,439	1,041
	VA	1,186	11,882	1,529	1,375	3,641	492
	WV	1,311	13,224	329	296	808	517
	Total	**19,568**	**187,328**	**5,815**	**5,232**	**14,022**	**7,761**
Grand Total		**125,597**	**421,918**	**23,780**	**22,107**	**52,444**	**25,401**

Table 1.3-20 Change in 2002 Emissions, Base G Inventory Relative to Base F Inventory

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	+48%	+6%	+5%	+14%	+7%	+41%
	FL	0%	0%	0%	0%	0%	0%
	GA	0%	0%	0%	0%	0%	0%
	KY	+109%	+41%	+40%	+40%	+41%	+51%
	MS	0%	0%	0%	0%	0%	0%
	NC	0%	0%	0%	0%	0%	0%
	SC	0%	0%	0%	0%	0%	0%
	TN	0%	0%	0%	0%	0%	0%
	VA	+22%	+41%	+77%	+77%	-65%	+12%
	WV	0%	0%	0%	0%	0%	0%
	Total	**+10%**	**+6%**	**+14%**	**+14%**	**-19%**	**+5%**
Commercial Marine (2280)	AL	0%	0%	0%	0%	0%	0%
	FL	0%	0%	0%	0%	0%	0%
	GA	0%	0%	0%	0%	0%	0%
	KY	0%	0%	0%	0%	0%	0%
	MS	0%	0%	0%	0%	0%	0%
	NC	0%	0%	0%	0%	0%	0%
	SC	0%	0%	0%	0%	0%	0%
	TN	0%	0%	0%	0%	0%	0%
	VA	0%	0%	0%	0%	0%	0%
	WV	0%	0%	0%	0%	0%	0%
	Total	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Military Marine (2283)	VA	0%	0%	0%	0%	0%	0%
	Total	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Locomotives (2285)	AL	+1%	+1%	0%	0%	0%	+1%
	FL	0%	0%	0%	0%	0%	0%
	GA	0%	0%	0%	0%	0%	0%
	KY	0%	0%	0%	0%	0%	0%
	MS	0%	0%	0%	0%	0%	0%
	NC	0%	0%	0%	0%	0%	0%
	SC	0%	0%	0%	0%	0%	0%
	TN	0%	0%	0%	0%	0%	0%
	VA	0%	0%	0%	0%	0%	0%
	WV	0%	0%	0%	0%	0%	0%
	Total	**+0%**	**+0%**	**0%**	**0%**	**0%**	**+0%**
Grand Total		**+6%**	**+0%**	**+4%**	**+4%**	**-1%**	**+2%**

Table 1.3-21 Base G Comparison of Aircraft Emissions (Airports with Aircraft NO_x > 200 tons per year)

Airport	FIP	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	Approx. LTOs	Predicted NO_x	VISTAS to Predicted
Base F 2002 Base Year Inventory										
Atlanta	13063	4,121	5,288	1,435	1,406	443	337	420,000	4,704	1.12
Miami	12086	6,670	2,933	805	789	274	1,596	150,000	1,680	1.75
Orlando	12095	3,456	2,170	568	556	204	642	150,000	1,680	1.29
Memphis	47157	3,462	1,934	506	495	185	603	125,000	1,400	1.38
Orlando-Sanford	12117	3,615	1,225	338	332	100	351			
Fort Lauderdale	12011	1,930	809	217	212	75	257	75,000	840	0.96
Charlotte	37119	1,643	788	206	202	75	255	150,000	1,680	0.47
Tampa	12057	1,399	785	206	202	74	240	75,000	840	0.93
Nashville	47037	1,819	653	170	166	33	239	60,000	672	0.97
Reagan	51013	1,269	635	171	168	193	97	100,000	1,120	0.57
Dulles 1	51107	1,807	595	164	161	252	153	37,500	420	1.42
Raleigh	37183	1,584	592	156	153	56	204	75,000	840	0.70
Dulles 2	51059	1,095	591	156	153	252	115	37,500	420	1.41
Hampton	51650	858	535	471	461	18	305	Military		
Louisville	21111	1,073	468	123	121	45	155	60,000	672	0.70
Jacksonville	12031	871	325	87	85	31	112	30,000	336	0.97
Palm Beach	12099	1,156	226	59	58	1	132	30,000	336	0.67
Cincinnati	21015	467	144	38	37	14	54	50,000	560	0.26
Aggregate		38,296	20,694	5,876	5,758	2,326	5,847			0.26-1.75
Base G 2002 Base Year Inventory										
Atlanta	13063	4,121	5,288	1,435	1,406	443	337	420,000	4,704	1.12
Miami	12086	6,670	2,933	805	789	274	1,596	150,000	1,680	1.75
Orlando	12095	3,456	2,170	568	556	204	642	150,000	1,680	1.29
Memphis	47157	3,462	1,934	506	495	185	603	125,000	1,400	1.38
Orlando-Sanford	12117	3,615	1,225	338	332	100	351			
Fort Lauderdale	12011	1,930	809	217	212	75	257	75,000	840	0.96
Charlotte	37119	1,643	788	206	202	75	255	150,000	1,680	0.47
Tampa	12057	1,399	785	206	202	74	240	75,000	840	0.93
Nashville	47037	1,819	653	170	166	33	239	60,000	672	0.97
Reagan	51013	1,269	635	171	168	193	97	100,000	1,120	0.57
Dulles 1	51107	1,807	595	164	161	252	153	37,500	420	1.42
Raleigh	37183	1,584	592	156	153	56	204	75,000	840	0.70
Dulles 2	51059	1,095	591	156	153	252	115	37,500	420	1.41
Hampton	51650	858	535	471	461	18	305	Military		
Louisville	21111	1,073	468	123	121	45	155	60,000	672	0.70
Cincinnati	21015	3,378	411	110	107	39	187	50,000	560	0.73
Jacksonville	12031	871	325	87	85	31	112	30,000	336	0.97
Palm Beach	12099	1,156	226	59	58	1	132	30,000	336	0.67
Aggregate		41,207	20,961	5,947	5,828	2,352	5,981			0.47-1.75
Net Change		**+8%**	**+1%**	**+1%**	**+1%**	**+1%**	**+2%**			

Note: For the revised inventory, Dulles International Airport emissions are split between two Virginia counties.
Predicted NO_x is based on the ratio of airport LTOs to test airport (Tucson International Airport) LTOs and NO_x.
This is not a rigorous comparison, but rather an approximate indicator of expected magnitude.

1.3.2.3 Emissions from NONROAD Model Sources in Illinois, Indiana, and Ohio

As part of the Base G update process, VISTAS requested that emissions estimates for 2002 be produced for the states of Illinois, Indiana, and Ohio. These estimates were to be produced at the same spatial (i.e., county level by SCC) and temporal resolution as estimates for the VISTAS region.

The requested estimates were produced by extracting a complete set of county-level input data applicable to each of the three states from the latest version of the EPA's NMIM (National Mobile Inventory Model) model. This included appropriate consideration of all non-default NMIM input files generated by the Midwest Regional Planning Organization (MRPO), as described below. These input data were then assembled into appropriate input files for the Final NONROAD2005 model and emission estimates were produced using the same procedure employed for the VISTAS region as part of the Base G updates.

A complete set of monthly input data was developed for each county in Illinois, Indiana, and Ohio by extracting data from the following NMIM database files (using the NMIM MySQL query browser):

> county, countrynrfile, countyyear, countyyearmonth, countyyearmonthhour, gasoline, diesel, and natural gas

The database files:

> countrynrfile, countyyear, countyyearmonth, and gasoline

were non-default database files provided to VISTAS by the MRPO, and are intended to reflect the latest planning data being used by MRPO modelers.

From these files, monthly data for gasoline vapor pressure, gasoline oxygen content, gasoline sulfur content, diesel sulfur content for land-based equipment, diesel sulfur content for marine-based equipment, natural gas sulfur content, minimum daily temperature, maximum daily temperature, and average daily temperature were developed. In addition, the altitude and Stage II refueling control status of each county, as well as the identity of the associated equipment population, activity, growth, allocation, and seasonal distribution files, was determined. These data were then assembled into Final NONROAD2005 input files on a seasonal basis, with monthly data being arithmetically averaged to produce seasonal equivalents as follows:

Winter	=	Average of December, January, and February
Spring	=	Average of March, April, and May
Summer	=	Average of June, July, and August,
Fall	=	Average of September, October, and November

Unlike the VISTAS Base G approach, this approach results in the use of the following non-default data files during the Final NONROAD2005 modeling process:

Table 1.3-22 Non-Default Files Used for MRPO Modeling

Data File	Illinois	Indiana	Ohio
Activity File	1700002.act	1800002.act	3900002.act
Growth File	17000.grw	18000.grw	39000.grw
Population File	17000.pop	18000.pop	39000.pop
Season File	17000.sea	18000.sea	39000.sea
Inboard Marine Allocation File	17000wib.alo	18000wib.alo	39000wib.alo
Outboard Marine Allocation File	17000wob.alo	18000wob.alo	39000wob.alo
Specific Fuel Consumption	MRPO-specific file provided by MRPO modelers (arbitrarily named “mrpoBSFC.emf” for this work)		

One compromise was made relative to the level of resolution that is available through the basic approach described above, that being the treatment of ambient temperature data. Because NMIM offers a unique temperature profile for every U.S. county -- developed by aggregating temperature data from included and surrounding weather stations on the basis of their distances from the county population centroid -- it is not possible to explicitly group counties with otherwise identical input streams. Ungrouped however, there would be 1,128 distinct input streams to be processed (102 Illinois counties plus 92 Indiana counties plus 88 Ohio counties at four seasons each), or over five times the number of files processed for the entire VISTAS region.

To surmount this problem and allow counties with similar temperature profiles to be grouped an approach was employed wherein counties were considered groupable if *all* temperature inputs[4] are within ± 2 ºF of the corresponding group average. This criterion is quite stringent in that it results in less tolerant grouping than that employed for VISTAS modeling, which uses temperature data from the nearest meteorological station as opposed to "unique" meteorological

4 Non-road temperature inputs used for county grouping are: winter minimum, spring minimum, summer minimum, fall minimum, winter maximum, spring maximum, summer maximum, fall maximum, winter average, spring average, summer average, and fall average.

data for each county. Under this approach, the actual deviation for grouped counties is *much* less that ± 2º F for the overwhelming majority of the 12 grouped temperature inputs.

In addition to the required temperature consistency, all other input data for counties to be grouped had to be identical for all four seasons. Using this criterion, Illinois emissions were modeled using 12 county groups, Indiana emissions were modeled using 9 county groups, and Ohio emissions were modeled using 10 county groups. Thus, 31 iterations of NONROAD2002 were required per season, as compared to the 53 iterations per season required for the VISTAS region.

It should be noted that a potential quality assurance issue was noted in assembling the NONROAD2005 input data for a number of Indiana counties. Specifically, the gasoline vapor pressure for most Indiana counties reflects a value of 9.0 psi in *all* spring, summer, fall, and winter months. This is likely to indicate a problem with the accuracy of the NMIM databases for these counties, but these data were used as defined for this work.

1.3.3 Quality Assurance steps

Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for VISTAS. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the area source component of the 2002 base year revised:

1. All CERR and NIF format State supplied data submittals were run through EPA's Format and Content checking software.
2. SCC level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.
3. Tier comparisons (by pollutant) were developed between the revised 2002 base year inventory and the initial base year inventory.
4. Data product summaries were provided to both the VISTAS Emission Inventory Technical Advisor and to Mobile Source SIWG representatives for review and comment. Changes based on these comments were implemented in the files.
5. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from 1.0 to 2.0. A minor change would cause a version number to go from 1.0 to 1.1. Minor changes resulting from largely editorial changes would result in a change from 1.00 to 1.01.

2.0 Projection Inventory Development

2.1 Point Sources

We used different approaches for different sectors of the point source inventory:

- For the EGUs, VISTAS relied primarily on the Integrated Planning Model® (IPM®) to project future generation as well as to calculate the impact of future emission control programs. The IPM results were adjusted based on S/L agency knowledge of planned emission controls at specific EGUs.
- For non-EGUs, we used recently updated growth and control data consistent with the data used in EPA's CAIR analyses, and supplemented these data with available S/L agency knowledge of planned emission controls or other changes at specific non-EGUs and updated fuel use forecast data for the U.S. Department of Energy.

For both sectors, we generated 2009 and 2018 inventories for a combined on-the-books (OTB) and on-the-way (OTW) control scenario. The OTB/OTW control scenario accounts for post-2002 emission reductions from promulgated and proposed non-EGU federal control programs as of July 1, 2004; the final Clean Air Interstate Rule (CAIR); and State, local, and site-specific control programs as of October 1, 2007. Section 2.1.1 discusses the EGU projection inventory development, while Section 2.1.2 discusses the non-EGU projection inventory development.

2.1.1 EGU Emission Projections

The following subsections discuss the following specific aspects of the development of the EGU projections. First, we present a chronology of the EGU development process and discuss key decisions in selecting the final methods for performing the emissions projections. Next, we describe the development of the final set of IPM runs that are included in the VISTAS Base G inventory. Next, we describe the process of transforming the IPM parsed files into NIF format. Fourth, we discuss the process for ensuring that units accounted for in IPM were not double-counted in the non-EGU inventory. Fifth, we describe the QA/QC checks that were made to ensure that the IPM results were properly incorporated into the VISTAS inventory. Sixth, we document the changes to the IPM results that S/L agencies specified they wanted included in the VISTAS inventory based on new information that were not accounted for in the IPM runs. Finally, we present summaries of the B&F projected EGU emissions by year, state, and pollutant.

2.1.1.1 Chronology of the Development of EGU Projections

At the beginning of the EGU inventory development process, VISTAS considered three options for developing the VISTAS 2009 and 2018 projection inventories for EGUs:

- Option 1 – Use the results of IPM modeling conducted in support of the proposed Clean Air Interstate Rule (CAIR) base and control case analyses as the starting point and refine the projections with readily available inputs from stakeholders; these IPM runs were conducted for 2010 and 2015, which VISTAS would use to represent projected emissions in 2009 and 2018 respectively.
- Option 2 – Use the VISTAS 2002 typical year as the starting point, apply growth factors from the Energy Information Administration, and refine future emission rates with stakeholder input regarding utilization rates, capacity, retirements, and new unit information.
- Option 3 – Use the results of a new round of IPM modeling sponsored by VISTAS and the Midwest Regional Planning Organization (MRPO). These runs incorporated VISTAS specific unit and regulation modified parameters, and generate results for 2009 and 2018 explicitly.

An additional consideration for each of the three options was the inclusion of emission projections developed by the Southern Company specifically for their units. Southern Company is a super-regional company which owns EGUs in Alabama, Florida, Georgia, and Mississippi and participates in VISTAS as an industry stakeholder. Southern Company used their energy budget forecast to project net generation and heat input for every existing and future Southern Company EGU for the years 2009 and 2018. Further documentation of how Southern Company generated the 2009/2018 inventory for their units can be found in *Developing Southern Company Emissions and Flue Gas Characteristics for VISTAS Regional Haze Modeling (April 2005, presented at 14th International Emission Inventory Conference).*

Each of these three options and the Southern Company projections were discussed in a series of conference calls with the VISTAS EGU Special Interest Work Group (SIWG) during the fall of 2004. During a conference call on December 6, 2004, the VISTAS EGU SIWG approved the use of the latest VISTAS/MRPO sponsored IPM runs (Option 3) to represent the 2009 and 2018 EGU forecasts of emissions for the OTB and OTW cases. During the call, Alabama and Georgia specified that they did not wish to use Southern Company provided emissions forecasts of 2009 and 2018 to represent the sources in their States. Mississippi decided to utilize the Southern Company projections to represent activity at Southern Company facilities in Mississippi. After the call, Florida decided against using Southern Company provided emissions forecasts of 2009 and 2018 to represent the sources in their State. Thus, Southern Company data was used only for Southern Company units in Mississippi for both the Base F and Base G projections.

The Option 3 IPM modeling resulted from a joint agreement by VISTAS and MRPO to work together to develop future year utility emissions based on IPM modeling. The decision to use

IPM modeling was based in part on a study of utility forecast methods by E.H. Pechan and Associates, Inc. (Pechan) for MRPO, which recommended IPM as a viable methodology (see *Electricity Generating Unit {EGU} Growth Modeling Method Task 2 Evaluation*, February 11, 2004). Although IPM results were available from EPA's modeling to support their rulemaking for the Clean Air Interstate Rule (CAIR), VISTAS stakeholders felt that certain model inputs needed to be improved. Thus, VISTAS and MRPO decided to hire contractors to conduct new IPM modeling and to post-process the IPM results. Southern Company projections in 2009 were roughly comparable with IPM. For 2018, Southern Company projections were generally less than IPM because of assumptions made by Southern Company on which units would be economical to control and incorrect data in the NEEDS database which feeds IPM.

In August 2004, VISTAS contracted with ICF International, Inc., to run IPM to provide utility forecasts for 2009 and 2018 under two future scenarios – Base Case and CAIR Case. The Base Case represents the current operation of the power system under currently known laws and regulations (as known at the time the run was made), including those that come into force in the study horizon. The CAIR Case is the Base Case with the proposed CAIR rule superimposed. The run results were parsed at the unit level for the 2009 and 2018 run years. Also in August 2004, MRPO contracted with E.H. Pechan to post-process the IPM outputs generated by ICF to provide model-ready emission files. The IPM output files were delivered by ICF to VISTAS in November (*Future Year Electricity Generating Sector Emission Inventory Development Using the Integrated Planning Model (IPM®) in Support of Fine Particulate Mass and Visibility Modeling in the VISTAS and Midwest RPO Regions*, January 2005), and the post-processed data files were delivered by Pechan to the MRPO in December 2004 (*LADCO IPM Model Parsed File Post-Processing Methodology and File Preparation*, February 8, 2005).

On March 10, 2005, EPA issued the final Clean Air Interstate Rule. VISTAS and MRPO, in conjunction with other RPOs, conducted another round of IPM modeling which reflected changes to control assumptions based on the final CAIR as well as additional changes to model inputs based on S/L agency and stakeholder comments. Several conference calls were conducted in the spring of 2005 to discuss and provide comments on IPM assumptions related to six main topics: power system operation, generating resources, emission control technologies, set-up parameters and rule, financial assumptions, and fuel assumptions. Based on these discussions, VISTAS sponsored a new set of IPM runs to reflect the final CAIR requirements as well as certain changes to IPM assumptions that were agreed to by the VISTAS states. This set of IPM runs is documented in *Future Year Electricity Generating Sector Emission Inventory Development Using the Integrated Planning Model (IPM®) in Support of Fine Particulate Mass and Visibility Modeling in the VISTAS and Midwest RPO Regions*, April 2005 (these runs are referred to as the VISTAS Phase I analysis).

Further refinements to the IPM inputs and assumptions were made by the RPOs, and ICF performed the following four runs using IPM during the summer of 2005 (these runs are referred to as the VISTAS/CENRAP Phase II analysis):

- Base Case with EPA 2.1.9 coal, gas and oil price assumptions.
- Base Case with EPA 2.1.9 coal and gas supply curves adjusted for AEO 2005 reference case price and volume relationships.
- Strategy Case with EPA 2.1.9 coal, gas and oil price assumptions.
- Strategy Case with EPA 2.1.9 coal and gas supply curves adjusted for AEO 2005 reference case price and volume relationships.

The above runs were parsed for 2009 and 2018 run years. The above four runs were based on VISTAS Phase I and the EPA 2.1.9 assumptions. The changes that were implemented in the above four runs are summarized below:

- Unadjusted AEO 2005 electricity demand projections were incorporated in the above four runs.
- The gas supply curves were adjusted for AEO 2005 reference case price and volume relationships. The EPA 2.1.9 gas supply curves were scaled such that IPM will solve for AEO 2005 gas prices when the power sector gas demand in IPM is consistent with AEO 2005 power sector gas demand projections.
- The coal supply curves used in EPA 2.1.9 were scaled in such a manner that the average mine mouth coal prices that the IPM is solving in aggregated coal supply regions are comparable to AEO 2005. Due to the fact that the coal grades and supply regions between AEO 2005 and the EPA 2.1.9 are not directly comparable, this was an approximate approach and had to be performed in an iterative fashion. The coal transportation matrix was not updated with EIA assumptions due to significant differences between the EPA 2.1.9 and EIA AEO 2005 coal supply and coal demand region configurations.
- The cost and performance of new units were updated to AEO 2005 reference case levels in all of the above four funs.
- The run years 2008, 2009, 2012, 2015, 2018, 2020 and 2026 were modeled.
- The AEO 2005 life extension costs for fossil and nuclear units were incorporated in the above runs.

- The extensive NEEDS comments provided by VISTAS, MRPO, CENRAP and MANE-VU were incorporated into the VISTAS Phase I NEEDS.
- MANE-VU's comments in regards to the state regulations in the northeast were incorporated.
- Renewable Portfolio Standards (RPS) in the northeast was modeled based on the Regional Greenhouse Gas Initiative analysis. A single RPS cap was modeled for MA, RI, NY, NJ, MD and CT. These states could buy credits from NY, PJM and New England model regions.
- The investments required under the Illinois power, Mirant and First Energy NSR settlements were incorporated in the above runs.

For the VISTAS/CENRAP Phase II set of IPM runs, ICF generated two different parsed files. One file includes all fuel burning units (fossil, biomass, landfill gas) as well as non-fuel burning units (hydro, wind, etc.). The second file contains just the fossil-fuel burning units (e.g., emissions from biomass and landfill gas are omitted). The RPOs decided to use the fossil-only file for modeling to be consistent with EPA, since EPA used the fossil only results for CAIR analyses. For the 10 VISTAS states, non-fossil fuels accounted for only 0.13 percent of the NOx emissions and 0.04 percent of the SO_2 emissions in the 2009 IPM runs.

S/L agencies reviewed the results of the VISTAS/CENRAP Phase II set of IPM runs, which were incorporated into the VISTAS Base F inventory. S/L agencies primarily reviewed and commented on the IPM results with respect to IPM decisions on NO_x post-combustion controls and SO_2 scrubbers. S/L agencies provided the latest information on when and where new SO_2 and NO_x controls are planned to come online. S/L agencies also reviewed the IPM results to verify that existing controls and emission rates were properly reflected in the IPM runs. As directed by the S/L agencies, adjustments to the IPM results were made to specific units with any new information they had as part of the permitting process or other contact with the industry that indicates which units will install controls as a result of CAIR and when these new controls will come on-line. Mississippi decided to continue to use the Southern Company projections instead of the IPM projections to represent emissions at Southern Company facilities in Mississippi. The initial set of state-specified changes to the VISTAS/CENRAP Phase II set of IPM runs were used to create the Base G projection inventory (and are documented later in Section 2.1.1.6). The second set of state specified changes were made only for the 2018 inventory, resulting in the Base G2 2018 inventory (documented later in Section 2.1.1.7). The final set of state specified changes applied to both the 2009 and 2018 inventories and were used to create the B&F 2009 and 2018 inventories (documented later in Section 2.1.1.8).

2.1.1.2 VISTAS IPM runs for EGU sources

The following general summary of the VISTAS IPM® modeling is based on ICF's documentation *Future Year Electricity Generating Sector Emission Inventory Development Using the IPM® in Support of Fine Particulate Mass and Visibility Modeling in the VISTAS and Midwest RPO Regions*, April 2005. The ICF documentation is to be used as an extension to EPA's proposed CAIR modeling runs documented in *Documentation Supplement for EPA Modeling Applications (V.2.1.6) Using the IPM*, EPA 430/R-03-007, July 2003.

IPM provides "forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints." The underlying database in this modeling is U.S. EPA's National Electric Energy Data System (NEEDS) released with the CAIR Notice of Data Availability (NODA). The NEEDS database contains the existing and planned/committed unit data in EPA modeling applications of IPM. NEEDS includes basic geographic, operating, air emissions, and other data on these generating units. VISTAS States and stakeholders provided changes for:

- NO_x post-combustion control on existing units
- SO_2 scrubbers on existing units
- SO_2 emission limitations
- PM controls on existing units
- Summer net dependable capacity
- Heat rate for existing units
- SO_2 and NO_x control plans based on State rules or enforcement settlements

The years 2009 and 2018 were explicitly modeled.

2.1.1.3 Post-Processing of IPM Parsed Files

The following summary of the VISTAS/Midwest Regional Planning Organization (MRPO) IPM modeling is based on Pechan's documentation *LADCO IPM Model Parsed File Post-Processing Methodology and File Preparation*, February 8, 2005. The essence of the IPM model post-processing methodology is to take an initial IPM model output file and transform it into air quality model input files. ICF via VISTAS/MRPO provides an initial spreadsheet file containing unit-level records of both

(1) "existing" units and

(2) committed or new generic aggregates.

All records have unit and fuel type data; existing, retrofit (for SO_2 and NO_x), and separate NO_x control information; annual SO_2 and NO_x emissions and heat input; summer season (May-September) NO_x and heat input; July day NO_x and heat input; coal heat input by coal type;

nameplate capacity megawatt (MW), and State FIPS code. Existing units also have county FIPS code, a unique plant identifier (ORISPL) and unit ID (also called boiler ID) (BLRID); generic units do not have these data. The processing includes estimating various types of emissions and adding in control efficiencies, stack parameters, latitude-longitude coordinates, and State identifiers (plant ID, point ID, stack ID, process ID). Additionally, the generic units are sited in a county and given appropriate IDs. This processing is described in more detail below.

The data are prepared by transforming the generic aggregates into units similar to the existing units in terms of the available data. The generic aggregates are split into smaller generic units based on their unit types and capacity, are provided a dummy ORIS unique plant and boiler ID, and are given a county FIPS code based on an algorithm that sites each generic by assigning a sister plant that is in a county based on its attainment/nonattainment status. Within a State, plants (in county then ORIS plant code order) in attainment counties are used first as sister sites to generic units, followed by plants in PM nonattainment counties, followed by plants in 8-hour ozone nonattainment counties. Note that no LADCO or VISTAS States provided blackout counties that would not be considered when siting generics, so this process is identical to the one used for EPA IPM post-processing.

SCCs were assigned for all units; unit/fuel/firing/bottom type data were used for existing units' assignments, while only unit and fuel type were used for generic units' assignments. Latitude-longitude coordinates were assigned, first using the EPA-provided data files, secondly using the September 17, 2004 Pechan in-house latitude-longitude file, and lastly using county centroids. These data were only used when the data were not provided in the 2002 NIF files. Stack parameters were attached, first using the EPA-provided data files, secondly using a March 9, 2004 Pechan in-house stack parameter file based on previous EIA-767 data, and lastly using an EPA June 2003 SCC-based default stack parameter file. These data were only used when the data were not provided in the 2002 NIF files.

Additional data were required for estimating VOC, CO, filterable primary PM_{10} and PM2.5, PM condensable, and NH_3 emissions for all units. Thus, ash and sulfur contents were assigned by first using 2002 EIA-767 values for existing units or SCC-based defaults; filterable PM10 and PM2.5 efficiencies were obtained from the 2002 EGU NEI that were based on 2002 EIA-767 control data and the PM Calculator program (a default of 99.2 percent is used for coal units if necessary); fuel use was back calculated from the given heat input and a default SCC-based heat content; and emission factors were obtained from an EPA-approved October 7, 2004 Pechan emission factor file based on AP-42 emission factors. Note that this updated file is not the one used for estimating emissions for previous EPA post-processed IPM files. Emissions for 28 temporal-pollutant combinations were estimated since there are seven pollutants (VOC, CO, primary PM_{10} and $PM_{2.5}$, NH_3, SO_2 and NO_x) and four temporal periods (annual, summer season, winter season, July day).

The next step was to match the IPM unit IDs with the identifiers in VISTAS 2002 inventory. A crosswalk file was used to obtain FIPS State and county, plant ID (within State and county), and point ID. If the FIPS State and county, plant ID and point ID are in the 2002 VISTAS NIF tables, then the process ID and stack ID are obtained from the NIF; otherwise, defaults, described above, were used.

Pechan provided the post-processed files in NIF 3.0 format. Two sets of tables were developed : “NIF files” for IPM units that have a crosswalk match and are in the 2002 VISTAS inventory, and “NoNIF files” for IPM units that are not in the 2002 VISTAS inventory (which includes existing units with or without a crosswalk match as well as generic units).

For Base F and Base G projections, VISTAS reviewed the PM and NH_3 emissions from EGUs as provided by Pechan and identified significantly higher emissions in 2009/2018 than in 2002. VISTAS determined that Pechan used a set of PM and NH_3 emission factors that are “the most recent EPA approved uncontrolled emission factors” for estimating 2009/2018 emissions. These factors are most likely not the same emission factors used by States for estimating these emissions in 2002 for EGUs in the VISTAS domain. Thus, the emission increase from 2002 to 2009/2018 was simply an artifact of the change in emission factor, not anything to do with changes in activity or control technology application. Also, VISTAS identified an inconsistent use of SCCs for determining emission factors between the base and future years.

VISTAS resolution of the PM and NH_3 problem is fully documented in *EGU Emission Factors and Emission Factor Assignment*, memorandum from Greg Stella to VISTAS State Point Source Contacts and VISTAS EGU Special Interest Workgroup, June 13, 2005. The first step was the adjustment of the 2002 base year emissions inventory. Using the latest “EPA-approved” uncontrolled emission factors by SCC, Alpine Geophysics utilized CERR or VISTAS reported annual heat input, fuel throughput, heat, ash and sulfur content to estimate annual uncontrolled emissions for units identified as output by IPM. This step was conducted for non-CEM pollutants (CO, VOC, PM, and NH_3) only. For PM emissions, the condensable component of emissions was calculated and added to the resulting PM primary estimations. The resulting emissions were then adjusted by any control efficiency factors reported in the CERR or VISTAS data collection effort. The second adjustment was to the future year inventories. Alpine Geophysics updated the SCCs in the future year inventory to assign the same base year SCC. Using the same methods as described for the 2002 revisions, those non-IPM generated pollutants were estimated using IPM predicted fuel characteristics and base year 2002 SCC assignments.

2.1.1.4 Eliminating Double Counting of EGU Units

The following procedures were used to avoid double counting of EGU emissions in the 2009/2018 point source inventory. The 2002 VISTAS point source emission inventory contains both EGUs and non-EGUs. Since this file contains both EGUs and non-EGU point sources, and

EGU emissions are projected using the IPM, it was necessary to split the 2002 point source file into two components. The first component contains those emission units accounted for in the IPM forecasts. The second component contains all other point sources not accounted for in IPM.

As described in the previous section, Pechan developed 2009/2018 NIF files for EGUs from the IPM parsed files. All IPM matched units were initially removed from the 2009/2018 point source inventory to create the non-EGU inventory (which was projected to 2009/2018 using the non-EGU growth and control factors described in Section 2.1.2). This was done on a unit-by-unit basis based on a cross-reference table that matches IPM emission unit identifiers (ORISPL plant code and BLRID emission unit code) to VISTAS NIF emission unit identifiers (FIPSST state code, FIPSCNTY county code, State Plant ID, State Point ID). When there was a match between the IPM ORISPL/BLRID and the VISTAS emission unit ID, the unit was assigned to the EGU inventory; all other emission units were assigned to the non-EGU inventory.

If an emission unit was contained in the NIF files created by Pechan from the IPM output, the corresponding unit was removed from the initial 2009/2018 point source inventory. The NIF 2009/2018 EGU files from the IPM parsed files were then merged with the non-EGU 2009/2018 files to create the 2009/2018 Base F point source files.

Next, we prepared several ad-hoc QA/QC queries to verify that there was no double-counting of emissions in the EGU and non-EGU inventories:

- We reviewed the IPM parsed files {VISTASII_PC_1f_AllUnits_2009 (To Client).xls and VISTASII_PC_1f_AllUnits_2018 (To Client).xls} to identify EGUs accounted for in IPM. We compared this list of emission units to the non-EGU inventory derived from the VISTAS cross-reference table to verify that units accounted for in IPM were not double-counted in the non-EGU inventory. As a result of this comparison, we made a few adjustments in the cross-reference table to add emission units for four plants to ensure these units accounted for in IPM were moved to the EGU inventory.
- We reviewed the non-EGU inventory to identify remaining emission units with an Standard Industrial Classification (SIC) code of "4911 Electrical Services" or Source Classification Code of "1-01-xxx-xx External Combustion Boiler, Electric Generation". We compared the list of sources meeting these selection criteria to the IPM parsed file to ensure that these units were not double-counted.

S/L agencies also reviewed the 2009/2018 point source inventory to verify whether there was any double counting of EGU emissions. In two instances, S/L agencies provided corrections where an emission unit was double counted.

2.1.1.5 Quality Assurance Steps

Quality assurance was an important component to the inventory development process. The following QA steps on the EGU component of the VISTAS revised 2009/2018 EGU inventory:

1. Provided parsed files (i.e., Excel spreadsheets that provide unit-level results derived from the model plant projections obtained by the IPM) to the VISTAS EGU SIWG for review.
2. Provided facility level emission summaries for 2009/2018 for both the base case and CAIR case to the VISTAS EGU SIWG to ensure that emissions were consistent and that there were no missing sources.
3. Compared, at the State-level, emissions from the IPM parsed files and the post-processed NIF files to verify that the post-processed NIF files were consistent with the IPM parsed file results.

VISTAS requested S/L review of these files – the changes specified by states as a result of this review are documented in the following subsection.

2.1.1.6 S/L Adjustments to IPM Modeling Results for Base G Projections

After S/L agency review of the final set of IPM runs (as incorporated into the Base F inventory), S/L agencies specified a number of changes to the IPM results to better reflect current information on when and where future controls would occur. These changes to the IPM results primarily involved S/L agency addition or subtraction future emission controls based on the best available data from state rules, enforcement agreements, compliance plans, permits, and discussions/commitments from individual companies.

For example, Dominion Virginia Power released their company-wide plan to reduce emission to meet the requirements of CAIR and other programs. This plan varies substantially from the IPM results both in terms current and future controls and timing of these controls. As a result, VA DEQ developed their best estimates of future controls on EGUs in Virginia. Also, Duke Energy and Progress Energy have updated their plans for complying with North Carolina's Clean Smokestack Act. These plans vary substantially from the IPM results both in terms current and future controls and timing of these controls. As a result, NC DENR replaced the IPM emission projections for 2009 with projections from the Duke Energy and Progress Energy compliance plan. NC DENR elected to use the IPM results for 2018.

Some S/L agencies specified changes to the controls assigned by IPM to reflect their best estimates of emission controls. These changes involved either 1) adding selective catalytic reduction (SCR) or scrubber controls to units where IPM did not predict SCR or scrubber controls, or 2) removing IPM-assigned SCR or scrubber controls at units where the S/L agency indicated their were no firm plans for controls at those units. We generally used a control efficiency of 90 percent when adding or removing SO_2 scrubber controls (unless a different control efficiency was provided by the State). We generally used a control efficiency of 90 percent when adding or removing NO_x SCR controls at coal-fired plants, 80 percent when adding or removing NO_x SCR controls at gas-fired plants, and 35 percent when adding or removing NO_x SNCR controls (unless a different control efficiency was provided by the State). The changes specified by the S/L agencies are summarized in Table 2.1-1. A comparison of the IPM and VISTAS control assumptions for all coal-fired EGUs in the Base G/G2 inventories are summarized in Appendix H. In addition to the changes to the IPM-assigned controls, the S/L agencies also specified other types of changes to the IPM results. These other specific changes to the IPM results are summarized in Table 2.1-2.

S/L agencies provided information and/or comment on changes in stack parameters from the 2002 inventory for 2009/2018 inventory. Changes to stack parameters were also made in cases where new controls are scheduled to be installed. In cases where an emission unit projected to have a SO_2 scrubber in either 2009 or 2018, some states were able to provide revised stack parameters for some units based on design features for the new control system. Other units projected to install scrubbers by 2009 or 2018 are not far enough along in the design process to have specific design details. For those units, the VISTAS EGU SIWG made the following assumptions: 1) the scrubber is a wet scrubber; 2) keep the current stack height the same; 3) keep the current flow rate the same, and 4) change the stack exit temperature to 169 degrees F (this is the virtual temperature derived from a wet temperature of 130 degrees F). VISTAS determined that exit temperature (wet) of 130 degrees F +/- 5 degrees F is representative of different size units and wet scrubber technology.

2.1.1.7 S/L Adjustments to IPM Modeling Results for Base G2 2018 Projections

Following release of the Base G inventory, four States specified additional changes to reflect their best estimates of emission controls in 2018. These additional changes are marked with an "*" in Tables 2.1-1 and 2.1-2. The following changes were requested and implemented in the VISTAS 2018 Base G2 EGU emissions and modeling inventories:

- **Florida -** Removed scrubbers from Smith units 1 & 2. Added scrubbers to Crist units 4, 5, & 6. Forecast emissions (from 2002 base) using growth factors for Northside units 1A and 2A. These units were estimated to be non operational in the IPM base case run.
- **Georgia -** Added scrubbers to Plant Scherer (Units 1-4) and Plant Yates (Units 6 & 7).
- **North Carolina -** Remove scrubber from F Lee unit 3.
- **West Virginia -** Pleasants Units 1 and 2 had SO2 emissions reduced to account for the facility's inclusion of previously bypassed 15% effluent stream to the scrubber and the control efficiency and emissions will reflect a change from 79.9% to 95% control.

Table 2.1-1 Adjustments to IPM Control Determinations Specified by S/L Agencies for the Base G/G2 2009/2018 EGU Inventories.

State	Plant Name and ID	Unit	NO_x Retrofit Emission Controls				SO_2 Retrofit Emission Controls			
			2009		2018		2009		2018	
			IPM	State	IPM	State	IPM	State	IPM	State
AL	James H. Miller ORISID=6002	1 & 2	SCR during ozone season	SCR probable year round due to CAIR	SCR during ozone season	SCR probable year round due to CAIR	None	None	None	Scrubber
		3 & 4	SCR during ozone season	SCR year round from Consent Decree	SCR during ozone season	SCR year round from Consent Decree	None	None	None	Scrubber
	Barry	1, 2, 3	None	SNCR	SCR	SNCR	None	None	None	None
	ORISID=3	4	None	SNCR	SCR	SNCR	None	None	Scrubber	Scrubber
		5	None	None	SCR	SCR	None	None	Scrubber	Scrubber
	E C Gaston	1 - 4	SCR	None	SCR	None	None	None	Scrubber	Scrubber
	ORISID=26	5	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
	Gorgas	6 & 7	None	None	None	None	None	None	None	None
	ORISID=8	8 & 9	None	None	None	None	None	Scrubber	None	Scrubber
		10	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
	Charles R. Lowman	1	None	None	None	None	None	Scrubber	None	Scrubber
	ORISID=56	2 & 3	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
FL	Lansing Smith	1	None	None	SCR	SCR	None	None	Scrubber	None*
	ORISID=643	2	None	None	SCR	SCR	None	None	Scrubber	None*
	Northside ORISID=667	1A & 1B	No operation	No operation	No operation	No control, emissions forecasted using growth rates*	No operation	No operation	No operation	No control, emissions forecasted using growth rates*

Table 2.1-1 (continued)

State	Plant Name and ID	Unit	NO_x Retrofit Emission Controls				SO_2 Retrofit Emission Controls			
			2009		2018		2009		2018	
			IPM	State	IPM	State	IPM	State	IPM	State
FL	Crist	4	None	None	None	None	None	None	None	Scrubber*
	ORISID=641	5	None	None	None	None	None	None	None	Scrubber*
		6	None	None	None	None	None	None	None	Scrubber*
GA	Bowen	1BLR	SCR	SCR	SCR	SCR	IPM had retrofit scrubbers but little emission reductions	None	Scrubber	Scrubber
	ORISID=703	2BLR	SCR	SCR	SCR	SCR		None	Scrubber	Scrubber
		3BLR	SCR	SCR	SCR	SCR		Scrubber	Scrubber	Scrubber
		4BLR	SCR	SCR	SCR	SCR		Scrubber	Scrubber	Scrubber
	Wansley	1	SCR	SCR	SCR	SCR	IPM had retrofit scrubbers but little emission reductions	Scrubber	Scrubber	Scrubber
	ORISID=6052	2	SCR	SCR	SCR	SCR		None	Scrubber	Scrubber
	Kraft	1, 2	None	None	None	None	None	None	None	None
	ORISID=733	3	None	None	SCR	None	None	None	None	None
	McIntosh ORISID=6124	1	None	None	SCR	None	None	None	None	None
	Yates	1	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
	ORISID=728	2, 3	None	None	None	None	None	None	None	None
		4, 5	None	None	SCR	SCR	None	None	Scrubber	None
		6, 7	None	None	SCR	SCR	None	None	Scrubber	Scrubber*

Table 2.1-1 (continued)

State	Plant Name and ID	Unit	NO_x Retrofit Emission Controls				SO_2 Retrofit Emission Controls			
			2009		2018		2009		2018	
			IPM	State	IPM	State	IPM	State	IPM	State
GA	Hammond	1	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
	ORISID=708	2	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
		3	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
		4	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
	Scherer	1	None	None	None	None	None	None	None	Scrubber*
	ORISID=6257	2	None	None	None	None	None	None	None	Scrubber*
		3	None	None	None	None	None	None	None	Scrubber*
		4	None	None	None	None	None	None	None	Scrubber*
KY	Ghent	1	None	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
	ORISID=1356	2	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
		3, 4	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
	Coleman	C1	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
	ORISID=1381	C2	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
		C3	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
	HMP&L Station 2	H1	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
		H2	None	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
	E W Brown	1	None	None	None	None	None	Scrubber	None	Scrubber
	ORISID=1355	2	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
		3	None	None	SCR	SCR	None	Scrubber	Scrubber	Scrubber
SC	Jeffries	3	SCR	None	SCR	None	None	None	None	None
	ORISID=3319	4	None	None	None	None	None	None	None	None
	Wateree	WAT1	SCR	SCR	SCR	SCR	None	Scrubber	None	Scrubber
	ORISID=3297	WAT2	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber

Table 2.1-1 (continued)

State	Plant Name and ID	Unit	NO_x Retrofit Emission Controls				SO_2 Retrofit Emission Controls			
			2009		2018		2009		2018	
			IPM	State	IPM	State	IPM	State	IPM	State
SC	Canadys ORISID=3280	CAN1	None	None	None	None	None	None	None	None
		CAN2	None	None	None	None	None	None	None	None
		CAN3	None	None	None	None	None	Scrubber	None	Scrubber
	Rainey ORISID=7834	CT1A	None	SCR	None	SCR	None	None	None	None
		CT1B	None	SCR	None	SCR	None	None	None	None
TN	Kingston ORISID=3407	1 – 8	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
		9	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
	Johnsonville ORISID=3406	1 – 10	SCR	None	SCR	SCR	None	None	None	None
WV	Willow Island ORISID=3946	2	SCR	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
	Kammer ORISID=3947	1 -3	SCR	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber

Note: See Appendix H for a complete list of IPM and VISTAS control determinations for all coal and oil/gas units.

Table 2.1-2 Other Adjustments to IPM Results Specified by S/L Agencies for the Base G/G2 2009/2018 EGU Inventories.

State	Plant Name and ID	Unit	Nature of Update/Correction
FL	Central Power and Lime ORISID= 10333	GEN1	Central Power and Lime (ORIS10333) is a duplicate entry. This is point 18 in Florida Crushed Stone (12-053-0530021). Removed IPM emissions for Central Power and Lime.
	Cedar Bay Generating ORISID=10672	GEN1	FLDEP disagrees with IPM projections - no knowledge of expansion of this facility and the cogeneration facility should not grow faster than the underlying industry. Cedar Bay is connected to Stone Container (12-031-0310067). Replaced IPM emissions with 2002 emissions for Cedar Bay (12-031-0310337) times the growth factors for Stone Container.
	Indiantown Cogeneration ORISID=50976	GEN1	FLDEP disagrees with IPM projections - no knowledge of expansion of this facility and the cogeneration facility should not grow faster than the underlying industry. Indiantown is connected to Louis Dreyfus Citrus (12-085-0850002). Replaced IPM emissions with 2002 emissions for Indiantown (12-085-0850102) times the growth factors for Louis Drefus Citrus.
GA	Bowen ORISID=703	1BLR 2BLR 3BLR 4BLR	IPM indicated retrofit scrubbers on all 4 units in 2009, but the IPM emissions showed little reductions from 2002 levels. Changed emissions to reflect scrubbers on 3BLR and 4BLR by 2009.
	Wansley ORISID=6052	1, 2	IPM indicated retrofit scrubbers on both units in 2009, but the IPM emissions showed little reductions from 2002 levels. Changed emissions to reflect one scrubber on Unit 1 by 2009.
	Riverside ORISID=734	4	All of plant Riverside was retired from service June 1, 2005; emissions set to zero in 2009 and 2018.
	McIntosh ORISID=727	CT10A CT10B CT11A CT11B	The McIntosh Combined Cycle facility became commercial June 1, 2005. Added 346 tons of NO_x and 121 tons of SO_2 per unit to the 2009 and 2018 inventories.
	Longleaf Energy Station	1, 2	Longleaf Energy Station is being proposed by LS Power Development, Inc. GA specified that the emissions from this proposed plant be included in the 2018 projections. Boilers 1 and 2 added 1,882 tons of NO_x and 3,227 tons of SO_2 per unit to the 2018 inventory.
	Duke Murray (55382)	1	Corrected coordinates to 34.7189 and -84.9353
MS	R D Morrow ORISID=6061	1, 2	Revised the 2018 emissions to reflect controls not indicated by IPM. The SO_2 emissions are much lower than IPM, but their expected NO_x emissions are actually higher than IPM. The controls will be coming online 2009 or 2010, so the 2009 inventory did not change.
	Jack Watson (2049) Victor J Daniel (6073) Chevron Oil (2047)	All	MS DEQ specified that the emission projections provided by the Southern Company for their units in Mississippi were to be used instead of the IPM results.

Table 2.1-2 (continued)

State	Plant Name and ID	Unit	Nature of Update/Correction
NC	G G Allen (2718) Belews Creek (8042)1 Buck (2720) Cliffside (2721) Dan River (2723) Marshall (2727) Riverbend (2732)	All	Replaced all IPM 2009 results with emission projections from Duke Power's NC Clean Air Compliance Plan for 2006. Used IPM results for 2018
	Asheville (2706) Cape Fear (2708) Lee (2709) Mayo (6250) Roxboro (2712) Sutton (2713) Weatherspoon (2716)	All	Replaced all IPM 2009 results with emission projections from Progress Energy's NC Clean Smokestacks Act Calendar Year 2005 Progress Report. Used IPM results for 2018, except for Lee #3* where IPM projected a retrofit scrubber but NC specified that no scrubber was to be applied.
	Dwayne Collier Battle Cogeneration Facility ORISID=10384	GEN1 GEN2	Dwayne Collier Battle is a duplicate entry. This is Cogentrix of Rocky Mount (37-065-3706500146, stacks G-26 and G-27). Duplicate entries were removed both the 2009 and 2018 inventories.
	Kannapolis Energy Partners ORISID=10626	GEN2 GEN3	Kannapolis Energy emissions are being used as credits for another facility. IPM emissions from this facility (37-025-ORIS10626) were removed from the EGU inventory for 2009 and 2018. Emissions from Kannapolis Energy (37-025-3702500113) were carried forward in the 2009/2018 inventory.
SC	Cross ORISID=130	1, 2	Unit 1: upgrade scrubber from 82 percent to 95 percent removal efficiency by June 30, 2006. Recalculate emissions based on upgrade in control efficiency. Unit 2: upgrade scrubber from 70 percent to 87 percent removal efficiency by June 30, 2006. Recalculate emissions based on upgrade in control efficiency.
	Winyah ORISID=6249	1 – 4	Unit 1: Install scrubber that meets 95 percent removal efficiency by Dec. 31, 2008; Upgrade ESP from 0.38 to 0.03 lb/mmBTU by Dec. 31, 2008 Unit 2: Replace scrubber with one that meets 95 percent removal efficiency from 45 percent by Dec. 31, 2008; Upgrade ESP from 0.10 to 0.03 lb/mmBTU by Dec. 31, 2008 Unit 3: Upgrade scrubber from 70 percent to 90 percent removal efficiency by Dec. 31, 2012; Upgrade ESP from 0.10 to 0.03 lb/mmBTU by Dec. 31, 2012 Unit 4: Upgrade scrubber from 70 percent to 90 percent removal efficiency by Dec. 31, 2007; Upgrade ESP from 0.10 to 0.03 lb/mmBTU by Dec. 31, 2007 Recalculated SO_2 and PM emissions based on upgrade in control efficiencies.

Table 2.1-2 (continued)

State	Plant Name and ID	Unit	Nature of Update/Correction
SC	Dolphus Grainger ORISID=3317	1, 2	Unit 1: Upgrade ESP from 0.60 to 0.03 lb/mmBTU by Dec. 31, 2012. Reduced PM_{10} and PM25 emissions in 2018 by 95 percent based on change in allowable emission rate Unit 2: Install low NO_x burners that meet 0.46 lb/mmBTU from 0.9 by May 1, 2004. Recalculated NO_x emissions using 0.46/lbs/mmBtu and IPM heat input Unit 2: Upgrade ESP from 0.60 to 0.03 lb/mmBTU by Dec. 31, 2012. Reduced PM_{10} and PM25 emissions in 2018 by 95 percent based on change in allowable emission rate
	Jeffries ORISID=3319	3, 4	Unit 3: Upgrade ESP from 0.54 to 0.03 lb/mmBTU by Dec. 31, 2012. Reduced PM_{10} and PM25 emissions in 2018 by 94.44 percent based on change in allowable emission rate Unit 4: Upgrade ESP from 0.54 to 0.03 lb/mmBTU by Dec. 31, 2012. Reduced PM_{10} and PM25 emissions in 2018 by 94.44 percent based on change in allowable emission rate
	W S Lee ORISID=3264	1, 2	IPM does not indicate that these units are installing SOFA NO_x control technology by April 30, 2006 to meet 0.27 lb/mmBTU, down from 0.45 lb/mmBtu. Calculated NO_x emissions using IPM heat input and 0.27 lbs/mmBtu
	Generic Unit ORISID=900545	All	All predictions for generic units appear reasonable with the exception of Plant ID ORIS900545 Point ID GSC45 which was modeled in Georgetown County. It will be very difficult to add new generation this close to the Cape Romain Class I area. Santee Cooper has no plans for future generation in Georgetown County, but does have plans for new future generation in Florence County. This unit was moved to coordinates specified in Florence County.
VA	AEP Clinch River ORISID=3775	1, 2, 3	Used IPM results for 2009; replaced all 2018 IPM results with VADEQ's growth and control estimates (no SCR or scrubbers).
	AEP Glen Lyn ORISID=3776	51, 52, 6	Used 2009/2018 IPM results for units 51 and 52; used 2009 IPM for unit 6; replaced 2018 IPM for unit 6 with VADEQ's growth and control estimates (nor SCR or scrubber).
	Dominion Clover ORISID=7213	1, 2	Used 2009/2018 IPM results.
	Dominion Bremo ORISID=3796	3, 4	Used 2009/2018 IPM results.
	Dominion Chesterfield ORISID=3797	3, 4, 5, 6	Replaced all 2009/2018 IPM results using VADEQ's growth and control estimates.
	Dominion Yorktown ORISID=3809	1, 2, 3	Units 1, 2: Used 2009/2018 IPM results for NOx and used VADEQ's growth and control estimates for SO2. Unit 3: IPM predicts zero heat input for this 880 MW #6 oil fired unit. Dominion plans to continue to operate Unit 3. Replaced all 2009/2018 IPM results using VADEQ's growth and control estimates.

Table 2.1-2 (continued)

State	Plant Name and ID	Unit	Nature of Update/Correction
VA	Dominion Chesapeake ORISID=3803	1 – 4	Unit 1: Used 2009/2018 IPM for NOx; used 2009 IPM for SO2; used VADEQ's growth and control estimates for SO2 (added scrubber that IPM did not have) Unit 2: Used 2009/2018 IPM for NOx; used 2009 IPM for SO2; used VADEQ's growth and control estimates for SO2 (added scrubber that IPM did not have) Unit 3: Used VA DEQ's growth and control estimates for 2009 NOx (added SCR that IPM did not have); used IPM result for 2018 NOx; Used 2009/2018 IPM for SO2. Unit 4: Used VA DEQ's growth and control estimates for 2009 NOx (added SCR that IPM did not have); used IPM result for 2018 NOx; Used 2009/2018 IPM for SO2.
	Dominion Possum Point ORISID=3804	3 & 4 5 6	Unit 3&4: IPM had 137 tons of NO_x for these units in 2009 and 111 tons in 2018. VA DEQ specified that the permitted emission rates should be used, which equates to 3,066 tons in 2009 and 2018. Unit 5: IPM had zero heat input. Replaced all 2009/2018 IPM results using VADEQ's growth and control estimates. Unit 6: Replaced all 2009/2018 IPM results using VADEQ's growth and control estimates.
	Potomac River ORISID=3788	1 - 5	Units 1&2: IPM retired these units. Mirant has no plans at this time to retire any units. Replaced all 2009/2018 IPM results using VADEQ's growth and control estimates. Units 3, 4, 5: Replaced all 2009/2018 IPM results using VADEQ's growth and control estimates.
WV	Albright ORISID=3942	1, 2	IPM predicted early retirement for these units. AEP indicated there are no plans for early retirement. For 2009, used 2002 actual emissions as these units are not likely to retire by 2009. For 2018, used IPM prediction of retirement.
	Rivesville ORISID=3945	7, 8	IPM predicted early retirement for these units. AEP indicated there are no plans for early retirement. For 2009, used 2002 actual emissions as these units are not likely to retire by 2009. For 2018, used IPM prediction of retirement.
	Willow Island ORISID=3946	1, 2	Unit 1: IPM predicted early retirement for these units. AEP indicated there are no plans for early retirement. For 2009, used 2002 emissions as these units are not likely to retire by 2009. For 2018, used IPM prediction of retirement. Unit 2: IPM predicted SCR and scrubber for 2009. These controls will not be in place by 2009.
	North Branch ORISID=7537	1A, 1B	SO_2 Permit Rate was corrected from 2.7 to 0.678 lb/MMBtu. Used SO_2 Permit Rate and IPM predicted total fuel used to calculate SO_2 emissions in 2009 and 2018
	Mt. Storm ORISID=3954	1, 2, 3	SO_2 Permit Rate was corrected from 2.7 to 0.15 lb/MMBtu. Used SO_2 Permit Rate of 0.15 lb/MMBtu and IPM predicted total fuel used to calculate SO_2 emissions in 2009 and 2018
	Pleasants Power Station ORISID=6004	1, 2	IPM applied a scrubber with a 79.9% control efficiency; WV indicated that the control efficiency should be 95%.

2.1.1.8 S/L Adjustments to IPM Modeling Results for B&F Projections

For the B&F inventory, the S/L agencies were asked to review the Base G2 inventory with respect to the following items:

- Identify any updates needed to better reflect current information on when and where future controls would occur based on the best available data from state rules, enforcement agreements, compliance plans, permits, and discussions/commitments from individual companies;
- Identify any updates needed to change the IPM determination that most oil/gas steam units would either retire early or have no operation in 2009 or 2018; and
- Identify any updates needed to change the IPM assignment and VISTAS post-processing of generic units with specific information on new capacity.

The changes specified by the S/L agencies are summarized in Table 2.1-3. A comparison of the IPM and VISTAS control assumptions for all coal-fired EGUs in the B&F inventories are summarized in Appendix I.

Table 2.1-3 Additional Adjustments to IPM Results Specified by S/L Agencies for the B&F 2009/2018 EGU Inventories.

State	Plant Name and ID	Unit	Nature of Update/Correction
AL	Multiple	---	Alabama suggest additional changes to the 2009 inventory resulting from their $PM_{2.5}$ modeling for the Birmingham area; however, these changes were identified too late to be incorporated in the VISTAS B&F inventory and ASIP modeling.
FL	Cape Canaveral Indian River Port Everglades Turkey Point Manatee Martin Riviera Anclote CD McIntosh Northside B Suwannee River	1, 2 1, 2, 3 1 – 4 1, 2 1, 2 1, 2 3, 4 1, 2 1 3 3	The IPM 2009/2018 solution has either shut-down these oil-fired units or converted them to natural gas only. FLDEP has reason to believe that these units may continue to operate using oil. For some of these units, the owner or operator of the units have provided (and FLDEP approved) an estimate of how the units will be operated in 2009/2018. For others, to be conservative, FLDEP assumed that the oil-fired units will operate in 2009/2018 exactly as they operated in 2002.
	Gulf Power Schultz ORISID=643	1 - 4	Plant is expected to shut down and was taken out of the 2018 projection.
	Northside ORISID=667	1A, 1B	These units were estimated to be non operational by IPM in 2009 and 2018. FLDEP believes these units will continue to operate. Emissions were estimated using the 2002 base case emissions and growth factors for Northside units 1A and 2A. The changes for 2009 were made in the B&F inventory; the changes for 2018 were made in the Base G2 inventory.

	Crist ORISID=641	4, 5 6, 7	IPM did not assign scrubbers to these units. Scrubbers are currently being installed and should be operational in 2009. SO2 emissions reduced by 90%.
GA	Mitchell ORISID=727	SG03	GADNR provided new emission projections for 2018.

Table 2.1-3 (continued)

State	Plant Name and ID	Unit	Nature of Update/Correction
GA	Kraft ORISID=733	SG03	GADNR provided new emission projections for 2018.
	McIntosh ORISID=6124	SG01	GADNR provided new emission projections for 2018.
	Bowen ORISID=703	SG03 SG04	GADNR provided new SO2 emission projections for 2009 and 2018 based on a 95% control efficiency instead of 90%.
	Hammond ORISID=708	SG01 to SG04	GADNR provided new SO2 emission projections for 2009 and 2018 based on a 95% control efficiency instead of 90%.
	Wansley ORISID=6052	SG01	GADNR provided new SO2 emission projections for 2009 and 2018 based on a 95% control efficiency instead of 90%.
KY	John Sherman Cooper ORISID=1384	1	IPM did not assign a scrubber to this unit in 2018. KDAQ believes that a scrubber should be assigned for 2018.
	John Sherman Cooper ORISID=1384	2	IPM assigned SCR in 2009. KDAQ does not expect SCR by then; emissions changed to reflect low-NOx burner.
	Spurlock Station ORISID=6041	1, 2	IPM did not assign scrubbers to these units in 2009. Per a consent decree and for BART, KDAQ specified a 90% reduction in SO2 emissions from SO2 controls.
	Big Sandy ORISID=1353	BSU1	IPM assigned a scrubber and SCR in 2009. KDAQ does not expect scrubber or SCR controls to be operational in 2009.
MS	Entergy Delta Entergy Rex Brown Entergy Baxter Wilson Entergy Gerald Andrus	1, 2 3, 4 1, 2 1	The IPM 2009/2018 solution has either shut-down these oil-fired units or converted them to natural gas only. MSDEQ has reason to believe that these units may continue to operate using oil. To be conservative, MSDEQ assumed that the oil-fired units will operate in 2009/2018 exactly as they operated in 2002.
NC	Cliffside ORISID=2721	7	Removed Unit 7 from the 2018 inventory since the NC Utilities Commission disapproved the permit application.
	Cape Fear ORISID=2798	1, 2	IPM assigned scrubbers to both units in 2018; NCDENR indicated that the facility projected Furnace Sorbent Injection. Increased SO2 emissions to reflect change in control efficiency.
SC	99 Oil-fired Units		The IPM 2009/2018 solution has either shut-down 99 oil-fired units or converted them to natural gas only. SCDHEC has reason to believe that these units may continue to operate using oil. To be conservative, SCDHEC assumed that the oil-fired units will operate in 2009/2018 exactly as they operated in 2002.
SC	Santee Cooper Cross ORISID=130	4	For both 2009 and 2018, added in a new 660 MW Unit 4 (not in IPM) that is identical to the new Unit 3 (which was in IPM). Used the new Unit 4 to replace the IPM-generated 500 MW coal-fired Generic Unit (ORIS900545) located in the adjacent county.

Table 2.1-3 (continued)

State	Plant Name and ID	Unit	Nature of Update/Correction
SC	New Santee Cooper Units Planned for Florence County	1, 2	Santee Cooper is planning two new coal burning units in Florence County, each at 660 MW. These units were not explicitly identified in IPM. Used these new units to replace three IPM-generated 500 MW coal-fired Generic Units (ORIS900145, ORIS900245, ORIS900345) in Darlington and Colleton Counties.
	USDOE SRS Area D ORISID=7652	1	Facility is replacing coal-fired boilers with three biomass boilers. Recalculated emissions for 2018 using emission factors for biomass combustion and IPM heat inputs.
VA	Dominion Chesapeake ORISID=3803	1 - 4	Changed SO2 emissions in 2009 and 2018 to reflect information from the facility on project SO2 controls.
	Dominion Southwest Virginia Project	1	For 2018, replace the IPM generated Generic Unit located in Russell county (ORISID=900251) to Wise County to reflect the planned Dominion facility going into Wise County. Used the potential to emit for the Dominion facility.
	Clinch River ORISID=3775	1, 2, 3	Changed emissions in 2018 to reflect requirements of Consent Order. The CO requires SNCR by 12/31/2009; IPM assigned SCR in 2018. The CO caps SO2 emissions at 16,300 tpy starting Jan 1, 2015.
WV	Pleasants Power Station ORISID=6004	1, 2	For both 2009 and 2018, Units 1 and 2 had SO2 emissions reduced to account for the facility's inclusion of previously bypassed 15% effluent stream to the scrubber. The control efficiency and emissions changed from 79.9% to 95% control.
	Nine Generic Units Generated by IPM		IPM placed 746 MW of new fossil fuel-fired generation in West Virginia - 173 MW coal-fired, 24 MW IGCC, and the remainder gas-fired. A 600 MW pulverized coal-fired EGU is under construction, scheduled to be online in 2010 [Longview]; a 98 MW CFB co-generation unit is permitted and expected to be built [Western Greenbrier]; and a 600 MW IGCC plant is currently in the permitting process [Mountaineer IGCC]. WVDEP decided to replace the IPM generic units in WV with the 3 units mentioned above.
	Longview Site ID: 54- 061-0134	1	For 2018 inventory, added Longview which is permitted, under construction, and scheduled to be online in 2010. The unit is a 600 MW pulverized coal-fired unit with baghouse, LNB, SCR, and wet FGD as required controls. Used permitted emission rates for 2018.
WV	Western Greenbriar Site ID: 54-025-0066	1	For 2018 inventory, added Western Greenbrier, which is permitted but not under construction. The unit is a 98 MW coal-fired CFB burning waste coal. Used permitted emission rates for 2018.
	Mountaineer IGCC Site ID: 54-053-00063	1	For 2018 inventory, added Mountaineer IGCC, which has applied for a permit to construct a nominal 600 MW IGCC. Used emission rates from the permit application for 2018.

2.1.1.9 Conversion of MRPO BaseM 2009 EGU Data to SMOKE Input Format

To support ASIP $PM_{2.5}$ CAMx modeling of the future year 2009, Alpine Geophysics obtained and processed an emission inventory for the 5 MRPO states (Illinois, Indiana, Michigan, Wisconsin, and Ohio). Appendix x details the technical steps that were made as part of the conversion of the MRPO BaseM EGU files into IDA format for ASIP PM-2.5 CAMx modeling of the future year 2009.

2.1.1.10 Summary of 2009/2018 EGU Point Source Inventories

Tables 2.1-4 through 2.1-10 compare the Base G 2002 base year inventory to the Base F, Base G/G2 and B&F 2009/2018 projection inventories. The Base F projections rely primarily on the results of the IPM, while the Base G and B&F projections include the adjustments to the IPM results specified by the S/L agencies in the previous section.

Table 2.1-4 EGU Point Source SO_2 Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	447,828	340,194	378,052	378,052	190,099	135,851	135,851
FL	453,631	195,790	186,055	291,831	141,551	138,340	194,028
GA	514,952	534,469	417,449	408,679	180,178	79,430	68,515
KY	484,057	371,944	290,193	271,669	229,603	226,062	222,102
MS	67,429	85,629	76,579	76,646	27,230	15,146	15,213
NC	477,990	205,018	242,286	242,286	110,382	114,771	120,165
SC	206,399	171,206	124,608	129,122	121,694	93,274	95,377
TN	334,151	255,400	255,410	255,410	112,662	112,672	112,672
VA	241,204	169,714	193,112	174,777	90,935	114,255	98,988
WV	516,084	226,127	277,489	268,952	124,466	105,935	106,199
	3,743,725	**2,555,491**	**2,441,233**	**2,497,423**	**1,328,800**	**1,135,736**	**1,169,110**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-5 EGU Point Source NO_x Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	161,038	70,852	82,305	82,305	42,769	64,358	64,358
FL	257,677	89,610	86,165	132,535	77,080	74,640	87,645
GA	147,517	97,146	98,497	98,497	58,095	75,717	69,856
KY	198,817	107,890	92,021	97,263	64,378	64,378	64,378
MS	43,135	11,475	36,011	47,276	8,945	10,271	21,535
NC	151,853	66,431	66,522	66,521	60,914	62,353	61,110
SC	88,241	43,817	46,915	48,668	48,346	51,456	51,751
TN	157,307	41,767	66,405	66,405	31,725	31,715	31,715
VA	86,886	63,220	62,547	64,358	49,420	66,074	64,344
WV	230,977	63,510	86,328	85,476	51,241	51,241	51,474
	1,523,448	**655,718**	**723,717**	**789,304**	**492,913**	**552,203**	**568,166**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-6 EGU Point Source VOC Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	2,295	2,441	2,473	2,473	2,952	2,952	2,952
FL	2,524	1,867	1,910	2,730	2,324	2,422	3,047
GA	1,244	1,571	2,314	2,314	1,903	2,841	2,816
KY	1,487	1,369	1,369	1,369	1,426	1,426	1,426
MS	648	406	404	564	1,124	1,114	1,274
NC	988	974	954	954	1,272	1,345	1,302
SC	470	660	660	723	906	906	931
TN	926	932	932	932	977	976	976
VA	754	685	778	788	903	1,014	980
WV	1,180	1,342	1,361	1,361	1,387	1,387	1,387
	12,516	**12,247**	**13,155**	**14,208**	**15,174**	**16,383**	**17,091**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-7 EGU Point Source CO Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	11,279	14,948	14,986	14,986	24,342	24,342	24,342
FL	57,113	45,391	35,928	71,072	63,673	54,146	85,495
GA	9,712	20,066	23,721	23,721	32,744	44,476	44,269
KY	12,619	15,812	15,812	15,812	17,144	17,144	17,144
MS	5,303	5,078	5,051	7,116	15,364	15,282	17,348
NC	13,885	15,141	14,942	14,942	19,612	20,223	19,870
SC	6,990	11,135	11,135	11,643	14,786	14,786	14,975
TN	7,084	7,221	7,213	7,214	7,733	7,723	7,723
VA	6,892	11,869	12,509	12,535	14,755	15,564	18,850
WV	10,341	11,328	11,493	11,493	11,961	11,961	12,397
	141,218	**157,989**	**152,790**	**190,535**	**222,114**	**225,647**	**262,413**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-8 EGU Point Source PM_{10}-PRI Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	7,646	6,959	6,969	6,969	7,822	7,822	7,822
FL	21,387	9,384	9,007	20,182	10,310	10,022	12,791
GA	11,224	17,088	17,891	17,891	18,329	20,909	20,732
KY	4,701	6,463	6,463	6,463	6,694	6,694	6,694
MS	1,633	5,487	4,957	5,182	7,624	7,187	7,412
NC	22,754	22,888	22,152	22,152	33,742	37,376	35,275
SC	21,400	28,650	19,395	20,041	37,864	28,826	27,640
TN	14,640	15,608	15,608	15,608	15,941	15,941	15,941
VA	3,960	4,479	5,508	5,606	12,744	13,832	12,551
WV	4,573	5,471	5,657	5,657	6,349	6,349	5,784
	113,918	**122,477**	**113,607**	**125,750**	**157,419**	**154,958**	**152,642**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-9 EGU Point Source $PM_{2.5}$ -PRI Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	4,113	3,916	3,921	3,921	4,768	4,768	4,768
FL	15,643	6,250	5,910	14,790	7,171	6,886	9,417
GA	4,939	10,104	10,907	10,907	11,403	13,983	13,881
KY	2,802	4,279	4,279	4,279	4,434	4,434	4,434
MS	1,138	5,310	4,777	4,996	7,469	7,033	7,252
NC	16,498	16,514	15,949	15,949	26,966	29,792	28,137
SC	17,154	23,366	16,042	16,548	32,180	25,032	23,794
TN	12,166	13,092	13,092	13,092	13,387	13,387	13,387
VA	2,606	3,194	4,067	4,165	11,101	11,976	10,773
WV	2,210	2,850	2,940	2,940	3,648	3,648	3,116
	79,269	**88,875**	**81,884**	**91,587**	**122,527**	**120,939**	**118,959**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-10 EGU Point Source NH_3 Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	Actual Base G	Base F IPM Based	Base G IPM with State/local Updates	B&F IPM with Additional State/local Updates	Base F IPM Based	Base G2 IPM with State/local Updates	B&F IPM with Additional State/local Updates
AL	317	359	359	359	1,072	1,072	1,072
FL	234	1,659	1,631	1,629	3,004	2,976	2,976
GA	83	686	686	686	1,677	1,677	1,677
KY	326	400	400	400	476	476	476
MS	190	333	333	334	827	827	827
NC	54	423	445	445	691	663	663
SC	142	343	343	370	617	617	625
TN	204	227	227	227	241	241	241
VA	127	632	694	694	558	622	606
WV	121	330	330	330	180	180	143
	1,798	**5,392**	**5,448**	**5,474**	**9,343**	**9,351**	**9,306**

Note: Emission summaries above are based on SCCs 1-01-xxx-xx and 2-01-xxx-xx.

2.1.2 Non-EGU Emission Projections

The general approach for assembling future year data was to use growth and control data consistent with the data used in EPA's Clean Air Interstate Rule analyses, supplement these data with available stakeholder input, and provide the results for stakeholder review to ensure credibility. We used the revised 2002 VISTAS base year inventory, based on the 2002 CERR submittals as the starting point for the non-EGU projection inventories. As described in Section 2.1.1.4, we split the point source inventory into EGU and non-EGU components. MACTEC performed the following activities to apply growth and control factors to the 2002 inventory to generate the 2009 and 2018 projection inventories:

- Obtained, reviewed, and applied the most current growth factors developed by EPA, based on forecasts from an updated Regional Economic Models, Inc. (REMI) model (version 5.5) and the latest *Annual Energy Outlook* published by the Department of Energy (DOE);
- Obtained, reviewed, and applied any State-specific or sector-specific growth factors submitted by stakeholders;
- Obtained and incorporated information regarding sources that have shut down after 2002 and set the emissions to zero in the projection inventories;
- Obtained, reviewed, and applied control assumptions for programs "on-the-books" and "on-the-way";
- Provided data files in NIF3.0 format and emission summaries in EXCEL format for review and comment; and
- Updated the database with corrections or new information from S/L agencies based on their review of the Base F 2009/2018 inventories.

The following sections discuss each of these steps.

2.1.2.1 Growth assumptions for non-EGU sources

This section describes the growth factor data used in developing the Base F inventory for 2009 and 2018, as well as the changes to the growth factor data made for the Base G inventory.

The growth factor data used in developing the Base F inventory were consistent with EPA's analyses for the CAIR rulemaking. These growth factors are fully documented in the reports entitled *Development of Growth Factors for Future Year Modeling Inventories* (dated April 30, 2004) and *CAIR Emission Inventory Overview* (dated July 23, 2004). Three sources of data were used in developing the growth factors for the Base F inventory:

- State-specific growth rates from the Regional Economic Model, Inc. (REMI) Policy Insight® model, Version 5.5 (being used in the development of the EGAS Version 5.0). The REMI socioeconomic data (output by industry sector, population, farm sector value added, and gasoline and oil expenditures) are available by 4-digit SIC code at the State level.

- Energy consumption data from the DOE's Energy Information Administration's (EIA) *Annual Energy Outlook 2004, with Projections through 2025* for use in generating growth factors for non-EGU fuel combustion sources. These data include regional or national fuel-use forecast data that were mapped to specific SCCs for the non-EGU fuel use sectors (e.g., commercial coal, industrial natural gas). Growth factors for the residential natural gas combustion category, for example, are based on residential natural gas consumption forecasts that are reported at the Census division level. These Census divisions represent a group of States (e.g., the South Atlantic division includes eight southeastern States and the District of Columbia). Although one would expect different growth rates in each of these States due to unique demographic and socioeconomic trends, EIA's projects all States within each division using the same growth rate.
- Specific changes for sectors (e.g., plastics, synthetic rubber, carbon black, cement manufacturing, primary metals, fabricated metals, motor vehicles and equipment) where the REMI-based rates were unrealistic or highly uncertain. Growth projections for these sectors were based on industry group forecasts, Bureau of Labor Statistics (BLS) projections and Bureau of Economic Analysis (BEA) historical growth from 1987-2002.

In addition to the growth data described above, we received two sets of growth projections from VISTAS stakeholders.

The American Forest and Paper Association (AF&PA) supplied growth projections for the pulp and paper sector, which were applied to SIC 26xx Paper and Allied Products. The AF&PA projection factors are for the U.S. industry and apply to all States equally. The numbers come from the 15-year forecast for world pulp and recovered paper prepared by Resource Information Systems Inc. (RISI).

SIC Code	Sector	AF&PA Growth Factor	
		2002 to 2009	2002 to 2018
2611	Pulp Mills	1.067	1.169
2621	Paper Mills	1.067	1.169
2631	Paperboard Mills	1.067	1.169

For both the Base F and Base G inventories, we used the above AF&PA growth factors by SIC instead of the factors obtained from EPA's CAIR analysis.

For the Base F inventory, the NCDENR supplied recent projections for three key sectors in North Carolina where declining production was anticipated – SIC 22xx Textile Mill Products, 23xx Apparel and Other Fabrics, and 25xx Furniture and Fixtures. For the Base G inventory, NCDENR decided to use a growth factor of 1.0 for these SIC codes for both 2009 and 2018. Although NCDENR has data that shows a steady decline in these industries in NC, NCDENR wanted to maintain the emission levels at 2002 levels so the future emission reduction credits were available in the event that they are needed for nonattainment areas. The specific growth factors for these industrial sectors in North Carolina were:

NCDENR Growth Factors for Specific Industrial Sectors					
SIC Code	Industrial Sector	2009		2018	
		Base F	Base G	Base F	Base G
22xx	Textile Mill Products	0.6239	1.00	0.2792	1.00
23xx	Apparel and Other Fabrics	0.5867	1.00	0.2247	1.00
25xx	Furniture and Fixtures	0.8970	1.00	0.7647	1.00

For the Base G inventory, we made one additional change to the growth factors. The Base F inventory relied on DOE's AEO2004 forecasts for projecting emissions for fuel-burning SCCs (applies mainly to ICI boilers 1-02-xxx-xx and 1-03-xxx-xx, as well as in-process fuel use). We replaced the AEO2004 data with the more recent AEO2006 forecasts (released in February 2006) to reflect changes in the energy market and to improve the emissions growth factors produced. We obtained the corresponding AEO2006 projection tables from DOE's web site located at http://www.eia.doe.gov/oiaf/aeo/supplement/supref.html. We developed tables comparing the growth factors based on AEO2004 and AEO2006. These comparison tables were reviewed by the S/L agencies. Based on this review, VISTAS decided to use the AEO2006 growth factors for fuel burning SCCs.

We used the EPA's EGAS model and updated the corresponding AEO2006 projection tables to create growth factors by SCC. We applied the updated growth factors to 2002 actual emissions and replaced the 2009 and 2018 emissions in NIF EM tables for the affected SCCs.

2.1.2.2 Source Shutdowns

A few states indicated that significant source shutdowns have occurred since 2002 and that emissions from these sources should not be included in the future year inventories. These sources are identified in Table 2.1-11.

Table 2.1-11 Summary of Source Shutdowns Incorporated in Base G Inventory.

State	Description of Source Shutdowns
AL	None specified.
FL	The following facilities are shutdown and projected emissions were set to zero in 2009/2018. 0570075 CORONET INDUSTRIES, INC. 1050050 U S AGRI-CHEMICALS CORP. 1050051 U.S. AGRI-CHEMICALS CORPORATION These facilities emitted 2,417 tons of SO_2 and 113 tons of NO_x in 2002.
GA	Georgia indicated that the former Blue Circle (now LaFarge) facility in downtown Atlanta will likely shut down before 2009. The facility has two cement kilns, one of which is already shut down. The second kiln will continue to operate until the new facility in Alabama has enough milling capacity, after which the entire Atlanta facility will be completely closed down. This facility emitted 1,617 tons of SO_2 and 587 tons of NO_x in 2002.
KY	None specified.
MS	AF&PA indicated that the International Paper Natchez Mill (28-001-2800100010) has shut down. This facility emitted 1,398 tons of SO_2 and 1,773 tons of NO_x in 2002.
	The Magnolia Resources - Pachuta Harmony Gas Plant (28-023-00031) is out of business and no longer holds an air permit. This facility emitted 2,257 tons of $SO_2$and 134 tons of NO_x in 2002.
NC	In Base F, two paper mills were identified as being shut down in the 2018 inventory. NCDENR indicated that these mills are not expected to close. The two facilities are Ecusta Business Development (37-175-3717500056) and International Paper (37-083-00007). Their emissions were added back into the Base G 2018 inventory.
	BASF Corporation (37-021-724) in Buncombe County is currently operating but has plans to shut down in 2007. This facility emitted 461 tons of SO_2 and 266 tons of NO_x in 2002.
SC	South Carolina provided a list of facilities that were identified as closing down on or after Jan. 1, 2003. The emissions for these facilities were set to zero in the 2009 and 2018 projection inventories. Emissions from these plants in 2002 were: 6,195 tons of SO_2, 2,994 tons of NO_x, and 2,836 tons of VOC. Most of the emissions were from one facility – Celanese Acetate (45-091-2440-0010) in York County.
TN	Davidson County (Nashville) indicated that significant source shutdowns have occurred since data were submitted for the 2002 CERR. Source number 47-037-00002 (Dupont) shut down a portion of their facility, which was permanently taken out of service. Source 47-037-00050 (Nashville Thermal Transfer Corp.) shut down their municipal waste combustors and replaced them with natural gas fired boilers with propane stand by.
	Weyerhaeuser (AKA Willamette) Power Boiler 7 (47-163-0022, EU ID = 017) is being shut down. This emission unit emitted 4,297 tons of SO_2 and 1,443 tons of NO_x in 2002.
	Liberty Fibers (47-063-0197) in Hamblen County has recently shut down. This facility emitted 5,377 tons of SO_2; 2,057 tons of NO_x; and 9,059 tons of VOC in 2002.
VA	Rock-Tenn (51-680-00097) received a permit dated 9/13/2003 which required the shutdown of units 1 and 2 by 2/27/2004. This permit was part of a netting exercise that allowed the installation of a new NG/DO boiler. These two units emitted 507 tons of SO_2 and 276 tons of NO_x in 2002.
WV	None specified.

2.1.2.3 Control Programs applied to non-EGU sources

We used the same control programs for both the 2009 and 2018 non-EGU point inventory. Two control scenarios were developed: on-the-books (OTB) controls and on-the-way (OTW) controls. The OTB control scenario accounts for post-2002 emission reductions from promulgated federal, State, local, and site-specific control programs. The OTW control scenario accounts for proposed (but not final) control programs that are reasonably anticipated to result in post-2002 emission reductions. The methodologies used to account for the emission reductions associated with these emission control programs are discussed in the following sections.

Table 2.1-12 Non-EGU Point Source Control Programs Included in 2009/2018 Projection Inventories.

On-the-Books (Cut-off of July 1, 2004 for Base 1 adoption)

- Atlanta / Northern Kentucky / Birmingham 1-hr SIPs
- Industrial Boiler/Process Heater/RICE MACT (see Section 2.1.2.3.2)
- NO_x RACT in 1-hr NAA SIPs
- NO_x SIP Call (Phase I- except where States have adopted II already e.g. NC)
- Petroleum Refinery Initiative (October 1, 2003 notice; MS & WV)
- RFP 3 percent Plans where in place for one hour plans
- VOC 2-, 4-, 7-, and 10-year maximum achievable control technology (MACT0 Standards
- Combustion Turbine MACT

On-the-Way

- NO_x SIP Call (Phase II – remaining States & IC engines)

2.1.2.3.1 OTB - NO_x SIP Call (Phase I)

Phase I of the NO_x SIP call applies to certain large non-EGUs, including large industrial boilers and turbines, and cement kilns. States in the VISTAS region affected by the NO_x SIP call have developed rules for the control of NO_x emissions that have been approved by EPA. We reviewed the available State rules and guidance documents to determine the affected sources and ozone season allowances. We also obtained and reviewed information in the EPA's CAMD NO_x Allowance Tracking System – Allowances Held Report. Since these controls are to be in effect by the year 2007, we capped the emissions for NO_x SIP call affected sources at 2007 levels and carried forward the capped levels for the 2009/2018 future year inventories. Since the NO_x SIP call allowances are given in terms of tons per ozone season (5 month period from May to

September), we calculated annual emissions by multiplying the 5-month allowances by a factor of 12 divided by 5.

2.1.2.3.2 OTB - Industrial Boiler/Process Heater MACT

EPA anticipates reductions in PM and SO_2 as a result of the Industrial Boiler/Process Heater MACT standard. The methods used to account for these reductions are the same as those used for the CAIR analysis. Reductions were included for existing units firing solid fuel (coal, wood, waste, biomass) which had a design capacity greater than 10 mmBtu/hr. EPA prepared a list of SCCs for solid fuel industrial and commercial/ institutional boilers and process heaters. We identified boilers greater than 10 mmBtu/hr using either the boiler capacity from the VISTAS 2002 inventory, or if the boiler capacity was missing, a default capacity based on a methodology developed by EPA for assigning default capacities based on SCC. The applied MACT control efficiencies were 4 percent for SO_2 and 40 for percent for PM_{10} and PM2.5 to account for the co-benefit from installation of acid gas scrubbers and other control equipment to reduce HAPs. On June 8, 2007, the U.S. Court of Appeals for the District of Columbia Circuit vacated and remanded the NESHAP for Industrial, Commercial and Institutional Boilers and Process Heaters. VISTAS States decided to leave the emission reductions in place since they envision using a 112(j) strategy (e.g., the “MACT hammer”) to obtain similar levels of control)

2.1.2.3.3 OTB - 2, 4, 7, and 10-year MACT Standards

Maximum achievable control technology (MACT) requirements were also applied, as documented in the report entitled *Control Packet Development and Data Sources,* dated July 14, 2004. The point source MACTs and associated emission reductions were designed from Federal Register (FR) notices and discussions with EPA’s Emission Standards Division (ESD) staff. We did not apply reductions for MACT standards with an initial compliance date of 2001 or earlier, assuming that the effects of these controls are already accounted for in the 2002 inventories supplied by the States. Emission reductions were applied only for MACT standards with an initial compliance date of 2002 or greater.

2.1.2.3.4 OTB Combustion Turbine MACT

The projection inventories do not include the NO_x co-benefit effects of the MACT regulations for Gas Turbines or stationary Reciprocating Internal Combustion Engines, which EPA estimates to be small compared to the overall inventory.

2.1.2.3.5 OTB - Petroleum Refinery Initiative (MS and WV)

Three refineries in the VISTAS region are affected by two October 2003 Clean Air Act settlements under the EPA Petroleum Refinery Initiative. The refineries are: (1) the Chevron refinery in Pascagoula, MS; (2) the Ergon refinery in Vicksburg, MS; and (3) the Ergon refinery in Newell, WV.

The first consent decree pertained to Chevron refineries in Richmond and El Segundo, CA; Pascagoula, MS; Salt Lake City, UT; and Kapolei, HI. Actions required under the Consent Decree will reduce annual emissions of NO_x by 3,300 tons and SO_2 by 6,300 tons. The consent decree requires a program to reduce NO_x emissions from refinery heaters and boilers through the installation of NO_x controls that meet at least an SNCR level of control. The refineries are to eliminate fuel oil burning in any combustion unit. The consent decree also requires reductions of NO_x and SO_2 from the fluid catalytic cracking unit and control of acid gas flaring incidents. The consent decree does not provide sufficient information to calculate emission reductions for the FCCU or flaring at the Pascagoula refinery. Therefore, we calculated a general percent reduction for NO_x and SO_2 by dividing the expected emission reductions at the five Chevron refineries by the total emissions from these five refineries (as reported in the 1999 NEI). This resulted in applying percent reductions of 45 percent for SO_2 and 28 percent for NO_x to FCCU and flaring emissions at the Chevron Pascagoula refinery.

The second consent decree pertained to the Ergon-West Virginia refinery in Newell, WV; and the Ergon Refining facility in Vicksburg, MS. The consent decree requires the two facilities to implement a 6-year program to reduce NO_x emission from all heaters and boilers greater than 40 mmBtu/hr, and to eliminate fuel oil burning in any combustion unit (except during periods of natural gas curtailment). Specifically, ultra low NO_x burners are required on Boilers A and B at Newell, a low NO_x-equivalent level of control for heater H-101 at Newell and heaters H-1 and H-3 at Vicksburg, and an ultra low NO_x burner level of control for heater H-451 at Vicksburg.

2.1.2.3.6 OTW - NO_x SIP Call (Phase II)

The final Phase II NO_x SIP call rule was finalized on April 21, 2004. States had until April 21, 2005, to submit SIPs meeting the Phase II NO_x budget requirements. The Phase II rule applies to large IC engines, which are primarily used in pipeline transmission service at compressor stations. We identified affected units using the same methodology as was used by EPA in the proposed Phase II rule (i.e., a large IC engine is one that emitted, on average, more than 1 ton per day during 2002). The final rule reflects a control level of 82 percent for natural gas-fired IC engines and 90 percent for diesel or dual fuel categories. As shown later in Table 2.1-12, several S/L agencies provided move specific information on the anticipated controls at the compressor stations. This information was used in the Base G inventory instead of the default approach used by EPA in the proposed Phase II rule.

2.1.2.3.7 Clean Air Interstate Rule

CAIR does not require or assume additional emission reductions from non-EGU boilers and turbines.

2.1.2.4 Quality Assurance steps

Final QA checks were run on the revised projection inventory data set to ensure that all corrections provided by the S/L agencies and stakeholders were correctly incorporated into the S/L inventories and that there were no remaining QA issues that could be addressed during the duration of the project. After exporting the inventory to ASCII text files in NIF 3.0, the EPA QA program was run on the ASCII files and the QA output was reviewed to verify that all QA issues that could be addressed were resolved

Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, and to ensure that a full and complete inventory was developed for VISTAS. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the point source component of the VISTAS revised 2002 base year inventory:

Facility level emission summaries were prepared and evaluated to ensure that emissions were consistent and reasonable. The summaries included base year 2002 emissions, 2009/2018 projected emissions accounting only for growth, 2009/2018 projected emissions accounting for both growth and emission reductions from OTB and OTW controls.

State-level non-EGU comparisons (by pollutant) were developed for the base year 2002 emissions, 2009/2018 projected emissions accounting only for growth, 2009/2018 projected emissions accounting for both growth and emission reductions from OTB and OTW controls.

Data product summaries and raw NIF 3.0 data files were provided to the VISTAS Emission Inventory Technical Advisor and to the Point Source, EGU, and non-EGU Special Interest Work Group representatives for review and comment. Changes based on these comments were reviewed and approved by the S/L point source contact prior to implementing the changes in the files.

Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from Base F1 to Base F2.

2.1.2.5 Additional Base G Updates and Corrections

Table 2.1-13 summarizes the updates and corrections to the Base F inventory that were requested by S/L agencies and incorporated into the Base G 2009/2018 inventories.

Table 2.1-13 Summary of Updates and Corrections Incorporated into the Base G 2009/2018 Non-EGU Inventories.

State	Nature of Update/Correction
AL	Corrected the latitude and longitude for two facilities: Ergon Terminalling (Site ID: 01-073-010730167) and Southern Power Franklin (Site ID: 01-081-0036).
	Corrections to stack parameters at 10 facilities for stacks with parameters that do not appear to fall into the ranges typically termed "acceptable" for AQ modeling.
FL	Corrected 2009/2018 emission values for the Miami Dade RRF facility (Site ID: 12-086-0250348) based on revised 2002 emissions and application of growth control factors for 2009/2018.
GA	Hercules Incorporated (12-051-05100005) had an erroneous process id (#3) within emission unit id SB9 and was deleted. This removes about 6,000 tons of SO_2 from the 2009/2018 inventories.
	Provided a revised file of location coordinates at the stack level that was used to replace the location coordinated in the ER file.
	There are several sources that have updated their emissions from their BART eligible units. most of these changes were for fairly small (<50 tpy) sources.
NC	Made several changes to Base F inventory to correct the following errors: 1. Corrected emissions at Hooker Furniture (Site ID: 37-081-3708100910), release point G-29, to use the corrected values in 2002 and carry those same numbers through to 2009 and 2018 since NCDENR assumes zero growth for furniture industry. 2. Identified many stack parameters in the ER file that were unrealistic. Several have zero for height, diameter, gas velocity, and flow rate. NC used the procedures outlined in Section 8 of the document ""National Emission Inventory QA and Augmentation Report" to correct unrealistic stack parameters. 3. Identified truncated latitude and longitude values in Base F inventory. NC updated all Title V facility latitude and longitude that was submitted to EPA for those facilities in 2004. Smaller facilities with only two decimal places were not corrected. 4. Corrected 2018 VOC emissions for International Paper (3709700045) Emission Unit ID, G-12, to reflect changes to the 2002 inventory.
	There are three Transcontinental Natural Gas Pipeline facilities in NC that are subject to the NO_x SIP call. NCDENR took 2004 emissions and grew them to 2009 & 2018 and capped those units that are subject to the NO_x SIP Call Rule. These facility IDs are 37-057-3705700300, 37-097-3709700225, and 37-157-3715700131.
	NCDENR applied NO_x RACT to a two facilities located in the Charlotte nonattainment area. NCDENR provided 2009 & 2018 emissions for Philip Morris USA (37-025-3702500048) and Norandal USA (37-159-3715900057).
SC	Corrected PM species emission values. SC DHEC's initial CERR submittal reported particulate matter emissions using the PM-FIL, PM_{10}-FIL, and $PM_{2.5}$ -FIL pollutant codes. In August 2005, SC DHEC indicated that data reported using the PM-FIL, PM_{10}-FIL, and $PM_{2.5}$ -FIL pollutant codes should actually have been reported using the PM-PRI, PM_{10}-PRI, and $PM_{2.5}$ _PRI codes. MACTEC performed a subsequent PM augmentation in April 2006 using the revised pollutant codes. These changes were reflected in the Base G 2009/2018 emission inventory.
	Specified that the Bowater Inc. facility (45-091-2440-0005) in York County conducted an expansion in 2003/2004 and plans a future expansion. SC provided updated emissions for 2009 and 2018 for this facility.

Table 2.1-13. Continued.

State	Nature of Update/Correction
TN	Updated 2009/2018 emissions for Eastman Chemical (47-163-0003) based on final (Feb. 2005) BART rule.
	Updated 2009/2018 emission inventory for the Bowater facility (47-107-0012) based on the facility's updated 2002 emission inventory update.
	Replaced 2009/2018 data from Hamilton County, Tennessee, using data from Hamilton County's CERR submittal as contained in EPA's 2002 NEI (in Base F, the inventory for Hamilton County was based on the draft VISTAS 2002 inventory, which in turn was based on the 1999 NEI); applied growth and control factors to revised 2002 inventory to generate emission projections for 2009/2018.
	Updated 2009/2018 emissions for PCS Nitrogen Fertilizer LP (Site ID: 47-157-00146) based on the facility's updated 2002 emission inventory update.
	The 2002 NEI correctly reports the actual emissions for CEMEX (47-093-0008) after the NO_x SIP call. There is no reason to suspect that that rate would change in 2008, 2009, or 2018. Emissions for 2009/2018 were set equal to 2002 emissions.
	In the Base F 2009/2018 inventories, NO_x controls were applied for two units at Columbia Gulf Transmission (47-111-0004). There are no plans for controls at these units, EO3 and EO4. The assumed control efficiency of 82 percent was backed out in the 2009/2018 inventories.
VA	VADEQ provided 2009/2018 NO_x emission estimates for NO_x Phase II gas transmission sources at three Transco facilities (51-011-00011, 51-137-00027, 51-143-00120) which were used to replace the default NO_x Phase II control assumptions for these facilities.
	VADEQ provided updated 2009/2018 NO_x and SO_2 emissions based on new controls required by a November 2005 permit modification and netting exercise. The entire power plant facility is limited to 213 tons of NO_x and 107 tons of SO_2 per year. The permit also allowed the installation of 3 new boilers, also under the 213 tons of NO_x /year cap.
WV	Updated 2009/2018 emissions for Steel of West Virginia (Site ID: 54-011-0009) based on the facility's updated 2002 emission inventory update.
	Made changes to several Site ID names due to changes in ownership
	Base F emissions were much too high for Weirton Steel (54-021-0029). WV believes that the source is very unlikely to emit the NO_x SIP Call budgeted amounts in 2009 or 2018. WV provided revised emission estimates based on EGAS for 2009/2018.
	Made corrections to latitude/longitude and stack parameters at a few facilities for stacks with parameters that do not appear to fall into the ranges typically termed "acceptable" for AQ modeling.

2.1.2.6 Additional B&F Updates and Corrections

Table 2.1-14 summarizes the updates and corrections to the Base G non-EGU inventory that were requested by S/L agencies and incorporated into the B&F 2009/2018 non-EGU inventories. The changes were primarily related to better information on anticipated BART controls for specific facilities and emission units.

Table 2.1-14 Summary of Updates and Corrections Incorporated into the B&F 2009/2018 Non-EGU Inventories.

State	Nature of Update/Correction
AL	Alabama suggest additional changes to the 2009 inventory resulting from their $PM_{2.5}$ modeling for the Birmingham area; however, these changes were identified too late to be incorporated in the VISTAS B&F inventory and ASIP modeling.
	For 2018, incorporated emission changes due to BART controls at Exxon Mobil (Site ID: 01-053-0007), International Paper (Site ID: 01-079-0001), and Solutia (Site ID: 01-103-0010). International Paper (Site ID: 01-079-0001) Unit 004 to be shutdown in the 2018 inventory.
FL	For both 2009 and 2018, incorporated emission changes due to BART controls at Georgia Pacific (Site ID: 12-107-1070005) Unit 15.
MS	For 2018 only, changed SO2 emission estimate for Pursue Energy (Site ID: 28-121-00036) based on the facility's estimates of the gas reserve at the site.
	For 2018 only, changed emission estimates for all pollutants at several emission units at the Chevron Pascagoula Refinery (Site ID: 28-059-00058) to reflect BART source reductions.
SC	For both 2009 and 2018, identified 15 facilities that have permanently closed. Emissions from these facilities set to zero for all pollutants.
TN	For both 2009 and 2018, identified seven facilities that have permanently closed. Emissions from these facilities were set to zero for all pollutants.
	For both 2009 and 2018, identified three emission units that have permanently closed. Emissions from these units were set to zero for all pollutants. 47-009-0130-002 (APAC – TN, Inc.-Harrison Construction – Asphalt plant), 47-009-0130-003 (APAC – TN, Inc.-Harrison Construction – Asphalt crusher), and 47-139-0004-001 (Intertrade - Number 6 acid plant)
	The following individual source will be shut down in 2010: 47-001-0020-002 (DOE, Y-12 – Boilers 1-4). For the 2018 inventory only, emissions from this unit were set to zero for all pollutants.
	A portion of 47-163-0003-020101 (Eastman, B-83-1 Stoker Boilers). This source previously consisted of 14 boilers (Boilers 11-24). Boilers 11-17 have been removed from service. Emissions for both 2009 and 2018 were reduced by 26.64%, based on the portion of the heat input capacity that is being removed from service.
	SO2 emissions in 2018 from 47-163-0003-021520 (Eastman, B-253-1 Tangential PC Boilers) were reduced by 90% to reflect anticipated BART controls.
	Reduced SO2 emissions at 47-157-00475 (Lucite International) in Shelby County as a result of a consent decree with U.S. EPA.
VA	Changed SO2 emissions in 2009 and 2018 for thirteen facilities to reflect updated information from VADEQ regarding projected SO2 controls.
WV	Weirton Steel (54-029-00001) and Wheeling Pittsburgh Steel (54-009-00002) have undergone significant, permanent process changes since 2002. WV DEP staff have consulted with facility staff and determined that calendar year 2004 emissions represent a better basis for future year emissions estimates. Therefore, WVDEP compiled emissions data from the 2004 inventory for these sources and applied the most current VISTAS growth factors to estimate emissions in 2009 and 2018.

2.1.2.7 Conversion of MRPO BaseM 2009 non-EGU Data to SMOKE Input Format

To support ASIP $PM_{2.5}$ CAMx modeling of the future year 2009, Alpine Geophysics obtained and processed an emission inventory for the 5 MRPO states (Illinois, Indiana, Michigan, Wisconsin, and Ohio). Appendix x details the technical steps that were made as part of the conversion of the MRPO BaseM non-EGU files into IDA format for ASIP PM-2.5 CAMx modeling of the future year 2009.

2.1.2.8 Summary of the 2009/2018 non-EGU Point Source Inventories

Tables 2.1-15 through 2.1-21 summarize the revised 2009/2018 non-EGU point source inventories. The "growth only" column does not include the shutdowns (section 2.1.2.2) or control factors (section 2.1.2.3), only the growth factors described in section 2.1.2.1.

Table 2.1-15 Non-EGU Point Source SO_2 Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	96,481	100,744	101,246	101,246	112,703	113,224	103,303
FL	65,090	68,549	65,511	62,651	79,015	75,047	71,810
GA	53,778	61,535	53,987	53,987	68,409	59,349	59,349
KY	34,029	35,470	36,418	36,418	38,806	40,682	40,682
MS	35,960	27,488	25,564	25,564	40,195	26,678	25,674
NC	44,123	48,751	42,536	42,536	50,415	46,314	46,314
SC	53,518	55,975	48,324	47,193	56,968	53,577	52,410
TN	79,604	89,149	70,678	64,964	96,606	77,247	56,682
VA	63,903	63,075	62,560	58,039	69,776	68,909	57,790
WV	54,070	54,698	55,973	55,598	60,137	62,193	61,702
	580,556	**605,434**	**562,797**	**548,196**	**673,030**	**623,220**	**575,716**

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-16 Non-EGU Point Source NO_x Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	83,310	69,676	69,409	69,409	79,101	78,318	77,960
FL	45,156	44,859	46,020	47,125	50,635	51,902	52,959
GA	49,251	51,556	50,353	50,353	57,323	55,824	55,824
KY	38,392	36,526	37,758	37,758	40,363	41,034	41,034
MS	61,526	55,877	56,397	56,398	62,132	61,533	61,252
NC	44,929	44,877	34,767	34,768	47,200	37,801	37,802
SC	42,153	42,501	40,019	39,368	44,480	44,021	43,331
TN	64,344	63,431	57,883	57,514	70,313	63,453	62,519
VA	60,415	51,335	51,046	51,001	56,876	55,945	55,734
WV	46,612	40,433	38,031	38,023	44,902	43,359	43,280
	536,088	**501,071**	**481,683**	**481,715**	**553,325**	**533,190**	**531,695**

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-17 Non-EGU Point Source VOC Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	47,037	46,660	46,644	46,644	54,268	54,291	54,290
FL	38,471	36,675	36,880	36,882	42,787	42,811	42,813
GA	33,709	34,082	34,116	34,116	40,267	40,282	40,282
KY	44,834	47,648	47,785	47,785	55,564	55,861	55,861
MS	43,204	37,921	37,747	37,747	45,769	45,338	45,335
NC	61,182	70,464	61,925	61,925	76,027	70,875	70,875
SC	38,458	38,273	35,665	34,403	44,545	43,656	41,987
TN	84,328	89,380	74,089	73,498	111,608	93,266	92,456
VA	43,152	43,620	43,726	43,725	53,065	53,186	53,186
WV	14,595	14,012	13,810	13,043	16,632	16,565	15,582
	448,970	458,735	432,387	429,768	540,532	516,131	512,667

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-18 Non-EGU Point Source CO Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	174,271	176,899	180,369	180,369	194,280	201,794	201,663
FL	81,933	83,937	87,037	87,661	96,642	96,819	97,438
GA	130,850	147,362	147,427	147,427	168,570	167,904	167,904
KY	109,936	121,727	122,024	122,024	139,121	139,437	139,437
MS	54,568	58,023	57,748	57,749	67,764	66,858	65,884
NC	50,576	53,955	53,744	53,744	61,127	62,197	62,197
SC	56,315	62,144	60,473	59,934	71,318	68,988	68,415
TN	115,264	123,844	119,665	119,216	146,407	140,942	140,556
VA	63,796	67,046	68,346	68,326	74,364	76,998	76,846
WV	89,879	100,248	100,045	93,839	119,318	119,332	111,302
	927,388	**995,185**	**996,878**	**990,289**	**1,138,911**	**1,141,269**	**1,131,642**

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-19 Non-EGU Point Source PM_{10}-PRI Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	25,240	25,450	25,421	25,421	29,973	29,924	29,889
FL	35,857	39,363	39,872	39,947	46,573	46,456	46,492
GA	21,610	23,509	23,103	23,103	27,781	27,273	27,273
KY	16,626	17,164	17,174	17,174	20,142	20,153	20,153
MS	19,472	19,200	19,245	19,244	22,952	22,859	22,837
NC	13,838	14,738	13,910	13,910	15,816	15,737	15,737
SC	14,142	17,631	13,370	12,959	20,197	15,139	14,674
TN	35,174	37,040	34,833	34,581	45,168	42,280	41,999
VA	13,252	13,043	13,048	13,046	15,150	15,112	15,111
WV	17,503	17,723	17,090	11,882	21,699	21,735	14,202
	212,714	224,861	217,066	211,267	265,451	256,668	248,367

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-20 Non-EGU Point Source PM25-PRI Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	19,178	19,256	19,230	19,230	22,628	22,598	22,584
FL	30,504	33,387	33,946	34,019	39,436	39,430	39,486
GA	17,462	19,361	18,982	18,982	22,882	22,416	22,416
KY	11,372	11,680	11,686	11,686	13,734	13,739	13,739
MS	9,906	9,144	9,199	9,199	10,768	10,739	10,719
NC	10,500	11,192	10,458	10,458	11,927	11,825	11,825
SC	10,245	13,101	9,390	9,048	14,947	11,086	10,699
TN	27,807	29,302	27,577	27,367	35,750	33,532	33,293
VA	10,165	9,980	9,988	9,988	11,604	11,594	11,605
WV	13,313	13,364	12,769	7,638	16,474	16,516	9,124
	160,452	**169,767**	**163,225**	**157,615**	**200,150**	**193,475**	**185,490**

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

Table 2.1-21 Non-EGU Point Source NH_3 Emission Comparison for 2002/2009/2018.

	2002	2009			2018		
State	**Base G**	**Base F**	**Base G**	**B&F**	**Base F**	**Base G**	**B&F**
AL	1,883	2,132	2,132	2,132	2,464	2,464	2,464
FL	1,423	1,544	1,544	1,544	1,829	1,829	1,829
GA	3,613	3,963	3,963	3,963	4,799	4,797	4,797
KY	674	733	760	760	839	901	901
MS	1,169	667	668	668	761	764	764
NC	1,180	1,288	1,285	1,285	1,422	1,466	1,466
SC	1,411	1,578	1,578	1,578	1,779	1,779	1,779
TN	1,613	1,861	1,841	1,840	2,240	2,214	2,213
VA	3,104	3,050	3,049	3,045	3,613	3,604	3,604
WV	332	341	341	314	416	413	378
	16,402	**17,157**	**17,161**	**17,129**	**20,162**	**20,231**	**20,195**

Note: Emission summaries above include all SCCs except 1-01-xxx-xx and 2-01-xxx-xx.

2.2 Area Sources

This section describes the methodology used to develop the 2009 and 2018 projection Base F and Base G projection inventories. This section describes two approaches to these projections. Separate methods for projecting emissions were used for non-agricultural (stationary area) and agricultural area sources (predominantly NH_3 emissions). The two methods used for these sectors are described in the sections that follow.

2.2.1 Stationary area sources

The general approach used to calculate Base F projected emissions for stationary area sources was as follows:

1. Use the VISTAS Base F 2002 base year inventory as the starting point for projections.
2. MACTEC then worked with the VISTAS States (via the Stationary Area Source SIWG) to obtain any State specific growth factors and/or future controls from the States to use in developing the projections.
3. MACTEC then back calculated uncontrolled emissions from the Base F 2002 base year inventory based on existing controls reported in the 2002 Base F base year inventory.
4. Controls (including control efficiency, rule effectiveness and rule penetration) provided by the States or originally developed for use in estimating projected emissions for U.S. EPA's Heavy Duty Diesel (HDD) rulemaking emission projections and used in the Clean Air Interstate Rule (CAIR) projections were then used to calculate controlled emissions. State submitted controls had precedence over the U.S. EPA developed controls.
5. Growth factors supplied from the States or the U.S. EPA's CAIR emission projections were then applied to project the controlled emissions to the appropriate year. In some cases EGAS Version 5 growth factors were used if no growth factor was available from either the States or the CAIR growth factor files. The use of EGAS Version 5 growth factors was on a case-by-case basis wherever State-supplied or CAIR factors were not available for SCCs found in the 2002 Base F inventory. Use of the EGAS factors was necessitated due to the CERR submittals used in constructing the Base F 2002 inventory. Use of the CERR data resulted in SCCs that were not found in the CAIR inventory and if no State-supplied growth factor was provided required the use of an EGAS growth factor.
6. MACTEC then provided the final draft Base F projection inventory for review and comment by the VISTAS States.

For Base F stationary area sources, no State-supplied growth or control factors were provided. Thus for all of the sources in this sector of the inventory, growth and controls for Base F were applied based on controls initially identified for the CAIR and growth factors identified for the CAIR projections.

For the Base G projections, the Base G 2002 base year inventory (see section 1.2.3) was used as a starting point. States provided some updated future controls but growth factors used were identical to those used for Base F. The revised controls for Base G were largely for new sources added as part of the 2002 Base F comments. The calculation of Base G projections was identical to the six steps outlined above with the exception of revisions made to prescribed fire for 2009 and 2018 and for the State of North Carolina. North Carolina provided 2009 and 2018 updated emission files used to update the emissions for each year for several source categories. However not all sources in the inventory were included in these NC updates. As a consequence, the final Base G 2009 and 2018 inventory for NC included emissions updated using the NC supplied files and emissions developed using growth and control factors as outlined above.

In a few cases, additional growth factors had to be added for source categories that had not initially been included in the Base F inventory. These growth factors were obtained from EGAS 5.0. Finally updates to growth factors from EGAS 5.0 were made for fuel fired emission sources. The updated growth factors reflected the most recent data from the Department of Energy's Annual Energy Outlook (AEO). These data were used to reflect changes in energy efficiency resulting from new or updated fuel firing technologies.

2.2.1.1 Stationary area source controls

The controls obtained by MACTEC for the HDD rulemaking were controls for the years 2007, 2020, and 2030. Since MACTEC was preparing 2009 and 2018 projections, control values for intermediate years were prepared using a straight line interpolation of control level between 2007 and 2020. The equation used to calculate the control level was as follows:

CE = (((2020 CE – 2007 CE)/13)*YRS) + 2007 CE

Where:

CE	=	Control Efficiency for either 2009 or 2018
2020 CE	=	HDD Control Efficiency value for 2020
2007 CE	=	HDD Control Efficiency value for 2007
13	=	Number of years between 2020 and 2007
YRS	=	Number of years beyond 2007 to VISTAS Projection year

For 2009 the value of YRS would be two (2) and for 2018 the value would be eleven (11). Control efficiency values were determined for VOC, CO and PM. Rule penetration values for each year in the HDD controls tables obtained by MACTEC were always 100 percent so those values were maintained for the VISTAS projections.

Prior to performing the linear interpolation of the controls, MACTEC evaluated controls from the CAIR projections (NOTE: Initially the controls came from the IAQTR projections, however the controls used in CAIR were virtually identical to those in IAQTR). Those controls appeared to be identical to those used for the HDD rulemaking. In addition, MACTEC received some additional information on some controls for area source solvents (email from Jim Wilson, E.H. Pechan and Associates, Inc. to Gregory Stella, VISTAS Emission Inventory Technical Advisor, 3/5/04) that were used to check against the controls in the HDD rulemaking files. Where those controls proved to be more stringent than the HDD values, MACTEC updated the control file with those values (which were then used in the interpolation to develop 2009 and 2018 values). Finally, for VOC the HDD controls were initially provided at the State-county-SCC level. However, upon direction from the VISTAS Emission Inventory Technical advisor, the VOC controls were consolidated at the SCC level and applied across all counties within the VISTAS region (email from Gregory Stella, Alpine Geophysics, 3/3/2004) to ensure that no controls were missed due to changes in county FIPS codes and/or SCC designations between the time the HDD controls were developed and 2002.

The equation below indicates how VOC emissions were projected for stationary area sources.

$$VOC_{2018} = VOC_{2002}\ x \left(1 - \left(\frac{VOC\_CE_{2018}}{100}\right)\left(\frac{VOC\_RE_{2018}}{100}\right)\left(\frac{VOC\_RP_{2018}}{100}\right)\right)$$

Where:

VOC_{2018} = VOC emissions for 2018

VOC_{2002} = Uncontrolled VOC emissions for 2002

VOC_CE_{2018} = Control Efficiency for VOC (in this example for 2018)

VOC_RE_{2018} = Rule Effectiveness for VOC (in this example for 2018)

VOC_RP_{2018} = Rule Penetration for VOC (in this example for 2018)

A similar equation could be constructed for either PM or CO. It should be noted that the control efficiencies calculated based on the HDD rulemaking were only applied if they were greater than any existing 2002 base year controls. No controls were found for SO_2 or NO_x area sources.

In the pre-Base F 2018 emission estimates, an energy efficiency factor was applied to energy related stationary area sources. The energy efficiency factor was applied along with the growth factor to account for both growth and changes in energy efficiency. That factor was not applied to the Base F projections since information supplied by U.S. EPA related to the CAIR growth factors indicated that growth values for those categories were derived from U.S. Department of Energy (DOE) and were felt to account for changes in growth and projected energy efficiency. For the Base G inventory, these energy efficiency factors were re-instituted and used in conjunction with EGAS 5.0 growth factors in a manner identical to that used for the pre-Base F inventories. The energy efficiency factors were derived from U.S. DOE's Annual Energy Outlook report.

One significant difference between the Base F and Base G control factors was for counties and independent cities in northern Virginia. Several counties and independent cities in northern Virginia are subject to Ozone Transport Commission rules. For these counties and independent cities, controls for portable fuel containers, mobile equipment repair/refinishing, consumer products, solvent metal cleaning, and the architectural and industrial maintenance rules were added. The counties/independent cities (FIPS code) included in the changes for Base G were: Alexandria City (51510), Arlington (51013), Fairfax City (51600), Fairfax (51059), Falls Church City (51610), Fredericksburg City (51630), Loudoun (51107), Manassas City (51683), Manassas Park City (51685), Prince William County (51153), Spotsylvania (51177), and Stafford (51179). Not all OTC rules applied to all counties/cities.

2.2.1.2 Stationary area source growth

As indicated above, growth factors for the Base F and Base G 2009 and 2018 inventories were obtained from the U.S. EPA and are linear interpolations of the growth factors used for the Clean Air Interstate Rule (CAIR) projections. The growth factors for the CAIR obtained by MACTEC were developed using a base year of 2001 and provided growth factors for 2010 and 2015. MACTEC used the TREND function in Microsoft Excel™ to calculate 2002, 2009 and 2018 values from the 2001, 2010 and 2015 values. The TREND function provides a linear interpolation of intermediate values from a known series of data points (in this case the 2001, 2010 and 2015 values) based on the equation for a straight line. These values were calculated at the State and SCC level with the exception of paved road emissions (SCC = 2294000000). The growth factors for paved roads were available in the CAIR data set at the State, county and SCC level so they were applied at that level.

Prior to utilizing the growth factors from the CAIR projections, MACTEC confirmed that all SCCs found in the VISTAS 2002 base year inventory were in the CAIR file (for Base F the starting point was the version 3.1 2002 base year inventory, for Base G the starting point was the Base F 2002 base year inventory). Some SCCs were not found in the CAIR file. For those SCCs, the growth factors used were derived in one of five ways. First where possible, they were taken from a beta version of EGAS 5.0. In other cases, the growth factor was set to one (i.e., no growth). In other cases, a similar SCC that had a CAIR growth factor was used. In a few cases a growth factor based on an average CAIR growth at the 6 digit SCC level was calculated. Finally a number of records used population as the growth surrogate. For the Base G inventory, CAIR growth factors for fuel fired area sources were replaced with EGAS 5.0 growth factors (used in conjunction with AEO fuel efficiency factors). A comment field in the growth factor file was used to mark those records that were not taken directly from the CAIR projection growth factors.

2.2.1.3 Differences between 2009/2018

Methodologically, there was no difference in the way that 2009 and 2018 emissions were calculated for stationary area sources. The individual control and growth factors were different (due to the linear interpolation used to calculate the values) but the calculation methods were identical. This applies to both Base F and Base G.

The only exception to this is for the State of North Carolina for Base G. North Carolina provided an emissions update file used to override calculated projections for a number of area source categories. The values in these files (provided for both 2009 and 2018) were used to overwrite the calculated projected emissions in the final NIF file.

2.2.2 Agricultural area sources

The general approach used to calculate projected emissions for agricultural area sources (predominantly NH_3 emission sources) was as follows:

1. MACTEC used the version 3.1 2002 base year inventory data (which was based on the CMU ammonia model version 3.6).

2. MACTEC worked with the VISTAS States (via the Agricultural Sources SIWG) to obtain any State specific growth and/or future controls from the States for agricultural sources.

3. Since the base year emissions were uncontrolled, and no future controls for these sources were identified, MACTEC projected the agricultural emissions using State-specific growth if available, otherwise the U.S. EPA's Interstate Air Quality Transport Rule (IAQTR)/Ammonia inventory was used to develop the growth factors used to project the revised 2002 base year inventory to 2009 or 2018. Since the IAQTR inventory was only used to construct growth factors rather than using the emissions directly, no updated growth factors were prepared from the CAIR inventory values.

4. MACTEC then provided the final draft inventory for review and comment by the VISTAS States.

No change in the agricultural area source emission projections were made between Base F and Base G other than the removal of wild animal and human perspiration as a result of their removal from the 2002 base year file for Base G.

2.2.2.1 Control assumptions for agricultural area sources

No controls were identified either by the individual VISTAS States or in the information provided in the EPA's IAQTR or CAIR Ammonia inventory documents. Thus all projected emissions for agricultural area sources represent simple growth with no controls.

2.2.2.2 Growth assumptions for agricultural area sources

Growth for several agricultural area source livestock categories was developed using the actual emission estimates developed by the EPA as part of the NEI. That work included projections for the years 2002, 2010, 2015, 2020, and 2030. The actual emissions themselves were not used other than to develop growth factors since the 2002 NEI upon which the growth projections were based was prepared prior to the release of the 2002 Census of Agriculture data which was included in the CMU model (version 3.6) used to develop the Base F 2002 VISTAS base year inventory. Thus VISTAS Agricultural Sources SIWG decided to use the NEI ammonia inventory projected emissions to develop the 2009 and revised 2018 growth factors used to project emission for VISTAS. Details on the NEI inventory and projections can be found at:

http://www.epa.gov/ttn/chief/ap42/ch09/related/nh3inventorydraft_jan2004.pdf. The actual data files for the projected emissions can be found at:

http://www.epa.gov/ttn/chief/ap42/ch09/related/nh3output01_23_04.zip.

In order to use the NEI projected emissions as growth factors, several steps were required. These steps were as follows:

1. NEI projected emissions were only available for the years 2002, 2010, 2015, 2020, and 2030, thus the first task was to calculate intermediate year emissions for 2009 and 2018. These values were calculated based on linear interpolation of the existing data.

2. Once the intermediate emissions were calculated, MACTEC developed emission ratios to provide growth factors for 2009 and 2018. Ratios of emissions were established relative to the 2002 NEI emissions.

3. Once the growth factors were established, MACTEC then evaluated whether or not all agricultural SCCs within the revised 2002 base year inventory had corresponding

growth factors. MACTEC established that not all SCCs within the base year inventory had growth factors. These SCCs fell into one of two categories:

b. SCCs that had multiple entries in the NEI but only a single SCC in the 2002 VISTAS base year inventory. The NEI was established using a process model and for some categories of animals, emissions were calculated for several aspects of the process. The CMU model version 3.6 which was the basis for the VISTAS 2002 Base F inventory did not use a process model. As a consequence a mapping of SCCs in the NEI projections and corresponding SCCs in the CMU inventory was made and for those SCCs an average growth factor was calculated from the NEI projections for use with the corresponding SCC in the CMU based 2002 Base F inventory.

c. There were also State, county, SCC trios in the 2002 VISTAS Base F inventory which had no corresponding emissions in the NEI files. For these instances, MACTEC first developed State level average growth factors from the NEI projections for use in growing these records. Even after developing State level average growth factors there were still some State/SCC pairs that did not have matching growth. For these records, MACTEC developed VISTAS regional average growth factors at the SCC level from the NEI data.

1. Once all of the growth factors were developed, they were used to project the emissions to 2009 and 2018. Growth factors were first applied at the State, county and SCC level. Then remaining records were grown with the State/SCC specific growth factors. Finally, any remaining ungrown records were projected at the SCC level using the VISTAS regional growth factor.

For the livestock categories, the NEI emission projections only had data for beef and dairy cattle, poultry and swine. Thus for other livestock categories and for fertilizers alternative growth factors were required.

The growth factors for other livestock categories and fertilizers were obtained from growth factors used for the IAQTR projections made by the U.S. EPA. The methodology for these categories was identical to that used for dairy, beef, poultry and swine with the exception that State/SCC and VISTAS/SCC growth factors were not required for these categories since the IAQTR data contained State, county and SCC level growth factors. The IAQTR data provided growth factors for 1996, 2007, 2010, 2015 and 2020. Linear interpolation was used to develop the growth factors for the intermediate years 2009 and 2018 required for the VISTAS projections.

There were a few exceptions to the methods used for projecting agricultural sources for the VISTAS projections. These exceptions were:

1. All swine emissions for North Carolina were maintained at 2002 levels for each projection year to capture a moratorium on swine production in that State.
2. Ammonia growth factors for a few categories (mainly feedlots) were assigned to be the same as growth factors for PM emissions from the NEI projections. This assignment was made because the CMU model showed emissions from these categories but the NEI projections did not show ammonia emissions but did show PM emissions.
3. No growth factors were found for horse and pony emissions. These emissions were held constant at 2002 levels.

There was no change in this method between Base F and Base G. Thus Base F and Base G agricultural emissions are the same in each inventory. Future efforts on the agricultural emissions category should look at any changes made to the CMU model to reflect the model farm approach used by EPA in their inventory plus any updated growth factors that may be more recent than the EPA inventory used to develop growth estimates for Base F/G.

2.2.2.2.1 Differences between 2009/2018

Methodologically, there was no difference in the way that 2009 and 2018 emissions were calculated for agricultural area sources. The growth factors were different (due to the linear interpolation used to calculate the values) but the calculation methods were identical. In addition there was no difference between Base F and Base G for this category. Thus Base F and Base G agricultural emissions are the same in each inventory.

Tables 2.2-1 show the differences between Base F and Base G emissions for all area sources (including agricultural sources but excluding fires) for the 2002 base year and 2009 and 2018 by State and pollutant.

Table 2.2-1 2002 Base Year Emissions and Percentage Difference for Base F and Base G (based on actual emissions).

Actual Area 2002 - Base G							
State	**CO**	**NH3**	**NOX**	**PM10-PRI**	**PM25-PRI**	**SO2**	**VOC**
AL	83,958	58,318	23,444	393,588	56,654	52,253	182,674
FL	71,079	37,446	28,872	443,346	58,878	40,491	404,302
GA	108,083	80,913	36,142	695,414	103,794	57,559	299,679
KY	66,752	51,135	39,507	233,559	45,453	41,805	95,375
MS	37,905	58,721	4,200	343,377	50,401	771	131,808
NC	345,315	161,860	36,550	280,379	64,052	5,412	237,926
SC	113,714	28,166	19,332	260,858	40,291	12,900	161,000
TN	89,828	34,393	17,844	212,554	42,566	29,917	153,307
VA	155,873	43,905	51,418	237,577	43,989	105,890	174,116
WV	39,546	9,963	12,687	115,346	21,049	11,667	60,443
Base F							
AL	83,958	59,486	23,444	393,093	73,352	47,074	196,538
FL	105,849	44,902	29,477	446,821	81,341	40,537	439,019
GA	107,889	84,230	36,105	695,320	133,542	57,555	309,411
KY	66,752	51,097	39,507	233,559	52,765	41,805	100,174
MS	37,905	59,262	4,200	343,377	63,135	771	135,106
NC	373,585	164,467	48,730	303,492	69,663	7,096	346,060
SC	113,714	29,447	19,332	260,858	51,413	12,900	187,466
TN	89,235	35,571	17,829	211,903	49,131	29,897	161,069
VA	155,873	46,221	51,418	237,577	52,271	9,510	129,792
WV	39,546	10,779	12,687	115,346	25,850	11,667	61,490
Percentage Difference (negative values means Base G increased from Base F)							
AL	0.00%	1.96%	0.00%	-0.13%	22.76%	-11.00%	7.05%
FL	32.85%	16.61%	2.05%	0.78%	27.62%	0.12%	7.91%
GA	-0.18%	3.94%	-0.10%	-0.01%	22.28%	-0.01%	3.15%
KY	0.00%	-0.07%	0.00%	0.00%	13.86%	0.00%	4.79%
MS	0.00%	0.91%	0.00%	0.00%	20.17%	0.00%	2.44%
NC	7.57%	1.59%	24.99%	7.62%	8.05%	23.74%	31.25%
SC	0.00%	4.35%	0.00%	0.00%	21.63%	0.00%	14.12%
TN	-0.67%	3.31%	-0.09%	-0.31%	13.36%	-0.07%	4.82%
VA	0.00%	5.01%	0.00%	0.00%	15.84%	-1013.45%	-34.15%
WV	0.00%	7.57%	0.00%	0.00%	18.57%	0.00%	1.70%

Table 2.2-2 2009 Projection Year Emissions and Percentage Difference for Base F and Base G (based on actual emissions).

Actual Area 2009 - Base G							
State	**CO**	**NH3**	**NOX**	**PM10-PRI**	**PM25-PRI**	**SO2**	**VOC**
AL	66,654	64,268	23,930	413,020	58,699	48,228	143,454
FL	57,011	38,616	28,187	503,230	64,589	36,699	420,172
GA	94,130	89,212	37,729	776,411	112,001	57,696	272,315
KY	57,887	53,005	42,088	242,177	46,243	43,087	94,042
MS	27,184	63,708	4,249	356,324	51,661	753	124,977
NC	301,163	170,314	39,954	292,443	69,457	5,751	187,769
SC	90,390	30,555	19,360	278,299	41,613	13,051	146,107
TN	74,189	35,253	18,499	226,098	44,124	30,577	154,377
VA	128,132	46,639	52,618	252,488	44,514	105,984	147,034
WV	31,640	10,625	13,439	115,089	20,664	12,284	55,288
Base F							
AL	68,882	65,441	26,482	411,614	76,248	17,818	157,405
FL	101,356	46,950	31,821	507,515	90,487	52,390	462,198
GA	103,579	92,838	38,876	776,935	146,691	57,377	294,204
KY	64,806	53,023	42,122	242,345	54,397	40,779	94,253
MS	37,161	64,289	4,789	356,516	65,321	637	125,382
NC	332,443	173,187	53,550	317,847	75,570	7,607	252,553
SC	95,826	31,966	20,852	278,852	54,230	12,945	176,104
TN	82,196	36,578	19,148	225,650	51,753	29,787	160,265
VA	133,738	49,173	53,344	252,924	54,587	10,619	120,022
WV	37,704	11,461	13,816	115,410	25,835	12,156	57,082
Percentage Difference (negative values means Base G increased from Base F)							
AL	3.24%	1.79%	9.64%	-0.34%	23.02%	-170.67%	8.86%
FL	43.75%	17.75%	11.42%	0.84%	28.62%	29.95%	9.09%
GA	9.12%	3.91%	2.95%	0.07%	23.65%	-0.56%	7.44%
KY	10.68%	0.03%	0.08%	0.07%	14.99%	-5.66%	0.22%
MS	26.85%	0.90%	11.27%	0.05%	20.91%	-18.10%	0.32%
NC	9.41%	1.66%	25.39%	7.99%	8.09%	24.41%	25.65%
SC	5.67%	4.41%	7.16%	0.20%	23.27%	-0.82%	17.03%
TN	9.74%	3.62%	3.39%	-0.20%	14.74%	-2.65%	3.67%
VA	4.19%	5.15%	1.36%	0.17%	18.45%	-898.09%	-22.51%
WV	16.08%	7.29%	2.73%	0.28%	20.02%	-1.06%	3.14%

Table 2.2-3 2018 Projection Year Emissions and Percentage Difference for Base F and Base G (based on actual emissions).

Actual Area 2018 - Base G							
State	**CO**	**NH3**	**NOX**	**PM10-PRI**	**PM25-PRI**	**SO2**	**VOC**
AL	59,626	71,915	25,028	445,256	62,323	50,264	153,577
FL	53,903	40,432	30,708	578,516	72,454	38,317	489,975
GA	93,827	99,885	41,332	880,199	123,704	59,729	319,328
KY	54,865	55,211	44,346	256,052	47,645	44,186	103,490
MS	22,099	69,910	4,483	375,495	53,222	746	140,134
NC	290,809	180,866	43,865	315,294	71,262	6,085	189,591
SC	83,167	33,496	20,592	304,251	44,319	13,457	161,228
TN	68,809	36,291	19,597	246,252	46,692	31,962	182,222
VA	121,690	50,175	56,158	275,351	46,697	109,380	150,919
WV	28,773	11,504	14,828	121,549	21,490	12,849	60,747
Base F							
AL	63,773	73,346	28,754	445,168	82,449	49,975	168,507
FL	100,952	49,889	35,047	582,832	101,872	59,413	533,141
GA	105,059	103,911	42,260	880,800	163,925	61,155	342,661
KY	65,297	55,356	45,597	256,544	57,110	42,326	102,117
MS	36,425	70,565	5,230	375,931	68,338	831	139,419
NC	327,871	184,167	60,073	345,275	85,018	8,273	234,207
SC	89,343	35,082	22,467	304,940	58,441	13,517	196,946
TN	81,242	37,812	20,928	245,893	55,712	31,047	188,977
VA	129,037	53,023	56,668	275,790	58,141	11,479	128,160
WV	36,809	12,390	15,079	121,964	27,088	13,450	62,164
Percentage Difference (negative values means Base G increased from Base F)							
AL	6.50%	1.95%	12.96%	-0.02%	24.41%	-0.58%	8.86%
FL	46.61%	18.96%	12.38%	0.74%	28.88%	35.51%	8.10%
GA	10.69%	3.87%	2.20%	0.07%	24.54%	2.33%	6.81%
KY	15.98%	0.26%	2.74%	0.19%	16.57%	-4.40%	-1.34%
MS	39.33%	0.93%	14.28%	0.12%	22.12%	10.19%	-0.51%
NC	11.30%	1.79%	26.98%	8.68%	16.18%	26.45%	19.05%
SC	6.91%	4.52%	8.34%	0.23%	24.16%	0.44%	18.14%
TN	15.30%	4.02%	6.36%	-0.15%	16.19%	-2.95%	3.57%
VA	5.69%	5.37%	0.90%	0.16%	19.68%	-852.83%	-17.76%
WV	21.83%	7.15%	1.66%	0.34%	20.66%	4.46%	2.28%

2.2.3 Changes to Prescribed Fire for 2009/2018 Base G

Just prior to release of version 3.1 of the VISTAS inventory several Federal agencies indicated that they had plans for increased prescribed fire burning in future years and that the “typical” fire inventory would likely not adequately capture those increases (memo from Bill Jackson and Cindy Huber, August 13, 2004). However data were not readily available to incorporate those changes up through the Base F inventory. As a consequence MACTEC worked with Federal Land Managers to acquire the data necessary to provide 2009 and 2018 specific projections for the prescribed fire component of the Base G fire inventory. The 2009 and 2018 projections developed using the method described below are being used by VISTAS as the 2009 and 2018 base case inventories for all States except FL. For FL the supplied data from the FLMs is not being used as FL felt that their data adequately reflected current and future prescribed burning practices. The "typical" fire projection is the 2002 base prescribed fire projection.

One of the biggest issues in preparing the projection was how best to incorporate the data. Two agencies submitted data: Fish and Wildlife Service (FWS) and Forest Service (FS). FWS submitted annual acreage data by National Wildlife Refuge (NWR) and county with estimates of acres burned per day for each NWR. FS provided fire-by-fire acreage estimates based on mapping projected burning acreage to current 2002 modeling days. However, FWS did not submit data for VISTAS original base year preparation process, thus there was no known FWS data in the 2002 actual or typical inventories. Thus MACTEC had to develop a method that could use the county level data submitted by FWS.

In addition, despite the fact that the FS submitted fire-by-fire data for the 2002 actual inventory and had mapped the projections to current burn days in the 2002 actual inventory, MACTEC could not do a simple replacement of those records with the 2009/2018 projections. This situation was created because several VISTAS States run a prescribed fire permitting program. To avoid double counting, only State data was used in those States for the 2002 actual inventory. Thus there were no Federal data in those States since the Federal data could have potentially duplicated State-supplied prescribed fire data. In VISTAS States without permit programs, the FS supplied data for 2002 was used and those records were marked in database. Thus for those States, the FS supplied 2009/2018 data could be directly substituted for the 2002 data.

The method used by MACTEC to include the FS data applied a county level data approach for FS data where a State had a prescribed fire permitting program and a fire-by-fire replacement for FS data in States without permit programs. MACTEC used a county level approach for all of the FWS data. The approach used for each data set is discussed below.

For the FWS data MACTEC summed the annual acres burned supplied by the FWS across all NWRs in a county. We then subtracted out 2002 acreage for that county from the FWS projected acreage annual total to avoid double counting. The remaining acreage was then multiplied by 0.8 to account for blackened acres instead of the total perimeter acres that were reported. The revised total additional FWS acreage was then added to the total county "typical" acreage to determine future acreage burned for either 2009 or 2018. MACTEC then allocated the increased acreage to current modeling days. The average daily acres burned data provided by FWS per NWR/county was used to allocate the acreage to the correct number of days required to burn all of the acres. Guidance supplied by FWS indicated that up to three times the average daily acres burned could potentially be allocated to any one day. Thus if the estimated acreage per day were 100 acres then up to 300 acres could actually be allocated to a particular day. This approach (use of up to three times the average daily acres burned) was used if there were an insufficient number of 2002 modeling days available to account for all of the acreage increase. MACTEC used an incremental approach to using the increase above the base average daily acres. First we used twice the average daily acreage if that was sufficient to completely allocate the increased acreage over the total number of days available. If that wasn't sufficient then we used three times the average daily acres burned to allocate the acreage. We applied the highest increases to days in the database that already had the highest acreage burned since we felt those days were most likely to represent days with representative conditions for conducting prescribed burns.

The approach used by MACTEC for the FS was slightly different. For States that had permit programs, we used similar approach to the FWS county level approach. First we summed the FS data at county level, we then added that value to the typical acreage and then we allocated the acres to current modeling days. The mapping to current modeling days was performed by Bill Jackson of the USFS and provided to MACTEC. For States that do not have a prescribed fire permit program, MACTEC simply replaced the current fire-by-fire records in the database with fire-by-fire records from the FS and recalculated emissions based on fuel model and fuel loading. We also applied the same 0.8 correction for blackened acres applied to all FS supplied acreage as the supplied values represented perimeter acres.

An additional problem with developing year-specific prescribed fire projections was how to adequately capture the temporal profile for those fires. In the 2002 actual fire inventory, fires occur on same days as state/FLM records. In the 2002 "typical" year inventory, fire acreage increased or decreased from acreage on the same fire days as were in the 2002 actual inventory, since the acres were simply increased for each day based on a multiplier used to convert from actual to typical.

When prescribed fires acreage was added to a future year, MACTEC added acreage to individual fire days proportional to the annual increase (if acreage on a day is 10 percent of annual, add 10 percent of projected increase to that same day).

The table below shows how the FWS data for Okefenokee NWR were allocated for 2009 for Clinch County (Okefenokee NWR is located in four different counties). You can see that the total additional acres for the Clinch County portion of Okefenokee NWR was 1,956 acres. Two hundred eighty (280) acres were the estimated average daily acres burned for that NWR/county combination. Thus to allocate the entire 1,956 acres would require almost 7 burn days (1,956 divided by 280). However only 5 burn days were found for Clinch County in the 2002 actual fire database. Thus we allocated twice the average acreage to the burn day with the most acres burned in the 2002 actual fire database (since our method allowed us to increase the average daily acres burned up to three times the recommended level). Thus the first burn day received 560 acres and all others received 280 except the final day which received 276 to make the total equal to the required 1,956 acres. The table also indicates that the increased acres burned provided increases of from 10-48 percent in the acres burned on the individual burn days and an average of approximately 14 percent for the year as a whole.

CLINCH COUNTY	3/1/2002	4/1/2002	2/1/2002	1/1/2002	11/1/2002	12/1/2002	Total Annual
Acres (typical)	3,757	2,612	1,996	1,801	616	472	11,764
Add on FWS Projection	560	280	280	280	280	276	1,956
Total	4,316	2,891	2,276	2,080	895	747	13,720
Percent Increase	14.9%	10.7%	14.0%	15.6%	45.5%	58.5%	14.3%

The figure below shows the increases for prescribed burning in the four counties that comprise the Okefenokee NWR area (which also includes FS land). In this figure you can see the additional acreage added for the burn days from FWS and the individual day increases caused by projected increases in prescribed burning based on FS data. It should be noted that while the emissions represent 2009, all fire event dates listed are for 2002 to match up with the base year meteorology used in modeling exercises.

Table 2.2-4 shows the percentage difference between the 2009 and 2018 projections developed for Base F and Base G. Base G includes the revised prescribed burning estimates described above. Values are calculated using Base F as the basis for change, thus negative values imply an increase in emissions for Base G.

Figure 2.2-1 Prescribed Fire Projection for Okeefenokee NWR for 2009

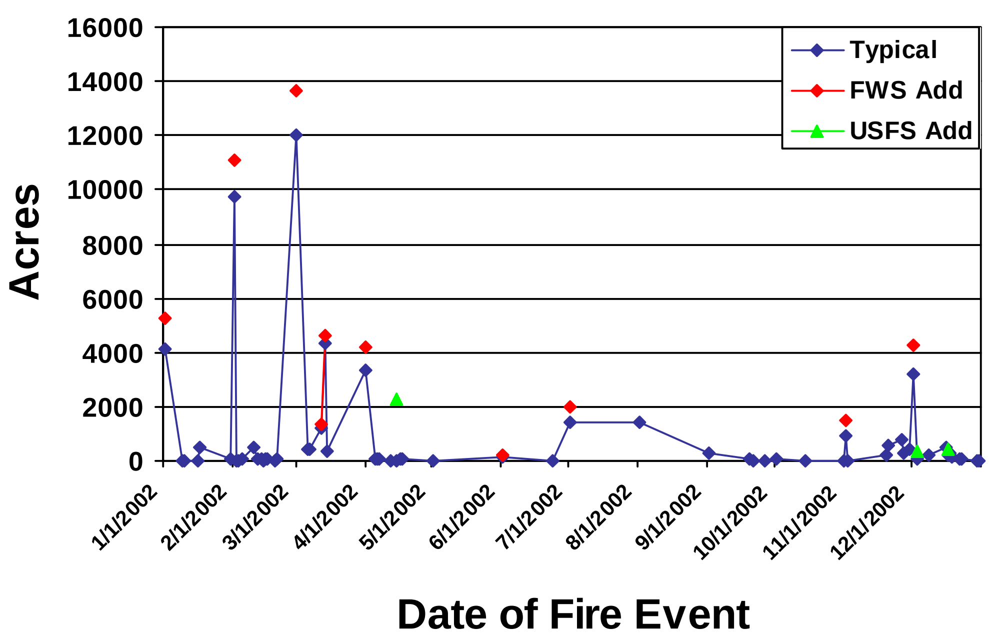


Table 2.2-4 Percentage Difference Between Base F and Base G Fire Emissions by State

State	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
2009 Fires Base G								**2018 Fires Base G**						
AL	534,873	2,050	11,901	52,851	46,543	2,681	27,502	535,658	2,054	11,918	52,927	46,608	2,686	27,539
FL	923,310	3,157	19,791	98,470	88,756	4,129	51,527	923,310	3,157	19,791	98,470	88,756	4,129	51,527
GA	637,177	2,229	14,243	63,973	57,116	2,914	34,710	637,177	2,229	14,243	63,973	57,116	2,914	34,710
KY	31,810	143	682	3,093	2,653	187	1,497	33,296	150	714	3,237	2,777	196	1,567
MS	48,160	217	1,033	4,683	4,016	283	2,266	50,037	225	1,073	4,865	4,173	294	2,355
NC	96,258	433	2,065	9,359	8,027	566	4,530	111,266	501	2,387	10,819	9,279	655	5,236
SC	282,307	1,039	5,899	29,153	25,955	1,359	16,045	282,307	1,039	5,899	29,153	25,955	1,359	16,045
TN	17,372	78	373	1,689	1,449	102	817	18,860	85	405	1,834	1,573	111	888
VA	21,130	95	453	2,054	1,762	124	994	26,923	121	578	2,618	2,245	158	1,267
WV	3,949	18	85	384	329	23	186	5,013	23	108	487	418	29	236
2009 Fires Base F								**2018 Fires Base F**						
AL	514,120	1,957	11,456	50,833	44,812	2,559	26,526	514,120	1,957	11,456	50,833	44,812	2,559	26,526
FL	923,310	3,157	19,791	98,470	88,756	4,129	51,527	923,310	3,157	19,791	98,470	88,756	4,129	51,527
GA	620,342	2,153	13,882	62,336	55,712	2,815	33,918	620,342	2,153	13,882	62,336	55,712	2,815	33,918
KY	56,686	110	1,460	6,667	6,310	136	3,338	56,686	110	1,460	6,667	6,310	136	3,338
MS	128,471	177	3,328	14,693	13,680	100	13,625	128,471	177	3,328	14,693	13,680	100	13,625
NC	200,564	324	5,005	20,488	19,491	423	12,499	200,564	324	5,005	20,488	19,491	423	12,499
SC	253,005	908	5,270	26,304	23,511	1,187	14,666	253,005	908	5,270	26,304	23,511	1,187	14,666
TN	78,370	46	2,232	8,875	8,730	59	5,153	78,370	46	2,232	8,875	8,730	59	5,153
VA	19,159	159	978	18,160	17,361	99	912	19,159	159	978	18,160	17,361	99	912
WV	32,656	12	944	3,276	3,239	16	2,184	32,656	12	944	3,276	3,239	16	2,184
Percentage Difference (negative number means an increase in Base G emissions)														
AL	-4.04%	-4.77%	-3.89%	-3.97%	-3.86%	-4.77%	-3.68%	-4.19%	-4.95%	-4.03%	-4.12%	-4.01%	-4.95%	-3.82%
FL	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
GA	-2.71%	-3.52%	-2.60%	-2.63%	-2.52%	-3.52%	-2.34%	-2.71%	-3.52%	-2.60%	-2.63%	-2.52%	-3.52%	-2.34%
KY	43.88%	-29.52%	53.25%	53.61%	57.96%	-37.90%	55.15%	41.26%	-35.57%	51.07%	51.44%	56.00%	-44.34%	53.06%
MS	62.51%	-22.07%	68.95%	68.13%	70.64%	-183.85%	83.37%	61.05%	-26.83%	67.74%	66.89%	69.50%	-194.91%	82.72%
NC	52.01%	-33.75%	58.74%	54.32%	58.82%	-33.75%	63.76%	44.52%	-54.60%	52.31%	47.19%	52.40%	-54.60%	58.11%
SC	-11.58%	-14.52%	-11.93%	-10.83%	-10.39%	-14.52%	-9.40%	-11.58%	-14.52%	-11.93%	-10.83%	-10.39%	-14.52%	-9.40%
TN	77.83%	-69.40%	83.30%	80.97%	83.41%	-74.42%	84.14%	75.93%	-83.92%	81.87%	79.34%	81.98%	-89.36%	82.78%
VA	-10.29%	40.36%	53.67%	88.69%	89.85%	-25.40%	-9.03%	-40.53%	24.00%	40.97%	85.59%	87.07%	-59.79%	-38.93%
WV	87.91%	-48.65%	91.03%	88.28%	89.83%	-49.46%	91.49%	84.65%	-88.70%	88.61%	85.12%	87.09%	-89.73%	89.20%

2.2.4 Quality Assurance steps

Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, to ensure that a full and complete inventory was developed for VISTAS, and to make sure that projection calculations were working correctly. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on the stationary and agricultural area source components of the 2009 and revised 2018 projection inventories:

1. All final files were run through EPA's Format and Content checking software.
2. SCC level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources.
3. Tier comparisons (by pollutant) were developed between the 2002 base year inventory and the 2009 and 2018 projection inventories. In addition, total VISTAS pollutant summaries were prepared to compare total emissions by pollutant between versions of the inventory (e.g., between Base F and Base G).
4. Data product summaries were provided to both the VISTAS Emission Inventory Technical Advisor and to the SIWG representatives for review and comment. Changes based on these comments were implemented in the files.
5. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from 1.0 to 2.0. A minor change would cause a version number to go from 1.0 to 1.1. Minor changes resulting from largely editorial changes would result in a change from 1.00 to 1.01.

2.3 Mobile Sources

Our general approach for assembling data was to use as much existing data from the pre-Base F preliminary projections as possible for these inventories, supplement these data with easily available stakeholder input, and provide the results for stakeholder review to ensure credibility. To develop the "base case" projections, MACTEC originally assembled data to develop two 2009 and 2018 base case inventories: 1) an inventory that included all "on-the-books" control programs and 2) an "on-the-way" inventory that included controls that were likely to be "on-the-way". For the Base F and Base G emission forecasts to the mobile source sector, "on-the-books" and "on-the-way" are defined with the same strategies and therefore only a single projection scenario was developed for each forecast year.

To ensure consistency across evaluation years, the 2009 and 2018 base case inventories were developed, to the maximum extent practical, using methodologies identical to those employed in developing the 2002 on-road portion of the revised 2002 VISTAS base year inventory. All modifications to the 2002 inventory methods were developed in consultation with the Mobile Source Special Interest Workgroup (MSSIWG). Generally, modifications were only made to properly account for actual changes expected in the intervening period (i.e., between 2002 and 2009 and between 2002 and 2018), but the underlying inventory development methodology was identical, except to the extent requested by VISTAS or the MSSIWG.

MACTEC developed a preliminary 2018 inventory in early 2004. That inventory was designed to 1) be used for modeling sensitivity evaluations and 2) help establish the methods that would be used for the final 2018 inventory and the initial 2009 inventory. Since that work took place prior to the revision of the 2002 base year inventory data files, MACTEC provided a review of the data and methods used to develop on-road mobile source input files for the initial 2002 base year inventory prior to developing the preliminary 2018 inventory. Through this review, MACTEC determined the following:

- On-road VMT. Most States provided local data for 2002 (or a neighboring year that was converted to 2002 using appropriate VMT growth surrogates such as population). Since these data were not applicable to 2018 due to intervening growth, input for 2018 was solicited from the MSSIWG. At the same time we researched county-specific growth rate data utilized for recent national rulemakings as a backstop approach to State supplied VMT projections.
- Modeling Temperatures. Actual 2002 temperatures were used for the initial 2002 base year inventory.
- Vehicle Registration Mix (age fractions by type of vehicle). A mix of State, local, and MOBILE6 default data were used for the 2002 initial base year inventory. Forecast data were solicited from the States, with a fallback position that we hold the fractions constant at their 2002 values.
- Vehicle Speed by Roadway Type. For the 2002 initial base year inventory, speeds varying by vehicle and road type were used.
- VMT Mixes (fraction of VMT by vehicle type). A mix of State, local, and quasi MOBILE6 default (i.e., MOBILE6 defaults normalized to better reflect local conditions) data were used for the 2002 initial base year inventory. Forecast data were solicited from the States.
- Diesel Sales Fractions. As with the VMT mix data, the diesel sales fraction data employed for the 2002 initial base year inventory represents a mix of State, local, and quasi MOBILE6 default data. The issues related to updating these data to 2018 are also

similar, but are complicated by the fact that MOBILE6 treats diesel sales fraction on a model year, rather than age specific basis. Therefore, diesel sales fractions generally cannot be held constant across time. Once again, we solicited any local projections, with a fallback position that we would keep the data for 2002 and earlier model years constant for the forecast inventory, supplemented with MOBILE6 default data for 2003 and newer model years.

- State/Local Fuel Standards. For the 2002 initial base year inventory, these data were based on appropriate local requirements and updated data for 2018 was only required if changes were expected between 2002 and 2018. There are some national changes in required fuel quality for both on-road and non-road fuels that are expected to occur between 2002 and 2018 and these would be reflected in the 2018 inventory in the absence of more stringent local fuel controls. Expected changes in local fuel control programs were solicited.

- Vehicle Standards. The 2002 initial base year inventory assumed NLEV applicability. This was altered to reflect Tier 2 for 2018, unless a State indicated a specific plan to adopt the California LEV II program. If so, we made the required changes to implement those plans for the preliminary 2018 inventory.

- Other Local Controls. This includes vehicle emissions inspection (i.e., I/M) programs, Stage II vapor recovery programs, anti tampering programs, etc. By nature, the assumptions used for the 2002 initial base year inventory vary across the VISTAS region, but our presumption is that these data accurately reflected each State's situation as it existed in 2002. If a State had no plans to change program requirements between 2002 and 2018, we proposed to maintain the 2002 program descriptions without change. However, if a State planned changes, we requested information on those plans. In the final implementation of the Base F and earlier inventories, Stage II controls were exercised in the area source component of the inventory, since the units used to develop Stage II refueling estimates are different between MOBILE6 and the NONROAD models. However, in the Base G inventories, Stage II refueling was moved to the on-road and non-road sectors.

Once the preliminary 2018 (pre-Base F) base case projection inventory data were compiled, MACTEC applied the data and methods selected and proceeded to develop the preliminary (pre-base F) base case 2018 projection inventories. The resulting inventories were provided to the MSSIWG in a user-friendly format for review. After stakeholder review and comment, the final preliminary 2018 base case inventories and input files were provided to VISTAS in formats identified by the VISTAS Technical Advisor (in this case, MOBILE input files and VMT, NONROAD input files and annual inventory files for NONROAD in NIF 3.0 format). Annual inventory files for MOBILE were not developed as part of this work, only input files and VMT forecasts. MOBILE emissions were calculated by VISTAS air quality modeling contractor using the provided files.

2.3.1 Development of on-road mobile source input files

As indicated above, MACTEC prepared a preliminary version of the 2018 base case mobile inventory input data files. These files were then updated to provide a final set of 2018 base case inventory input data files as well as a set of input files for 2009. The information below describes the updates performed on the preliminary 2018 files and the development of the 2009 input data files for Base F emission estimation.

Our default approach to preparing the revised 2018 and initial 2009 projection inventories for on-road mobile sources was to estimate the emissions by using either:

1. the revised 2002 data provided by each State coupled with the projection methods employed for the preliminary 2018 inventory, or
2. the same data and methods used to generate the preliminary 2018 inventory.

We also investigated whether or not there was more recent VMT forecasting data available (e.g., from the CAIR and if appropriate revised the default VMT growth rates accordingly. This did not affect any State that provided local VMT forecasting data, but would alter the VMT estimates used for other areas.

Since no preliminary 2009 inventory was developed there did not exist an option (2) above for 2009. As a consequence, MACTEC crafted the 2009 initial inventory for on-road mobile sources using methods identical to those employed for the 2018 preliminary inventories coupled with any changes/revisions provided by the States during the review of the revised 2002 base year and the 2018 preliminary inventories. Therefore, as was the case for 2018, we obtained from the States any input data revisions, methodological revisions, and local control program specifications (to the extent that they differed from 2002/2018).

2.3.1.1 Preparation of revised 2018 input data files

Preparation of the revised 2018 inventories required the following updates:

1. The evaluation year was updated to 2018 in all files.
2. The diesel fuel sulfur content was revised from 500 ppm to 11 ppm, consistent with EPA data for 2018 in all files.
3. Since the input data is model year, rather than age, specific for diesel sales fractions (with data for the newest 25 model years required), we updated all files that included

diesel sales fractions. In the revised 2002 base year files, the data included applied to model years 1978-2002. For 2018, the data included would reflect model years 1994-2018. To forecast the 2002 data, MACTEC took the data for 1994-2002 from the 2002 files and added data for 2003-2018. To estimate the data for these years, we employed the assumption employed by "default" in MOBILE6 -- namely that diesel sales fractions for 1996 and later are constant. Therefore, we set the diesel sales fractions for 2003-2018 at the same value as 2002.

4. VMT mix fractions must be updated to reflect expected changes in sales patterns between 2002 and 2018. If explicit VMT mix fractions are not provided, these changes are handled internally by MOBILE6 or externally through absolute VMT distributions. However, files that include explicit VMT mix fractions override the default MOBILE6 update and may or may not be consistent with external VMT distributions. MACTEC updated the VMT mix in such files as follows:

   First, we calculated the VMT fractions for LDV, LDT1, LDT2, HDV, and MC from the external VMT files for 2018. This calculation was performed in accordance with section 5.3.2 of the MOBILE6 Users Guide which indicates:

   LDV = LDGV + LDDV

   LDT1 = LDGT1 + LDDT

   LDT2 = LDGT2

   HDV = HDGV + HDDV

   MC = MC

   The resulting five VMT fractions were then split into the 16 fractions required by MOBILE6 using the distributions for 2018 provided in Appendix D of the MOBILE6 Users Guide. This approach ensures that explicit input file VMT fractions are consistent with the absolute VMT distributions prepared by MACTEC. These changes were made to all files that included VMT mixes.

5. All other input data were retained at 2002 values, except as otherwise instructed by the States. This includes all control program descriptions (I/M, Anti-Tampering Program [ATP], Stage II, etc.), all other fuel qualities (RVP, oxy content, etc.), all other vehicle descriptive data (registrations age distributions, etc.), and all scenario descriptive data. The State-specific updates performed are described below.

<u>Kentucky:</u>

MACTEC revised the 2018 input files for the Louisville, Kentucky area (Louisville Air Pollution Control District [APCD]) based on comments received relative to several components of

MOBILE input data. Based on these comments, the input files for Jefferson County, Kentucky were updated accordingly as follows:

a) I/M and tampering program definitions were removed since the program was discontinued at the end of 2003.

b) The "Speed VMT", "Facility VMT" and "Registration Age Distribution" file pointers were updated to reflect revised 2002 files provided by the Louisville APCD.

c) The "VMT Mix" data, which was previously based on the default approach of "growing" 2002 data, was replaced by 2018-specific data provided by the Louisville APCD.

North Carolina:

North Carolina provided a wide range of revised input data, including complete MOBILE6 input files for July modeling. MACTEC did not use the provided input files directly as they did not match the 2002 NC input files for critical elements such as temperature distributions and gasoline RVP (while they were close, they were slightly different). To maintain continuity between 2002 and 2018 modeling, MACTEC instead elected to revise the 2002 input files to reflect all control program and vehicle-related changes implied by the new 2018 files, while retaining the basic temperature and gasoline RVP assumptions at their 2002 values. Under this approach, the following changes were made:

a) NC provided a county cross reference file specific to 2018 that differed from that used for 2002. We removed files that were referenced in the 2002 input data and replaced those files with those referenced in the 2018 data. In addition, since NC only provided 2018 input files for July, we estimated the basic data for these new files for the other months by cross referencing the target files for 2002 by county against the target files for 2018 by county.

b) We then revised the 2002 version of each input file to reflect the 2018 "header" data included in the NC-provided 2018 files. These data are exclusively limited to I/M and ATP program descriptions, so that the 2002 I/M and ATP data were replaced with 2018 I/M and ATP data.

c) We retained the registration age fractions at their 2002 "values" (external file pointers) as per NC instructions.

d) We retained all scenario-specific data (i.e., temperatures, RVP, etc.) at 2002 values, which (as indicated above), were slightly different in most cases from data included in the 2018 files provided by NC. We believe these differences were due to small deviations between the data assembled to support VISTAS 2002 and the process used to generate the 2018 files provided by NC, and that revising the VISTAS 2002 data to reflect these variations was not appropriate given the resulting inconsistencies that would be reflected between VISTAS 2002 and VISTAS 2018.

e) NC also provided non-I/M versions of the 2018 input files that would generally be used to model the non-I/M portion of VMT. While these files were retained they were not used for the 2018 input data preparation.

Finally, NC also provided a speed profile file and a speed profile cross reference file for 2018. We did not use these in our updates as they have no bearing on the MOBILE6 input files, but they were maintained in case they needed to be included in SMOKE control files for a future year control strategy scenario.

Virginia:

In accordance with instructions from VA, the input files that referenced an external I/M descriptive program file (VAIM02.IM) were revised to reference an alternative external file (VAIM05.IM). This change was to make the I/M program more relevant to the year 2018.

One additional important difference was made with respect to the revised 2018 and initial 2009 on-road mobile source input data files for all States. MACTEC developed updated SMOKE ready input files rather than MOBILE6 files so that the input data could be used directly by the VISTAS modeling contractor to estimate on-road mobile source emissions during modeling runs.

2.3.1.2 Preparation of initial 2009 input data files

The methodology used to develop the 2009 on-road input files was based on forecasting the previously developed revised 2002 base year input files and is identical to that previously described for the revised 2018 methodology except as follows:

1. The evaluation year was updated to 2009.
2. Diesel fuel sulfur content was revised from 500 ppm to 29 ppm. The 29 ppm value was derived from an EPA report entitled "Summary and Analysis of the Highway Diesel Fuel 2003 Pre-compliance Reports" (EPA420-R-03-013, October 2003), which includes the Agency's estimates for the year-to-year fuel volumes associated with the transition from 500 ppm to 15 ppm diesel fuel. According to Table 2 of the report, there will be 2,922,284 barrels per day of 15 ppm diesel distributed in 2009 along with 110,488 barrels per day of 500 ppm diesel. Treating the 15 ppm diesel as 11 ppm on average (consistent with EPA assumptions and assumptions employed for the 2018 input files) and sales weighting the two sulfur content fuels results in an average 2009 diesel fuel sulfur content estimate of 29 ppm.

3. Diesel sales fractions were updated identically to 2018 except that the diesel sales fractions for 2003-2009 were set at the same value as those for 2002 (rather than 2003-2018).
4. VMT mix fractions were updated to 2009 using an identical method to that described for 2018.
5. All other input data were retained at 2002 values, except as otherwise instructed by individual States (see below). This includes all control program descriptions (I/M, ATP, Stage II, etc.), all other fuel qualities (RVP, oxy content, etc.), all other vehicle descriptive data (registration age distributions, etc.), and all scenario descriptive data.

In addition to the updates described above that were applied to all VISTAS-region inputs, the following additional State-specific updates were performed:

KY – Identical changes to those made for 2018 (but specific to 2009) were made for the 2009 input files.

NC – Identical changes to those made for 2018 (but specific to 2009) were made for the 2009 input files.

VA – Identical changes to those made for 2018 were made for 2009.

2.3.2 VMT Data

The basic methodology used to generate the 2009 and 2018 VMT for use in estimating on-road mobile source emissions was as follows:

1. All estimates start from the final VMT estimates used for the 2002 revised base year inventory.
2. Initial 2009 and 2018 VMT estimates were based on linear growth rates for each State, county, and vehicle type as derived from the VMT data assembled by the U.S. EPA for their most recent HDD (heavy duty diesel) rulemaking. The methodology used to derive the growth factors is identical to that employed for the preliminary 2018 VMT estimates (which is described in the next section).
3. For States that provided no independent forecast data, the estimates derived in step 2 are also the final estimates. These States are: Alabama, Florida, Georgia, Kentucky, Mississippi, and West Virginia. For States that provided forecast data, the provided data were used to either replace or augment the forecast data based on the HDD rule. These States, and the specific approaches employed, are detailed following the growth method description.

The steps involved in performing the growth estimates for VMT were as follows:

1. Linear growth estimates were used (although MACTEC investigated the potential use of nonlinear factors and presented that information to the MSSIWG, the decision was made to use linear growth factors instead of nonlinear).
2. Estimates were developed at the vehicle class (i.e., LDGV, LDGT1, LDGT2, etc.) level of detail since the base year 2002 estimates were presented at that level of resolution. In effect, the county and vehicle class specific growth factors were applied to the 2002 VMT estimates for each vehicle and road class.
3. Overall county-specific VMT estimates for each year (developed by summing the vehicle and road class specific forecasts) were then compared to overall county-specific growth. Since overall county growth is a more appropriate controlling factor as it includes the combined impacts of all vehicle classes, the initial year-specific vehicle and road class VMT forecasts were normalized so that they matched the overall county VMT growth. Mathematically, this process is as follows:

(Est_rv_f) = (Est_rv_i) * (C_20XX / Sum(Est_rv_i))

where:

Est_rv_f = the final road/vehicle class-specific estimates,

Est_rv_i = the initial road/vehicle class-specific estimates, and

C_20XX = the county-specific growth target for year 20XX.

Table 2.3-1 presents a basic summary of the forecasts for the preliminary 2018 inventory for illustrative purposes:

Table 2.3-1 2002 versus 2018 VMT (million miles per year)

State	2002	2018	Growth Factor
Alabama	55,723	72,966	1.309
Florida	178,681	258,191	1.445
Georgia	106,785	148,269	1.388
Kentucky	51,020	66,300	1.299
Mississippi	36,278	46,996	1.295
North Carolina	80,166	110,365	1.377
South Carolina	47,074	63,880	1.357
Tennessee	68,316	91,647	1.342
Virginia	76,566	102,971	1.345
West Virginia	19,544	24,891	1.274

The following States provided some types of forecast data for VMT. The information presented below indicates how those data were processed by MACTEC for use in the VISTAS projection inventories.

Kentucky:

Revised 2009 and 2018 VMT mix data were provided by the Louisville APCD. Therefore, the distribution of Jefferson County VMT by vehicle type within the KY VMT file was revised to reflect the provided mix. This did not affect the total forecasted VMT for either Jefferson County or the State, but does alter the fraction of that VMT accumulated by each of the eight vehicle types reflected in the VMT file. The following procedure was employed to make the VMT estimates consistent with the provided 2009/2018 VMT mix:

a) The 16 MOBILE6 VMT mix fractions were aggregated into the following five vehicle types: LDV, LDT1, LDT2, HDV, and MC.

b) The 8 VMT mileage classes were aggregated into the same five vehicle types (across all roadway types) and converted to fractions by normalizing against the total Jefferson County VMT.

c) The ratio of the "desired" VMT fraction (i.e., that provided in the Louisville APCD VMT mix) to the "forecasted" VMT fraction (i.e., that calculated on the basis of the forecasted VMT data) was calculated for each of the five vehicle classes.

d) All forecasted VMT data for Jefferson County were multiplied by the applicable ratio from step c as follows:

new LDGV = old LDGV * LDV ratio
new LDGT1 = old LDGT1 * LDT1 ratio
new LDGT2 = old LDGT2 * LDT2 ratio
new HDGV = old HDGV * HDV ratio
new LDDV = old LDDV * LDV ratio
new LDDT = old LDDT * LDT1 ratio
new HDDV = old HDDV * HDV ratio
new MC = old MC * MC ratio

The total forecasted VMT for Jefferson County was then checked to ensure that it was unchanged.

North Carolina:

North Carolina provided both VMT and VMT mix data by county and roadway type for 2018. Therefore, these data replaced the data developed for North Carolina using HDD rule growth rates in their entirety. Similar data were submitted for 2009. Table 2.3-2 presents the resulting VMT estimates which differ from the "default" HDD rule estimates as follows:

Table 2.3-2 VMT and HDD Rule Estimates for North Carolina (million miles per year)

North Carolina		
2002	106,795	
	State Data	**HDD Data**
2009	123,396	124,626
2018	129,552	146,989

As indicated, there are substantial reductions in the State-provided forecast data relative to that derived from the HDD rule. The growth rates for both 2009 and 2018 are only about half that implied by the HDD data (1.15 versus 1.17 for 2009 and 1.21 versus 1.38 for 2018). The resulting growth rates are the lowest in the VISTAS region.

NC did not provide VMT mix data for 2009. Therefore, the VMT mix fractions estimated using the "default" HDD rule growth rates were applied to the State-provided VMT estimates to generate vehicle-specific VMT. Essentially, the default HDD methodology produces VMT estimates at the county-road type-vehicle type level of detail, and these data can be converted into VMT fractions at that same level of detail. Note that these are not HDD VMT fractions, but VMT fractions developed from 2002 NC data using HDD vehicle-specific growth rates. In effect, they are 2002 NC VMT fractions "grown" to 2009.

The default VMT mix fraction was applied to the State-provided VMT data at the county and road type level of detail to generate VMT data at the county-road type-vehicle type level of detail. The one exception was for county 063, road 110, for which no VMT data were included in the HDD rule. For this single county/road combination, State-aggregate VMT mix fractions (using the HDD growth methodology) were applied to the county/road VMT data. The difference between road 110 VMT fractions across all NC counties is minimal, so there is no effective difference in utilizing this more aggregate approach vis-à-vis the more resolved county/road approach.

South Carolina:

South Carolina provided county and roadway type-specific VMT data for several future years. Data for 2018 was included and was used directly. Data for 2009 was not included, but was linearly interpolated from data provided for 2007 and 2010. The data were disaggregated into vehicle type-specific VMT using the VMT mixes developed for South Carolina using the HDD rule VMT growth rates. Table 2.3-3 presents the resulting VMT estimates which differ from the "default" HDD rule estimates as follows:

Table 2.3-3 VMT and HDD Rule Estimates for South Carolina (million miles per year)

South Carolina		
2002	**47,074**	
	State Data	**HDD Data**
2009	55,147	54,543
2018	65,133	63,880

Tennessee:

In general, Tennessee estimates are based on the HDD rule growth rate as described in step two. However, Knox County provided independent VMT estimates for 2018 and these were used in place of the HDD rule-derived estimates. The Knox County estimates were total county VMT data only, so these were disaggregated into roadway and vehicle-type VMT using the distributions developed for Knox County in step two using the HDD rule VMT growth rates. No data for Knox County were provided for 2009, so the estimates derived using the HDD rule growth factors were adjusted by the ratio of "Knox County provided 2018 VMT" to "Knox County HDD Rule-derived 2018 VMT." Table 2.3-4 presents the resulting VMT estimates which differ from the "default" HDD rule estimates as follows:

Table 2.3-4 VMT and HDD Rule Estimates for Tennessee (million miles per year)

Tennessee		
2002	68,316	
	State Data	**HDD Data**
2009	78,615	78,813
2018	91,417	91,647

Virginia:

Virginia provided county and roadway type-specific annual VMT growth rates and these data were applied to Virginia -provided VMT data for 2002 to estimate VMT in both 2009 and 2018. Virginia provided VMT mix data for 2002, but not 2009 or 2018. Therefore, the estimated VMT data for both 2009 and 2018 were disaggregated into vehicle type-specific VMT using the VMT mixes developed for VA using the HDD rule VMT growth rates. Table 2.3-5 presents the resulting VMT estimates which differ from the "default" HDD rule estimates as follows:

Table 2.3-5 VMT and HDD Rule Estimates for Virginia (million miles per year)

Virginia		
2002	77,472	
	State Data	**HDD Data**
2009	88,419	89,196
2018	104,944	104,164

2.3.3 Base G Revisions

For the development of the VISTAS 2009 and 2018 Base G inventories and input files, VISTAS states reviewed the Base F inputs, and provided corrections, updates and supplemental data as noted below.

For all states modeled, the Base G updates include:

- Adding Stage II refueling emissions calculations to the SMOKE processing.
- Revised the HDD compliance. (REBUILD EFFECTS = .1)
- Revised Diesel sulfur values in 2009 to 43 ppm and 2018 to 11 ppm

In addition to the global changes, individual VISTAS states made the following updates:

KY – updated VMT and M6 input values for selected counties

NC – revised VMT estimates, speeds and vehicle distributions and updated registration distributions for Mobile 6.

TN - revised VMT and vehicle registration distributions for selected counties.

WV – revised VMT input data

AL, FL, and GA and VA did not provide updates for 2009/2018 Base G, and the Base F inputs were used for these States.

2.3.4 Development of non-road emission estimates

The sections that follow describe the projection process used to develop 2009 and 2018 non-road projection estimates, as revised through the spring of 2006, for sources found in the NONROAD model and those sources estimated outside of the model (locomotives, airplanes and commercial marine vessels).

2.3.4.1 NONROAD model sources

NONROAD model input files were prepared in both the fall of 2004 (Base F) and the spring of 2006 (Base G) based on the corresponding 2002 base year inventory input files available at the time the forecasts were developed, with appropriate updates for the projection years. Generally, this means that the Base F 2002 base year input files (as updated through the fall of 2004) were used as the basis for Base F projection year input file development and Base G 2002 base year input files as updated through the spring of 2006 were used as the basis for Base G projection year input file development. Thus, all base year revisions are inherently incorporated into the associated projection year revisions. Other specific updates for the projection years for NONROAD model sources consist of:

1. Revise the emission inventory year in the model (as well as various output file naming commands) to be reflective of the projection year.
2. Revise the fuel sulfur content for gasoline and diesel powered equipment.
3. Implement a limited number of local control program charges (national control program changes are handled internally within the NONROAD model, so explicit input file changes are not required).

All equipment population growth and fleet turnover impacts are also handled internally within the NONROAD model, so that explicit changes input file changes are not required.

Base F Input File Changes:

To correctly account for diesel fuel sulfur content differences between the base and projection years, two sets of input and output files were prepared for each forecast year, one set for land-based equipment and one set for marine equipment. This two-step projection process was required for Base F, because diesel fuel sulfur contents varied between land-based and marine-based non-road equipment and the Draft NONROAD2004 used for Base F allowed only a single diesel fuel sulfur input. Thus, the model was executed separately for land-based and marine-based equipment for Base F, and the associated outputs subsequently combined. The specific diesel fuel sulfur contents modeled were as follows:

Diesel S (ppm)	2002	2009	2018
Land-Based	2500	348	11
Marine-Based	2500	408	56

As indicated, the Draft NONROAD2004 model was run with both sets of input files and the output file results were then combined to produce a single NONROAD output set.

To correctly account for the national reduction in gasoline sulfur content (a national control not explicitly handled by the NONROAD model), all NONROAD input files for both 2009 and 2018 were revised to reflect a gasoline fuel sulfur content of 30 ppmW.

Base G Input File Changes:

With the release of Final NONROAD2005 that was used for the Base G projection year inventory development, the NONROAD model is capable of handling separate diesel fuel sulfur inputs for land-based and marine-based non-road equipment in a single model execution. Therefore, the two step modeling process described above for Base F updates was no longer required. Instead, the differential diesel fuel sulfur values are assembled into a single NONROAD input file as follows:

Diesel S (ppm)	2002	2009	2018
Land-Based	2500	348	11
Marine-Based	2638	408	56

Additionally, revised gasoline vapor pressure data were provided by Georgia regulators for 20 counties[5] where reduced volatility requirements were established in 2003. Since this requirement began after the 2002 base year, the vapor pressure values in the base year input files for these counties are not correct for either the 2009 or 2018 forecast years. Therefore, to correctly forecast emissions in these counties, the forecast year gasoline vapor pressure inputs were revised to:

Gasoline RVP (psi)	2002	2009	2018
Spring	9.87	9.2	9.2
Summer	9.0	7.0	7.0
Fall	9.87	9.2	9.2
Winter	12.5	12.5	12.5

The summer vapor pressure was simply set equal to the 2003 control value, while the spring and fall vapor pressures were adjusted to reflect a single month of the reduced volatility limit. The winter volatility was assumed to be unaffected by the summertime control requirement.

2.3.4.1.1 Differences between 2009/2018

Other than diesel fuel sulfur content and the year of the projections, there are no differences in the methodology used to estimate emissions from NONROAD model sources. As indicated above, however the Base F 2009/2018 projections were developed using Draft NONROAD2004, while the Base G 2009/2018 projections were made using Final NONROAD2005.

5 The specific counties are: Banks, Chattooga, Clarke, Floyd, Gordon, Heard, Jasper, Jones, Lamar, Lumpkin, Madison, Meriwether, Monroe, Morgan, Oconee, Pike, Polk, Putnam, Troup, and Upson.

2.3.4.2 Non-NONROAD model sources

Using the 2002 base year emissions inventory for aircraft, locomotives, and commercial marine vessels (CMV) prepared as described earlier in this document, corresponding emission projections for 2009 and 2018 were developed in both the fall of 2004 (Base F) and the spring of 2006 (Base G). This section describes the procedures employed in developing those inventories. The information presented is intended to build off of that presented in the section describing the 2002 Base F base year inventory. It should be recognized that for both the Base F and Base G inventories, the base year inventory used to develop the emission forecasts was the latest available at the time of forecast development. Generally, this means that the 2002 base year inventory as updated through the fall of 2004 was used as the basis for the Base F projection year inventory development, and the Base F 2002 base year inventory was used as the basis for Base G projection year inventory development. Thus, all base year revisions (as described earlier in this document) are inherently incorporated into the associated projection year revisions.

Base F Revisions:

Table 2.3-6 shows the 2002 base year emissions for each State in the VISTAS region for aircraft, locomotives and CMV (as they existed prior to Base F development).

Table 2.3-6 Pre-Base F 2002 Aircraft, Locomotive, and Non-Recreational Marine Emissions (annual tons, as of the fall of 2004)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	3,787	175	226	87	17	196
	FL	25,431	8,891	2,424	2,375	800	3,658
	GA	6,620	5,372	1,475	1,446	451	443
	KY	2,666	657	179	175	63	263
	MS	1,593	140	44	43	13	96
	NC	6,088	1,548	419	411	148	613
	SC	6,505	515	409	401	88	863
	TN	7,251	2,766	734	719	235	943
	VA	9,763	2,756	1,137	1,115	786	2,529
	WV	1,178	78	25	24	8	66
	Total	**70,882**	**22,899**	**7,072**	**6,797**	**2,607**	**9,670**
Commercial Marine (2280)	AL	1,196	9,218	917	844	3,337	737
	FL	5,888	44,817	1,936	1,781	6,683	1,409
	GA	1,038	7,875	334	307	1,173	246
	KY	6,607	50,267	2,246	2,066	9,608	1,569
	MS	5,688	43,233	1,903	1,751	7,719	1,351
	NC	599	4,547	193	178	690	142
	SC	1,067	8,100	343	316	1,205	253
	TN	3,624	27,555	1,217	1,120	4,974	860
	VA	972	2,775	334	307	359	483
	WV	1,528	11,586	487	448	525	362
	Total	**28,207**	**209,972**	**9,911**	**9,118**	**36,275**	**7,413**
Military Marine (2283)	VA	110	313	25	23	27	48
	Total	**110**	**313**	**25**	**23**	**27**	**48**
Locomotives (2285)	AL	3,490	26,339	592	533	1,446	1,354
	FL	1,006	9,969	247	222	605	404
	GA	2,654	26,733	664	598	1,622	1,059
	KY	2,166	21,811	542	488	1,321	867
	MS	2,302	23,267	578	520	1,429	899
	NC	1,638	16,502	410	369	1,001	654
	SC	1,160	11,690	291	261	710	462
	TN	2,626	25,627	633	570	1,439	1,041
	VA	1,186	11,882	1,529	1,375	3,641	492
	WV	1,311	13,224	329	296	808	517
	Total	**19,540**	**187,044**	**5,815**	**5,232**	**14,022**	**7,750**
Grand Total		**118,739**	**420,228**	**22,823**	**21,170**	**52,931**	**24,881**

Although some of the data utilized was updated, the methodology used to develop the Base F 2009 and 2018 emissions forecasts for aircraft, locomotives, and CMV is identical to that used earlier to develop preliminary 2018 Base 1 ("On the Books") and 2018 Base 2 ("On the Way") inventories. Briefly, the methodology relies on growth and control factors developed from inventories used in support of recent EPA rulemakings, and consists of the following steps:

(a) Begin with the 2002 base year emission estimates for aircraft, locomotive, and CMV as described above (at the State-county-SCC-pollutant level of detail).

(b) Detailed inventory data (both before and after controls) for these same emission sources for 1996, 2010, 2015, and 2020 were obtained from the EPA's Clean Air Interstate Rule (CAIR) Technical Support Document (which can be found at http://www.epa.gov/cair/pdfs/finaltech01.pdf). Using these data, combined growth and control factors for the period 2002-2009 and 2002-2018 were estimated using straight line interpolation between 1996 and 2010 (for 2009) and 2015 and 2020 (for 2018). This is done at the State-county-SCC-pollutant level of detail.

(c) The EPA growth and control data are matched against the 2002 VISTAS base year data using State-county-SCC-pollutant as the match key. Ideally, there would be a one-to-one match and the process would end at this point. Unfortunately, actual match results were not always ideal, so additional matching criteria were required. For subsequent reference, this initial (highest resolution) matching criterion is denoted as the "CAIR-Primary" criterion.

(d) A second matching criterion is applied that utilizes a similar, but higher-level SCC (lower resolution) matching approach. For example, SCC 2275020000 (commercial aircraft) in the 2002 base year inventory data would be matched with SCC 2275000000 (all aircraft) in the CAIR data. This criterion is applied to records in the 2002 base year emissions file that are not matched using the "CAIR-Primary" criterion, and is also performed at the State-county-SCC-pollutant level of detail. For subsequent reference, this is denoted as the "CAIR-Secondary" criterion. At the end of this process, a number of unmatched records remained, so a third level matching criterion was required.

(e) In the third matching step, the most frequently used SCC in the EPA CAIR files for each of the aircraft, locomotive, and commercial marine sectors was averaged at the State level to produce a "default" State and pollutant-specific growth and control factor for the sector. The resulting factor is used as a "default" growth factor for all unmatched county-SCC-pollutant level data in each State. In effect, State-specific growth data are applied to county level data for which an explicit match between the VISTAS 2002 base year data and EPA CAIR data could not be developed. The default growth and control

SCCs are 2275020000 (commercial aircraft) for the aircraft sector, 2280002000 (commercial marine diesel total) for the CMV sector, and 2285002000 (railroad equipment diesel total) for the locomotive sector. Matches made using this criterion are denoted as “CAIR-Tertiary” matches.

(f) According to EPA documentation, the CAIR baseline emissions include the impacts of the (then proposed) Tier 4 (T4) non-road diesel rulemaking, which implements a low sulfur fuel requirement that affects both future CMV and locomotive emissions. However, the impacts of this rule were originally intended to be excluded from the initial VISTAS 2018 forecast, which was to include only “on-the-books” controls. (The T4 rule was finalized subsequent to the development of the preliminary 2018 inventory in March of 2004.) Given its final status, T4 impacts were moved into the “on the books” inventory for non-road equipment. In addition, since there are no other proposed rules affecting the non-road sector between 2002 and 2018, there is no difference between the 2018 “on the books” and 2018 “on the way” inventories for the sector; so that only a single forecast inventory (for each evaluation year) was developed. Nevertheless, since the algorithms developed to produce the VISTAS forecasts were developed when there was a distinction between the “on the books” and “on the way” inventories, the distinct algorithms used to produce the two inventories have been maintained even though the conceptual distinctions have been lost. This approach was taken for two reasons. First, it allowed the previously developed algorithms to be utilized without change. Second, it allowed for separate treatment of the T4 emissions impact which was important as those impacts changed between the proposed and final T4 rules. Thus, previous EPA inventories that include the proposed T4 impacts would not be accurate. Therefore, the procedural discussion continues to reflect the distinctions between non-T4 and T4 emissions, as these distinctions continue to be intrinsically important to the forecasting process. Therefore, a second set of EPA CAIR files that excluded the Tier 4 diesel impacts was obtained and the same matching exercise described above in steps (b) through (e) was performed using these “No T4” files. It is important to note that the matching exercise described in steps (b) through (e) cannot simply be replaced because the “No T4” files obtained from the EPA include only those SCCs specifically affected by the T4 rule (i.e., diesel CMV and locomotives). So in effect, the matching exercise was augmented (rather than replaced) with an additional three criteria analogous to those described in steps (c) through (e), and these are denoted as the “No T4-Primary,” “No T4-Secondary,” and “No T4-Tertiary” criteria. Because they exclude the impacts of the proposed T4 rule, matches using the “No T4” criteria supersede matches made using the basic CAIR criteria (as described in steps (c) through (e) above).

(g) The CAIR matching criteria were overridden for any record for which States provided local growth data. Only North Carolina provided these forecasts, as that State has provided specific growth factors for airport emissions in four counties. Because the provided data were based on forecasted changes in landings and takeoffs at major North Carolina airports, the factors were applied only to commercial (SCC 2275020000) and air taxi (SCC 2275060000) emissions. Emissions forecasts for military and general aviation aircraft operations, as well as all aircraft operations in counties other than the four identified in the North Carolina growth factor submission, continued to utilize the growth factors developed according to steps (b) through (f) above. Table 2.3-7 presents the locally generated growth factors applied in North Carolina.

Table 2.3-7 Locally Generated Growth Factors for North Carolina

FIP	2009 Factor	2018 Factor
37067	0.71	0.84
37081	0.97	0.89
37119	1.15	1.01
37183	0.88	0.81

Note:

Growth factor = Year Emissions/2002 Emissions.
Under CAIR approach, 2009 = 1.16 to 1.17 for all 4 counties.
Under CAIR approach, 2018 = 1.36 to 1.37 for all 4 counties.

(h) Using this approach, each State-county-SCC-pollutant was assigned a combined growth and control factor using the EPA CAIR forecast or locally provided data. The 22,838 data records for aircraft, locomotives, and CMV in the 2002 revised base year emissions file were assigned growth factors in accordance with the following breakdown:

48 records matched State-provided growth factors,
4,179 records matched using the CAIR-Primary criterion,
240 records matched using the CAIR-Secondary criterion,
7,463 records matched using the CAIR-Tertiary criterion,
720 records matched using the No T4-Primary criterion,
3,858 records matched using the No T4-Secondary criterion, and
6,330 records matched using the No T4-Tertiary criterion.

(i) Finally, the impacts of the T4 rule as adopted were applied to the grown "non T4" emission estimates. The actual T4 emission standards do not affect aircraft, locomotive, or CMV directly, but associated diesel fuel sulfur requirements do affect locomotives and CMV. Lower fuel sulfur content affects both SO_2 and PM emissions. Expected fuel sulfur contents were obtained for each evaluation year from the EPA technical support document for the final T4 rule (*Final Regulatory Analysis: Control of Emissions from Non-road Diesel Engines,* EPA420-R-04-007, May 2004). According to that document, the average diesel fuel sulfur content for locomotives and CMV is expected to be 408 ppmW in 2009 and 56 ppmW in 2018. These compare to expected non-T4 fuel sulfur levels of 2599 ppmW in 2009 and 2336 ppmW in 2018. Table 2.3-8 uses calculated emissions estimates for base and T4 control scenarios to estimate emission reduction impacts.

Table 2.3-8 Estimated Emission Reduction Impacts based on T-4 Rule

				2009	2018
CMV SO_2	=	Non-T4 SO_2	×	0.1569	0.0241
Locomotive SO_2	=	Non-T4 SO_2	×	0.1569	0.0241
CMV PM	=	Non-T4 PM	×	0.8962	0.8762
Locomotive PM	=	Non-T4 PM	×	0.8117	0.7734

However, since the diesel fuel sulfur content assumed for the 2002 VISTAS base year inventory, upon which both the 2009 and 2018 inventories were based, is 2500 ppmW, a small adjustment to the emission reduction multipliers calculated from the T4 rule is appropriate since they are measured relative to modestly different sulfur contents (2599 ppmW for 2009 and 2336 ppmW for 2018). Correcting for these modest differences produces the emission reduction impact estimates relative to forecasts based on the VISTAS 2002 inventory shown in Table 2.3-9.

Table 2.3-9 Estimated Emission Reduction Impacts Relative to VISTAS 2002 Base Year Values

				2009	2018
CMV SO_2	=	Non-T4 SO_2	×	0.1632	0.0225
Locomotive SO_2	=	Non-T4 SO_2	×	0.1632	0.0225
CMV PM	=	Non-T4 PM	×	0.9004	0.8685
Locomotive PM	=	Non-T4 PM	×	0.8187	0.7610

These factors were applied directly to the non-T4 emission forecasts to produce the final VISTAS 2009 and 2018 emissions inventories for aircraft, locomotive, and CMV.

The only exception is for Palm Beach County, Florida, where CMV emissions are reported as “all fuels” rather than separately by residual and diesel fuel components. To estimate T4 impacts in Palm Beach County, the ratio of diesel CMV emissions to total

CMV emissions in the remainder of Florida was calculated and the T4 impact estimates for Palm Beach County were adjusted to reflect that ratio. Table 2.3-10 shows the calculated diesel CMV ratios.

Table 2.3-10 Diesel CMV Adjustment Ratios for Palm Beach County, FL

GROWTH BASIS	SO_2	PM
2009 (1996, 2020 Growth Basis)	0.2410	0.7861
2009 (1996, 2010, 2015, and 2020 Growth Basis)	0.1279	0.7875
2018 (1996, 2020 Growth Basis)	0.2432	0.7925
2018 (1996, 2010, 2015, and 2020 Growth Basis)	0.2624	0.7918

The differences between the growth bases are discussed in detail below.

Combining these ratios with the T4 impact estimates for diesel engines, as presented above, yields the following impact adjustment factors for Palm Beach County:

Table 2.3-11 Overall Adjustment Factors for Palm Beach County, FL

GROWTH BASIS		
2009 SO_2 (19, 20 Growth Basis)	0.7894	[0.1632×0.2410+(1-0.2410)]
2009 SO_2 (96, 10, 15, and 20 Growth Basis)	0.8930	[0.1632×0.1279+(1-0.1279)]
2018 SO_2 (96, 20 Growth Basis)	0.7623	[0.0225×0.2432+(1-0.2432)]
2018 SO_2 (96, 10, 15, and 20 Growth Basis)	0.7436	[0.0225×0.2624+(1-0.2624)]
2009 PM (19, 20 Growth Basis)	0.9217	[0.9004×0.7861+(1-0.7861)]
2009 PM (96, 10, 15, and 20 Growth Basis)	0.9216	[0.9004×0.7875+(1-0.7875)]
2018 PM (96, 20 Growth Basis)	0.8958	[0.8685×0.7925+(1-0.7925)]
2018 PM (96, 10, 15, and 20 Growth Basis)	0.8959	[0.8685×0.7918+(1-0.7918)]

The differences between the growth bases are discussed in detail below.

Utilizing this approach, emission inventory forecasts for both 2009 and 2018 were developed. As indicated in step (b) above, basic growth factors were developed using EPA CAIR inventory data for 1996, 2010, 2015, and 2020. From these data, equivalent EPA CAIR inventories for 2002 and 2009 were developed through linear interpolation of the 1996 and 2010 inventories, while an equivalent CAIR inventory for 2018 was developed through linear interpolation of the 2015 and 2020 inventories. Growth factors for 2009 and 2018 were then estimated as the ratios of the CAIR 2009 and 2018 inventories to the CAIR 2002 inventory.

During the development of the preliminary 2018 VISTAS inventory in March 2004, this process yielded reasonable results and exhibited no particular systematic concerns. However, when the 2009 Base F inventory was developed, significant concerns related to SO_2 and PM were encountered. Essentially, what was revealed by the Base F 2009 forecast was a series of apparent inconsistencies in the CAIR 2010 and 2015 emission inventories (as compared to the 1996 and 2020 CAIR inventories) that were masked during the construction of the “longer-term” 2018 inventory.

The apparent inconsistencies are best illustrated by looking at the actual data extracted from the CAIR inventory files. Note that although a limited example is being presented, the same general issue applies throughout the CAIR files. For FIP 01001 (Autauga County, Alabama) and SCC 2285002000 (Diesel Rail), the CAIR inventories indicate SO_2 emission estimates as shown in Table 2.3-12.

Table 2.3-12 SO_2 Emissions for Diesel Rail in Autauga County, AL from the CAIR Projections

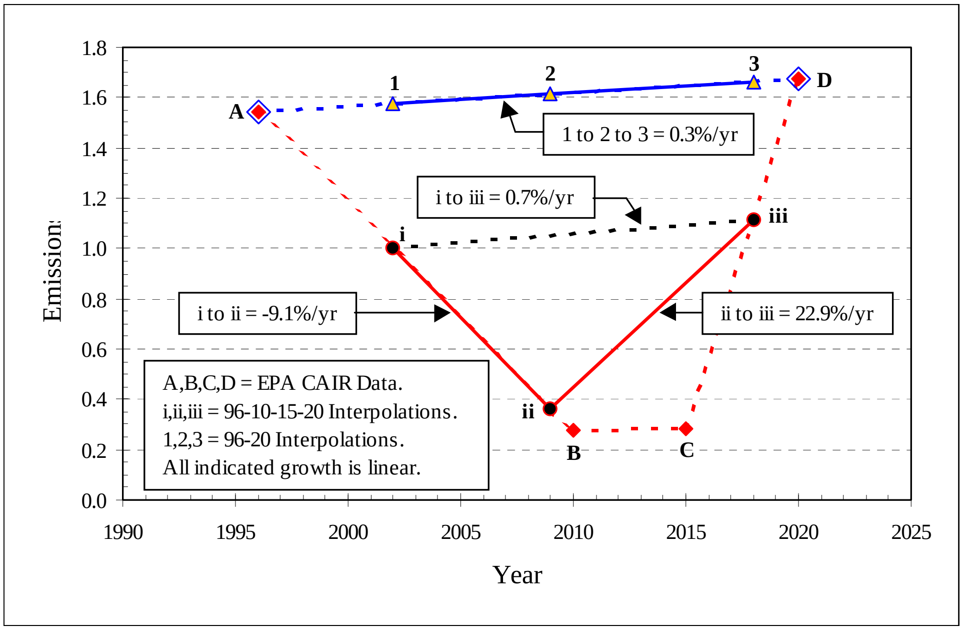
YEAR	TONS
1996:	15.3445
2010:	2.7271
2015:	2.8178
2020:	16.6232

Clearly, there is a major drop in emissions between 1996 and 2010, followed by a major increase in emissions between 2015 and 2020. Several observations regarding these changes are important. First, the CAIR data were reported to exclude the T4 rule, so that the drop in emissions should be related to something other than simply a change in diesel fuel sulfur content. Second, if the T4 rule impacts were “accidentally” included in the estimates, there should be a resultant 90 percent drop in diesel sulfur between 2010 and 2015; so such inclusion is unlikely. Third, the rate of growth between 2015 and 2020 (43 percent *per year* compound or 97 percent *per year* linear) is well beyond any reasonable expectations for rail service; and fuel sulfur content during this period is constant both with and without T4. In short, there appeared to be no rational explanation for the data, yet the same basic relations are observed for thousands of CAIR inventory records.

For the most part, the issue seems to be centered on SO_2 and PM records, which are those records primarily affected by the T4 rule. But, as noted above, there does not seem to be any pattern of consistency that would indicate that either inclusion or exclusion of T4 rule impacts is the underlying cause. Moreover, where they occur, the observed growth extremes generally affect both SO_2 and PM equally, while one would expect PM effects to be buffered if the T4 rule was the underlying cause, since changes in diesel fuel sulfur content will only affect a fraction of PM (i.e., sulfate), while directly reducing SO_2.

The data presented in Figure 2.3-1 illustrates what this meant to the VISTAS forecasting process. Figure 2.3-1 depicts the same data presented above for Autauga County, Alabama, but normalized so that the interpolated 2002 CAIR emissions estimate equals unity. The "raw" CAIR data is depicted by the markers labeled A, B, C, and D. Interpolated data for 2002 and 2009, based on 1996 and 2010 CAIR data, is depicted by the markers labeled "i" and "ii." Interpolated data for 2018, based on 2015 and 2020 CAIR data is depicted by the marker labeled "iii." The relationship between marker "iii" and marker "i" is exactly the relationship used to construct the preliminary (e.g., pre-Base F) 2018 VISTAS inventory (i.e., a linear growth rate equal to 0.7 percent per year). Thus, it is easy to see that although there is a major "dip and rise" between 2002 and 2018, it is essentially masked unless data for intervening years are examined. Since no intervening year was examined for the preliminary 2018 inventory, the "dip and rise" was not discovered. However, upon the development of the 2009 inventory forecast, the issue became obvious, as the marker labeled "ii" readily illustrates. In effect, the 2009 inventory reflected very low negative "growth rates" for some SCCs and pollutants relative to the 2002 inventory, while the 2018 inventory reflected very high and positive growth rates for those same SCCs and pollutants. In effect, the path between 2002 and 2018 that previously looked like the dotted line connecting markers "i" and "iii," now looks like the solid line connecting markers "i", "ii," and "iii." For reference purposes, this path is hereafter referred to as the 1996, 2010, 2015, and 2020 growth basis, since all interpolated data is based on CAIR data for those four years.

Figure 2.3-1 Impacts of the Apparent CAIR Inventory Discrepancy



In light of the apparent discrepancies inherent in the 1996, 2010, 2015, and 2020 growth basis data and the inconsistencies its use would impart into the 2009 and 2018 VISTAS inventories, a secondary forecasting method was developed. This second method relies on the apparent consistency between the 1996 and 2020 non-T4 CAIR inventories, interpolating equivalent 2002, 2009, and 2018 inventories solely from these two inventories. In effect, the CAIR inventories for 2010 and 2015 are ignored. In Figure 2.3-1, this secondary approach is depicted by the data points that lie along the lines connecting markers A and D. Markers A and D represent the 1996 and 2020 CAIR inventories, and the markers labeled 1, 2, and 3 represent the interpolated 2002, 2009, and 2018 CAIR equivalent inventories. The growth rate between 2009 and 2002 is then equal to the ratio of the 2009 and 2002 CAIR inventories, while that between 2018 and 2002 is equal to the ratio of the 2018 and 2002 CAIR inventories. For the example data, the resulting linear growth estimate is 0.3 percent per year. For reference purposes, this path is hereafter referred to as the 1996-2020 growth basis, since all interpolated data are based on CAIR data for only those two years.

It is perhaps worth noting that the only elements of Figure 2.3-1 that have any bearing on the VISTAS inventories are the growth rates. The absolute CAIR data are of importance only in determining those rates, as all VISTAS inventories were developed on the basis of the VISTAS 2002 base year inventory, not any of the CAIR inventories. So referring to Figure 2.3-1, the two growth options are summarized in Table 2.3-13.

Table 2.3-13 Growth Options based on CAIR Data

GROWTH BASIS	PERCENT PER YEAR
1996, 2010, 2015, 2020 Growth Basis:	-9.1% per year (linear) between 2002 and 2009
1996-2020 Growth Basis:	+0.3% per year (linear) between 2002 and 2009
1996, 2010, 2015, 2020 Growth Basis:	+22.9% per year (linear) between 2009 and 2018
1996-2020 Growth Basis:	+0.3% per year (linear) between 2009 and 2018
1996, 2010, 2015, 2020 Growth Basis:	+0.7% per year (linear) between 2002 and 2018
1996-2020 Growth Basis:	+0.3% per year (linear) between 2002 and 2018

Of course, these specific rates are applicable only to the example case (i.e., diesel rail SO_2 in Autauga County, Alabama), but there are thousands of additional CAIR records that are virtually identical from a growth viewpoint.

While forecast inventories for aircraft, locomotives, and CMV were developed for 2009 and 2018 using both growth methods, it was ultimately decided to utilize the 1996-2020 growth basis for Base F since it provided more reasonable growth rates for 2009. Tables 2.3-14 and 2.3-15 present a summary of each Base F inventory, while Tables 2.3-16 and 2.3-17 present the associated change in emissions for each Base F forecast inventory relative to the Base F 2002 base year VISTAS inventory. The larger reduction in CMV SO_2 emissions in 2009 and 2018 (relative to 2002) for Virginia and West Virginia is notable relative to the other VISTAS States, but this has been checked and is attributable to a high diesel contribution to total CMV SO_2 in the 2002 inventories for these two States.

Figures 2.3-2 through 2.3-13 graphically depict the relationships between the various Base F inventories and preliminary 2002 and 2018 projections prepared prior to Base F. There are two figures for each pollutant, the first of which presents a comparison of total VISTAS regional emission estimates for aircraft, locomotives, and CMV, and the second of which presents total VISTAS region emission estimates for locomotives only. This two figure approach is intended to provide a more robust illustration of the differences between the various inventories, as some of the differences are less distinct when viewed through overall aggregate emissions totals. All of the figures include the following emissions estimates:

- The 2002 Base F base year VISTAS emissions inventory (labeled as “2002”),
- The 2002 pre-Base F base year VISTAS emissions inventory (labeled as “2002 Prelim”),
- The Base F 2009 VISTAS emissions inventory developed using growth rates derived from 1996 and 2020 EPA CAIR data (labeled as “2009”),
- The Base F 2018 VISTAS emissions inventory developed using growth rates derived from 1996 and 2020 EPA CAIR data (labeled as “2018”), and
- The pre-Base F 2018 VISTAS emissions inventory estimates as developed using growth rates derived from 1996, 2010, 2015, and 2020 EPA CAIR data (labeled as “2018 Prelim”).

All 12 figures generally illustrate a reduction in emissions estimates between the 2002 pre-Base F emission estimates published in February 2004 (the initial 2002 VISTAS inventory) and the 2002 Base F emission estimates. This reduction generally results from emission updates reflected in the State 2002 CERR submittals used to develop the Base F 2002 base year inventory, although the major differences in aggregate PM emission estimates are driven to a greater extent by modifications in the methodology used to estimate aircraft PM in the Base F 2002 base year inventory (as documented under the base year inventory section of this report).

Table 2.3-14 Base F 2009 Aircraft, Locomotive, and Non-Recreational Marine Emissions (annual tons) -- Based on Growth Using 1996 and 2020 EPA Inventories

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	4,178	202	278	102	19	217
	FL	29,258	10,316	2,812	2,756	928	4,235
	GA	7,635	6,233	1,712	1,678	523	512
	KY	3,075	762	207	203	73	304
	MS	1,765	162	51	50	16	108
	NC	6,551	1,601	436	427	153	644
	SC	7,372	559	446	437	98	975
	TN	8,020	3,096	824	807	268	1,050
	VA	10,994	3,094	1,239	1,214	907	2,892
	WV	1,312	91	28	28	9	74
	Total	**80,159**	**26,116**	**8,033**	**7,704**	**2,993**	**11,011**
Commercial Marine (2280)	AL	1,280	8,888	872	802	2,753	768
	FL	6,236	43,198	1,838	1,691	5,864	1,467
	GA	1,097	7,599	317	291	974	256
	KY	7,087	48,039	2,158	1,985	8,350	1,649
	MS	6,074	41,437	1,821	1,676	6,587	1,415
	NC	634	4,386	184	169	584	148
	SC	1,133	7,796	326	300	1,012	264
	TN	3,887	26,333	1,168	1,074	4,512	904
	VA	1,042	2,662	312	286	61	506
	WV	1,638	11,073	455	419	89	381
	Total	**30,109**	**201,412**	**9,450**	**8,693**	**30,786**	**7,759**
Military Marine (2283)	VA	118	299	23	21	5	50
	Total	**118**	**299**	**23**	**21**	**5**	**50**
Locomotives (2285)	AL	3,648	23,529	452	406	242	1,279
	FL	1,052	8,905	189	170	101	382
	GA	2,769	24,398	507	456	271	1,003
	KY	2,264	19,597	415	374	221	819
	MS	2,406	20,785	441	397	239	849
	NC	1,712	14,741	313	282	167	618
	SC	1,213	10,443	222	200	119	437
	TN	2,745	23,924	483	435	240	984
	VA	1,236	11,134	1,167	1,050	608	467
	WV	1,369	12,177	251	226	135	489
	Total	**20,412**	**169,635**	**4,440**	**3,995**	**2,343**	**7,328**
Grand Total		**130,798**	**397,462**	**21,946**	**20,413**	**36,126**	**26,148**

Table 2.3-15 Base F 2018 Aircraft, Locomotive, and Non-Recreational Marine Emissions (annual tons) -- Based on Growth Using 1996 and 2020 EPA Inventories

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	4,681	236	345	122	23	245
	FL	34,178	12,147	3,312	3,246	1,093	4,976
	GA	8,939	7,340	2,016	1,976	616	601
	KY	3,602	898	244	239	86	357
	MS	1,986	190	60	58	18	122
	NC	6,728	1,454	400	392	139	615
	SC	8,487	616	493	484	112	1,119
	TN	9,009	3,519	939	921	309	1,187
	VA	12,578	3,528	1,370	1,342	1,063	3,358
	WV	1,484	106	33	33	10	85
	Total	**91,670**	**30,035**	**9,213**	**8,814**	**3,468**	**12,666**
Commercial Marine (2280)	AL	1,388	8,464	880	809	2,715	809
	FL	6,684	41,117	1,853	1,705	6,248	1,543
	GA	1,174	7,246	319	293	976	269
	KY	7,703	45,174	2,199	2,023	8,383	1,752
	MS	6,571	39,129	1,850	1,702	6,556	1,498
	NC	679	4,179	185	170	596	155
	SC	1,217	7,406	329	303	1,027	278
	TN	4,225	24,763	1,190	1,095	4,808	960
	VA	1,133	2,517	314	289	9	537
	WV	1,781	10,412	459	422	13	404
	Total	**32,554**	**190,407**	**9,578**	**8,811**	**31,330**	**8,205**
Military Marine (2283)	VA	128	282	23	21	1	53
	Total	**128**	**282**	**23**	**21**	**1**	**53**
Locomotives (2285)	AL	3,850	19,917	381	343	34	1,183
	FL	1,110	7,538	159	143	14	353
	GA	2,917	21,395	427	385	38	932
	KY	2,389	16,751	352	317	31	757
	MS	2,540	17,594	372	335	34	785
	NC	1,807	12,478	264	237	24	571
	SC	1,280	8,840	187	168	17	404
	TN	2,897	21,735	407	367	34	910
	VA	1,300	10,173	983	885	86	436
	WV	1,444	10,831	212	190	19	453
	Total	**21,534**	**147,252**	**3,744**	**3,368**	**333**	**6,785**
Grand Total		**145,885**	**367,975**	**22,557**	**21,015**	**35,132**	**27,709**

Table 2.3-16 Change in Emissions between 2009 and 2002 Base F Inventories (Based on Growth Using 1996 and 2020 EPA Inventories)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	+10%	+15%	+23%	+18%	+16%	+11%
	FL	+15%	+16%	+16%	+16%	+16%	+16%
	GA	+15%	+16%	+16%	+16%	+16%	+16%
	KY	+15%	+16%	+16%	+16%	+16%	+16%
	MS	+11%	+16%	+15%	+15%	+16%	+12%
	NC	+8%	+3%	+4%	+4%	+3%	+5%
	SC	+13%	+9%	+9%	+9%	+12%	+13%
	TN	+11%	+12%	+12%	+12%	+14%	+11%
	VA	+13%	+12%	+9%	+9%	+15%	+14%
	WV	+11%	+16%	+15%	+15%	+16%	+12%
	Total	**+13%**	**+14%**	**+14%**	**+13%**	**+15%**	**+14%**
Commercial Marine (2280)	AL	+7%	-4%	-5%	-5%	-18%	+4%
	FL	+6%	-4%	-5%	-5%	-12%	+4%
	GA	+6%	-3%	-5%	-5%	-17%	+4%
	KY	+7%	-4%	-4%	-4%	-13%	+5%
	MS	+7%	-4%	-4%	-4%	-15%	+5%
	NC	+6%	-4%	-5%	-5%	-15%	+4%
	SC	+6%	-4%	-5%	-5%	-16%	+4%
	TN	+7%	-4%	-4%	-4%	-9%	+5%
	VA	+7%	-4%	-7%	-7%	-83%	+5%
	WV	+7%	-4%	-7%	-7%	-83%	+5%
	Total	**+7%**	**-4%**	**-5%**	**-5%**	**-15%**	**+5%**
Military Marine (2283)	VA	+7%	-4%	-7%	-7%	-83%	+5%
	Total	**+7%**	**-4%**	**-7%**	**-7%**	**-83%**	**+5%**
Locomotives (2285)	AL	+5%	-11%	-24%	-24%	-83%	-6%
	FL	+5%	-11%	-24%	-24%	-83%	-6%
	GA	+4%	-9%	-24%	-24%	-83%	-5%
	KY	+5%	-10%	-23%	-23%	-83%	-6%
	MS	+5%	-11%	-24%	-24%	-83%	-6%
	NC	+5%	-11%	-24%	-24%	-83%	-6%
	SC	+5%	-11%	-24%	-24%	-83%	-6%
	TN	+5%	-7%	-24%	-24%	-83%	-6%
	VA	+4%	-6%	-24%	-24%	-83%	-5%
	WV	+4%	-8%	-24%	-24%	-83%	-5%
	Total	**+4%**	**-9%**	**-24%**	**-24%**	**-83%**	**-5%**
Grand Total		**+10%**	**-5%**	**-4%**	**-4%**	**-32%**	**+5%**

Table 2.3-17 Change in Emissions between 2018 and 2002 Base F Inventories (Based on Growth Using 1996 and 2020 EPA Inventories)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	+24%	+35%	+53%	+41%	+36%	+25%
	FL	+34%	+37%	+37%	+37%	+37%	+36%
	GA	+35%	+37%	+37%	+37%	+37%	+36%
	KY	+35%	+37%	+37%	+37%	+37%	+36%
	MS	+25%	+36%	+35%	+35%	+36%	+27%
	NC	+10%	-6%	-5%	-5%	-6%	0%
	SC	+30%	+20%	+21%	+21%	+27%	+30%
	TN	+24%	+27%	+28%	+28%	+31%	+26%
	VA	+29%	+28%	+20%	+20%	+35%	+33%
	WV	+26%	+36%	+35%	+35%	+36%	+28%
	Total	**+29%**	**+31%**	**+30%**	**+30%**	**+33%**	**+31%**
Commercial Marine (2280)	AL	+16%	-8%	-4%	-4%	-19%	+10%
	FL	+14%	-8%	-4%	-4%	-7%	+9%
	GA	+13%	-8%	-5%	-5%	-17%	+9%
	KY	+17%	-10%	-2%	-2%	-13%	+12%
	MS	+16%	-9%	-3%	-3%	-15%	+11%
	NC	+13%	-8%	-4%	-4%	-14%	+9%
	SC	+14%	-9%	-4%	-4%	-15%	+10%
	TN	+17%	-10%	-2%	-2%	-3%	+12%
	VA	+17%	-9%	-6%	-6%	-98%	+11%
	WV	+17%	-10%	-6%	-6%	-98%	+12%
	Total	**+15%**	**-9%**	**-3%**	**-3%**	**-14%**	**+11%**
Military Marine (2283)	VA	+17%	-10%	-6%	-6%	-98%	+12%
	Total	**+17%**	**-10%**	**-6%**	**-6%**	**-98%**	**+12%**
Locomotives (2285)	AL	+10%	-24%	-36%	-36%	-98%	-13%
	FL	+10%	-24%	-36%	-36%	-98%	-13%
	GA	+10%	-20%	-36%	-36%	-98%	-12%
	KY	+10%	-23%	-35%	-35%	-98%	-13%
	MS	+10%	-24%	-36%	-36%	-98%	-13%
	NC	+10%	-24%	-36%	-36%	-98%	-13%
	SC	+10%	-24%	-36%	-36%	-98%	-13%
	TN	+10%	-15%	-36%	-36%	-98%	-13%
	VA	+10%	-14%	-36%	-36%	-98%	-11%
	WV	+10%	-18%	-36%	-36%	-98%	-12%
	Total	**+10%**	**-21%**	**-36%**	**-36%**	**-98%**	**-12%**
Grand Total		**+23%**	**-12%**	**-1%**	**-1%**	**-34%**	**+11%**

Figure 2.3-2 Total Aircraft, Locomotive, and CMV CO Emissions (Base F)

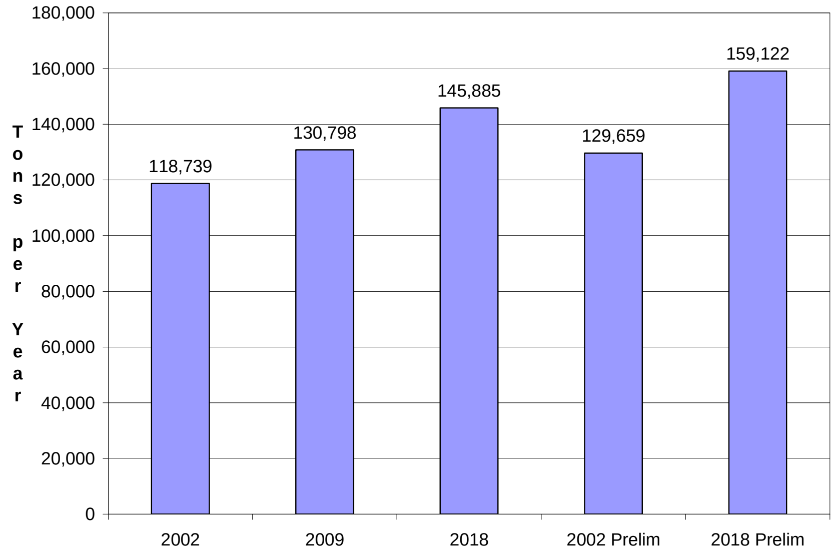


Figure 2.3-3 Locomotive CO Emissions (Base F)

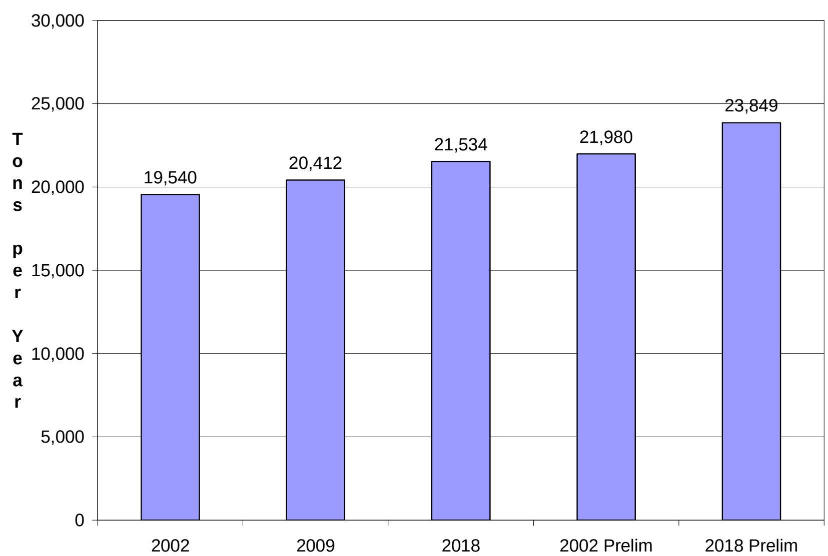


Figure 2.3-4 Total Aircraft, Locomotive, and CMV NO_x Emissions (Base F)

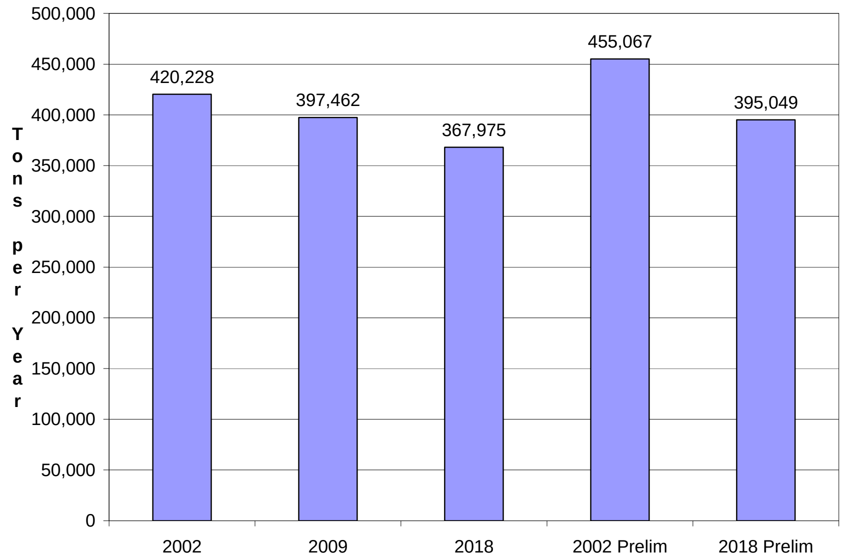


Figure 2.3-5 Locomotive NO_x Emissions (Base F)

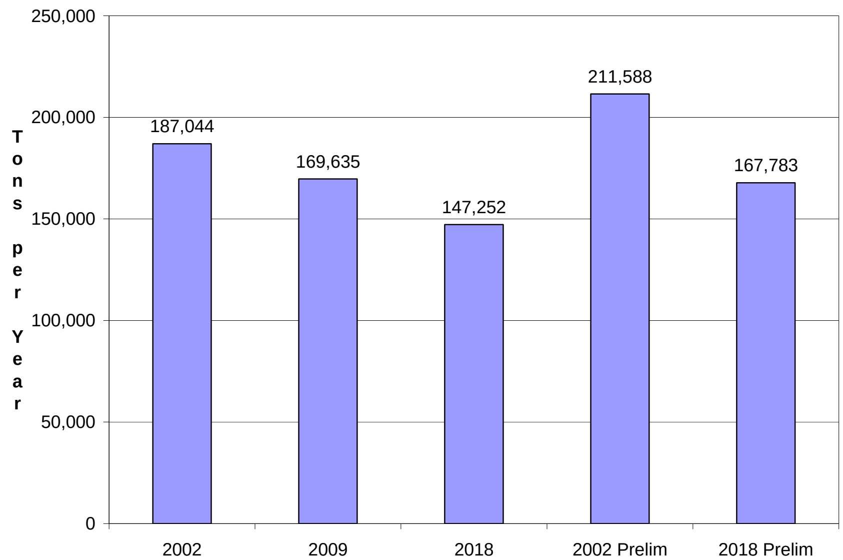


Figure 2.3-6 Total Aircraft, Locomotive, and CMV PM_{10} Emissions (Base F)

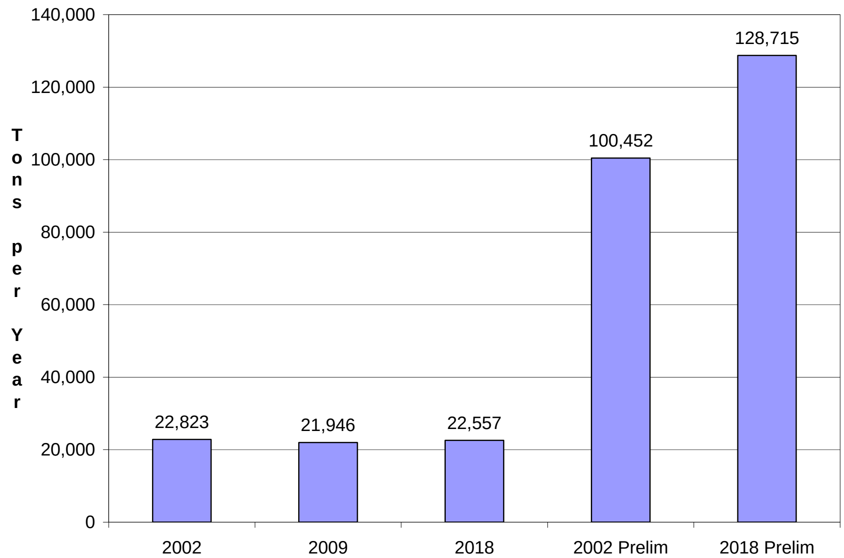


Figure 2.3-7 Locomotive PM_{10} Emissions (Base F)

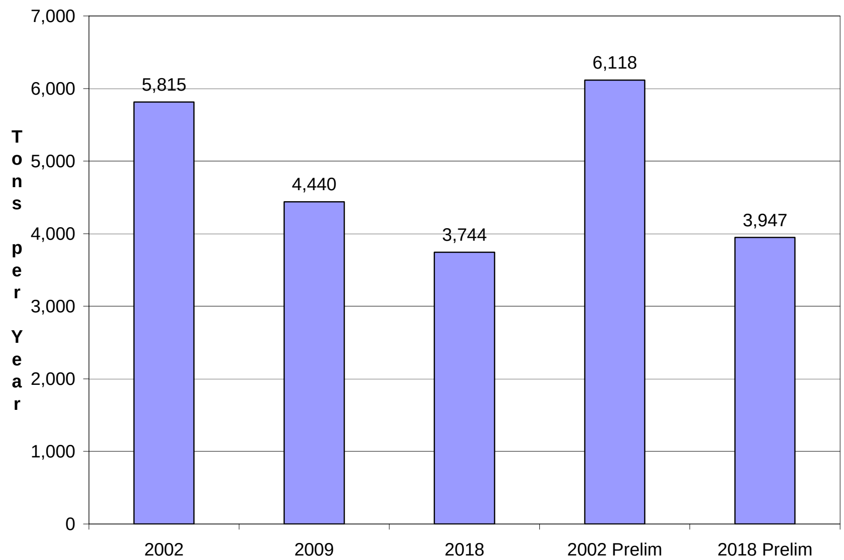


Figure 2.3-8 Total Aircraft, Locomotive, and CMV $PM_{2.5}$ Emissions (Base F)

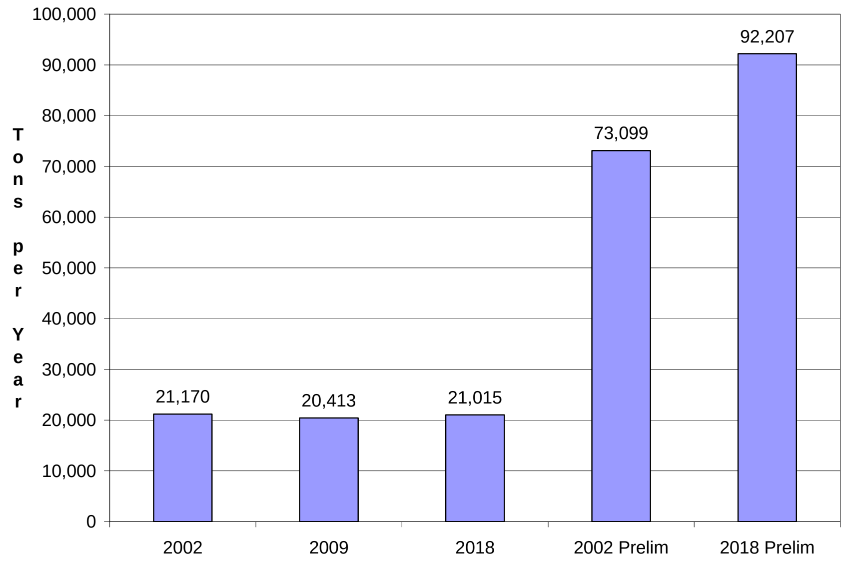


Figure 2.3-9 Locomotive $PM_{2.5}$ Emissions (Base F)

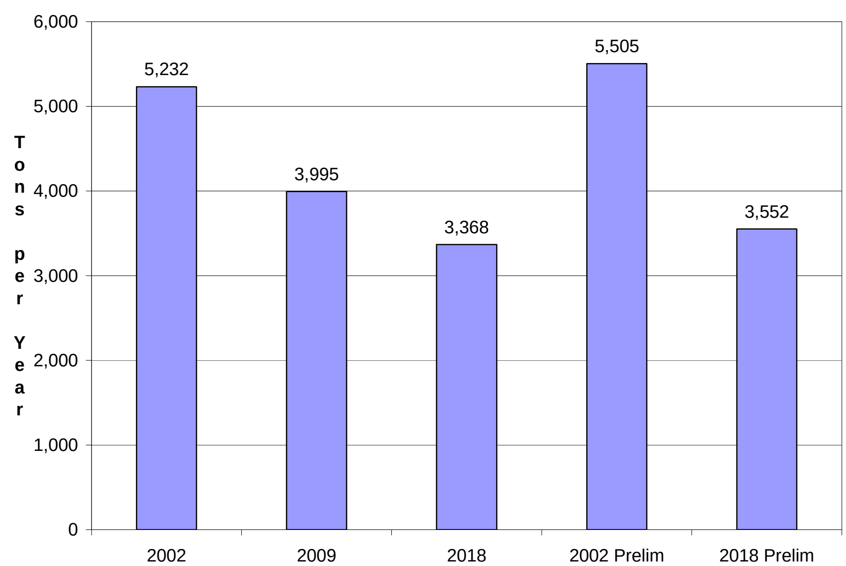


Figure 2.3-10 Total Aircraft, Locomotive, and CMV SO_2 Emissions (Base F)

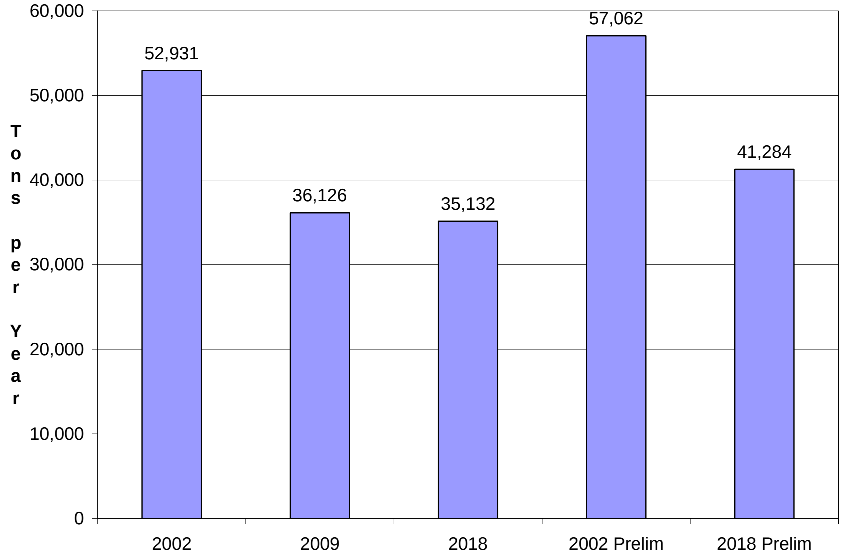


Figure 2.3-11 Locomotive SO_2 Emissions (Base F)

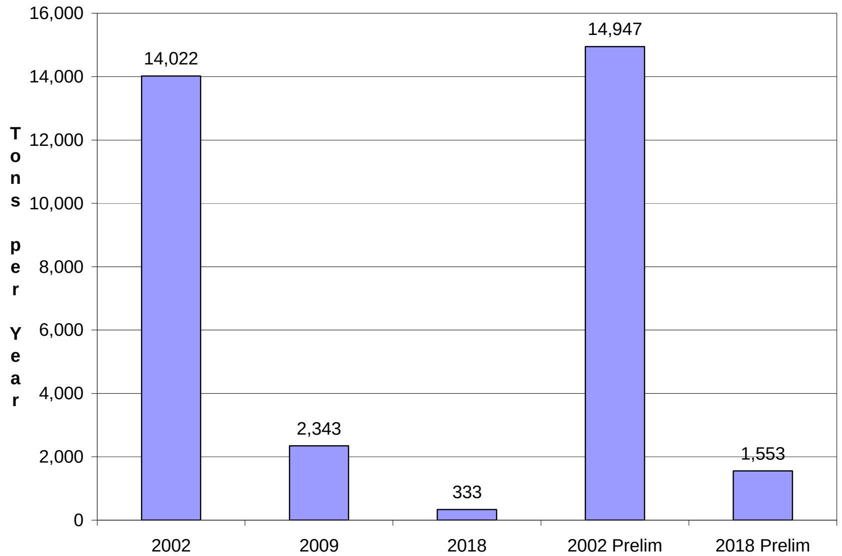


Figure 2.3-12 Total Aircraft, Locomotive, and CMV VOC Emissions (Base F)

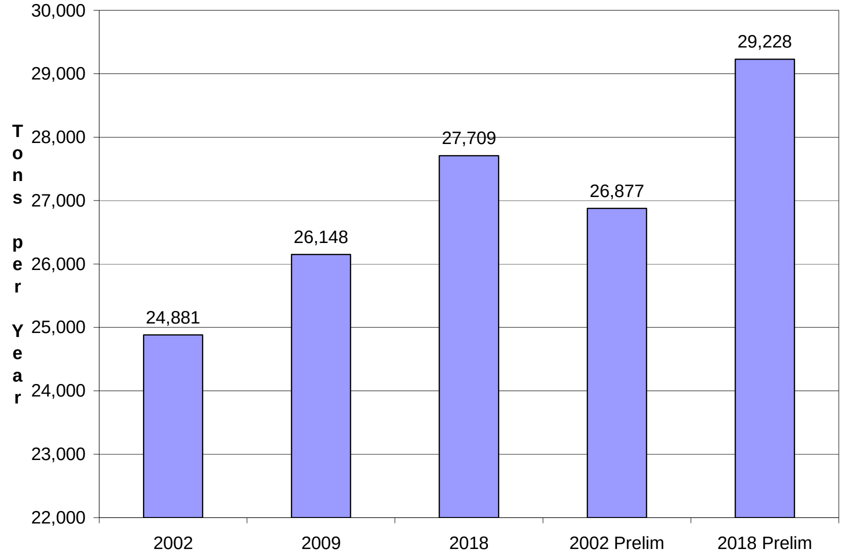
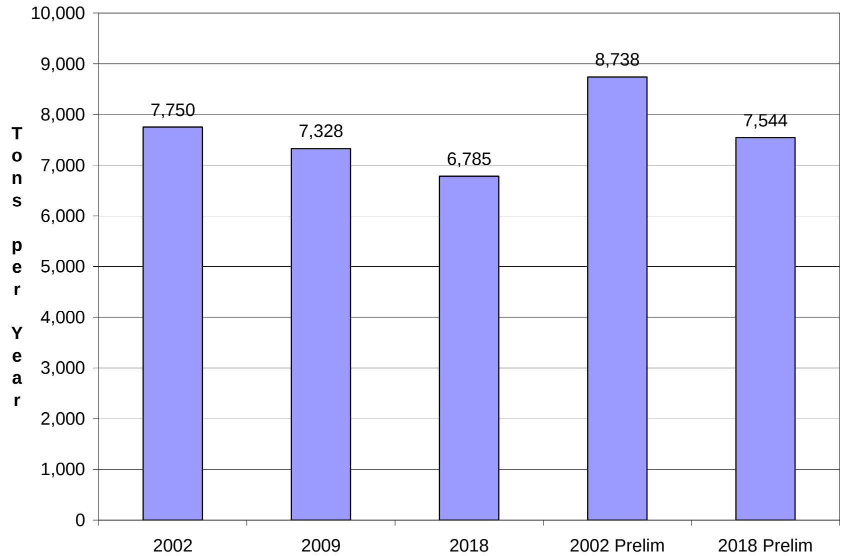


Figure 2.3-13 Locomotive VOC Emissions (Base F)



Base G Revisions:

Table 2.3-18 shows the Base G 2002 base year emissions for each State in the VISTAS region for aircraft, locomotives and CMV. Although some of these data are updated relative to those used as the basis of the Base F emissions forecasts, the methodology used to develop 2009 and 2018 emissions forecasts for aircraft, locomotives, and CMV for Base G is identical to that used for Base F (as documented above). The only exceptions are as follows:

(a) As indicated in the discussion of the Base F forecasts, the CAIR (growth rate) matching criteria were overridden for any record for which States provided local growth data. For Base F, only North Carolina provided such data. However, for Base G, Kentucky regulators provided growth data for aircraft emissions associated with Cincinnati/Northern Kentucky International Airport (located in Boone County, Kentucky). These data were applied to all pollutants and all aircraft types (i.e., military aircraft (SCC 2275001000), commercial aircraft (SCC 2275020000), general aviation aircraft (SCC 2275050000), and air taxi aircraft (SCC 2275060000)). Emissions forecasts for all aircraft operations in counties other than Boone continued to utilize the growth factors developed according to the CAIR matching criteria. Table 2.3-19 presents the locally generated growth factors applied in Kentucky. It should be recognized that although the locally provided growth factors presented in the table are significantly greater than those that would apply under the CAIR matching criteria, this is to be expected as local regulators noted a very significant decline in activity at the Cincinnati/Northern Kentucky International Airport in 2002 (relative to activity in preceding years). Moreover, this downward spike seems to have been alleviated since 2002, so that the provided growth factors represent not only "routine" growth expected between 2002 and the two forecast years, but growth required to offset the temporary decline observed in 2002.

Table 2.3-18 Base G 2002 Aircraft, Locomotive, and Non-Recreational Marine Emissions (annual tons)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	5,595	185	238	99	18	276
	FL	25,431	8,891	2,424	2,375	800	3,658
	GA	6,620	5,372	1,475	1,446	451	443
	KY	5,577	925	251	246	88	397
	MS	1,593	140	44	43	13	96
	NC	6,088	1,548	419	411	148	613
	SC	6,505	515	409	401	88	863
	TN	7,251	2,766	734	719	235	943
	VA	11,873	3,885	2,010	1,970	272	2,825
	WV	1,178	78	25	24	8	66
	Total	**77,712**	**24,305**	**8,029**	**7,734**	**2,121**	**10,179**
Commercial Marine (2280)	AL	1,196	9,218	917	844	3,337	737
	FL	5,888	44,817	1,936	1,781	6,683	1,409
	GA	1,038	7,875	334	307	1,173	246
	KY	6,607	50,267	2,246	2,066	9,608	1,569
	MS	5,688	43,233	1,903	1,751	7,719	1,351
	NC	599	4,547	193	178	690	142
	SC	1,067	8,100	343	316	1,205	253
	TN	3,624	27,555	1,217	1,120	4,974	860
	VA	972	2,775	334	307	359	483
	WV	1,528	11,586	487	448	525	362
	Total	**28,207**	**209,972**	**9,911**	**9,118**	**36,275**	**7,413**
Military Marine (2283)	VA	110	313	25	23	27	48
	Total	**110**	**313**	**25**	**23**	**27**	**48**
Locomotives (2285)	AL	3,518	26,623	592	533	1,446	1,365
	FL	1,006	9,969	247	222	605	404
	GA	2,654	26,733	664	598	1,622	1,059
	KY	2,166	21,811	542	488	1,321	867
	MS	2,302	23,267	578	520	1,429	899
	NC	1,638	16,502	410	369	1,001	654
	SC	1,160	11,690	291	261	710	462
	TN	2,626	25,627	633	570	1,439	1,041
	VA	1,186	11,882	1,529	1,375	3,641	492
	WV	1,311	13,224	329	296	808	517
	Total	**19,568**	**187,328**	**5,815**	**5,232**	**14,022**	**7,761**
Grand Total		**125,597**	**421,918**	**23,780**	**22,107**	**52,444**	**25,401**

Table 2.3-19 Locally Generated Growth Factors for Kentucky

FIP	2009 Factor	2018 Factor
21015	1.31	1.81

Note:

Growth factor = Year Emissions/2002 Emissions.
Under CAIR approach, 2009 = 0.99 to 1.17.
Under CAIR approach, 2018 = 0.97 to 1.40.

(b) Because of the additional emissions records added in Alabama, as discussed in the Base G 2002 base year inventory section of this report, the total number of emissions records in the Base G 2009 and 2018 forecasts increased to 23,042 (as compared to 22,838 for Base F). The 23,042 data records for aircraft, locomotives, and CMV were assigned growth factors in accordance with the following breakdown:

72 records matched State-provided growth factors,
4,287 records matched using the CAIR-Primary criterion,
240 records matched using the CAIR-Secondary criterion,
7,511 records matched using the CAIR-Tertiary criterion,
720 records matched using the No T4-Primary criterion,
3,858 records matched using the No T4-Secondary criterion, and
6,354 records matched using the No T4-Tertiary criterion.

Tables 2.3-20 and 2.3-21 present a summary of the resulting Base G 2009 and 2018 inventories, while Tables 2.3-22 and 2.3-23 present the associated change in emissions for each forecast inventory relative to the Base G 2002 base year VISTAS. As was the case with Base F, the larger reduction in CMV SO_2 emissions in 2009 and 2018 (relative to 2002) for Virginia and West Virginia is notable relative to the other VISTAS States, but is attributable to a high diesel contribution to total CMV SO_2 in the 2002 inventories for these two States.

Figures 2.3-14 through 2.3-25 graphically depict the relationships between the various inventories, as revised through Base G. There are two figures for each pollutant, the first of which presents a comparison of total VISTAS regional emission estimates for aircraft, locomotives, and CMV, and the second of which presents total VISTAS region emission estimates for locomotives only. This two figure approach is intended to provide a more robust illustration of the differences between the various inventories, as some of the differences are less distinct when viewed through overall aggregate emissions totals. All of the figures include the following emissions estimates:

- The Base G 2002 base year VISTAS emissions inventory (labeled as "2002"),
- The pre-Base F 2002 base year VISTAS emissions inventory (labeled as "2002 Prelim"),
- The Base G 2009 VISTAS emissions inventory developed using growth rates derived from 1996 and 2020 EPA CAIR data (labeled as "2009"),
- The Base G 2018 VISTAS emissions inventory developed using growth rates derived from 1996 and 2020 EPA CAIR data (labeled as "2018"), and
- The pre-Base F 2018 VISTAS emissions inventory estimates developed using growth rates derived from 1996, 2010, 2015, and 2020 EPA CAIR data (labeled as "2018 Prelim").

All 12 figures generally illustrate a reduction in emissions estimates between the pre-Base F 2002 emission estimates published in February 2004 and the Base G 2002 base year emission estimates. This reduction generally results from emission updates reflected in the Base F State CERR submittals, although the major differences in aggregate PM emission estimates are driven to a greater extent by modifications in the methodology used to estimate aircraft PM in the Base F revisions to the 2002 Base F base year inventory (as documented under the base year inventory section of this report).

Table 2.3-20 Base G 2009 Aircraft, Locomotive, and Non-Recreational Marine Emissions (annual tons) -- Based on Growth Using 1996 and 2020 EPA Inventories

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	6,265	213	292	116	21	309
	FL	29,258	10,316	2,812	2,756	928	4,235
	GA	7,635	6,233	1,712	1,678	523	512
	KY	6,959	1,135	307	301	108	487
	MS	1,765	162	51	50	16	108
	NC	6,991	1,795	486	477	171	709
	SC	7,372	559	446	437	98	975
	TN	8,020	3,096	824	807	268	1,050
	VA	13,141	4,244	2,124	2,082	306	3,153
	WV	1,312	91	28	28	9	74
	Total	**88,716**	**27,844**	**9,083**	**8,732**	**2,447**	**11,612**
Commercial Marine (2280)	AL	1,280	8,888	872	802	2,753	768
	FL	6,236	43,198	1,838	1,691	5,864	1,467
	GA	1,097	7,599	317	291	974	256
	KY	7,087	48,039	2,158	1,985	8,350	1,649
	MS	6,074	41,437	1,821	1,676	6,587	1,415
	NC	634	4,386	184	169	584	148
	SC	1,133	7,796	326	300	1,012	264
	TN	3,887	26,333	1,168	1,074	4,512	904
	VA	1,042	2,662	312	286	61	506
	WV	1,638	11,073	455	419	89	381
	Total	**30,108**	**201,412**	**9,450**	**8,693**	**30,786**	**7,759**
Military Marine (2283)	VA	118	299	23	21	5	50
	Total	**118**	**299**	**23**	**21**	**5**	**50**
Locomotives (2285)	AL	3,677	23,783	452	406	242	1,289
	FL	1,052	8,905	189	170	101	382
	GA	2,769	24,398	507	456	271	1,003
	KY	2,264	19,597	415	374	221	819
	MS	2,406	20,785	441	397	239	849
	NC	1,690	14,662	311	279	165	613
	SC	1,213	10,443	222	200	119	437
	TN	2,745	23,924	483	435	240	984
	VA	1,236	11,134	1,167	1,050	608	467
	WV	1,369	12,177	251	226	135	489
	Total	**20,420**	**169,808**	**4,437**	**3,993**	**2,341**	**7,333**
Grand Total		**139,362**	**399,364**	**22,994**	**21,440**	**35,578**	**26,754**

Table 2.3-21 Base G 2018 Aircraft, Locomotive, and Non-Recreational Marine Emissions (annual tons) -- Based on Growth Using 1996 and 2020 EPA Inventories

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	7,126	249	361	139	24	352
	FL	34,178	12,147	3,312	3,246	1,093	4,976
	GA	8,939	7,340	2,016	1,976	616	601
	KY	9,078	1,446	391	383	138	623
	MS	1,986	190	60	58	18	122
	NC	8,150	2,114	572	561	202	831
	SC	8,487	616	493	484	112	1,119
	TN	9,009	3,519	939	921	309	1,187
	VA	14,770	4,706	2,271	2,226	349	3,574
	WV	1,484	106	33	33	10	85
	Total	**103,206**	**32,435**	**10,450**	**10,027**	**2,871**	**13,472**
Commercial Marine (2280)	AL	1,388	8,464	880	809	2,715	809
	FL	6,684	41,117	1,853	1,705	6,248	1,543
	GA	1,174	7,246	319	293	976	269
	KY	7,703	45,174	2,199	2,023	8,383	1,752
	MS	6,571	39,129	1,850	1,702	6,556	1,498
	NC	678	4,179	185	170	596	155
	SC	1,217	7,406	329	303	1,027	278
	TN	4,225	24,763	1,190	1,095	4,808	960
	VA	1,133	2,517	314	289	9	537
	WV	1,781	10,412	459	422	13	404
	Total	**32,554**	**190,407**	**9,578**	**8,811**	**31,330**	**8,205**
Military Marine (2283)	VA	128	282	23	21	1	53
	Total	**128**	**282**	**23**	**21**	**1**	**53**
Locomotives (2285)	AL	3,881	20,131	381	343	34	1,192
	FL	1,110	7,538	159	143	14	353
	GA	2,917	21,395	427	385	38	932
	KY	2,389	16,751	352	317	31	757
	MS	2,540	17,594	372	335	34	785
	NC	1,782	12,539	263	237	23	570
	SC	1,280	8,840	187	168	17	404
	TN	2,897	21,735	407	367	34	910
	VA	1,300	10,173	983	885	86	436
	WV	1,444	10,831	212	190	19	453
	Total	**21,539**	**147,527**	**3,743**	**3,368**	**332**	**6,792**
Grand Total		**157,427**	**370,651**	**23,794**	**22,227**	**34,534**	**28,522**

Table 2.3-22 Change in Emissions between 2009 Base G and 2002 Base F Inventories (Based on Growth Using 1996 and 2020 EPA Inventories)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	+12%	+15%	+23%	+18%	+16%	+12%
	FL	+15%	+16%	+16%	+16%	+16%	+16%
	GA	+15%	+16%	+16%	+16%	+16%	+16%
	KY	+25%	+23%	+23%	+23%	+23%	+23%
	MS	+11%	+16%	+15%	+15%	+16%	+12%
	NC	+15%	+16%	+16%	+16%	+16%	+16%
	SC	+13%	+9%	+9%	+9%	+12%	+13%
	TN	+11%	+12%	+12%	+12%	+14%	+11%
	VA	+11%	+9%	+6%	+6%	+12%	+12%
	WV	+11%	+16%	+15%	+15%	+16%	+12%
	Total	**+14%**	**+15%**	**+13%**	**+13%**	**+15%**	**+14%**
Commercial Marine (2280)	AL	+7%	-4%	-5%	-5%	-18%	+4%
	FL	+6%	-4%	-5%	-5%	-12%	+4%
	GA	+6%	-3%	-5%	-5%	-17%	+4%
	KY	+7%	-4%	-4%	-4%	-13%	+5%
	MS	+7%	-4%	-4%	-4%	-15%	+5%
	NC	+6%	-4%	-5%	-5%	-15%	+4%
	SC	+6%	-4%	-5%	-5%	-16%	+4%
	TN	+7%	-4%	-4%	-4%	-9%	+5%
	VA	+7%	-4%	-7%	-7%	-83%	+5%
	WV	+7%	-4%	-7%	-7%	-83%	+5%
	Total	**+7%**	**-4%**	**-5%**	**-5%**	**-15%**	**+5%**
Military Marine (2283)	VA	+7%	-4%	-7%	-7%	-83%	+5%
	Total	**+7%**	**-4%**	**-7%**	**-7%**	**-83%**	**+5%**
Locomotives (2285)	AL	+5%	-11%	-24%	-24%	-83%	-6%
	FL	+5%	-11%	-24%	-24%	-83%	-6%
	GA	+4%	-9%	-24%	-24%	-83%	-5%
	KY	+5%	-10%	-23%	-23%	-83%	-6%
	MS	+5%	-11%	-24%	-24%	-83%	-6%
	NC	+3%	-11%	-24%	-24%	-83%	-6%
	SC	+5%	-11%	-24%	-24%	-83%	-6%
	TN	+5%	-7%	-24%	-24%	-83%	-6%
	VA	+4%	-6%	-24%	-24%	-83%	-5%
	WV	+4%	-8%	-24%	-24%	-83%	-5%
	Total	**+4%**	**-9%**	**-24%**	**-24%**	**-83%**	**-6%**
Grand Total		**+11%**	**-5%**	**-3%**	**-3%**	**-32%**	**+5%**

Table 2.3-23 Change in Emissions between 2018 Base G and 2002 Base F Inventories (Based on Growth Using 1996 and 2020 EPA Inventories)

Source	State	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Aircraft (2275)	AL	+27%	+35%	+52%	+41%	+36%	+28%
	FL	+34%	+37%	+37%	+37%	+37%	+36%
	GA	+35%	+37%	+37%	+37%	+37%	+36%
	KY	+63%	+56%	+56%	+56%	+56%	+57%
	MS	+25%	+36%	+35%	+35%	+36%	+27%
	NC	+34%	+37%	+36%	+36%	+37%	+36%
	SC	+30%	+20%	+21%	+21%	+27%	+30%
	TN	+24%	+27%	+28%	+28%	+31%	+26%
	VA	+24%	+21%	+13%	+13%	+28%	+27%
	WV	+26%	+36%	+35%	+35%	+36%	+28%
	Total	**+33%**	**+33%**	**+30%**	**+30%**	**+35%**	**+32%**
Commercial Marine (2280)	AL	+16%	-8%	-4%	-4%	-19%	+10%
	FL	+14%	-8%	-4%	-4%	-7%	+9%
	GA	+13%	-8%	-5%	-5%	-17%	+9%
	KY	+17%	-10%	-2%	-2%	-13%	+12%
	MS	+16%	-9%	-3%	-3%	-15%	+11%
	NC	+13%	-8%	-4%	-4%	-14%	+9%
	SC	+14%	-9%	-4%	-4%	-15%	+10%
	TN	+17%	-10%	-2%	-2%	-3%	+12%
	VA	+17%	-9%	-6%	-6%	-98%	+11%
	WV	+17%	-10%	-6%	-6%	-98%	+12%
	Total	**+15%**	**-9%**	**-3%**	**-3%**	**-14%**	**+11%**
Military Marine (2283)	VA	+17%	-10%	-6%	-6%	-98%	+12%
	Total	**+17%**	**-10%**	**-6%**	**-6%**	**-98%**	**+12%**
Locomotives (2285)	AL	+10%	-24%	-36%	-36%	-98%	-13%
	FL	+10%	-24%	-36%	-36%	-98%	-13%
	GA	+10%	-20%	-36%	-36%	-98%	-12%
	KY	+10%	-23%	-35%	-35%	-98%	-13%
	MS	+10%	-24%	-36%	-36%	-98%	-13%
	NC	+9%	-24%	-36%	-36%	-98%	-13%
	SC	+10%	-24%	-36%	-36%	-98%	-13%
	TN	+10%	-15%	-36%	-36%	-98%	-13%
	VA	+10%	-14%	-36%	-36%	-98%	-11%
	WV	+10%	-18%	-36%	-36%	-98%	-12%
	Total	**+10%**	**-21%**	**-36%**	**-36%**	**-98%**	**-12%**
Grand Total		**+25%**	**-12%**	**+0%**	**+1%**	**-34%**	**+12%**

Figure 2.3-14 Total Aircraft, Locomotive, and CMV CO Emissions (Base G)

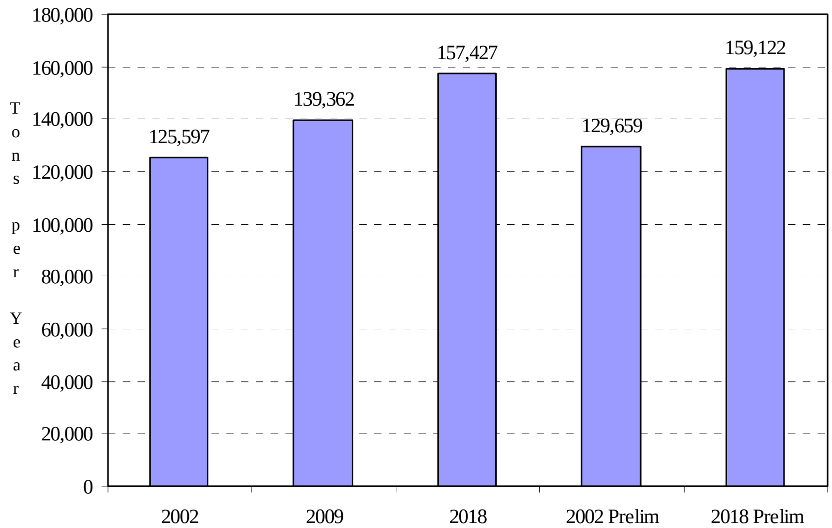


Figure 2.3-15 Locomotive CO Emissions (Base G)

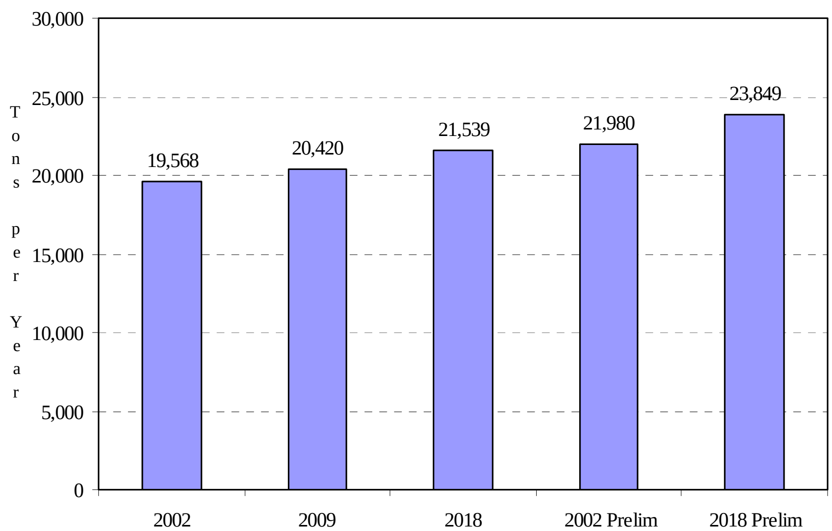


Figure 2.3-16 Total Aircraft, Locomotive, and CMV NO_x Emissions (Base G)

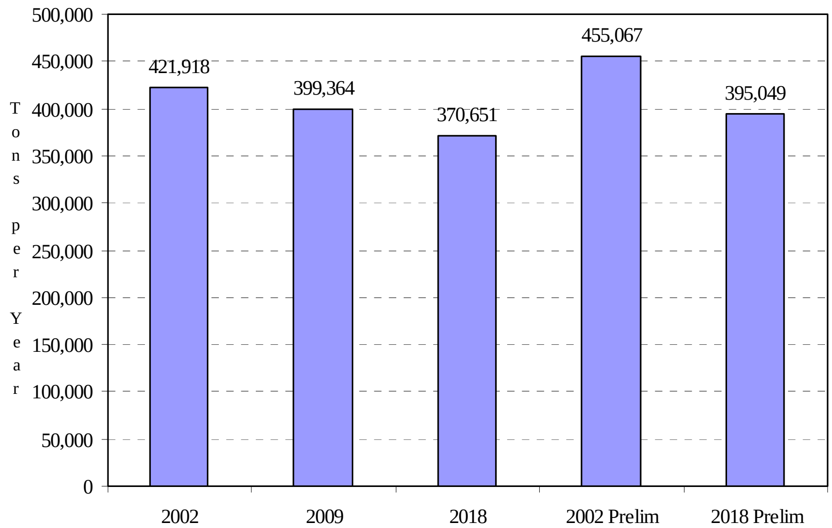


Figure 2.3-17 Locomotive NO_x Emissions (Base G)

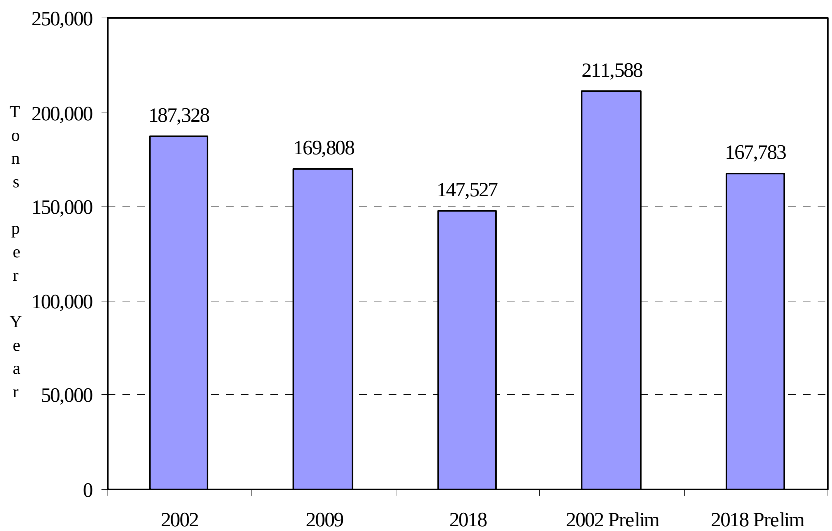


Figure 2.3-18 Total Aircraft, Locomotive, and CMV PM_{10} Emissions (Base G)

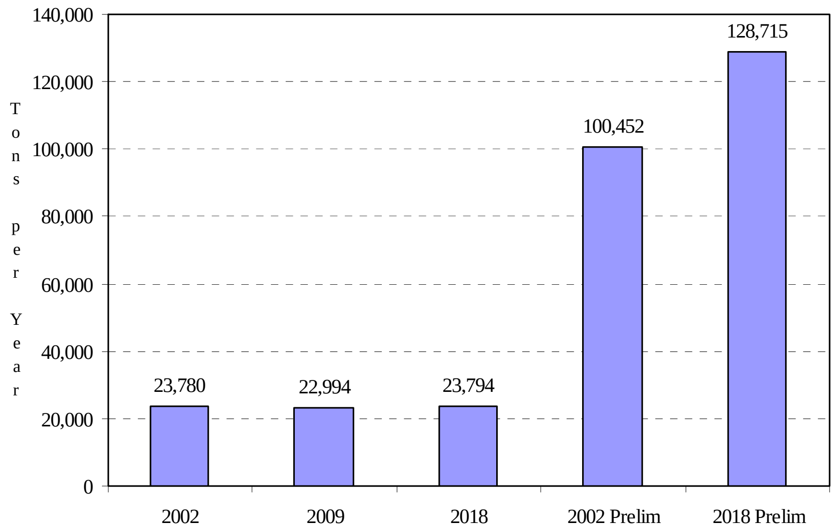


Figure 2.3-19 Locomotive PM_{10} Emissions (Base G)

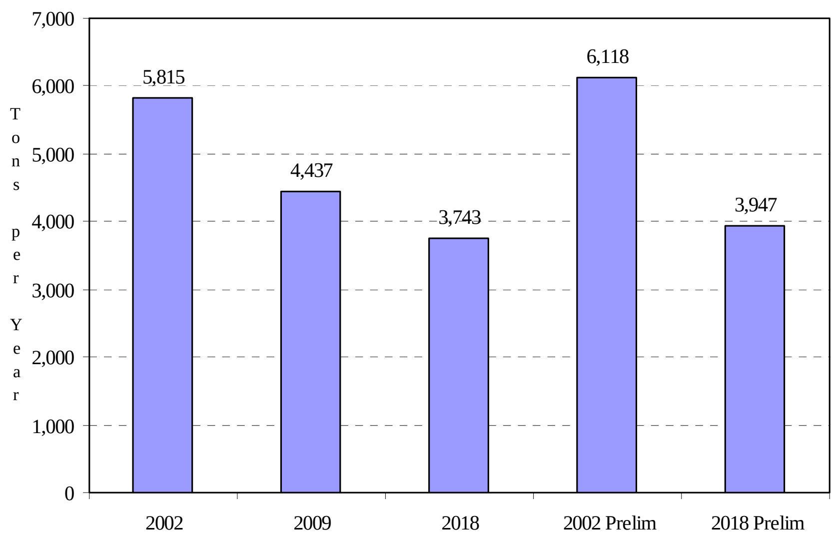


Figure 2.3-20 Total Aircraft, Locomotive, and CMV $PM_{2.5}$ Emissions (Base G)

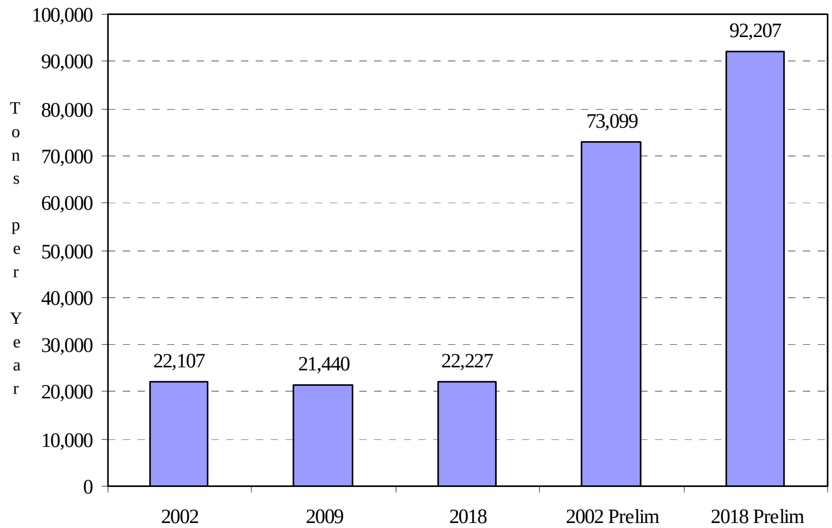


Figure 2.3-21 Locomotive $PM_{2.5}$ Emissions (Base G)

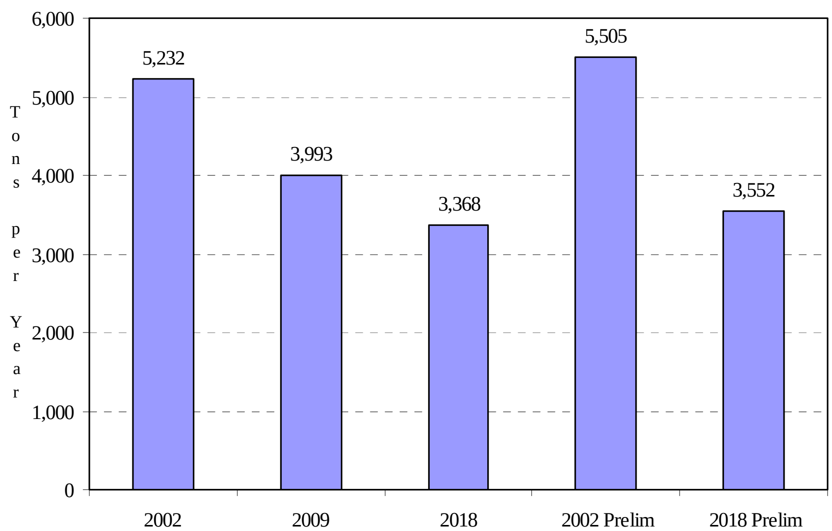


Figure 2.3-22 Total Aircraft, Locomotive, and CMV SO_2 Emissions (Base G)

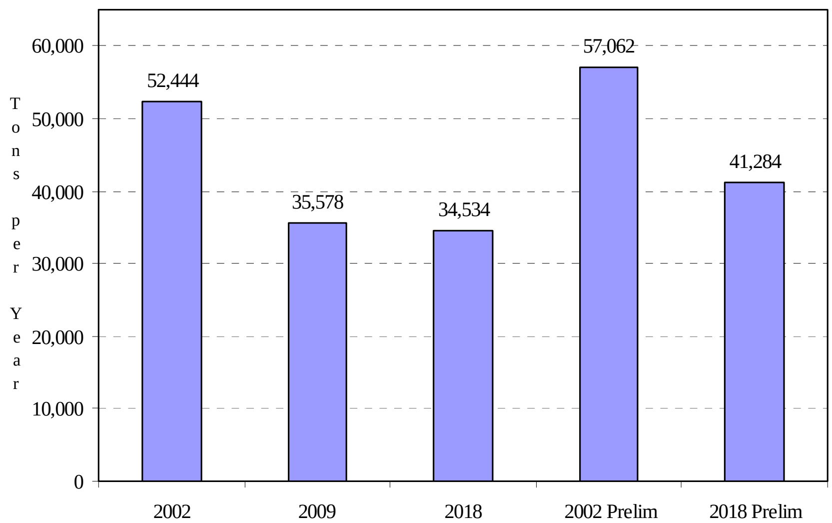


Figure 2.3-23 Locomotive SO_2 Emissions (Base G)

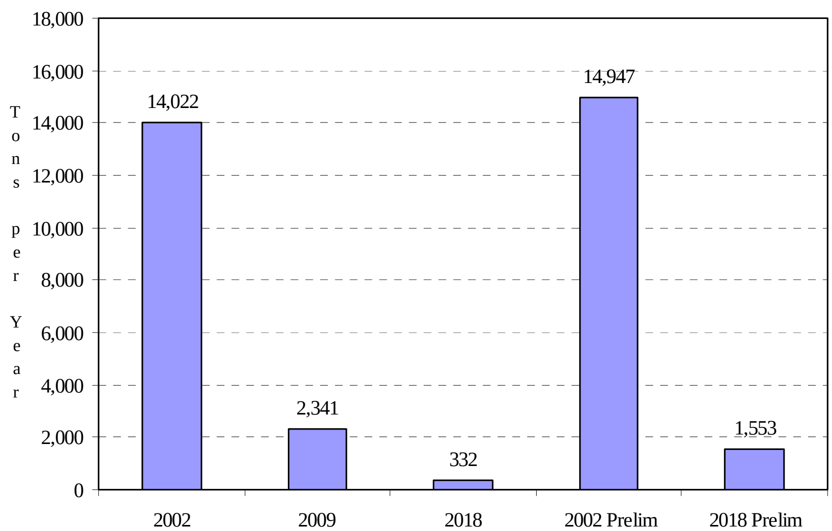


Figure 2.3-24 Total Aircraft, Locomotive, and CMV VOC Emissions (Base G)

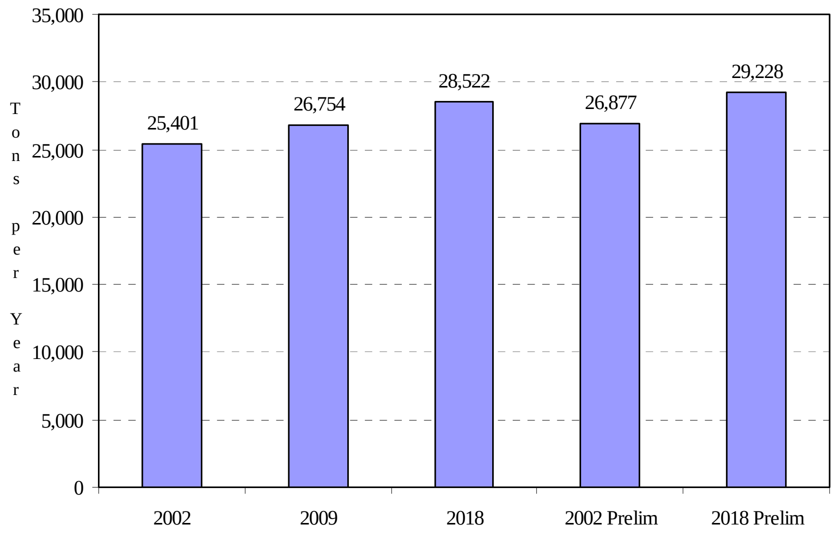
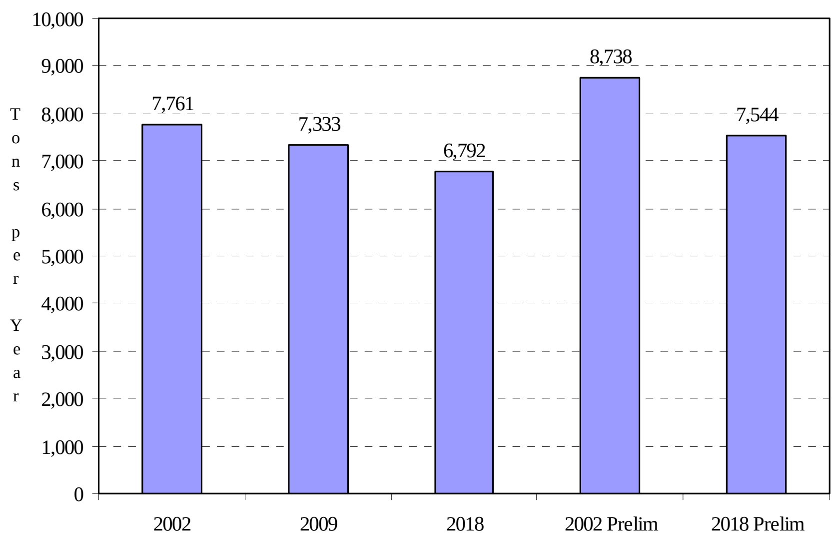


Figure 2.3-25 Locomotive VOC Emissions (Base G)



2.3.4.3 Emissions from NONROAD Model Sources in Illinois, Indiana, and Ohio

Base G projection inventories for 2009 and 2018 for NONROAD model sources in the states of Illinois, Indiana, and Ohio were produced using a methodology identical to that employed to develop a Base G 2002 base year inventory for the same states (as documented earlier in this report). This method consists of the extraction of a complete set of county-level input data applicable to each of the three states (in each of the two projection years) from the latest version of the EPA's NMIM model. This includes appropriate consideration of all non-default NMIM input files generated by the Midwest Regional Planning Organization as documented earlier in the discussion of the Base G 2002 base year inventory. These input data were then assembled into appropriate input files for the Final NONROAD2005 model and emission estimates were produced using the same procedure employed for the VISTAS region.

Changes noted between the base year (2002) and forecast year (2009 and 2018) input data extracted from NMIM include differences in gasoline vapor pressure, gasoline sulfur content, and diesel sulfur content in most counties. All temperature data (minimum, maximum, and average daily temperatures) was constant across years.

As described in the discussion of the Base G 2002 base year inventory, counties in the three states were grouped for modeling purposes using a temperature aggregation scheme that allowed for county-specific temperature variations of no more that 2 ºF from group average temperatures (for all temperature inputs). The same grouping scheme was applied to projection year modeling, so that Illinois emissions were modeled using 12 county groups, Indiana emissions were modeled using 9 county groups, and Ohio emissions were modeled using 10 county groups. Thus, 31 iterations of NONROAD2002 were required per season per projection year, as compared to the 53 iterations per season per projection year required for the VISTAS region.

As was also described in the discussion of the Base G 2002 base year inventory, several non-default equipment population, growth, activity, seasonal distribution, and county allocation files are assigned by NMIM model inputs for these counties. As was the case for the base year inventory development, these same non-default assignments were retained for both projection inventories.

2.3.4.4 Differences between 2009/2018

Methodologically, there was no difference in the way that 2009 and 2018 emissions were calculated for non-road mobile sources. The actual value of the growth factors were different for each type of mobile source considered, but the calculation methods were identical.

2.3.5 Quality Assurance steps

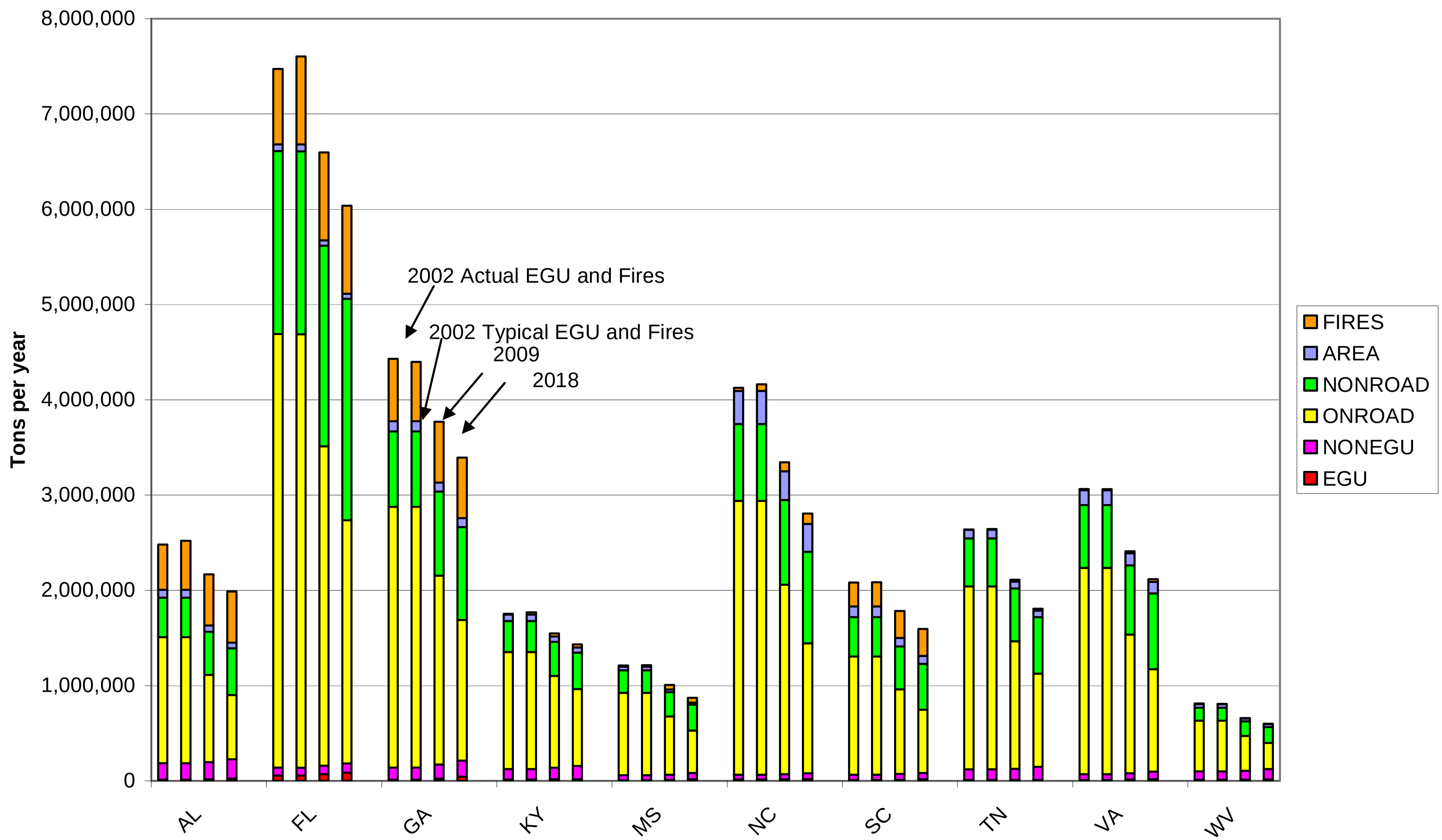
Throughout the inventory development process, quality assurance steps were performed to ensure that no double counting of emissions occurred, to ensure that a full and complete inventory was developed for VISTAS, and to make sure that projection calculations were working correctly. Quality assurance was an important component to the inventory development process and MACTEC performed the following QA steps on mobile source components of the 2009 and revised 2018 projection inventories:

1. All final files (NONROAD only) were run through EPA's Format and Content checking software. Input data files for MOBILE and VMT growth estimates were reviewed by the corresponding SIWG and by the VISTAS Emission Inventory Technical Advisor.
2. SCC level emission summaries were prepared and evaluated to ensure that emissions were consistent and that there were no missing sources (NONROAD only).
3. Tier comparisons (by pollutant) were developed between the 2002 base year inventory and the 2009 and 2018 projection inventories (NONROAD only). Total VISTAS level summaries by pollutant were developed for these sources to compare Base F and Base G emission levels.
4. Data product summaries were provided to both the VISTAS Emission Inventory Technical Advisor and to the SIWG representatives for review and comment. Changes based on these comments were implemented in the files.
5. Version numbering was used for all inventory files developed. The version numbering process used a decimal system to track major and minor changes. For example, a major change would result in a version going from 1.0 to 2.0. A minor change would cause a version number to go from 1.0 to 1.1. Minor changes resulting from largely editorial changes would result in a change from 1.00 to 1.01.

Appendix A:

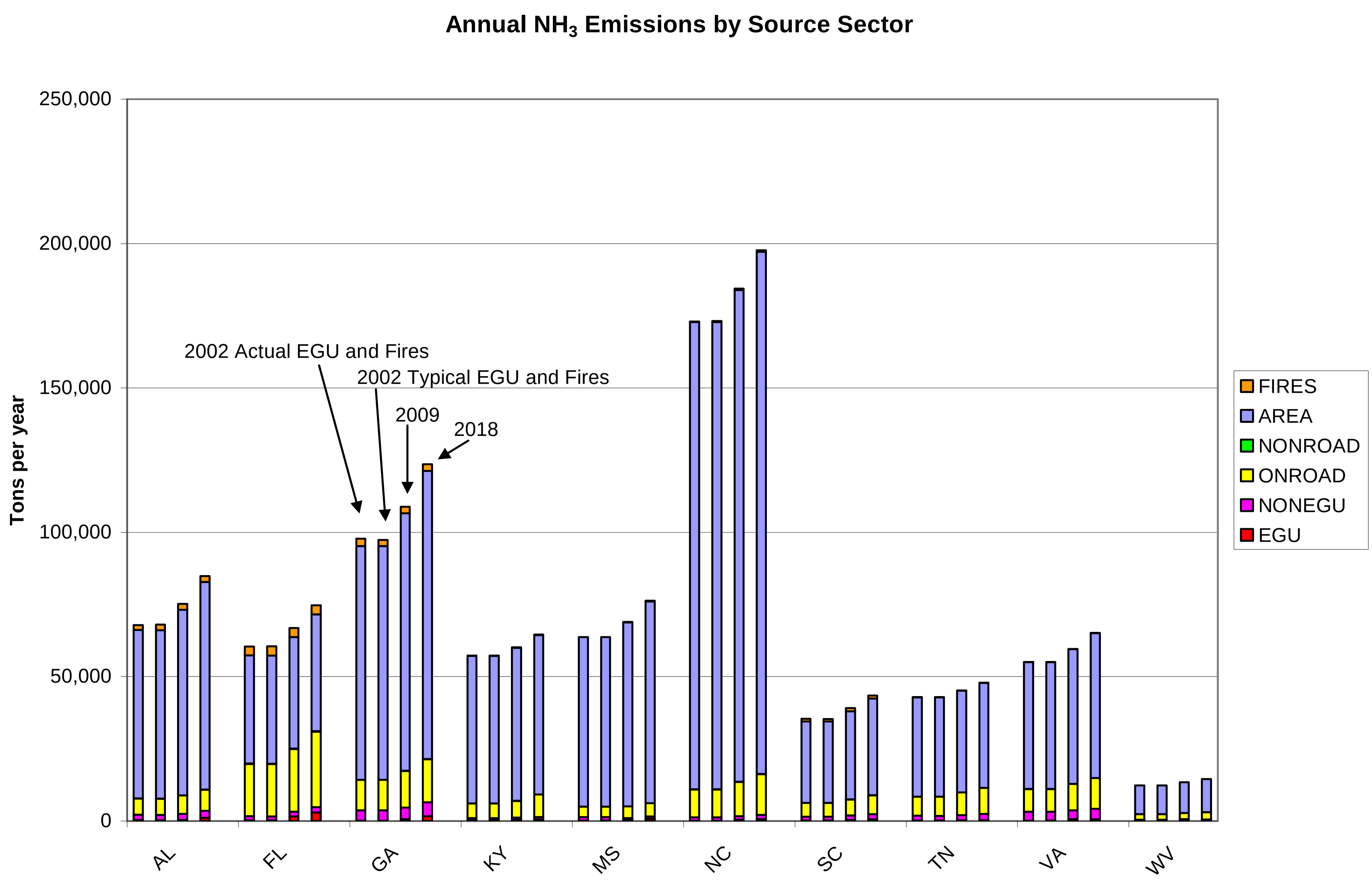
STATE EMISSION TOTALS BY POLLUTANT AND SECTOR

Annual CO Emissions by Source Sector



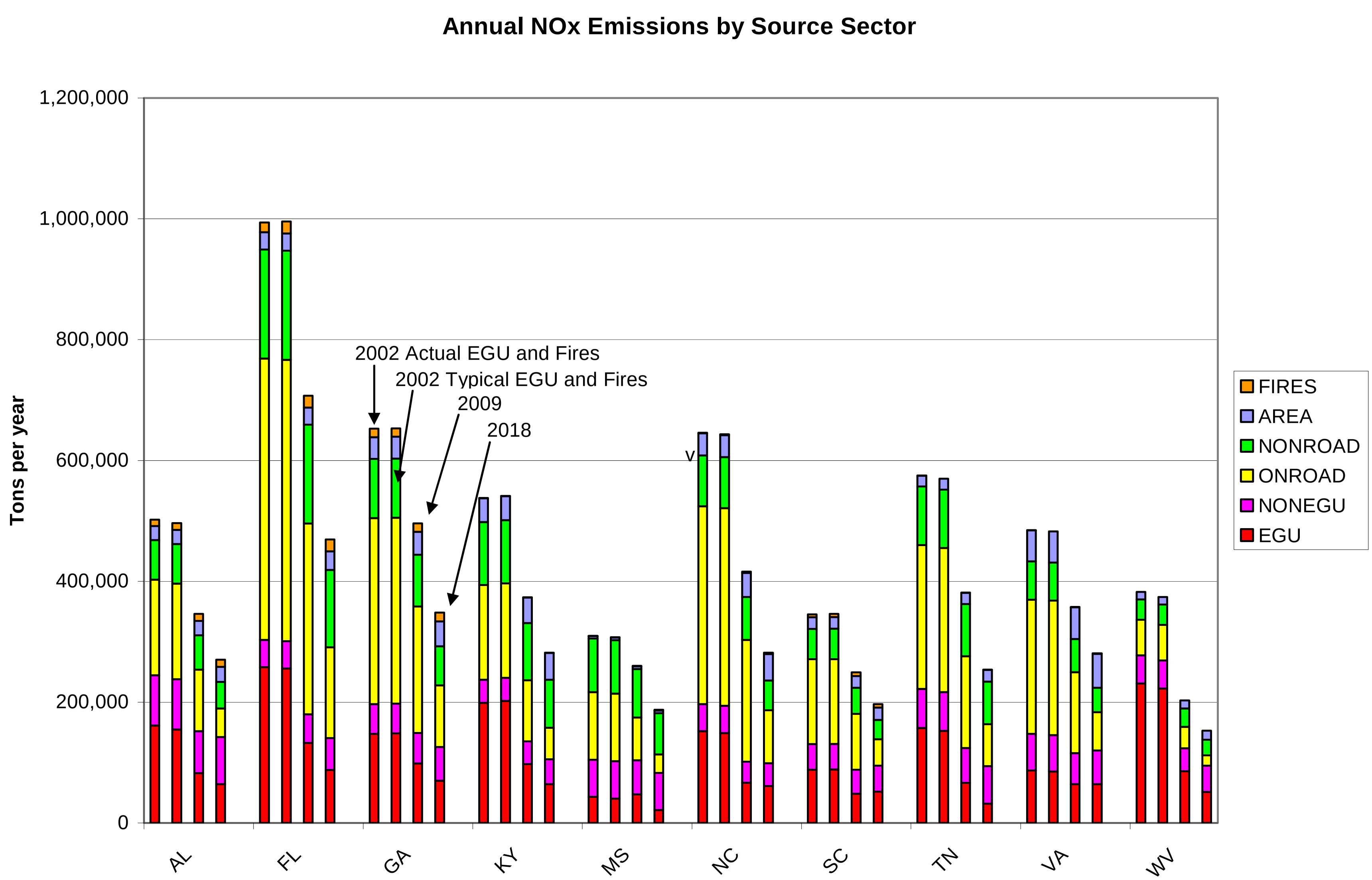
Annual CO Emissions by Source Sector

Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	11,279	174,271	1,321,528	414,385	83,958	474,959	2002 Actual
	11,460	174,260	1,321,528	414,385	83,958	514,120	2002 Typical
	14,986	180,369	915,647	454,686	66,654	534,873	2009
	24,342	201,663	676,210	488,924	59,626	535,658	2018
FL	57,113	81,933	4,550,447	1,920,729	71,079	790,620	2002 Actual
	55,899	81,928	4,550,447	1,920,729	71,079	923,310	2002 Typical
	71,072	87,661	3,352,509	2,104,920	57,011	923,310	2009
	85,495	97,438	2,554,160	2,323,327	53,903	923,310	2018
GA	9,712	130,850	2,735,968	791,158	108,083	654,411	2002 Actual
	9,650	130,850	2,735,968	791,158	108,083	620,342	2002 Typical
	23,721	147,427	1,983,803	882,970	94,130	637,177	2009
	44,269	167,904	1,476,981	973,872	93,827	637,177	2018
KY	12,619	109,936	1,230,148	325,993	66,752	8,703	2002 Actual
	12,607	109,936	1,230,148	325,993	66,752	24,900	2002 Typical
	15,812	122,024	963,762	357,800	57,887	31,810	2009
	17,144	139,437	807,536	381,215	54,865	33,296	2018
MS	5,303	54,568	864,290	236,752	37,905	13,209	2002 Actual
	5,219	54,568	864,290	236,752	37,905	14,353	2002 Typical
	7,116	57,749	609,972	257,453	27,184	48,160	2009
	17,348	65,884	445,493	270,726	22,099	50,037	2018
NC	13,885	50,576	2,873,992	808,231	345,315	34,515	2002 Actual
	14,074	50,576	2,873,992	808,231	345,315	71,970	2002 Typical
	14,942	53,744	1,991,708	887,605	301,163	96,258	2009
	19,870	62,197	1,362,214	960,709	290,809	111,266	2018
SC	6,990	56,315	1,241,359	413,964	113,714	248,341	2002 Actual
	6,969	56,315	1,241,359	413,964	113,714	253,005	2002 Typical
	11,643	59,934	889,957	448,625	90,390	282,307	2009
	14,975	68,415	663,493	481,332	83,167	282,307	2018
TN	7,084	115,264	1,917,842	505,163	89,828	4,302	2002 Actual
	6,787	115,264	1,917,842	505,163	89,828	10,124	2002 Typical
	7,214	119,216	1,338,016	554,121	74,189	17,372	2009
	7,723	140,556	976,634	593,100	68,809	18,860	2018
VA	6,892	63,796	2,163,259	660,105	155,873	15,625	2002 Actual
	6,797	63,784	2,163,259	660,105	155,873	12,611	2002 Typical
	12,535	68,326	1,453,946	726,815	128,132	21,130	2009
	18,850	76,846	1,075,104	797,683	121,690	26,923	2018
WV	10,341	89,879	533,471	133,113	39,546	6,738	2002 Actual
	10,117	89,878	533,471	133,113	39,546	2,652	2002 Typical
	11,493	93,839	365,549	152,862	31,640	3,949	2009
	12,397	111,302	274,804	167,424	28,773	5,013	2018


Annual NH_3 Emissions by Source Sector
Tons per year
250,000
200,000
150,000
100,000
50,000
0
2002 Actual EGU and Fires
2002 Typical EGU and Fires
2009
2018
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
FIRES
AREA
NONROAD
ONROAD
NONEGU
EGU

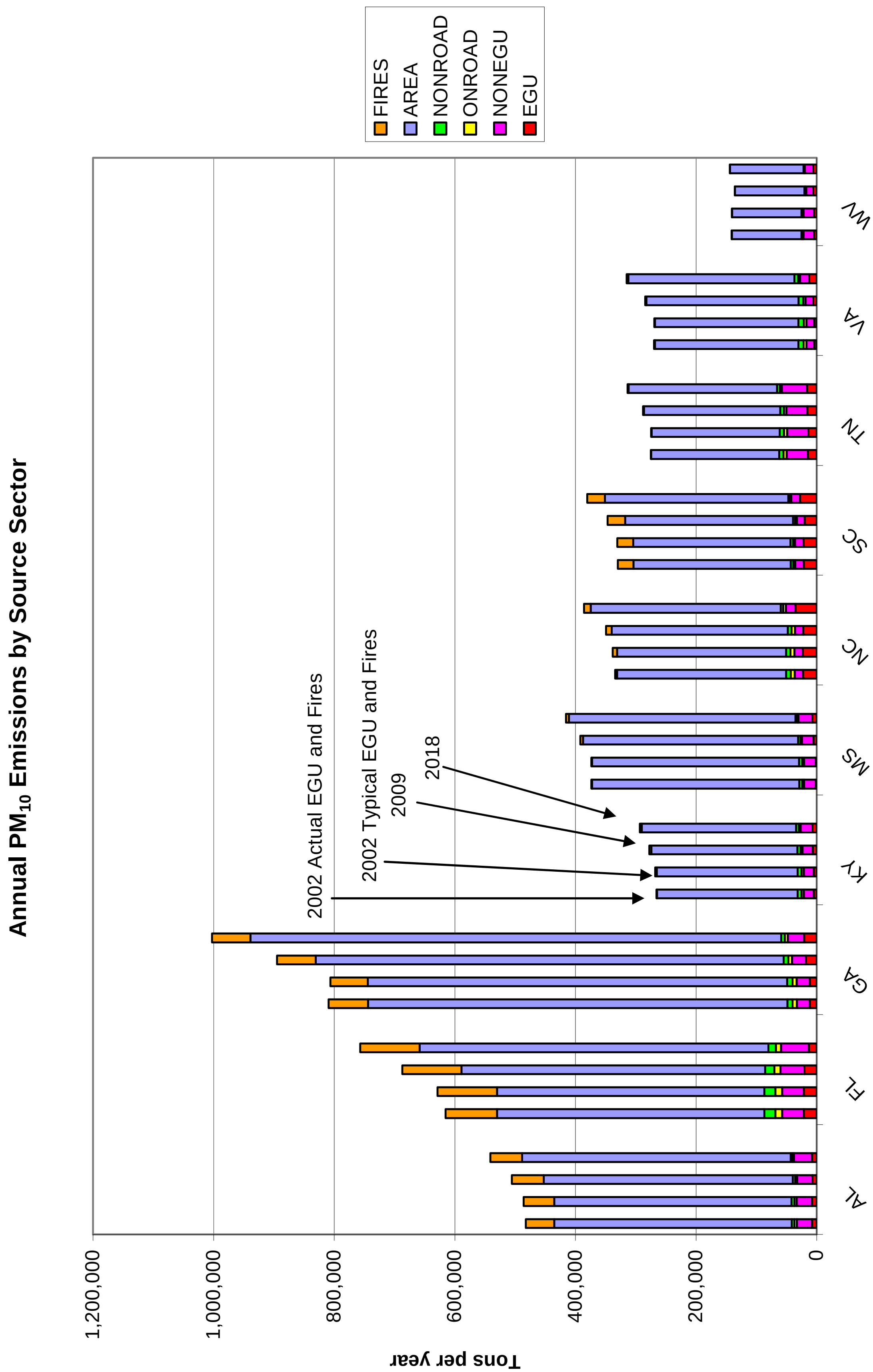
Annual NH_3 Emissions by Source Sector

Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	317	1,883	5,588	33	58,318	1,689	2002 Actual
	239	1,883	5,588	33	58,318	1,957	2002 Typical
	359	2,132	6,364	36	64,268	2,050	2009
	1,072	2,464	7,298	42	71,915	2,054	2018
FL	234	1,423	18,114	134	37,446	3,102	2002 Actual
	222	1,423	18,114	134	37,446	3,157	2002 Typical
	1,629	1,544	21,781	148	38,616	3,157	2009
	2,976	1,829	26,163	171	40,432	3,157	2018
GA	83	3,613	10,546	60	80,913	2,578	2002 Actual
	86	3,613	10,546	60	80,913	2,153	2002 Typical
	686	3,963	12,687	68	89,212	2,229	2009
	1,677	4,797	14,873	79	99,885	2,229	2018
KY	326	674	5,055	31	51,135	39	2002 Actual
	321	674	5,055	31	51,135	112	2002 Typical
	400	760	5,796	34	53,005	143	2009
	476	901	7,811	40	55,211	150	2018
MS	190	1,169	3,585	23	58,721	59	2002 Actual
	198	1,169	3,585	23	58,721	65	2002 Typical
	334	668	4,035	25	63,708	217	2009
	827	764	4,566	29	69,910	225	2018
NC	54	1,179	9,702	65	161,860	155	2002 Actual
	55	1,179	9,702	65	161,860	324	2002 Typical
	445	1,285	11,825	72	170,314	433	2009
	663	1,465	14,065	83	180,866	501	2018
SC	142	1,411	4,694	33	28,166	980	2002 Actual
	141	1,411	4,694	33	28,166	908	2002 Typical
	370	1,578	5,523	36	30,555	1,039	2009
	625	1,779	6,473	41	33,496	1,039	2018
TN	204	1,613	6,625	43	34,393	19	2002 Actual
	197	1,613	6,625	43	34,393	46	2002 Typical
	227	1,840	7,782	48	35,253	78	2009
	241	2,213	9,021	55	36,291	85	2018
VA	127	3,104	7,852	48	43,905	70	2002 Actual
	130	3,104	7,852	48	43,905	57	2002 Typical
	694	3,045	9,086	53	46,639	95	2009
	606	3,604	10,624	61	50,175	121	2018
WV	121	332	1,908	9	9,963	30	2002 Actual
	121	332	1,908	9	9,963	12	2002 Typical
	330	314	2,148	11	10,625	18	2009
	143	378	2,497	13	11,504	23	2018


Annual NOx Emissions by Source Sector
Tons per year
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
2002 Actual EGU and Fires
2002 Typical EGU and Fires
2009
2018
v
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
FIRES
AREA
NONROAD
ONROAD
NONEGU
EGU

Annual NO_x Emissions by Source Sector

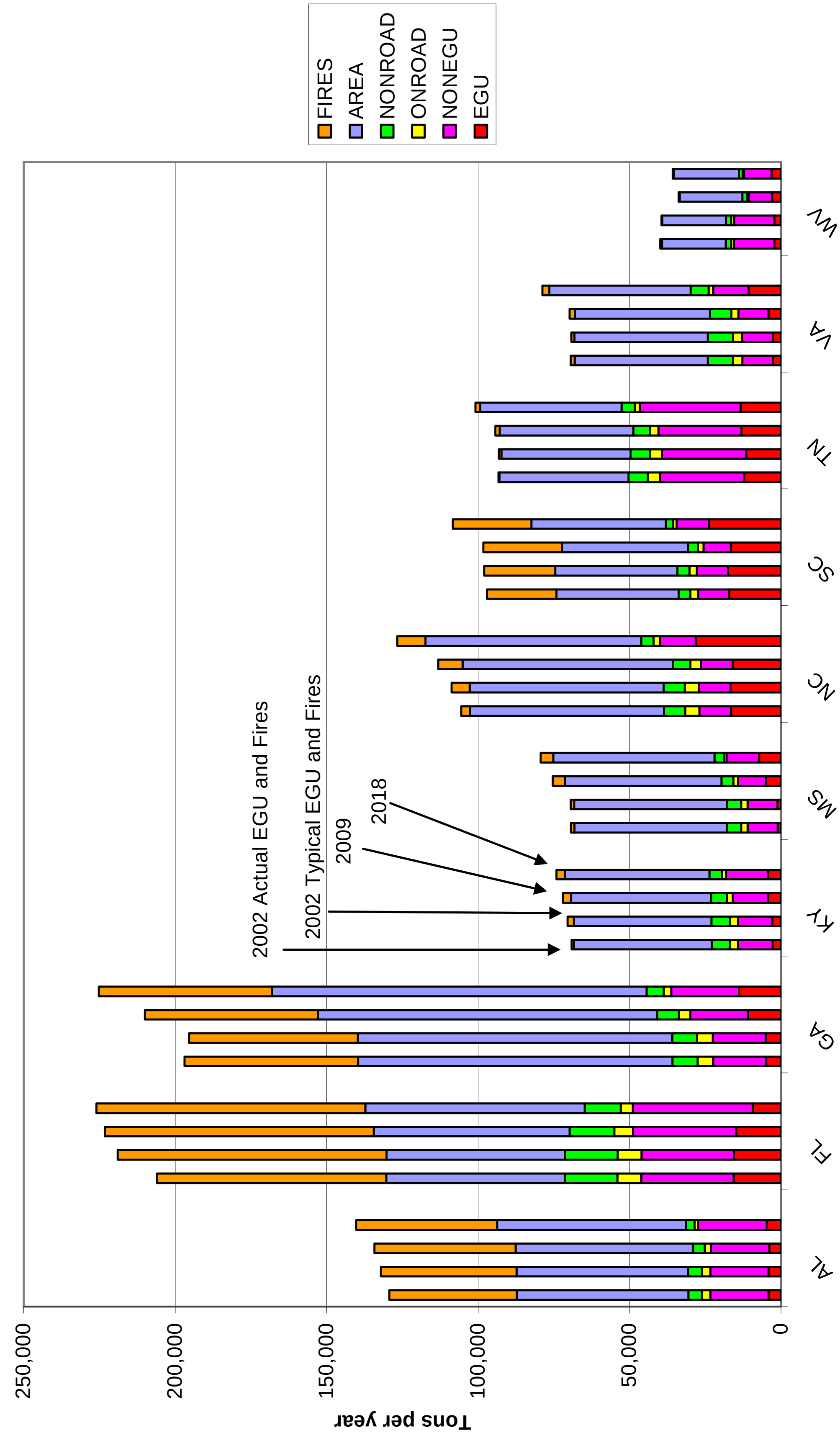
Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	161,038	83,310	158,212	65,366	23,444	10,728	2002 Actual
	154,704	83,302	158,212	65,366	23,444	11,456	2002 Typical
	82,305	69,409	101,831	56,862	23,930	11,901	2009
	64,358	77,960	47,298	43,799	25,028	11,918	2018
FL	257,677	45,156	465,640	180,627	28,872	15,942	2002 Actual
	255,678	45,150	465,640	180,627	28,872	19,791	2002 Typical
	132,535	47,125	315,840	163,794	28,187	19,791	2009
	87,645	52,959	150,180	127,885	30,708	19,791	2018
GA	147,517	49,251	307,732	97,961	36,142	14,203	2002 Actual
	148,126	49,251	307,732	97,961	36,142	13,882	2002 Typical
	98,497	50,353	209,349	85,733	37,729	14,243	2009
	69,856	55,824	102,179	64,579	41,332	14,243	2018
KY	198,817	38,392	156,417	104,571	39,507	187	2002 Actual
	201,928	38,434	156,417	104,571	39,507	534	2002 Typical
	97,263	37,758	101,182	94,752	42,088	682	2009
	64,378	41,034	52,263	79,392	44,346	714	2018
MS	43,135	61,526	111,914	88,787	4,200	283	2002 Actual
	40,433	61,553	111,914	88,787	4,200	308	2002 Typical
	47,276	56,398	70,743	80,567	4,249	1,033	2009
	21,535	61,252	30,619	68,252	4,483	1,073	2018
NC	151,850	44,929	327,329	84,284	36,550	740	2002 Actual
	148,812	44,929	327,329	84,284	36,550	1,544	2002 Typical
	66,521	34,768	201,609	70,997	39,954	2,065	2009
	61,110	37,802	87,791	49,046	43,865	2,387	2018
SC	88,241	42,153	140,489	50,249	19,332	4,932	2002 Actual
	88,528	42,153	140,489	50,249	19,332	5,270	2002 Typical
	48,668	39,368	92,499	43,235	19,360	5,899	2009
	51,751	43,331	43,490	31,758	20,592	5,899	2018
TN	157,307	64,344	238,577	96,827	17,844	92	2002 Actual
	152,137	64,344	238,577	96,827	17,844	217	2002 Typical
	66,405	57,514	151,912	86,641	18,499	373	2009
	31,715	62,519	69,385	70,226	19,597	405	2018
VA	86,886	60,415	222,374	63,219	51,418	335	2002 Actual
	85,081	60,390	222,374	63,219	51,418	271	2002 Typical
	64,358	51,001	134,232	54,993	52,618	453	2009
	64,344	55,734	63,342	40,393	56,158	578	2018
WV	230,977	46,612	58,999	33,239	12,687	145	2002 Actual
	222,437	46,618	58,999	33,239	12,687	57	2002 Typical
	85,476	38,023	35,635	30,133	13,439	85	2009
	51,474	43,280	17,247	25,710	14,828	108	2018


Annual PM10 Emissions by Source Sector
Tons per year
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 Actual EGU and Fires
2002 Typical EGU and Fires
2009
2018
FIRES
AREA
NONROAD
ONROAD
NONEGU
EGU

Annual PM_{10} Emissions by Source Sector

Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	7,646	25,240	3,903	4,787	393,588	47,237	2002 Actual
	7,845	25,239	3,903	4,787	393,588	50,833	2002 Typical
	6,969	25,421	3,171	4,027	413,020	52,851	2009
	7,822	29,889	2,410	3,041	445,256	52,927	2018
FL	21,387	35,857	11,275	18,281	443,346	85,263	2002 Actual
	21,391	35,856	11,275	18,281	443,346	98,470	2002 Typical
	20,182	39,947	9,911	15,613	503,230	98,470	2009
	12,791	46,492	8,268	12,497	578,516	98,470	2018
GA	11,224	21,610	7,246	8,618	695,414	65,227	2002 Actual
	11,467	21,610	7,246	8,618	695,414	62,336	2002 Typical
	17,891	23,103	6,072	7,521	776,411	63,973	2009
	20,732	27,273	4,844	6,015	880,199	63,973	2018
KY	4,701	16,626	3,723	6,425	233,559	846	2002 Actual
	4,795	16,626	3,723	6,425	233,559	2,421	2002 Typical
	6,463	17,174	2,976	5,544	242,177	3,093	2009
	6,694	20,153	2,580	4,556	256,052	3,237	2018
MS	1,633	19,472	2,859	5,010	343,377	1,284	2002 Actual
	1,706	19,469	2,859	5,010	343,377	1,396	2002 Typical
	5,182	19,245	2,275	4,270	356,324	4,683	2009
	7,412	22,837	1,624	3,452	375,495	4,865	2018
NC	22,754	13,838	6,579	7,348	280,379	3,356	2002 Actual
	22,994	13,838	6,579	7,348	280,379	6,998	2002 Typical
	22,152	13,910	5,572	6,055	292,443	9,359	2009
	35,275	15,737	4,392	4,298	315,294	10,819	2018
SC	21,400	14,142	3,452	4,152	260,858	25,968	2002 Actual
	21,827	14,142	3,452	4,152	260,858	26,304	2002 Typical
	20,041	12,959	2,862	3,471	278,299	29,153	2009
	27,640	14,674	2,184	2,617	304,251	29,153	2018
TN	14,640	35,174	5,371	6,819	212,554	418	2002 Actual
	13,866	35,174	5,371	6,819	212,554	984	2002 Typical
	15,608	34,581	4,206	5,877	226,098	1,689	2009
	15,941	41,999	3,092	4,672	246,252	1,834	2018
VA	3,960	13,252	4,549	8,728	237,577	1,519	2002 Actual
	3,892	13,252	4,549	8,728	237,577	1,226	2002 Typical
	5,606	13,046	3,747	7,510	252,488	2,054	2009
	12,551	15,111	3,212	6,208	275,351	2,618	2018
WV	4,573	17,503	1,381	1,850	115,346	655	2002 Actual
	4,472	17,503	1,381	1,850	115,346	258	2002 Typical
	5,657	11,882	1,068	1,640	115,089	384	2009
	5,784	14,202	819	1,292	121,549	487	2018

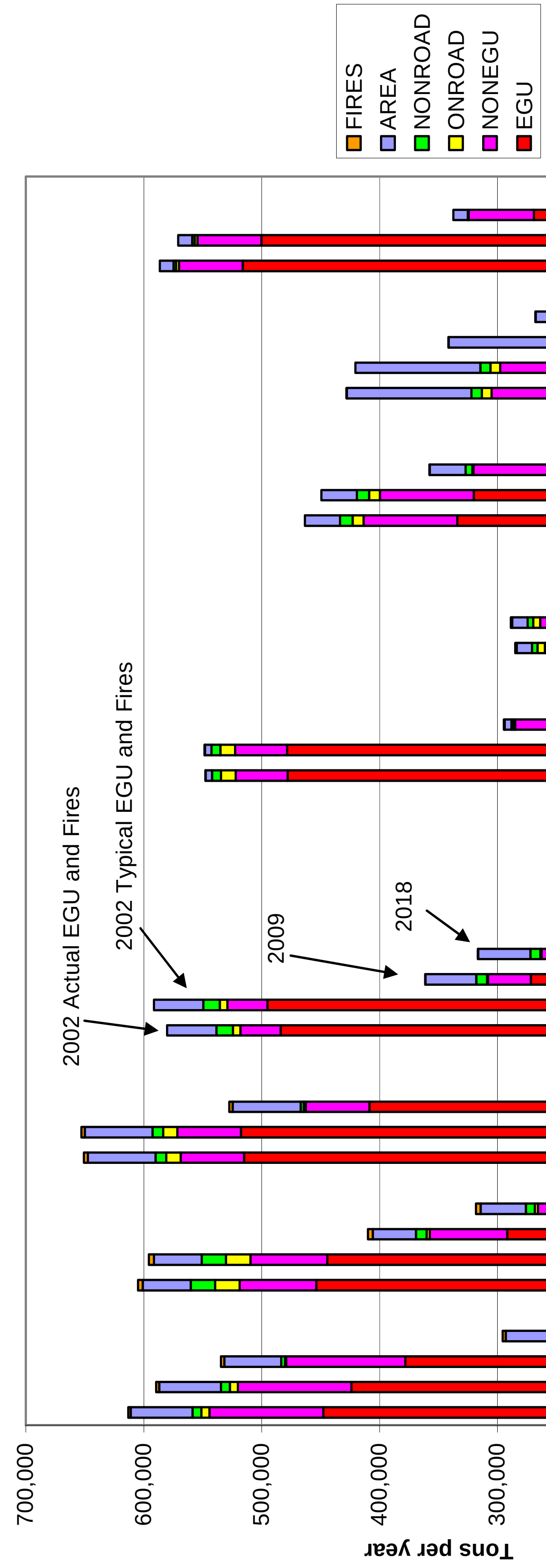
Annual $PM_{2.5}$ Emissions by Source Sector



Annual $PM_{2.5}$ Emissions by Source Sector

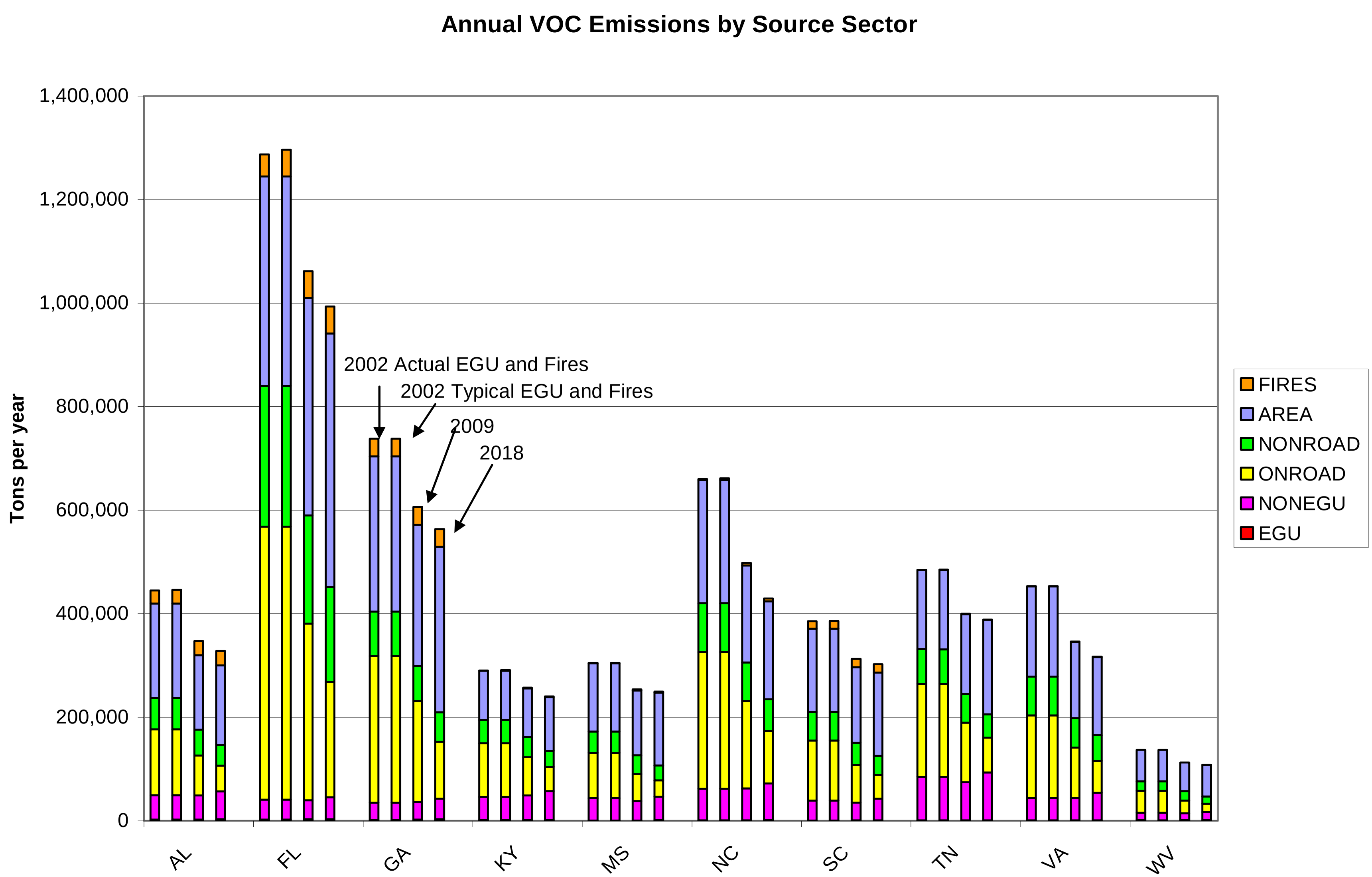
Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	4,113	19,178	2,799	4,502	56,654	42,041	2002 Actual
	4,176	19,177	2,799	4,502	56,654	44,812	2002 Typical
	3,921	19,230	2,032	3,776	58,699	46,543	2009
	4,768	22,584	1,192	2,835	62,323	46,608	2018
FL	15,643	30,504	7,868	17,415	58,878	75,717	2002 Actual
	15,575	30,504	7,868	17,415	58,878	88,756	2002 Typical
	14,790	34,019	6,173	14,866	64,589	88,756	2009
	9,417	39,486	4,038	11,868	72,454	88,756	2018
GA	4,939	17,462	5,168	8,226	103,794	57,293	2002 Actual
	5,070	17,462	5,168	8,226	103,794	55,712	2002 Typical
	10,907	18,982	3,840	7,175	112,001	57,116	2009
	13,881	22,416	2,380	5,730	123,704	57,116	2018
KY	2,802	11,372	2,697	6,046	45,453	726	2002 Actual
	2,847	11,372	2,697	6,046	45,453	2,076	2002 Typical
	4,279	11,686	1,920	5,203	46,243	2,653	2009
	4,434	13,739	1,272	4,256	47,645	2,777	2018
MS	1,138	9,906	2,112	4,690	50,401	1,102	2002 Actual
	1,147	9,902	2,112	4,690	50,401	1,197	2002 Typical
	4,996	9,199	1,508	3,985	51,661	4,016	2009
	7,252	10,719	819	3,203	53,222	4,173	2018
NC	16,498	10,500	4,623	7,005	64,052	2,878	2002 Actual
	16,623	10,500	4,623	7,005	64,052	6,002	2002 Typical
	15,949	10,458	3,493	5,760	69,457	8,027	2009
	28,137	11,825	2,123	4,069	71,262	9,279	2018
SC	17,154	10,245	2,501	3,945	40,291	22,953	2002 Actual
	17,521	10,245	2,501	3,945	40,291	23,511	2002 Typical
	16,548	9,048	1,855	3,294	41,613	25,955	2009
	23,794	10,699	1,087	2,474	44,319	25,955	2018
TN	12,166	27,807	3,949	6,458	42,566	359	2002 Actual
	11,491	27,807	3,949	6,458	42,566	844	2002 Typical
	13,092	27,367	2,751	5,557	44,124	1,449	2009
	13,387	33,293	1,544	4,403	46,692	1,573	2018
VA	2,606	10,165	3,102	8,288	43,989	1,303	2002 Actual
	2,650	10,165	3,102	8,288	43,989	1,052	2002 Typical
	4,165	9,988	2,241	7,136	44,514	1,762	'2009
	10,773	11,605	1,543	5,891	46,697	2,245	2018
WV	2,210	13,313	995	1,728	21,049	562	2002 Actual
	2,163	13,313	995	1,728	21,049	221	2002 Typical
	2,940	7,638	684	1,528	20,664	329	2009
	3,116	9,124	405	1,198	21,490	418	2018

Annual SO_2 Emissions by Source Sector



Annual SO_2 Emissions by Source Sector

Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	447,828	96,481	6,900	7,584	52,253	2,208	2002 Actual
	423,736	96,481	6,900	7,584	52,253	2,559	2002 Typical
	378,052	101,246	810	3,471	48,228	2,681	2009
	135,851	103,303	720	2,818	50,264	2,686	2018
FL	453,631	65,090	20,915	20,614	40,491	4,057	2002 Actual
	444,383	65,090	20,915	20,614	40,491	4,129	2002 Typical
	291,831	65,651	2,612	8,967	36,699	4,129	2009
	194,028	71,810	2,533	7,536	38,317	4,129	2018
GA	514,952	53,774	12,184	9,005	57,559	3,372	2002 Actual
	517,633	53,778	12,184	9,005	57,559	2,815	2002 Typical
	408,679	53,983	1,585	2,725	57,696	2,914	2009
	68,515	59,343	1,457	1,709	59,729	2,914	2018
KY	484,057	34,029	6,308	14,043	41,805	51	2002 Actual
	495,153	34,029	6,308	14,043	41,805	146	2002 Typical
	271,669	36,418	759	9,180	43,087	187	2009
	222,102	40,682	763	8,592	44,186	196	2018
MS	67,429	35,960	4,614	11,315	771	78	2002 Actual
	60,086	35,954	4,614	11,315	771	84	2002 Typical
	76,646	25,564	537	7,191	753	283	2009
	15,213	25,674	440	6,638	746	294	2018
NC	477,990	44,123	12,420	7,693	5,412	203	2002 Actual
	478,488	44,123	12,420	7,693	5,412	423	2002 Typical
	242,286	42,536	1,503	1,892	5,751	566	2009
	120,165	46,314	1,481	905	6,085	655	2018
SC	206,399	53,518	5,972	4,866	12,900	1,281	2002 Actual
	210,272	53,518	5,972	4,866	12,900	1,187	2002 Typical
	129,122	47,193	721	1,701	13,051	1,359	2009
	95,377	52,410	643	1,198	13,457	1,359	2018
TN	334,151	79,604	9,226	10,441	29,917	25	2002 Actual
	320,146	79,604	9,226	10,441	29,917	60	2002 Typical
	255,410	64,964	1,076	5,651	30,577	102	2009
	112,672	56,682	948	5,207	31,962	111	2018
VA	241,204	63,903	8,294	8,663	105,890	92	2002 Actual
	233,691	63,900	8,294	8,663	105,890	74	2002 Typical
	174,777	58,039	1,079	1,707	105,984	124	2009
	98,988	57,790	1,043	507	109,380	158	2018
WV	516,084	54,070	2,464	2,112	11,667	40	2002 Actual
	500,381	54,077	2,464	2,112	11,667	16	2002 Typical
	268,952	55,598	279	359	12,284	23	2009
	106,199	61,702	253	56	12,849	29	2018


Annual VOC Emissions by Source Sector
Tons per year
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
2002 Actual EGU and Fires
2002 Typical EGU and Fires
2009
2018
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
FIRES
AREA
NONROAD
ONROAD
NONEGU
EGU

Annual VOC Emissions by Source Sector

Name	EGU	NONEGU	ONROAD	NONROAD	AREA	FIRES	YEAR
AL	2,295	47,037	127,295	60,487	182,674	25,278	2002 Actual
	2,288	47,035	127,295	60,487	182,674	26,526	2002 Typical
	2,473	46,644	76,990	50,249	143,454	27,502	2009
	2,952	54,291	49,175	40,407	153,577	27,539	2018
FL	2,524	38,471	527,209	272,072	404,302	42,724	2002 Actual
	2,531	38,471	527,209	272,072	404,302	51,527	2002 Typical
	2,730	36,882	340,947	209,543	420,172	51,527	2009
	3,047	42,813	222,303	183,452	489,975	51,527	2018
GA	1,244	33,709	283,421	85,965	299,679	33,979	2002 Actual
	1,256	33,709	283,421	85,965	299,679	33,918	2002 Typical
	2,314	34,116	195,125	67,686	272,315	34,710	2009
	2,816	40,282	109,763	56,761	319,328	34,710	2018
KY	1,487	44,834	103,503	44,805	95,375	410	2002 Actual
	1,481	44,834	103,503	44,805	95,375	1,172	2002 Typical
	1,369	47,786	73,942	38,558	94,042	1,497	2009
	1,426	55,861	47,066	30,920	103,490	1,567	2018
MS	648	43,204	87,672	41,081	131,808	622	2002 Actual
	629	43,203	87,672	41,081	131,808	675	2002 Typical
	564	37,747	52,107	36,197	124,977	2,266	2009
	1,274	45,335	31,616	28,842	140,134	2,355	2018
NC	988	61,182	263,766	94,480	237,926	1,624	2002 Actual
	986	61,182	263,766	94,480	237,926	3,387	2002 Typical
	954	61,925	168,676	74,056	187,769	4,530	2009
	1,302	70,875	101,099	61,327	189,591	5,236	2018
SC	470	38,458	116,163	55,016	161,000	14,202	2002 Actual
	470	38,458	116,163	55,016	161,000	14,666	2002 Typical
	723	34,403	72,603	43,061	146,107	16,045	2009
	931	41,987	46,301	36,131	161,228	16,045	2018
TN	926	84,328	179,807	66,450	153,307	202	2002 Actual
	890	84,328	179,807	66,450	153,307	476	2002 Typical
	932	73,498	115,181	55,358	154,377	817	2009
	976	92,456	67,324	45,084	182,222	888	2018
VA	754	43,152	159,790	74,866	174,116	735	2002 Actual
	747	43,152	159,790	74,866	174,116	593	2002 Typical
	788	43,726	96,770	57,009	147,034	994	2009
	980	53,186	61,964	49,052	150,919	1,267	2018
WV	1,180	14,595	42,174	18,566	60,443	317	2002 Actual
	1,140	14,595	42,174	18,566	60,443	125	2002 Typical
	1,361	13,043	24,843	18,069	55,288	186	2009
	1,387	15,582	16,121	14,086	60,747	236	2018

APPENDIX B:

STATE VMT TOTALS

State VMT Totals

Million Miles Per Year

2002	LDGV	LDGT1	LDGT2	HDDV	LDDV	LDDT	HDDV	MC	TOTAL
AL	31,982	12,728	4,347	1,630	63	69	4,709	196	55,723
FL	105,340	40,835	13,945	5,079	206	220	12,465	591	178,681
GA	61,660	24,394	8,331	3,103	121	132	8,673	371	106,785
KY	28,751	12,189	3,366	1,606	55	55	4,827	171	51,020
MS	23,933	6,724	439	1,025	330	125	3,610	92	36,278
NC	51,189	30,339	10,787	4,119	230	230	9,440	461	106,795
SC	26,672	10,750	3,671	1,395	52	58	4,306	171	47,074
TN	30,809	20,272	6,922	2,943	52	111	6,810	397	68,316
VA	36,336	24,784	8,667	2,148	61	139	4,969	369	77,472
WV	9,010	5,931	2,028	732	25	37	1,664	117	19,544

2009	LDGV	LDGT1	LDGT2	HDDV	LDDV	LDDT	HDDV	MC	TOTAL
AL	30,638	18,598	5,511	2,069	65	72	5,976	249	63,178
FL	107,641	62,449	18,697	6,820	215	230	16,743	794	213,590
GA	61,569	36,641	10,933	4,077	126	137	11,374	487	125,343
KY	28,006	16,984	4,428	1,983	58	57	5,983	231	57,729
MS	23,641	10,131	573	1,341	356	135	4,719	120	41,017
NC	48,495	43,484	15,122	4,576	40	224	10,928	527	123,396
SC	26,451	16,119	4,796	1,824	55	61	5,617	223	55,147
TN	28,775	28,650	8,521	3,627	52	111	8,391	490	78,615
VA	33,663	34,814	10,597	2,624	61	137	6,073	451	88,419
WV	8,128	8,205	2,427	878	25	37	1,995	140	21,835

2018	LDGV	LDGT1	LDGT2	HDDV	LDDV	LDDT	HDDV	MC	TOTAL
AL	31,706	23,562	6,990	2,634	67	84	7,607	317	72,966
FL	116,576	83,385	24,996	9,156	221	301	22,491	1,066	258,191
GA	65,214	47,687	14,245	5,332	129	171	14,853	637	148,269
KY	29,353	21,058	5,558	2,463	60	66	7,454	288	66,300
MS	24,787	12,984	736	1,727	372	159	6,076	155	46,996
NC	42,247	51,568	18,260	4,985	279	279	11,396	553	129,566
SC	27,930	20,880	6,220	2,375	57	75	7,306	290	65,133
TN	29,253	35,702	10,629	4,538	52	130	10,500	613	91,417
VA	35,030	44,438	13,543	3,358	62	164	7,770	578	104,944
WV	8,130	10,025	2,969	1,078	25	41	2,451	172	24,891

APPENDIX C:

STATE TIER 1 EMISSION TOTALS

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
AL	2002	01	FUEL COMB. ELEC. UTIL.	11,279	317	161,038	7,646	4,113	447,828	2,295
AL	2002	02	FUEL COMB. INDUSTRIAL	67,132	234	51,535	6,730	3,792	40,918	2,239
AL	2002	03	FUEL COMB. OTHER	70,498	169	19,237	6,411	5,528	39,606	56,120
AL	2002	04	CHEMICAL & ALLIED PRODUCT MFG	5,721	35	2,032	1,220	888	12,770	7,273
AL	2002	05	METALS PROCESSING	38,247	376	6,011	9,107	7,803	14,039	3,299
AL	2002	06	PETROLEUM & RELATED INDUSTRIES	13,606	0	878	194	155	22,991	4,024
AL	2002	07	OTHER INDUSTRIAL PROCESSES	47,676	1,468	25,252	22,689	9,516	17,904	25,304
AL	2002	08	SOLVENT UTILIZATION	216	0	226	149	126	3	108,437
AL	2002	09	STORAGE & TRANSPORT	174	0	230	1,086	636	13	16,522
AL	2002	10	WASTE DISPOSAL & RECYCLING	104,914	10	4,016	15,832	14,946	489	12,612
AL	2002	11	HIGHWAY VEHICLES	1,321,528	5,588	158,212	3,903	2,799	6,900	127,295
AL	2002	12	OFF-HIGHWAY	414,385	33	65,366	4,787	4,502	7,584	60,487
AL	2002	14	MISCELLANEOUS	385,005	59,596	8,065	402,646	74,483	2,208	19,161
	2002 Total			**2,480,381**	**67,827**	**502,098**	**482,402**	**129,287**	**613,255**	**445,065**
AL	2009	01	FUEL COMB. ELEC. UTIL.	14,986	359	82,305	6,969	3,921	378,052	2,473
AL	2009	02	FUEL COMB. INDUSTRIAL	68,146	274	36,301	6,140	3,438	40,651	2,191
AL	2009	03	FUEL COMB. OTHER	52,256	158	19,514	5,904	5,104	36,048	31,403
AL	2009	04	CHEMICAL & ALLIED PRODUCT MFG	6,118	38	2,273	1,257	912	13,660	6,613
AL	2009	05	METALS PROCESSING	38,969	500	6,021	9,062	7,756	16,629	3,305
AL	2009	06	PETROLEUM & RELATED INDUSTRIES	13,241	0	858	221	177	22,495	3,336
AL	2009	07	OTHER INDUSTRIAL PROCESSES	52,004	1,571	26,340	24,196	10,197	19,383	26,519
AL	2009	08	SOLVENT UTILIZATION	247	0	257	165	139	4	92,631
AL	2009	09	STORAGE & TRANSPORT	192	0	253	1,146	584	14	17,738
AL	2009	10	WASTE DISPOSAL & RECYCLING	87,225	11	3,634	14,504	13,485	590	11,207
AL	2009	11	HIGHWAY VEHICLES	915,647	6,364	101,831	3,171	2,032	810	76,990
AL	2009	12	OFF-HIGHWAY	454,686	36	56,862	4,027	3,776	3,471	50,249
AL	2009	14	MISCELLANEOUS	463,498	65,899	9,788	428,698	82,679	2,681	22,657
	2009 Total			**2,167,216**	**75,209**	**346,238**	**505,457**	**134,201**	**534,489**	**347,312**
AL	2018	01	FUEL COMB. ELEC. UTIL.	24,342	1,072	64,358	7,822	4,768	135,851	2,952
AL	2018	02	FUEL COMB. INDUSTRIAL	69,068	275	38,424	6,427	3,599	40,126	2,293
AL	2018	03	FUEL COMB. OTHER	43,744	164	20,185	5,641	4,818	37,162	21,215
AL	2018	04	CHEMICAL & ALLIED PRODUCT MFG	7,384	46	2,804	1,523	1,106	16,509	8,040
AL	2018	05	METALS PROCESSING	49,770	674	7,519	11,036	9,423	21,824	4,234
AL	2018	06	PETROLEUM & RELATED INDUSTRIES	13,002	0	848	258	207	15,364	3,421
AL	2018	07	OTHER INDUSTRIAL PROCESSES	60,452	1,732	30,831	27,727	11,812	21,843	30,267
AL	2018	08	SOLVENT UTILIZATION	301	0	317	200	169	4	112,412
AL	2018	09	STORAGE & TRANSPORT	234	0	307	1,366	699	17	18,900
AL	2018	10	WASTE DISPOSAL & RECYCLING	88,758	13	3,867	15,343	14,143	718	11,938
AL	2018	11	HIGHWAY VEHICLES	676,210	7,298	47,298	2,410	1,192	720	49,175
AL	2018	12	OFF-HIGHWAY	488,924	42	43,799	3,041	2,835	2,818	40,407
AL	2018	14	MISCELLANEOUS	464,235	73,529	9,803	458,551	85,538	2,686	22,686
	2018 Total			**1,986,424**	**84,845**	**270,362**	**541,346**	**140,310**	**295,642**	**327,940**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
FL	2002	01	FUEL COMB. ELEC. UTIL.	57,113	234	257,677	21,387	15,643	453,631	2,524
FL	2002	02	FUEL COMB. INDUSTRIAL	64,798	131	45,157	20,442	18,547	42,524	4,219
FL	2002	03	FUEL COMB. OTHER	49,230	99	11,597	8,464	8,074	20,031	16,123
FL	2002	04	CHEMICAL & ALLIED PRODUCT MFG	745	1,101	2,221	1,868	1,488	34,462	3,542
FL	2002	05	METALS PROCESSING	1,404	1	194	449	334	882	82
FL	2002	06	PETROLEUM & RELATED INDUSTRIES	1,070	0	560	259	129	470	724
FL	2002	07	OTHER INDUSTRIAL PROCESSES	18,586	19	12,325	23,419	11,844	6,515	27,024
FL	2002	08	SOLVENT UTILIZATION	0	0	1	128	110	0	304,582
FL	2002	09	STORAGE & TRANSPORT	161	0	561	1,645	720	38	79,281
FL	2002	10	WASTE DISPOSAL & RECYCLING	54,721	351	2,535	9,943	9,405	659	9,125
FL	2002	11	HIGHWAY VEHICLES	4,550,447	18,114	465,640	11,275	7,868	20,915	527,209
FL	2002	12	OFF-HIGHWAY	1,920,729	134	180,627	18,281	17,415	20,614	272,072
FL	2002	14	MISCELLANEOUS	752,915	40,269	14,821	497,846	114,447	4,057	40,795
	2002 Total			**7,471,920**	**60,454**	**993,915**	**615,407**	**206,025**	**604,797**	**1,287,301**
FL	2009	01	FUEL COMB. ELEC. UTIL.	35,928	1,631	86,165	9,007	5,910	186,055	1,910
FL	2009	02	FUEL COMB. INDUSTRIAL	69,972	146	44,480	16,265	14,827	38,225	4,473
FL	2009	03	FUEL COMB. OTHER	33,014	100	10,800	7,555	7,174	19,882	10,907
FL	2009	04	CHEMICAL & ALLIED PRODUCT MFG	901	1,231	2,461	1,908	1,526	34,961	3,821
FL	2009	05	METALS PROCESSING	1,545	1	176	361	251	993	82
FL	2009	06	PETROLEUM & RELATED INDUSTRIES	1,190	0	612	304	156	519	748
FL	2009	07	OTHER INDUSTRIAL PROCESSES	18,593	26	13,521	33,084	19,357	6,881	26,413
FL	2009	08	SOLVENT UTILIZATION	0	0	1	132	113	0	319,723
FL	2009	09	STORAGE & TRANSPORT	187	0	621	1,661	727	50	83,880
FL	2009	10	WASTE DISPOSAL & RECYCLING	177,953	342	6,251	22,971	22,364	698	17,241
FL	2009	11	HIGHWAY VEHICLES	3,308,863	21,549	312,321	9,801	6,104	2,584	336,707
FL	2009	12	OFF-HIGHWAY	2,104,920	148	163,794	15,613	14,866	8,967	209,543
FL	2009	14	MISCELLANEOUS	764,004	41,471	15,075	557,331	120,796	4,129	41,290
	2009 Total			**6,596,484**	**66,874**	**707,273**	**687,353**	**223,192**	**406,888**	**1,061,801**
FL	2018	01	FUEL COMB. ELEC. UTIL.	85,495	2,976	87,645	12,791	9,417	194,028	3,047
FL	2018	02	FUEL COMB. INDUSTRIAL	77,465	156	48,879	17,876	16,324	37,205	4,894
FL	2018	03	FUEL COMB. OTHER	27,094	110	12,356	7,255	6,853	20,975	8,879
FL	2018	04	CHEMICAL & ALLIED PRODUCT MFG	1,200	1,448	3,119	2,367	1,907	41,395	4,739
FL	2018	05	METALS PROCESSING	1,973	2	225	466	323	1,325	106
FL	2018	06	PETROLEUM & RELATED INDUSTRIES	1,513	0	778	387	198	659	918
FL	2018	07	OTHER INDUSTRIAL PROCESSES	20,748	35	15,855	39,842	23,289	7,741	29,716
FL	2018	08	SOLVENT UTILIZATION	0	0	1	158	135	0	387,657
FL	2018	09	STORAGE & TRANSPORT	226	0	690	2,004	877	58	87,732
FL	2018	10	WASTE DISPOSAL & RECYCLING	180,730	418	6,486	24,140	23,427	769	18,335
FL	2018	11	HIGHWAY VEHICLES	2,554,160	26,163	150,180	8,268	4,038	2,533	222,303
FL	2018	12	OFF-HIGHWAY	2,323,327	171	127,885	12,497	11,868	7,536	183,452
FL	2018	14	MISCELLANEOUS	763,701	43,251	15,068	628,984	127,364	4,129	41,338
	2018 Total			**6,037,633**	**74,728**	**469,168**	**757,033**	**226,019**	**318,353**	**993,116**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
GA	2002	01	FUEL COMB. ELEC. UTIL.	9,712	83	147,517	11,224	4,939	514,952	1,244
GA	2002	02	FUEL COMB. INDUSTRIAL	59,492	27	53,039	12,037	7,886	88,791	3,956
GA	2002	03	FUEL COMB. OTHER	63,314	17	14,465	10,142	10,057	10,740	27,226
GA	2002	04	CHEMICAL & ALLIED PRODUCT MFG	5,387	920	2,277	391	305	2,721	2,668
GA	2002	05	METALS PROCESSING	330	0	60	147	94	0	70
GA	2002	06	PETROLEUM & RELATED INDUSTRIES	41	0	3	69	44	68	175
GA	2002	07	OTHER INDUSTRIAL PROCESSES	27,960	2,666	12,215	39,630	13,073	8,701	26,999
GA	2002	08	SOLVENT UTILIZATION	4	0	22	13	13	0	234,744
GA	2002	09	STORAGE & TRANSPORT	39	0	6	583	360	0	26,334
GA	2002	10	WASTE DISPOSAL & RECYCLING	146,183	16	5,164	23,422	22,506	312	15,003
GA	2002	11	HIGHWAY VEHICLES	2,735,968	10,546	307,732	7,246	5,168	12,184	283,421
GA	2002	12	OFF-HIGHWAY	791,158	60	97,961	8,618	8,226	9,005	85,965
GA	2002	14	MISCELLANEOUS	590,400	83,458	12,308	695,723	124,142	3,372	29,640
	2002 Total			**4,429,989**	**97,795**	**652,769**	**809,244**	**196,815**	**650,846**	**737,444**
GA	2009	01	FUEL COMB. ELEC. UTIL.	23,721	686	98,497	17,891	10,907	408,679	2,314
GA	2009	02	FUEL COMB. INDUSTRIAL	63,067	28	53,726	11,206	7,390	89,850	4,163
GA	2009	03	FUEL COMB. OTHER	45,184	17	15,347	8,496	8,400	10,981	15,683
GA	2009	04	CHEMICAL & ALLIED PRODUCT MFG	6,044	1,032	2,531	436	341	2,743	2,814
GA	2009	05	METALS PROCESSING	363	0	61	159	100	0	47
GA	2009	06	PETROLEUM & RELATED INDUSTRIES	50	0	4	83	54	82	154
GA	2009	07	OTHER INDUSTRIAL PROCESSES	29,976	2,902	12,528	45,339	14,758	7,662	28,441
GA	2009	08	SOLVENT UTILIZATION	4	0	25	14	14	0	216,248
GA	2009	09	STORAGE & TRANSPORT	45	0	7	649	401	0	27,821
GA	2009	10	WASTE DISPOSAL & RECYCLING	218,460	18	7,419	31,955	30,900	360	18,711
GA	2009	11	HIGHWAY VEHICLES	1,983,803	12,687	209,349	6,072	3,840	1,585	195,125
GA	2009	12	OFF-HIGHWAY	882,970	68	85,733	7,521	7,175	2,725	67,686
GA	2009	14	MISCELLANEOUS	515,329	91,406	10,637	765,043	125,665	2,914	26,388
	2009 Total			**3,769,016**	**108,844**	**495,864**	**894,865**	**209,944**	**527,582**	**605,595**
GA	2018	01	FUEL COMB. ELEC. UTIL.	44,269	1,677	69,856	20,732	13,881	68,515	2,816
GA	2018	02	FUEL COMB. INDUSTRIAL	67,067	30	57,232	11,755	7,769	94,403	4,424
GA	2018	03	FUEL COMB. OTHER	39,440	17	17,801	7,722	7,622	11,958	11,482
GA	2018	04	CHEMICAL & ALLIED PRODUCT MFG	7,076	1,208	2,982	517	405	3,436	3,524
GA	2018	05	METALS PROCESSING	421	0	76	185	118	0	55
GA	2018	06	PETROLEUM & RELATED INDUSTRIES	63	0	5	105	68	104	191
GA	2018	07	OTHER INDUSTRIAL PROCESSES	33,611	3,559	14,460	55,130	17,899	8,748	33,333
GA	2018	08	SOLVENT UTILIZATION	5	0	30	22	22	0	264,326
GA	2018	09	STORAGE & TRANSPORT	54	0	9	764	470	0	29,409
GA	2018	10	WASTE DISPOSAL & RECYCLING	235,690	22	8,120	35,280	34,038	423	20,411
GA	2018	11	HIGHWAY VEHICLES	1,476,981	14,873	102,179	4,844	2,380	1,457	109,763
GA	2018	12	OFF-HIGHWAY	973,872	79	64,579	6,015	5,730	1,709	56,761
GA	2018	14	MISCELLANEOUS	515,220	102,075	10,635	859,835	134,730	2,914	26,368
	2018 Total			**3,393,769**	**123,540**	**347,964**	**1,002,907**	**225,133**	**193,668**	**562,862**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
KY	2002	01	FUEL COMB. ELEC. UTIL.	12,619	326	198,817	4,701	2,802	484,057	1,487
KY	2002	02	FUEL COMB. INDUSTRIAL	14,110	182	60,674	2,155	1,463	41,825	1,565
KY	2002	03	FUEL COMB. OTHER	40,806	55	4,997	7,679	7,352	9,647	12,711
KY	2002	04	CHEMICAL & ALLIED PRODUCT MFG	176	214	296	774	581	2,345	3,462
KY	2002	05	METALS PROCESSING	89,197	6	1,082	3,396	2,720	12,328	1,508
KY	2002	06	PETROLEUM & RELATED INDUSTRIES	4,304	335	2,519	308	205	5,747	2,895
KY	2002	07	OTHER INDUSTRIAL PROCESSES	6,493	78	6,518	31,429	10,394	3,333	25,388
KY	2002	08	SOLVENT UTILIZATION	0	10	9	317	241	1	61,834
KY	2002	09	STORAGE & TRANSPORT	33	8	15	1,920	1,177	3	18,853
KY	2002	10	WASTE DISPOSAL & RECYCLING	20,622	8	1,768	7,229	6,476	606	7,927
KY	2002	11	HIGHWAY VEHICLES	1,230,148	5,055	156,417	3,723	2,697	6,308	103,503
KY	2002	12	OFF-HIGHWAY	325,993	31	104,571	6,425	6,046	14,043	44,805
KY	2002	14	MISCELLANEOUS	9,651	50,953	209	195,827	26,941	51	4,476
	2002 Total			**1,754,151**	**57,261**	**537,890**	**265,880**	**69,094**	**580,293**	**290,414**
KY	2009	01	FUEL COMB. ELEC. UTIL.	15,812	400	97,263	6,463	4,279	271,669	1,369
KY	2009	02	FUEL COMB. INDUSTRIAL	14,986	195	61,683	2,105	1,456	42,433	1,476
KY	2009	03	FUEL COMB. OTHER	30,045	54	5,178	7,035	6,725	10,123	9,148
KY	2009	04	CHEMICAL & ALLIED PRODUCT MFG	179	249	300	851	633	2,384	3,635
KY	2009	05	METALS PROCESSING	99,428	7	1,156	3,246	2,550	13,735	1,772
KY	2009	06	PETROLEUM & RELATED INDUSTRIES	4,818	377	2,828	344	230	6,460	3,052
KY	2009	07	OTHER INDUSTRIAL PROCESSES	7,212	84	6,674	32,194	10,912	3,634	27,548
KY	2009	08	SOLVENT UTILIZATION	0	10	11	371	283	1	62,595
KY	2009	09	STORAGE & TRANSPORT	38	9	18	2,064	1,268	3	20,038
KY	2009	10	WASTE DISPOSAL & RECYCLING	22,388	9	1,979	7,770	6,925	733	7,725
KY	2009	11	HIGHWAY VEHICLES	963,762	5,796	101,182	2,976	1,920	759	73,942
KY	2009	12	OFF-HIGHWAY	357,800	34	94,752	5,544	5,203	9,180	38,558
KY	2009	14	MISCELLANEOUS	32,627	52,915	702	206,463	29,601	187	6,335
	2009 Total			**1,549,096**	**60,139**	**373,725**	**277,427**	**71,984**	**361,300**	**257,193**
KY	2018	01	FUEL COMB. ELEC. UTIL.	17,144	476	64,378	6,694	4,434	222,102	1,426
KY	2018	02	FUEL COMB. INDUSTRIAL	15,692	205	64,533	2,203	1,528	43,772	1,555
KY	2018	03	FUEL COMB. OTHER	24,764	53	5,550	6,469	6,169	9,947	7,479
KY	2018	04	CHEMICAL & ALLIED PRODUCT MFG	219	317	367	1,054	781	2,884	4,384
KY	2018	05	METALS PROCESSING	114,470	9	1,508	3,898	3,065	15,800	2,343
KY	2018	06	PETROLEUM & RELATED INDUSTRIES	5,495	434	3,244	392	262	7,426	3,394
KY	2018	07	OTHER INDUSTRIAL PROCESSES	8,303	93	7,872	35,349	12,377	4,141	31,394
KY	2018	08	SOLVENT UTILIZATION	0	12	14	464	352	1	73,525
KY	2018	09	STORAGE & TRANSPORT	44	10	21	2,408	1,481	4	21,196
KY	2018	10	WASTE DISPOSAL & RECYCLING	24,677	11	2,256	8,481	7,518	894	8,392
KY	2018	11	HIGHWAY VEHICLES	807,536	7,811	52,263	2,580	1,272	763	47,066
KY	2018	12	OFF-HIGHWAY	381,215	40	79,392	4,556	4,256	8,592	30,920
KY	2018	14	MISCELLANEOUS	33,931	55,118	729	218,725	30,626	196	7,254
	2018 Total			**1,433,491**	**64,588**	**282,127**	**293,273**	**74,122**	**316,520**	**240,329**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
MS	2002	01	FUEL COMB. ELEC. UTIL.	5,303	190	43,135	1,633	1,138	67,429	648
MS	2002	02	FUEL COMB. INDUSTRIAL	22,711	28	48,699	5,011	3,638	9,746	8,024
MS	2002	03	FUEL COMB. OTHER	36,752	34	4,502	5,445	5,414	789	22,923
MS	2002	04	CHEMICAL & ALLIED PRODUCT MFG	15,410	361	1,725	849	440	1,663	2,375
MS	2002	05	METALS PROCESSING	1,031	0	115	122	58	36	371
MS	2002	06	PETROLEUM & RELATED INDUSTRIES	975	20	1,187	790	335	15,560	20,788
MS	2002	07	OTHER INDUSTRIAL PROCESSES	13,884	747	9,219	27,617	8,051	8,866	15,525
MS	2002	08	SOLVENT UTILIZATION	45	7	105	219	178	1	80,760
MS	2002	09	STORAGE & TRANSPORT	74	0	80	124	38	40	23,327
MS	2002	10	WASTE DISPOSAL & RECYCLING	1,414	9	89	447	324	31	886
MS	2002	11	HIGHWAY VEHICLES	864,290	3,585	111,914	2,859	2,112	4,614	87,672
MS	2002	12	OFF-HIGHWAY	236,752	23	88,787	5,010	4,690	11,315	41,081
MS	2002	14	MISCELLANEOUS	13,386	58,741	288	323,511	42,932	78	654
	2002 Total			**1,212,028**	**63,748**	**309,845**	**373,637**	**69,348**	**120,166**	**305,035**
MS	2009	01	FUEL COMB. ELEC. UTIL.	7,116	334	47,276	5,182	4,996	76,646	564
MS	2009	02	FUEL COMB. INDUSTRIAL	24,607	30	44,095	3,728	2,787	7,388	8,007
MS	2009	03	FUEL COMB. OTHER	26,024	33	4,514	5,278	5,245	751	17,445
MS	2009	04	CHEMICAL & ALLIED PRODUCT MFG	16,141	405	1,955	941	488	1,880	2,614
MS	2009	05	METALS PROCESSING	1,098	0	128	129	62	37	402
MS	2009	06	PETROLEUM & RELATED INDUSTRIES	1,101	23	1,262	894	379	7,926	13,317
MS	2009	07	OTHER INDUSTRIAL PROCESSES	14,181	197	8,376	31,380	8,628	8,254	16,282
MS	2009	08	SOLVENT UTILIZATION	50	8	118	239	194	1	80,393
MS	2009	09	STORAGE & TRANSPORT	92	0	100	172	59	49	23,494
MS	2009	10	WASTE DISPOSAL & RECYCLING	1,486	10	95	473	339	32	743
MS	2009	11	HIGHWAY VEHICLES	609,972	4,035	70,743	2,275	1,508	537	52,107
MS	2009	12	OFF-HIGHWAY	257,453	25	80,567	4,270	3,985	7,191	36,197
MS	2009	14	MISCELLANEOUS	48,314	63,886	1,037	337,018	46,695	283	2,295
	2009 Total			**1,007,634**	**68,987**	**260,266**	**391,978**	**75,365**	**110,975**	**253,858**
MS	2018	01	FUEL COMB. ELEC. UTIL.	17,348	827	21,535	7,412	7,252	15,213	1,274
MS	2018	02	FUEL COMB. INDUSTRIAL	26,082	33	46,792	4,073	3,039	5,167	8,556
MS	2018	03	FUEL COMB. OTHER	20,900	32	4,768	4,964	4,928	726	14,670
MS	2018	04	CHEMICAL & ALLIED PRODUCT MFG	20,175	475	2,337	1,132	588	2,242	3,290
MS	2018	05	METALS PROCESSING	1,357	0	167	160	79	48	461
MS	2018	06	PETROLEUM & RELATED INDUSTRIES	1,267	26	1,294	1,010	430	8,484	14,407
MS	2018	07	OTHER INDUSTRIAL PROCESSES	16,267	216	9,996	38,492	10,492	9,657	20,301
MS	2018	08	SOLVENT UTILIZATION	60	9	141	301	244	1	98,354
MS	2018	09	STORAGE & TRANSPORT	115	0	124	210	73	62	24,537
MS	2018	10	WASTE DISPOSAL & RECYCLING	1,638	12	114	533	372	34	870
MS	2018	11	HIGHWAY VEHICLES	445,493	4,566	30,619	1,624	819	440	31,616
MS	2018	12	OFF-HIGHWAY	270,726	29	68,252	3,452	3,203	6,638	28,842
MS	2018	14	MISCELLANEOUS	50,160	70,096	1,076	352,321	47,869	294	2,377
	2018 Total			**871,587**	**76,321**	**187,215**	**415,685**	**79,388**	**49,006**	**249,556**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
NC	2002	01	FUEL COMB. ELEC. UTIL.	13,885	54	151,850	22,754	16,498	477,990	988
NC	2002	02	FUEL COMB. INDUSTRIAL	23,578	301	48,590	5,596	4,334	33,395	2,540
NC	2002	03	FUEL COMB. OTHER	217,008	2,318	16,460	31,777	26,746	3,971	87,985
NC	2002	04	CHEMICAL & ALLIED PRODUCT MFG	13,952	535	859	866	538	5,736	4,313
NC	2002	05	METALS PROCESSING	5,876	60	201	564	467	1,010	2,512
NC	2002	06	PETROLEUM & RELATED INDUSTRIES	461	0	174	104	52	283	140
NC	2002	07	OTHER INDUSTRIAL PROCESSES	8,552	480	7,380	25,328	8,924	3,426	18,025
NC	2002	08	SOLVENT UTILIZATION	130	307	229	524	484	26	151,383
NC	2002	09	STORAGE & TRANSPORT	66	46	53	639	354	1	16,120
NC	2002	10	WASTE DISPOSAL & RECYCLING	125,528	247	7,482	2,239	2,218	1,666	15,568
NC	2002	11	HIGHWAY VEHICLES	2,873,992	9,702	327,329	6,579	4,623	12,420	263,766
NC	2002	12	OFF-HIGHWAY	808,231	65	84,284	7,348	7,005	7,693	94,480
NC	2002	14	MISCELLANEOUS	35,218	158,900	757	229,909	33,291	203	1,765
	2002 Total			**4,126,478**	**173,014**	**645,648**	**334,226**	**105,533**	**547,821**	**659,585**
NC	2009	01	FUEL COMB. ELEC. UTIL.	14,942	445	66,516	22,152	15,949	242,286	954
NC	2009	02	FUEL COMB. INDUSTRIAL	24,871	312	38,161	5,159	3,871	30,788	2,510
NC	2009	03	FUEL COMB. OTHER	158,837	2,723	18,441	25,334	19,467	4,060	49,819
NC	2009	04	CHEMICAL & ALLIED PRODUCT MFG	14,732	599	933	981	607	6,286	4,925
NC	2009	05	METALS PROCESSING	6,358	67	207	627	528	1,130	2,790
NC	2009	06	PETROLEUM & RELATED INDUSTRIES	556	0	212	127	64	349	162
NC	2009	07	OTHER INDUSTRIAL PROCESSES	9,211	507	8,061	28,524	9,788	3,712	18,144
NC	2009	08	SOLVENT UTILIZATION	142	335	246	549	506	28	136,114
NC	2009	09	STORAGE & TRANSPORT	75	51	55	696	380	1	17,367
NC	2009	10	WASTE DISPOSAL & RECYCLING	139,518	307	8,354	2,774	2,750	1,913	17,331
NC	2009	11	HIGHWAY VEHICLES	1,991,708	11,825	201,609	5,572	3,493	1,503	168,676
NC	2009	12	OFF-HIGHWAY	887,605	72	70,997	6,055	5,760	1,892	74,056
NC	2009	14	MISCELLANEOUS	96,825	167,131	2,080	250,912	49,956	566	4,648
	2009 Total			**3,345,380**	**184,373**	**415,874**	**349,461**	**113,118**	**294,514**	**497,496**
NC	2018	01	FUEL COMB. ELEC. UTIL.	19,870	663	61,103	35,275	28,137	120,165	1,302
NC	2018	02	FUEL COMB. INDUSTRIAL	26,873	341	40,898	5,594	4,222	32,507	2,702
NC	2018	03	FUEL COMB. OTHER	131,365	2,857	20,027	21,847	16,231	4,050	34,104
NC	2018	04	CHEMICAL & ALLIED PRODUCT MFG	18,463	702	1,105	1,175	726	7,414	6,113
NC	2018	05	METALS PROCESSING	7,576	76	255	771	657	1,335	3,516
NC	2018	06	PETROLEUM & RELATED INDUSTRIES	712	0	272	162	82	448	207
NC	2018	07	OTHER INDUSTRIAL PROCESSES	10,675	559	9,259	34,339	11,601	4,357	20,978
NC	2018	08	SOLVENT UTILIZATION	169	375	277	588	540	31	152,979
NC	2018	09	STORAGE & TRANSPORT	91	59	67	808	430	2	19,511
NC	2018	10	WASTE DISPOSAL & RECYCLING	156,599	387	9,456	3,502	3,474	2,234	19,789
NC	2018	11	HIGHWAY VEHICLES	1,362,214	14,065	87,791	4,392	2,123	1,481	101,099
NC	2018	12	OFF-HIGHWAY	960,709	83	49,046	4,298	4,069	905	61,327
NC	2018	14	MISCELLANEOUS	111,705	177,474	2,399	273,030	54,376	655	5,333
	2018 Total			**2,807,022**	**197,643**	**281,955**	**385,780**	**126,667**	**175,583**	**428,960**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
SC	2002	01	FUEL COMB. ELEC. UTIL.	6,990	142	88,241	21,400	17,154	206,399	470
SC	2002	02	FUEL COMB. INDUSTRIAL	31,771	97	38,081	5,308	3,641	44,958	1,338
SC	2002	03	FUEL COMB. OTHER	75,800	65	4,367	6,261	6,166	4,318	49,171
SC	2002	04	CHEMICAL & ALLIED PRODUCT MFG	2,526	173	25	501	318	59	8,784
SC	2002	05	METALS PROCESSING	13,833	0	450	639	408	4,160	660
SC	2002	06	PETROLEUM & RELATED INDUSTRIES	248	0	283	120	71	170	114
SC	2002	07	OTHER INDUSTRIAL PROCESSES	9,502	1,237	15,145	15,224	6,981	12,128	16,342
SC	2002	08	SOLVENT UTILIZATION	0	1	1	78	60	0	88,878
SC	2002	09	STORAGE & TRANSPORT	10	0	4	1,025	626	0	21,009
SC	2002	10	WASTE DISPOSAL & RECYCLING	44,844	10	3,380	6,852	6,321	625	13,708
SC	2002	11	HIGHWAY VEHICLES	1,241,359	4,694	140,489	3,452	2,501	5,972	116,163
SC	2002	12	OFF-HIGHWAY	413,964	33	50,249	4,152	3,945	4,866	55,016
SC	2002	14	MISCELLANEOUS	239,836	28,975	4,678	264,959	48,898	1,281	13,655
	2002 Total			**2,080,683**	**35,426**	**345,395**	**329,971**	**97,090**	**284,936**	**385,308**
SC	2009	01	FUEL COMB. ELEC. UTIL.	11,643	370	48,668	20,041	16,548	129,122	723
SC	2009	02	FUEL COMB. INDUSTRIAL	32,661	105	35,011	2,978	2,087	36,660	1,374
SC	2009	03	FUEL COMB. OTHER	49,914	63	4,551	5,264	5,183	4,359	25,073
SC	2009	04	CHEMICAL & ALLIED PRODUCT MFG	2,798	173	26	543	345	60	7,409
SC	2009	05	METALS PROCESSING	15,632	0	448	631	378	4,856	663
SC	2009	06	PETROLEUM & RELATED INDUSTRIES	302	0	340	145	86	200	131
SC	2009	07	OTHER INDUSTRIAL PROCESSES	10,241	1,403	15,069	18,201	7,997	13,443	15,425
SC	2009	08	SOLVENT UTILIZATION	1	1	1	75	58	0	94,590
SC	2009	09	STORAGE & TRANSPORT	13	0	5	569	352	0	21,987
SC	2009	10	WASTE DISPOSAL & RECYCLING	70,379	11	4,215	9,526	8,977	666	15,998
SC	2009	11	HIGHWAY VEHICLES	889,957	5,523	92,499	2,862	1,855	721	72,603
SC	2009	12	OFF-HIGHWAY	448,625	36	43,235	3,471	3,294	1,701	43,061
SC	2009	14	MISCELLANEOUS	250,690	31,416	4,962	282,480	51,151	1,359	13,906
	2009 Total			**1,782,856**	**39,101**	**249,028**	**346,786**	**98,312**	**193,147**	**312,943**
SC	2018	01	FUEL COMB. ELEC. UTIL.	14,975	625	51,751	27,640	23,794	95,377	931
SC	2018	02	FUEL COMB. INDUSTRIAL	35,532	113	36,645	3,683	2,548	38,548	1,482
SC	2018	03	FUEL COMB. OTHER	39,627	65	5,135	4,791	4,711	4,469	16,391
SC	2018	04	CHEMICAL & ALLIED PRODUCT MFG	3,296	212	32	664	423	74	9,107
SC	2018	05	METALS PROCESSING	18,853	0	585	773	476	5,920	867
SC	2018	06	PETROLEUM & RELATED INDUSTRIES	389	0	438	186	110	258	166
SC	2018	07	OTHER INDUSTRIAL PROCESSES	12,136	1,566	17,507	20,128	8,981	15,863	18,290
SC	2018	08	SOLVENT UTILIZATION	1	1	1	93	72	0	119,154
SC	2018	09	STORAGE & TRANSPORT	16	0	6	1,380	842	0	22,739
SC	2018	10	WASTE DISPOSAL & RECYCLING	73,403	13	4,512	10,038	9,443	735	17,167
SC	2018	11	HIGHWAY VEHICLES	663,493	6,473	43,490	2,184	1,087	643	46,301
SC	2018	12	OFF-HIGHWAY	481,332	41	31,758	2,617	2,474	1,198	36,131
SC	2018	14	MISCELLANEOUS	250,637	34,345	4,961	306,342	53,367	1,359	13,896
	2018 Total			**1,593,690**	**43,455**	**196,820**	**380,519**	**108,327**	**164,444**	**302,623**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
TN	2002	01	FUEL COMB. ELEC. UTIL.	7,084	204	157,307	14,640	12,166	334,151	926
TN	2002	02	FUEL COMB. INDUSTRIAL	15,257	6	44,510	8,015	6,649	74,146	2,021
TN	2002	03	FUEL COMB. OTHER	77,857	25	15,568	7,967	7,549	16,253	18,346
TN	2002	04	CHEMICAL & ALLIED PRODUCT MFG	36,920	1,518	1,772	3,246	2,201	6,516	24,047
TN	2002	05	METALS PROCESSING	41,371	14	1,182	7,620	7,030	5,818	6,898
TN	2002	06	PETROLEUM & RELATED INDUSTRIES	543	0	331	314	243	383	1,850
TN	2002	07	OTHER INDUSTRIAL PROCESSES	9,420	44	11,794	30,484	12,867	5,845	27,336
TN	2002	08	SOLVENT UTILIZATION	275	1	5,066	2,103	1,818	58	110,872
TN	2002	09	STORAGE & TRANSPORT	22	24	105	1,249	736	134	21,962
TN	2002	10	WASTE DISPOSAL & RECYCLING	22,143	31	1,839	7,068	6,469	349	15,505
TN	2002	11	HIGHWAY VEHICLES	1,917,842	6,625	238,577	5,371	3,949	9,226	179,807
TN	2002	12	OFF-HIGHWAY	505,163	43	96,827	6,819	6,458	10,441	66,450
TN	2002	14	MISCELLANEOUS	5,003	34,292	100	179,440	24,708	25	1,978
	2002 Total			**2,638,901**	**42,825**	**574,980**	**274,337**	**92,841**	**463,345**	**477,997**
TN	2009	01	FUEL COMB. ELEC. UTIL.	7,214	227	66,405	15,608	13,092	255,410	932
TN	2009	02	FUEL COMB. INDUSTRIAL	15,536	6	37,046	7,157	5,973	63,076	1,773
TN	2009	03	FUEL COMB. OTHER	61,442	27	14,792	7,134	6,786	16,955	12,781
TN	2009	04	CHEMICAL & ALLIED PRODUCT MFG	35,440	1,719	1,958	3,369	2,271	1,949	15,492
TN	2009	05	METALS PROCESSING	45,183	15	1,245	7,337	6,823	6,537	7,671
TN	2009	06	PETROLEUM & RELATED INDUSTRIES	572	0	328	355	276	263	1,401
TN	2009	07	OTHER INDUSTRIAL PROCESSES	9,911	62	12,635	32,599	13,687	6,240	28,338
TN	2009	08	SOLVENT UTILIZATION	309	1	5,983	2,431	2,095	65	112,264
TN	2009	09	STORAGE & TRANSPORT	26	31	12	1,218	733	42	23,686
TN	2009	10	WASTE DISPOSAL & RECYCLING	23,810	35	1,993	7,618	6,968	393	14,922
TN	2009	11	HIGHWAY VEHICLES	1,338,016	7,782	151,912	4,206	2,751	1,076	115,181
TN	2009	12	OFF-HIGHWAY	554,121	48	86,641	5,877	5,557	5,651	55,358
TN	2009	14	MISCELLANEOUS	17,921	35,200	379	192,464	26,830	102	2,814
	2009 Total			**2,109,500**	**45,152**	**381,331**	**287,371**	**93,842**	**357,760**	**392,612**
TN	2018	01	FUEL COMB. ELEC. UTIL.	7,723	241	31,715	15,941	13,387	112,672	976
TN	2018	02	FUEL COMB. INDUSTRIAL	16,702	7	38,028	7,648	6,408	47,982	1,905
TN	2018	03	FUEL COMB. OTHER	54,486	30	15,502	6,757	6,412	18,091	10,269
TN	2018	04	CHEMICAL & ALLIED PRODUCT MFG	45,455	2,053	2,424	4,263	2,888	6,563	19,950
TN	2018	05	METALS PROCESSING	52,834	17	1,589	9,579	8,953	7,790	9,950
TN	2018	06	PETROLEUM & RELATED INDUSTRIES	665	0	378	414	324	309	1,598
TN	2018	07	OTHER INDUSTRIAL PROCESSES	10,946	88	14,157	38,196	16,242	7,286	35,126
TN	2018	08	SOLVENT UTILIZATION	380	1	7,675	3,154	2,717	79	140,760
TN	2018	09	STORAGE & TRANSPORT	33	41	14	1,571	939	49	25,491
TN	2018	10	WASTE DISPOSAL & RECYCLING	26,712	42	2,326	8,562	7,828	468	17,530
TN	2018	11	HIGHWAY VEHICLES	976,634	9,021	69,385	3,092	1,544	948	67,324
TN	2018	12	OFF-HIGHWAY	593,100	55	70,226	4,672	4,403	5,207	45,084
TN	2018	14	MISCELLANEOUS	19,210	36,213	408	209,058	28,209	111	3,293
	2018 Total			**1,804,879**	**47,809**	**253,828**	**312,906**	**100,255**	**207,555**	**379,257**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
VA	2002	01	FUEL COMB. ELEC. UTIL.	6,892	127	86,886	3,960	2,606	241,204	754
VA	2002	02	FUEL COMB. INDUSTRIAL	64,398	100	75,831	18,480	8,453	137,451	5,332
VA	2002	03	FUEL COMB. OTHER	98,788	13	15,648	11,572	11,236	5,508	54,496
VA	2002	04	CHEMICAL & ALLIED PRODUCT MFG	321	2,158	8,062	449	393	2,126	1,530
VA	2002	05	METALS PROCESSING	3,580	0	937	1,575	1,349	5,251	513
VA	2002	06	PETROLEUM & RELATED INDUSTRIES	23,384	0	182	255	153	170	501
VA	2002	07	OTHER INDUSTRIAL PROCESSES	12,002	726	9,279	33,409	9,795	17,702	13,086
VA	2002	08	SOLVENT UTILIZATION	0	4	0	225	210	2	111,511
VA	2002	09	STORAGE & TRANSPORT	16	7	11	745	505	0	26,121
VA	2002	10	WASTE DISPOSAL & RECYCLING	16,566	109	1,866	3,152	1,277	1,581	4,065
VA	2002	11	HIGHWAY VEHICLES	2,163,259	7,852	222,374	4,549	3,102	8,294	159,790
VA	2002	12	OFF-HIGHWAY	660,105	48	63,219	8,728	8,288	8,663	74,866
VA	2002	14	MISCELLANEOUS	16,238	43,961	350	182,486	22,086	92	848
	2002 Total			**3,065,551**	**55,105**	**484,646**	**269,585**	**69,453**	**428,046**	**453,413**
VA	2009	01	FUEL COMB. ELEC. UTIL.	12,535	694	64,358	5,606	4,165	174,777	788
VA	2009	02	FUEL COMB. INDUSTRIAL	67,422	105	67,263	18,346	8,345	131,459	5,483
VA	2009	03	FUEL COMB. OTHER	66,016	10	15,920	10,059	9,741	5,118	28,062
VA	2009	04	CHEMICAL & ALLIED PRODUCT MFG	286	2,082	7,790	477	413	1,996	1,419
VA	2009	05	METALS PROCESSING	3,397	0	827	1,563	1,332	4,813	390
VA	2009	06	PETROLEUM & RELATED INDUSTRIES	26,288	0	197	275	169	187	557
VA	2009	07	OTHER INDUSTRIAL PROCESSES	12,471	733	9,425	33,961	9,984	18,643	13,394
VA	2009	08	SOLVENT UTILIZATION	0	5	0	248	231	3	110,127
VA	2009	09	STORAGE & TRANSPORT	17	7	12	797	544	0	26,456
VA	2009	10	WASTE DISPOSAL & RECYCLING	20,109	119	2,174	3,823	1,515	1,805	4,789
VA	2009	11	HIGHWAY VEHICLES	1,453,946	9,086	134,232	3,747	2,241	1,079	96,770
VA	2009	12	OFF-HIGHWAY	726,815	53	54,993	7,510	7,136	1,707	57,009
VA	2009	14	MISCELLANEOUS	21,582	46,719	464	198,040	23,990	124	1,077
	2009 Total			**2,410,884**	**59,612**	**357,655**	**284,451**	**69,806**	**341,710**	**346,321**
VA	2018	01	FUEL COMB. ELEC. UTIL.	18,850	606	64,344	12,551	10,773	98,988	980
VA	2018	02	FUEL COMB. INDUSTRIAL	72,065	114	70,132	19,247	8,904	134,790	5,861
VA	2018	03	FUEL COMB. OTHER	53,171	14	17,852	9,427	9,086	5,230	18,603
VA	2018	04	CHEMICAL & ALLIED PRODUCT MFG	338	2,462	9,211	579	502	1,297	1,708
VA	2018	05	METALS PROCESSING	4,034	0	1,017	1,861	1,592	5,374	469
VA	2018	06	PETROLEUM & RELATED INDUSTRIES	30,284	0	228	315	194	217	642
VA	2018	07	OTHER INDUSTRIAL PROCESSES	14,029	877	10,836	37,553	11,276	18,088	15,636
VA	2018	08	SOLVENT UTILIZATION	0	6	0	314	293	3	127,953
VA	2018	09	STORAGE & TRANSPORT	21	8	15	949	648	0	27,357
VA	2018	10	WASTE DISPOSAL & RECYCLING	24,293	141	2,595	4,694	1,828	2,170	5,821
VA	2018	11	HIGHWAY VEHICLES	1,075,104	10,624	63,342	3,212	1,543	1,043	61,964
VA	2018	12	OFF-HIGHWAY	797,683	61	40,393	6,208	5,891	507	49,052
VA	2018	14	MISCELLANEOUS	27,223	50,279	584	218,141	26,225	158	1,322
	2018 Total			**2,117,096**	**65,192**	**280,549**	**315,051**	**78,754**	**267,867**	**317,368**

State Tier 1 Emission Totals

State	Year	TIER1	TIER 1 NAME	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
WV	2002	01	FUEL COMB. ELEC. UTIL.	10,341	121	230,977	4,573	2,210	516,084	1,180
WV	2002	02	FUEL COMB. INDUSTRIAL	8,685	97	33,825	1,583	1,332	37,111	1,097
WV	2002	03	FUEL COMB. OTHER	29,480	13	15,220	3,814	3,683	3,990	9,275
WV	2002	04	CHEMICAL & ALLIED PRODUCT MFG	50,835	80	1,627	950	831	9,052	5,755
WV	2002	05	METALS PROCESSING	28,837	143	1,570	8,749	7,515	5,619	1,393
WV	2002	06	PETROLEUM & RELATED INDUSTRIES	1	0	1,086	475	475	7,550	2,163
WV	2002	07	OTHER INDUSTRIAL PROCESSES	2,003	56	5,347	18,751	5,567	2,316	1,803
WV	2002	08	SOLVENT UTILIZATION	15	0	18	49	44	0	35,989
WV	2002	09	STORAGE & TRANSPORT	15	0	3	1,952	947	0	12,432
WV	2002	10	WASTE DISPOSAL & RECYCLING	9,395	8	599	4,153	3,731	100	5,098
WV	2002	11	HIGHWAY VEHICLES	533,471	1,908	58,999	1,381	995	2,464	42,174
WV	2002	12	OFF-HIGHWAY	133,113	9	33,239	1,850	1,728	2,112	18,566
WV	2002	14	MISCELLANEOUS	6,897	9,928	149	93,030	10,799	40	349
	2002 Total			**813,089**	**12,364**	**382,659**	**141,310**	**39,857**	**586,436**	**137,275**
WV	2009	01	FUEL COMB. ELEC. UTIL.	11,493	330	85,476	5,657	2,940	268,952	1,361
WV	2009	02	FUEL COMB. INDUSTRIAL	9,529	104	27,109	1,432	1,243	36,964	979
WV	2009	03	FUEL COMB. OTHER	21,558	13	14,229	3,351	3,216	4,047	6,824
WV	2009	04	CHEMICAL & ALLIED PRODUCT MFG	58,271	82	1,804	981	858	10,102	5,426
WV	2009	05	METALS PROCESSING	24,501	116	1,494	2,016	1,507	5,608	831
WV	2009	06	PETROLEUM & RELATED INDUSTRIES	1	0	1,221	535	535	8,495	2,172
WV	2009	07	OTHER INDUSTRIAL PROCESSES	2,288	59	4,995	19,240	5,910	2,570	2,064
WV	2009	08	SOLVENT UTILIZATION	17	0	20	52	47	0	32,199
WV	2009	09	STORAGE & TRANSPORT	17	0	3	1,756	695	0	12,997
WV	2009	10	WASTE DISPOSAL & RECYCLING	9,131	8	583	4,036	3,618	97	4,806
WV	2009	11	HIGHWAY VEHICLES	365,549	2,148	35,635	1,068	684	279	24,843
WV	2009	12	OFF-HIGHWAY	152,862	11	30,133	1,640	1,528	359	18,069
WV	2009	14	MISCELLANEOUS	4,116	10,574	89	93,957	11,002	23	219
	2009 Total			**659,332**	**13,446**	**202,791**	**135,720**	**33,782**	**337,495**	**112,790**
WV	2018	01	FUEL COMB. ELEC. UTIL.	12,397	143	51,474	5,784	3,116	106,199	1,387
WV	2018	02	FUEL COMB. INDUSTRIAL	10,174	111	28,764	1,505	1,308	38,571	1,048
WV	2018	03	FUEL COMB. OTHER	18,891	16	17,254	3,160	3,024	4,065	6,270
WV	2018	04	CHEMICAL & ALLIED PRODUCT MFG	70,252	99	2,183	1,181	1,034	12,196	6,560
WV	2018	05	METALS PROCESSING	28,563	148	1,929	2,491	1,887	6,735	1,087
WV	2018	06	PETROLEUM & RELATED INDUSTRIES	1	0	1,407	616	616	9,786	2,338
WV	2018	07	OTHER INDUSTRIAL PROCESSES	2,756	68	5,949	21,363	6,809	3,101	2,561
WV	2018	08	SOLVENT UTILIZATION	20	0	24	61	55	0	37,886
WV	2018	09	STORAGE & TRANSPORT	19	0	4	2,080	824	0	13,394
WV	2018	10	WASTE DISPOSAL & RECYCLING	9,237	10	592	4,116	3,674	98	5,153
WV	2018	11	HIGHWAY VEHICLES	274,804	2,497	17,247	819	405	253	16,121
WV	2018	12	OFF-HIGHWAY	167,424	13	25,710	1,292	1,198	56	14,086
WV	2018	14	MISCELLANEOUS	5,175	11,453	112	99,667	11,803	29	268
	2018 Total			**599,712**	**14,557**	**152,647**	**144,134**	**35,752**	**181,088**	**108,159**

State Tier 1 Emission Totals

	CO	NH3	NOX	PM10	PM2.5	SO2	VOC
VISTAS 2002 Total	30,073,168	665,818	5,429,845	3,895,998	1,075,343	4,879,941	5,178,836
VISTAS 2009 Total	25,397,398	721,736	3,790,044	4,160,870	1,123,548	3,465,859	4,187,921
VISTAS 2018 Total	22,645,302	792,678	2,722,636	4,548,634	1,194,728	2,169,725	3,910,170

APPENDIX D:

VISTAS TIER 1 EMISSION TOTALS

VISTAS Tier 1 Emission Totals

Year	TIER1	TIER1NAME	CO	NH3	NOX	PM10-PRI	PM25-PRI	SO2	VOC
2002	01	FUEL COMB. ELEC. UTIL.	141,217	1,799	1,523,445	113,917	79,269	3,743,723	12,515
2002	02	FUEL COMB. INDUSTRIAL	371,932	1,204	499,943	85,357	59,735	550,866	32,333
2002	03	FUEL COMB. OTHER	759,534	2,810	122,062	99,532	91,805	114,852	354,375
2002	04	CHEMICAL & ALLIED PRODUCT MFG	131,993	7,093	20,896	11,114	7,982	77,450	63,748
2002	05	METALS PROCESSING	223,705	601	11,801	32,367	27,778	49,143	17,306
2002	06	PETROLEUM & RELATED INDUSTRIES	44,633	355	7,204	2,887	1,863	53,392	33,374
2002	07	OTHER INDUSTRIAL PROCESSES	156,077	7,520	114,474	267,980	97,013	86,736	196,831
2002	08	SOLVENT UTILIZATION	687	331	5,677	3,805	3,284	90	1,288,990
2002	09	STORAGE & TRANSPORT	610	85	1,069	10,968	6,100	230	261,959
2002	10	WASTE DISPOSAL & RECYCLING	546,331	801	28,738	80,336	73,673	6,418	99,497
2002	11	HIGHWAY VEHICLES	19,432,305	73,670	2,187,683	50,338	35,813	89,296	1,890,798
2002	12	OFF-HIGHWAY	6,209,596	477	865,130	72,019	68,302	96,336	813,788
2002	14	MISCELLANEOUS	2,054,548	569,073	41,724	3,065,377	522,726	11,407	113,321
2002 Total			**30,073,168**	**665,818**	**5,429,845**	**3,895,998**	**1,075,343**	**4,879,941**	**5,178,836**
2009	01	FUEL COMB. ELEC. UTIL.	190,535	5,474	789,299	125,750	91,587	2,497,423	14,208
2009	02	FUEL COMB. INDUSTRIAL	391,422	1,305	445,967	74,588	51,491	514,636	32,431
2009	03	FUEL COMB. OTHER	544,289	3,198	123,297	85,410	77,042	112,323	207,146
2009	04	CHEMICAL & ALLIED PRODUCT MFG	140,910	7,611	22,031	11,742	8,394	76,021	54,168
2009	05	METALS PROCESSING	236,473	705	11,763	25,130	21,288	54,337	17,954
2009	06	PETROLEUM & RELATED INDUSTRIES	48,118	399	7,863	3,282	2,124	46,975	25,028
2009	07	OTHER INDUSTRIAL PROCESSES	166,088	7,545	117,625	298,719	111,218	90,420	202,567
2009	08	SOLVENT UTILIZATION	771	360	6,662	4,274	3,679	100	1,256,884
2009	09	STORAGE & TRANSPORT	702	98	1,087	10,729	5,743	160	275,462
2009	10	WASTE DISPOSAL & RECYCLING	770,459	869	36,697	105,449	97,841	7,287	113,473
2009	11	HIGHWAY VEHICLES	13,864,869	87,027	1,414,834	41,861	26,498	10,962	1,217,185
2009	12	OFF-HIGHWAY	6,827,857	530	767,707	61,528	58,279	42,845	649,786
2009	14	MISCELLANEOUS	2,214,906	606,617	45,212	3,312,407	568,364	12,370	121,629
2009 Total			**25,397,398**	**721,736**	**3,790,044**	**4,160,870**	**1,123,548**	**3,465,859**	**4,187,921**
2018	01	FUEL COMB. ELEC. UTIL.	262,414	9,306	568,158	152,642	118,959	1,169,110	17,090
2018	02	FUEL COMB. INDUSTRIAL	416,721	1,383	470,326	80,011	55,648	513,072	34,720
2018	03	FUEL COMB. OTHER	453,482	3,358	136,431	78,032	69,854	116,672	149,363
2018	04	CHEMICAL & ALLIED PRODUCT MFG	173,857	9,023	26,564	14,454	10,360	94,010	67,414
2018	05	METALS PROCESSING	279,850	926	14,871	31,221	26,572	66,150	23,089
2018	06	PETROLEUM & RELATED INDUSTRIES	53,392	460	8,891	3,845	2,490	43,055	27,283
2018	07	OTHER INDUSTRIAL PROCESSES	189,922	8,793	136,722	348,119	130,778	100,824	237,601
2018	08	SOLVENT UTILIZATION	936	404	8,480	5,354	4,601	119	1,515,005
2018	09	STORAGE & TRANSPORT	855	119	1,258	13,540	7,283	192	290,267
2018	10	WASTE DISPOSAL & RECYCLING	821,737	1,068	40,324	114,690	105,745	8,544	125,406
2018	11	HIGHWAY VEHICLES	10,312,627	103,394	663,796	33,426	16,403	10,281	752,732
2018	12	OFF-HIGHWAY	7,438,312	612	601,040	48,648	45,927	35,166	546,062
2018	14	MISCELLANEOUS	2,241,196	653,831	45,776	3,624,653	600,107	12,532	124,137
2018 Total			**22,645,302**	**792,678**	**2,722,636**	**4,548,634**	**1,194,728**	**2,169,725**	**3,910,170**

APPENDIX E:

AIRCRAFT PM EXCERPT FROM 2001 TUCSON REPORT

Final Report

EMISSIONS INVENTORIES FOR THE TUCSON AIR PLANNING AREA

VOLUME I. STUDY DESCRIPTION AND RESULTS

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ABBREVIATIONS AND ACRONYMS

ADEQ	Arizona Department of Environmental Quality
ADWM	Arizona Department of Weights and Measures
ALD2	High Molecular Weight Aldehydes (RCHO, $R \neq H$)
AML	Arc Macro Language
AQM	Air Quality Model
APU	Aircraft Power Unit
ARB	California Air Resources Board
ASC	Area Source Category Code
AT	Air Taxi
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CSF	Chemical Speciation Factor
DM	Davis-Monthan Air Force Base
DOT	Department of Transportation
EDMS	Emissions Dispersion Modeling System
EEA	Energy & Environmental Analysis, Inc.
EIPP	Emission Inventory Preparation Plan
EPA	The U.S. Environmental Protection Agency
ETH	Ethene ($CH_2{=}CH_2$)
FAA	Federal Aviation Administration
FAEED	FAA Aircraft Engine Emission Database
FIPS	Federal Information Processing System
FIRE	EPA's Factor Information REtrieval Data System
FORM	Formaldehyde ($CH_2{=}O$)
GA	General Aviation
GIS	Geographical Information System
GSE	Ground Support Equipment
ICAO	International Civil Aviation Organization

ABBREVIATIONS AND ACRONYMS

ISOP	Isoprene
LPG	Liquid Petroleum Gas
LTO	Landing and TakeOff
NAD27	North American Datum - 1927
NCDC	National Climatic Data Center
NEI	US EPA National Emission Inventory
NEVES	Nonroad Engine and Vehicle Emission Study
NG	Natural Gas
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
OLE	Olefinic Carbon Bond (C═C)
ORNL	Oak Ridge National Laboratory
PAG	Pima Association of Governments
PAR	Paraffinic Carbon Bond (C—C)
PDEQ	Pima County Department of Environmental Quality
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter less than 2.5 microns
PM_{10}	Particulate Matter less than 10 microns
RASP	Regional Aviation System Plan
RVP	Reid Vapor Pressure
SAF	Spatial Allocation Factor
SCC	Source Category Code
SCF	Standard Cubic Foot
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SO_X	Oxides of Sulfur
TAF	Temporal Allocation Factor

ABBREVIATIONS AND ACRONYMS

TAPA	Tucson Air Planning Area
TAZ	Transportation Analysis Zone
THC	Total Hydrocarbon
TIA	Tucson International Airport
TIM	Time-In-Mode
TOL	Tolulene (C_6H_5—CH_3)
TTN	EPA Technology Transfer Network
UAM	Urban Airshed Model
UP	Union Pacific Railroad
VOC	Volatile Organic Compounds as defined by the 1990 Clean Air Act Amendments
XYL	Xylene (C_6H_6—$(CH_3)_2$)

(Prior material unrelated to VISTAS modeling is intentionally omitted)

While emission rates for HC, CO, and NO_x are routinely measured from (new) commercial air carrier engines under the emissions certification component of International Civil Aviation Organization (ICAO) regulations, measurement of PM emissions is not required. As a result, almost all aircraft engine PM emission rate data have been collected under special studies. Currently, such data exists for only about 20 aircraft engines, with a considerable portion of these data collected by the U.S. Air Force for military aircraft engines. While emission factors for these engines are included in the AP-42 database upon which the FAEED and EDMS emission inventory models were developed, they have not been included in either model due to their limited applicability. To date, it has been standard EPA practice not to estimate PM emissions for aircraft engines. However, since the emissions models maintain a placekeeper for PM emission rates and include PM emission estimates for GSE, it can appear to the uninformed user that aircraft PM emission rates are zero. As a result, aircraft are often incorrectly considered to be insignificant PM sources even though those engines tested for PM have demonstrated significant emission rates. This policy of exclusion by omission is not appropriate in developing an accurate modeling inventory, even in the absence of a large emissions database. While a precise emissions estimate cannot be made with available data, it is clear that a zero emission rate is far from accurate.

As an alternative for this study, measured emissions data for aircraft engines that have been tested for PM were statistically analyzed to determine whether or not a relationship to other measured emissions parameters could be established. Intuitively, it was hoped that an inverse relationship with NO_x might be demonstrated, as such a relationship is theoretically attractive. While the level of sophistication of the statistical analysis is constrained by the quantity of data available, simple direct and indirect linear relationships can be examined. Because data are not available for each test engine in each of the four LTO cycle modes and because relationships might be expected to vary by operating mode (due to significant changes in engine and combustion efficiency), all statistical analysis was performed for each operating mode individually.

Statistically significant relationships were found for the direct linear analysis for three of the four LTO cycle modes. Significant in this context means that coefficient t-statistics for one or more of the other measured pollutants (HC, CO, or NO_x) indicated a direct relationship with measured PM (at a confidence level exceeding 95 percent). In all cases, correlation coefficients were poor (as expected), suggesting a high level of variability and poor predictability of PM emissions for any given engine. Nevertheless, statistics were unbiased and should provide an accurate mechanism to initially assess PM emissions on a aggregate basis (i.e., over a range of aircraft engine models such as those associated with an analysis for an entire set of airport operations). Only at idle was no significant relation found, which is not surprising given relative engine inefficiency in this mode.

The indirect linear analysis revealed a consistent and significant inverse relationship between PM and NO_x based on calculated t-statistics. Correlation coefficients continue to be poor, but t-statistics are generally improved over those of the direct linear analysis (all developed inverse relations, including idle, were significant at the 99 percent confidence level). In selecting the most appropriate relationship for estimation of PM emission rates for non-tested aircraft engines, the statistical analysis that produced the best combination of a significant t-statistic, a relatively low root mean square error, and an intuitive engineering basis was identified. This was the inverse NO_x relationship for the takeoff (i.e., full throttle) mode of operation. Figure 4-1 illustrates the selected statistical relationship.

With this relationship established, PM emission rate data for the other aircraft operating modes (i.e., the approach, taxi, and climbout modes) was statistically analyzed against observed PM emission rate data for the takeoff mode. Statistically significant relations were developed for all three modes. Table 4-23 presents the coefficients developed for these PM-to-PM regressions as well as the statistics for the PM-to-NO_x regression developed for the takeoff mode. These four relations were used to develop a set of fleetwide PM emission factors based on measured takeoff NO_x emission rates. These emission factors were then input into the EEA aircraft emissions model and used to generate PM emission estimates for TIA aircraft operations.

FIGURE 4-1. Relationship Used to Estimate Aircraft PM Emission Rates

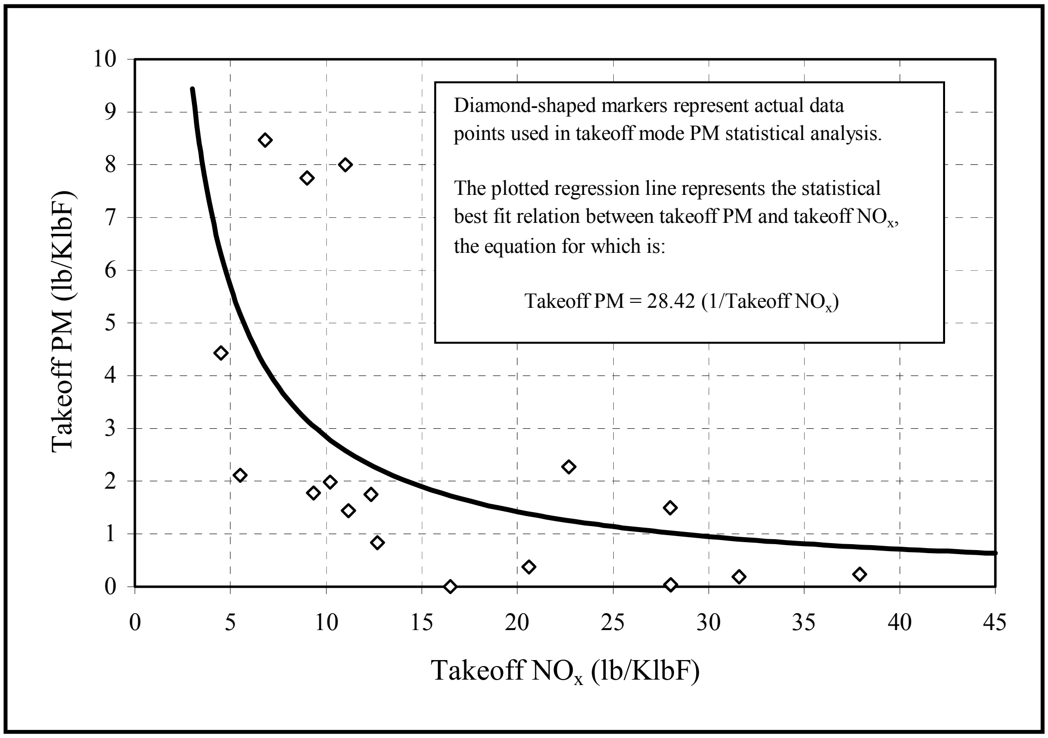


TABLE 4-23. Statistics for Aircraft and APU PM Relations

Statistical Parameter	Takeoff PM	Climbout PM	Approach PM	Taxi PM
Predictive Parameter	1/Takeoff NO_x	Takeoff PM	Takeoff PM	Takeoff PM
Coefficient	28.42	1.42	1.53	3.10
Coefficient t-statistic	5.1	11.8	14.9	5.7
Correlation Coefficient	0.30	0.84	0.91	0.56
F-statistic	7.4	86.1	135.7	21.9
Number of Observations	18	17	15	18

(Subsequent material unrelated to VISTAS modeling is intentionally omitted)

APPENDIX F:

COMPARISON OF BASE F AND BASE G ON-ROAD MOBILE EMISSIONS

Base G Onroad Mobile Emissions (Annual Tons)

	VOC			NOx			CO			SO2			PM-10			PM-2.5			NH3		
FIPSST	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**
AL	125,768	76,065	44,503	156,460	100,693	42,622	1,303,508	902,469	594,725	6,827	802	654	3,861	3,136	2,193	2,768	2,010	1,085	5,530	6,298	6,630
FL	520,757	336,707	199,050	460,503	312,321	136,040	4,493,820	3,308,863	2,263,190	20,687	2,584	2,302	11,148	9,801	7,516	7,779	6,104	3,671	17,922	21,549	23,778
GA	279,975	192,773	99,464	304,309	207,024	92,113	2,699,650	1,956,263	1,303,529	12,043	1,568	1,325	7,165	6,005	4,406	5,110	3,797	2,166	10,436	12,554	13,511
KY	102,362	73,142	42,810	154,634	100,025	46,993	1,214,191	950,912	711,211	6,238	751	694	3,682	2,944	2,348	2,667	1,899	1,158	5,003	5,737	7,095
MS	86,811	51,600	28,699	110,672	69,952	27,620	853,774	602,257	394,247	4,566	532	401	2,828	2,250	1,479	2,089	1,491	746	3,549	3,995	4,147
NC	260,895	166,844	91,720	323,606	199,281	79,433	2,839,283	1,966,195	1,207,391	12,286	1,487	1,346	6,505	5,510	3,994	4,571	3,453	1,931	9,601	11,702	12,776
SC	114,861	71,781	41,866	138,940	91,471	39,348	1,226,555	878,825	588,536	5,909	713	584	3,414	2,831	1,986	2,473	1,834	988	4,646	5,466	5,878
TN	177,943	114,032	61,339	235,869	150,179	62,446	1,893,704	1,320,562	863,682	9,127	1,065	862	5,312	4,160	2,813	3,904	2,720	1,405	6,556	7,702	8,196
VA	157,989	95,694	55,992	219,835	132,699	57,192	2,136,288	1,435,359	954,463	8,196	1,067	949	4,499	3,706	2,922	3,067	2,216	1,404	7,770	8,990	9,653
WV	41,703	24,570	14,652	58,340	35,234	15,530	526,841	360,865	243,683	2,438	276	231	1,366	1,057	747	984	676	369	1,889	2,126	2,268
VISTAS	**1,869,063**	**1,203,208**	**680,096**	**2,163,168**	**1,398,879**	**599,336**	**19,187,613**	**13,682,570**	**9,124,656**	**88,316**	**10,844**	**9,348**	**49,780**	**41,400**	**30,403**	**35,411**	**26,200**	**14,922**	**72,902**	**86,118**	**93,932**

Base F Onroad Mobile (Annual Tons)

	VOC			NOx			CO			SO2			PM-10			PM-2.5			NH3		
FIPSST	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**
AL	118,978	73,137	47,151	157,626	101,299	46,598	1,300,754	934,442	675,902	6,898	637	720	3,905	3,195	2,488	2,799	2,053	1,262	5,586	6,362	7,296
FL	438,761	293,423	192,096	402,099	284,737	134,465	4,022,000	3,090,443	2,306,759	18,802	1,911	2,289	10,185	9,027	7,691	7,126	5,653	3,848	16,183	19,553	23,595
GA	265,972	187,102	104,678	306,998	208,568	100,707	2,712,473	2,044,169	1,474,029	12,182	1,256	1,458	7,252	6,116	4,995	5,169	3,877	2,517	10,545	12,685	14,870
KY	96,202	63,210	38,814	154,093	97,731	43,014	1,195,656	932,296	669,891	5,988	587	651	3,728	3,008	2,283	2,699	1,946	1,160	5,055	5,807	6,584
MS	81,701	49,986	30,337	110,242	69,949	29,829	849,049	624,575	445,150	4,614	398	441	2,863	2,296	1,688	2,114	1,525	876	3,585	4,035	4,565
NC	272,594	167,894	87,718	290,873	207,670	83,399	2,677,118	2,192,253	1,238,802	12,482	1,314	1,323	6,733	5,874	4,299	4,754	3,651	2,158	9,711	12,663	13,077
SC	107,236	69,026	44,121	139,403	91,832	42,641	1,220,825	921,308	663,597	5,972	558	643	3,454	2,884	2,258	2,502	1,874	1,154	4,694	5,522	6,472
TN	168,389	109,716	63,916	233,324	147,591	66,879	1,881,893	1,359,880	961,929	9,202	833	944	5,349	4,247	3,199	3,927	2,788	1,643	6,629	7,753	8,962
VA	143,969	91,230	59,737	222,830	133,039	64,079	1,996,287	1,483,125	1,091,546	7,234	902	1,059	4,546	3,768	3,343	3,097	2,258	1,641	7,852	9,084	10,757
WV	39,581	23,914	15,375	60,335	36,000	16,940	533,258	379,272	273,900	2,495	228	255	1,399	1,099	844	1,005	705	428	1,938	2,188	2,484
VISTAS	**1,733,382**	**1,128,638**	**683,942**	**2,077,822**	**1,378,416**	**628,551**	**18,389,312**	**13,961,764**	**9,801,505**	**85,868**	**8,622**	**9,783**	**49,414**	**41,513**	**33,086**	**35,191**	**26,330**	**16,687**	**71,778**	**85,652**	**98,664**

Emissions Change (Base G - Base F, Annual Tons) -- Positive Value Indicates Increase from Base F

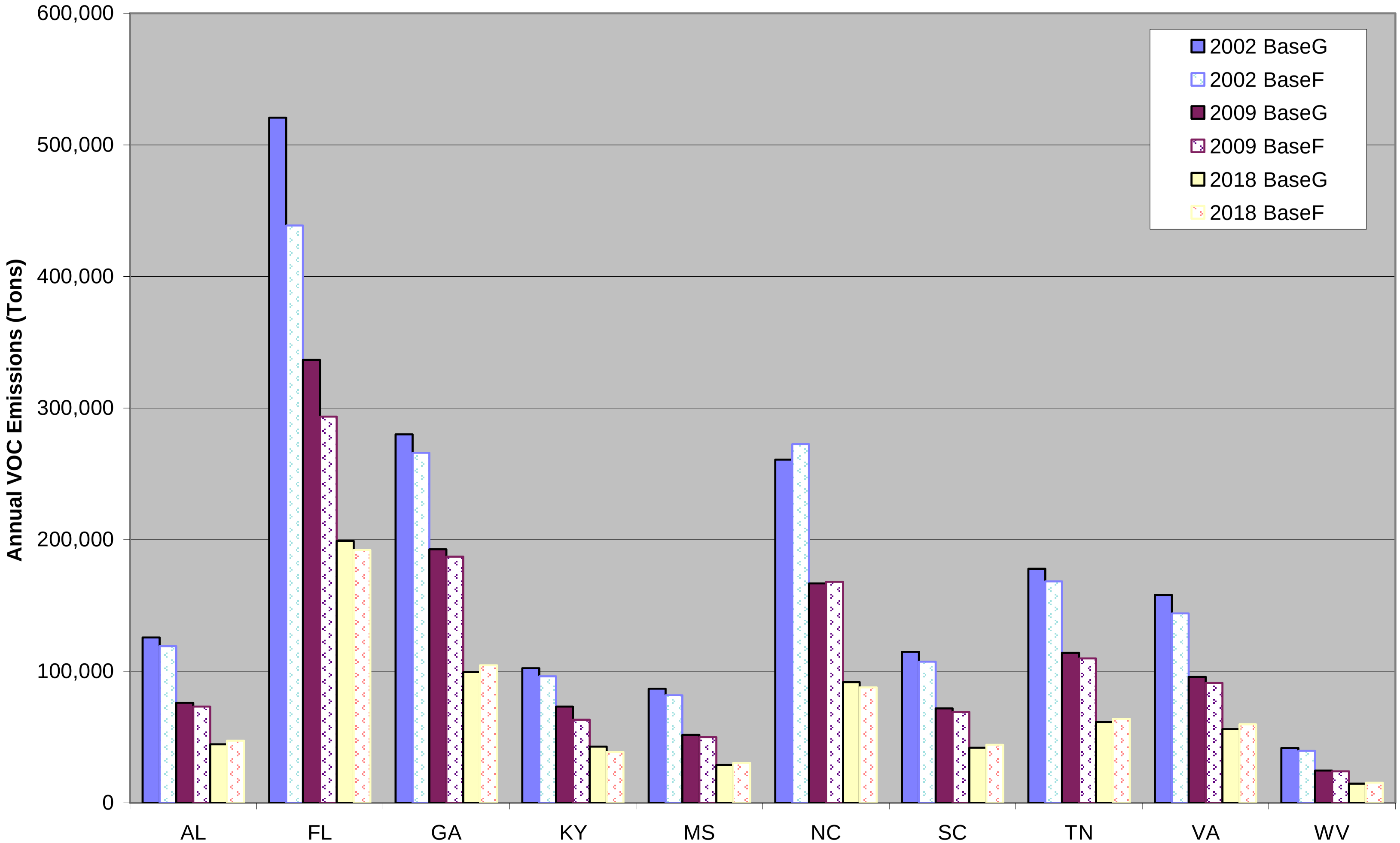
	VOC			NOx			CO			SO2			PM-10			PM-2.5			NH3		
FIPSST	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**
AL	6,789	2,928	-2,647	-1,166	-606	-3,977	2,754	-31,973	-81,178	-71	165	-66	-45	-58	-295	-31	-43	-178	-56	-63	-666
FL	81,997	43,284	6,955	58,404	27,584	1,575	471,820	218,420	-43,569	1,885	672	14	963	774	-175	653	451	-177	1,738	1,996	183
GA	14,003	5,671	-5,214	-2,689	-1,544	-8,594	-12,823	-87,906	-170,500	-139	312	-133	-86	-111	-589	-59	-80	-352	-109	-131	-1,359
KY	6,160	9,933	3,996	541	2,294	3,979	18,534	18,615	41,319	250	164	43	-46	-65	65	-32	-47	-2	-52	-70	512
MS	5,110	1,613	-1,638	430	3	-2,209	4,724	-22,319	-50,903	-48	134	-41	-35	-46	-209	-25	-34	-130	-35	-40	-419
NC	-11,699	-1,049	4,001	32,734	-8,389	-3,966	162,165	-226,057	-31,411	-196	174	23	-228	-364	-304	-183	-198	-226	-111	-961	-302
SC	7,625	2,755	-2,255	-462	-362	-3,293	5,731	-42,483	-75,061	-63	156	-59	-40	-53	-272	-29	-40	-166	-48	-56	-594
TN	9,554	4,316	-2,577	2,545	2,589	-4,433	11,811	-39,318	-98,246	-75	232	-82	-37	-87	-385	-22	-68	-238	-73	-52	-766
VA	14,020	4,464	-3,744	-2,995	-340	-6,887	140,001	-47,766	-137,084	962	165	-110	-47	-62	-420	-30	-42	-237	-83	-94	-1,104
WV	2,122	656	-723	-1,995	-766	-1,410	-6,416	-18,407	-30,217	-57	49	-24	-32	-42	-97	-22	-29	-59	-49	-62	-217
VISTAS	**135,680**	**74,570**	**-3,846**	**85,346**	**20,462**	**-29,215**	**798,301**	**-279,194**	**-676,850**	**2,448**	**2,222**	**-435**	**367**	**-114**	**-2,683**	**219**	**-130**	**-1,764**	**1,123**	**466**	**-4,732**

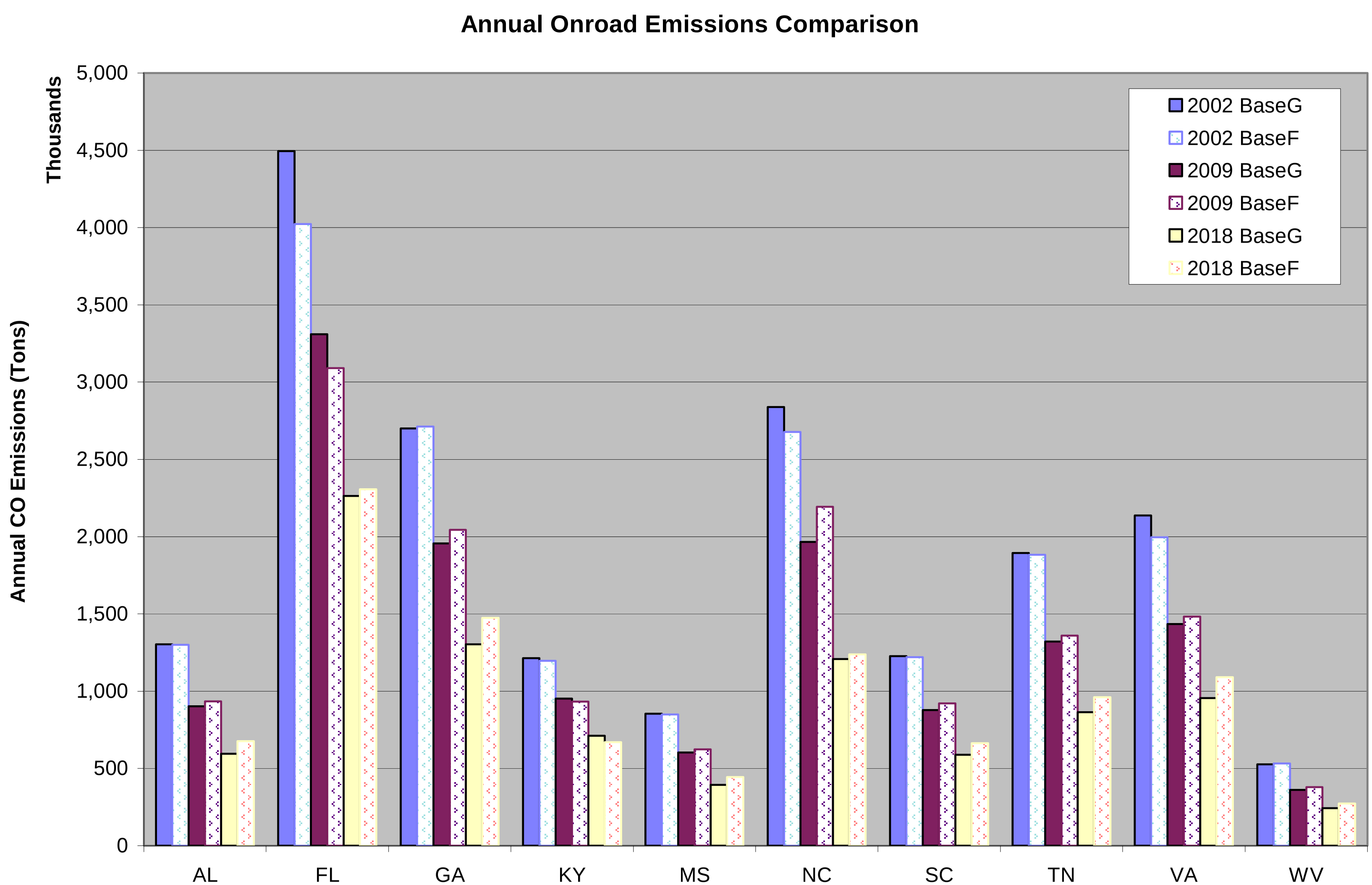
Emissions Change (Base G - Base F/Base F, Annual %) -- Positive Value Indicates Increase from Base F

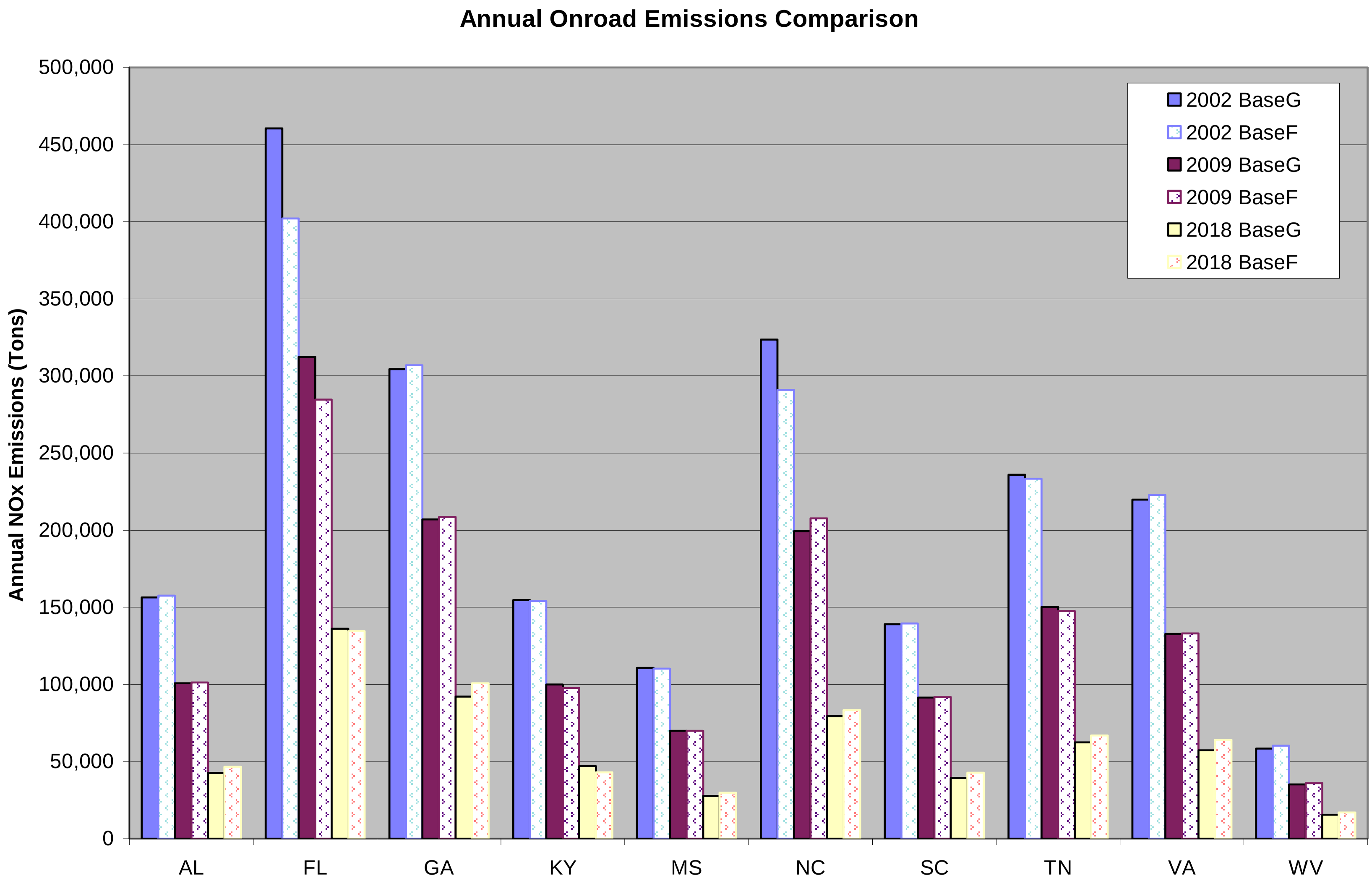
	VOC			NOx			CO			SO2			PM-10			PM-2.5			NH3		
FIPSST	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**	**2002**	**2009**	**2018**
AL	6%	4%	-6%	-1%	-1%	-9%	0%	-3%	-12%	-1%	26%	-9%	-1%	-2%	-12%	-1%	-2%	-14%	-1%	-1%	-9%
FL	19%	15%	4%	15%	10%	1%	12%	7%	-2%	10%	35%	1%	9%	9%	-2%	9%	8%	-5%	11%	10%	1%
GA	5%	3%	-5%	-1%	-1%	-9%	0%	-4%	-12%	-1%	25%	-9%	-1%	-2%	-12%	-1%	-2%	-14%	-1%	-1%	-9%
KY	6%	16%	10%	0%	2%	9%	2%	2%	6%	4%	28%	7%	-1%	-2%	3%	-1%	-2%	0%	-1%	-1%	8%
MS	6%	3%	-5%	0%	0%	-7%	1%	-4%	-11%	-1%	34%	-9%	-1%	-2%	-12%	-1%	-2%	-15%	-1%	-1%	-9%
NC	-4%	-1%	5%	11%	-4%	-5%	6%	-10%	-3%	-2%	13%	2%	-3%	-6%	-7%	-4%	-5%	-10%	-1%	-8%	-2%
SC	7%	4%	-5%	0%	0%	-8%	0%	-5%	-11%	-1%	28%	-9%	-1%	-2%	-12%	-1%	-2%	-14%	-1%	-1%	-9%
TN	6%	4%	-4%	1%	2%	-7%	1%	-3%	-10%	-1%	28%	-9%	-1%	-2%	-12%	-1%	-2%	-14%	-1%	-1%	-9%
VA	10%	5%	-6%	-1%	0%	-11%	7%	-3%	-13%	13%	18%	-10%	-1%	-2%	-13%	-1%	-2%	-14%	-1%	-1%	-10%
WV	5%	3%	-5%	-3%	-2%	-8%	-1%	-5%	-11%	-2%	21%	-9%	-2%	-4%	-12%	-2%	-4%	-14%	-3%	-3%	-9%
VISTAS	**8%**	**7%**	**-1%**	**4%**	**1%**	**-5%**	**4%**	**-2%**	**-7%**	**3%**	**26%**	**-4%**	**1%**	**0%**	**-8%**	**1%**	**0%**	**-11%**	**2%**	**1%**	**-5%**

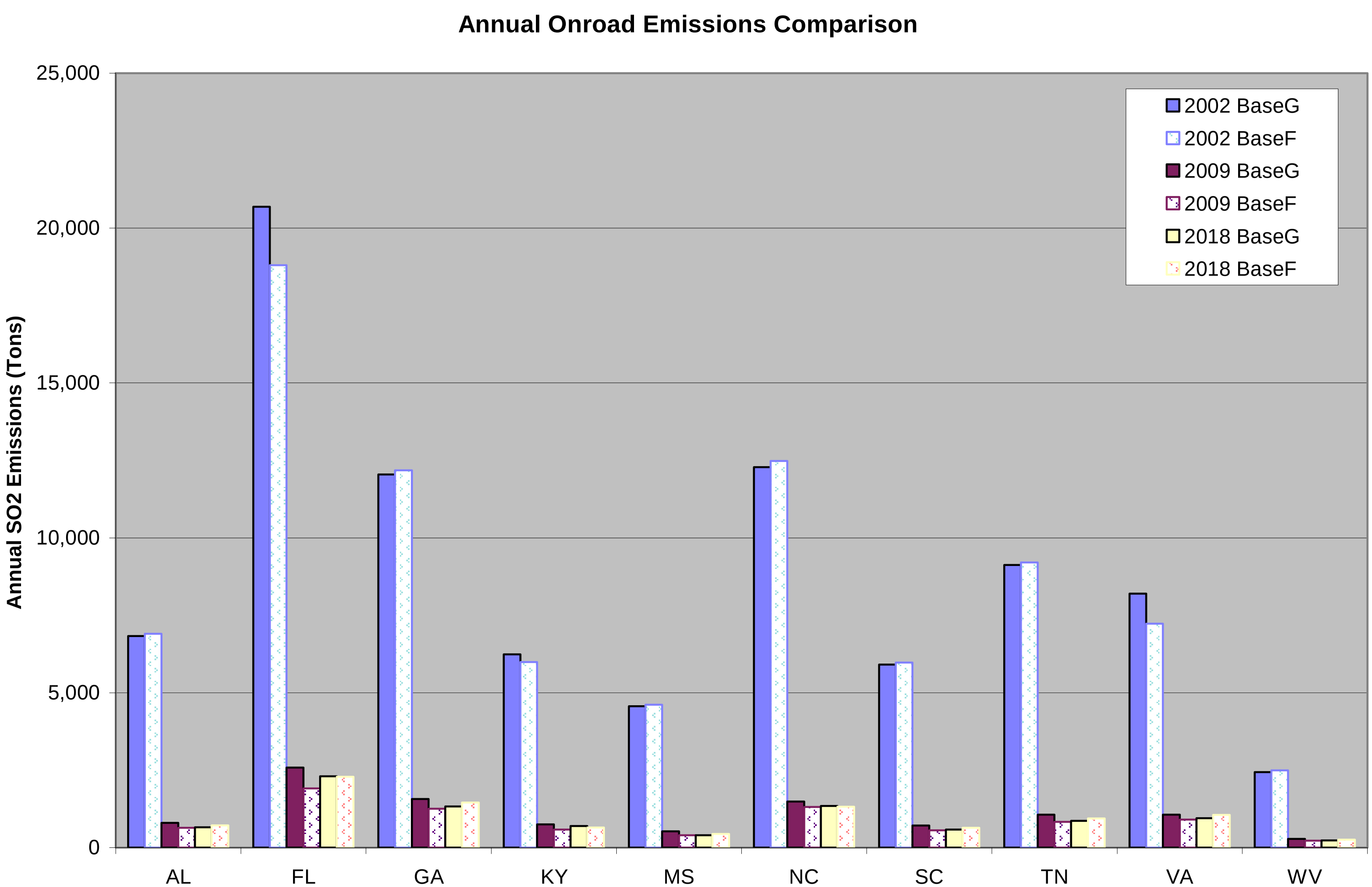
Note: Base G is equivalent to the Best and Final inventory for onroad mobile sources.

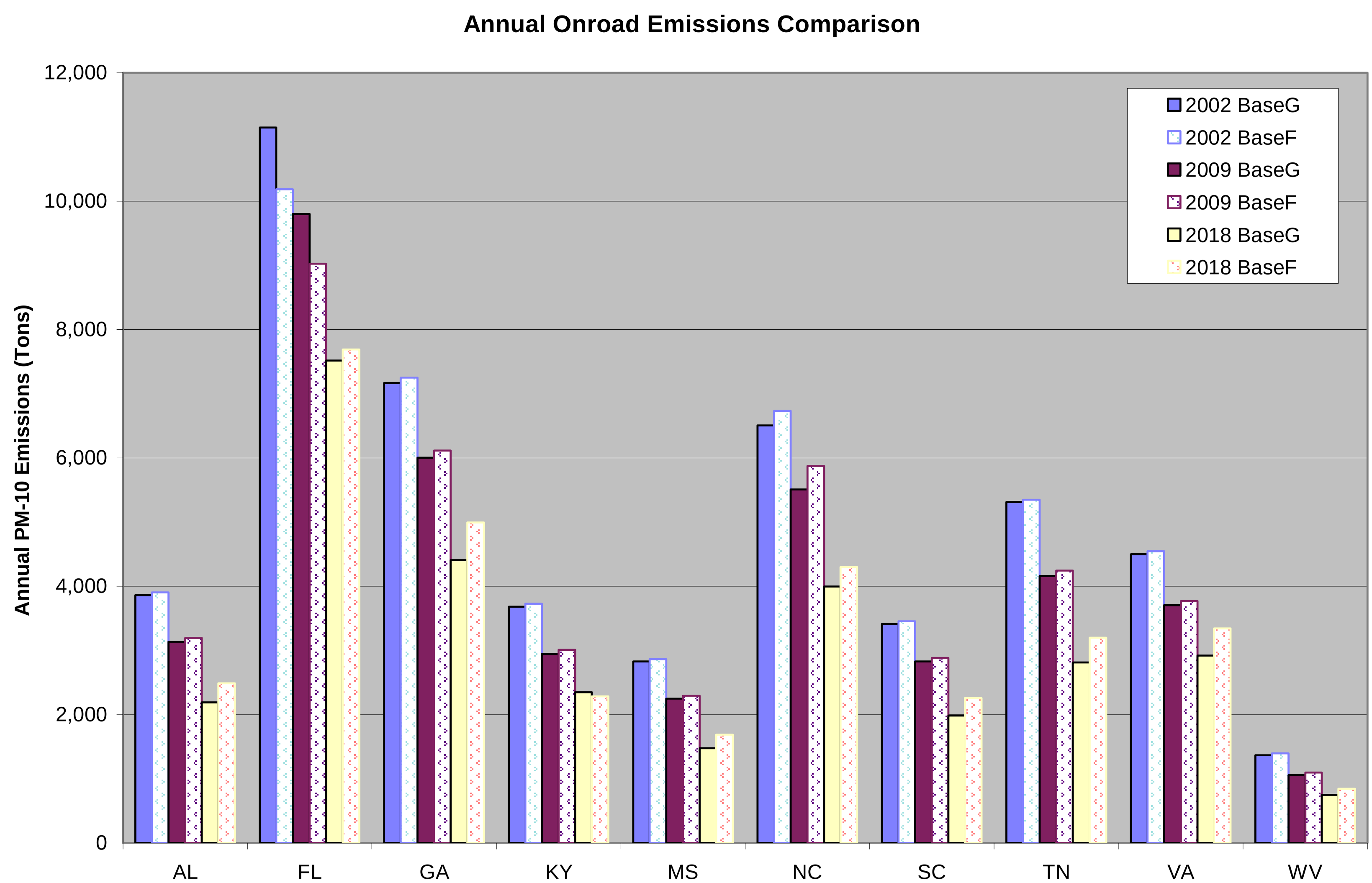
Annual Onroad Emissions Comparison

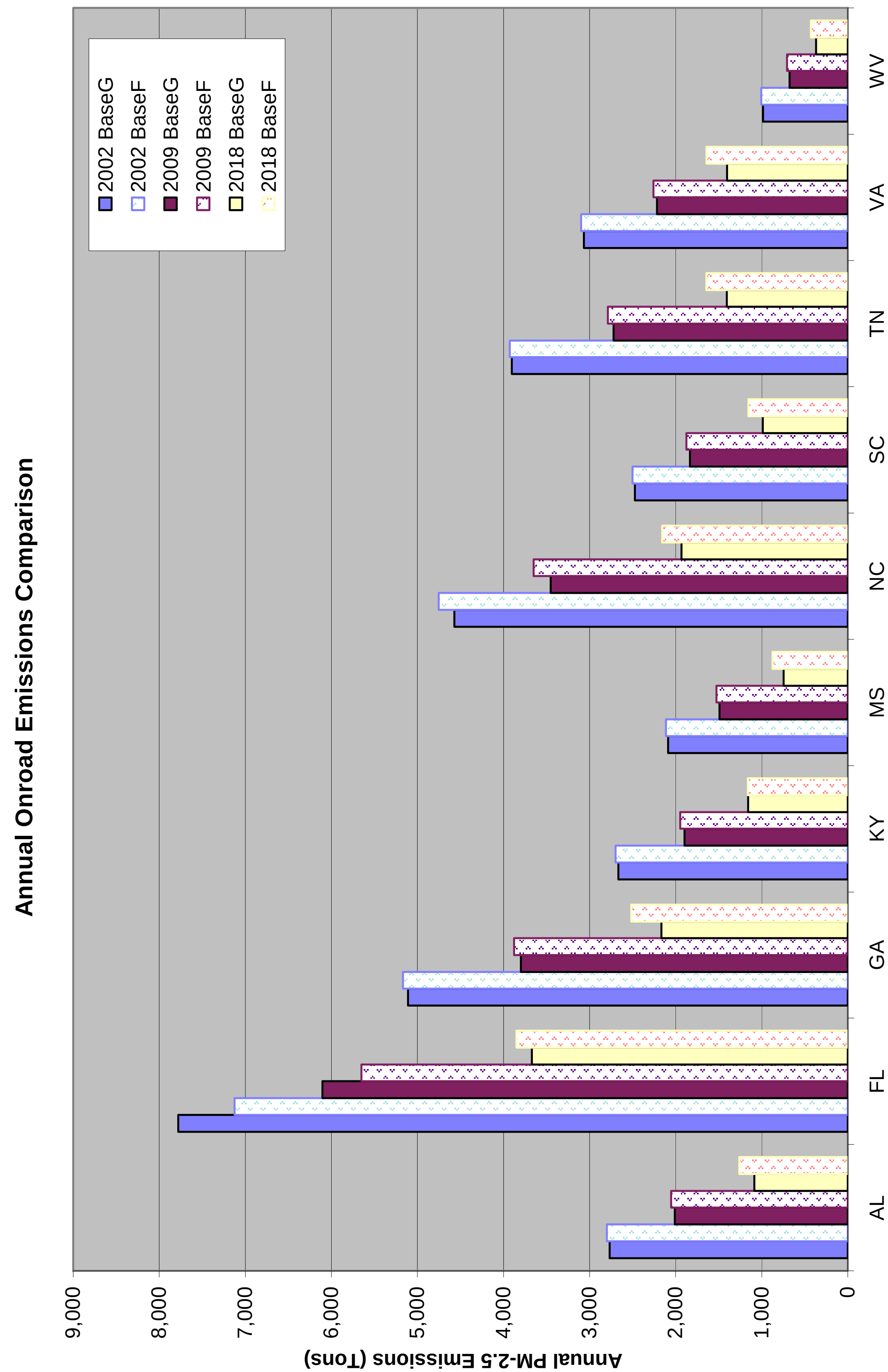


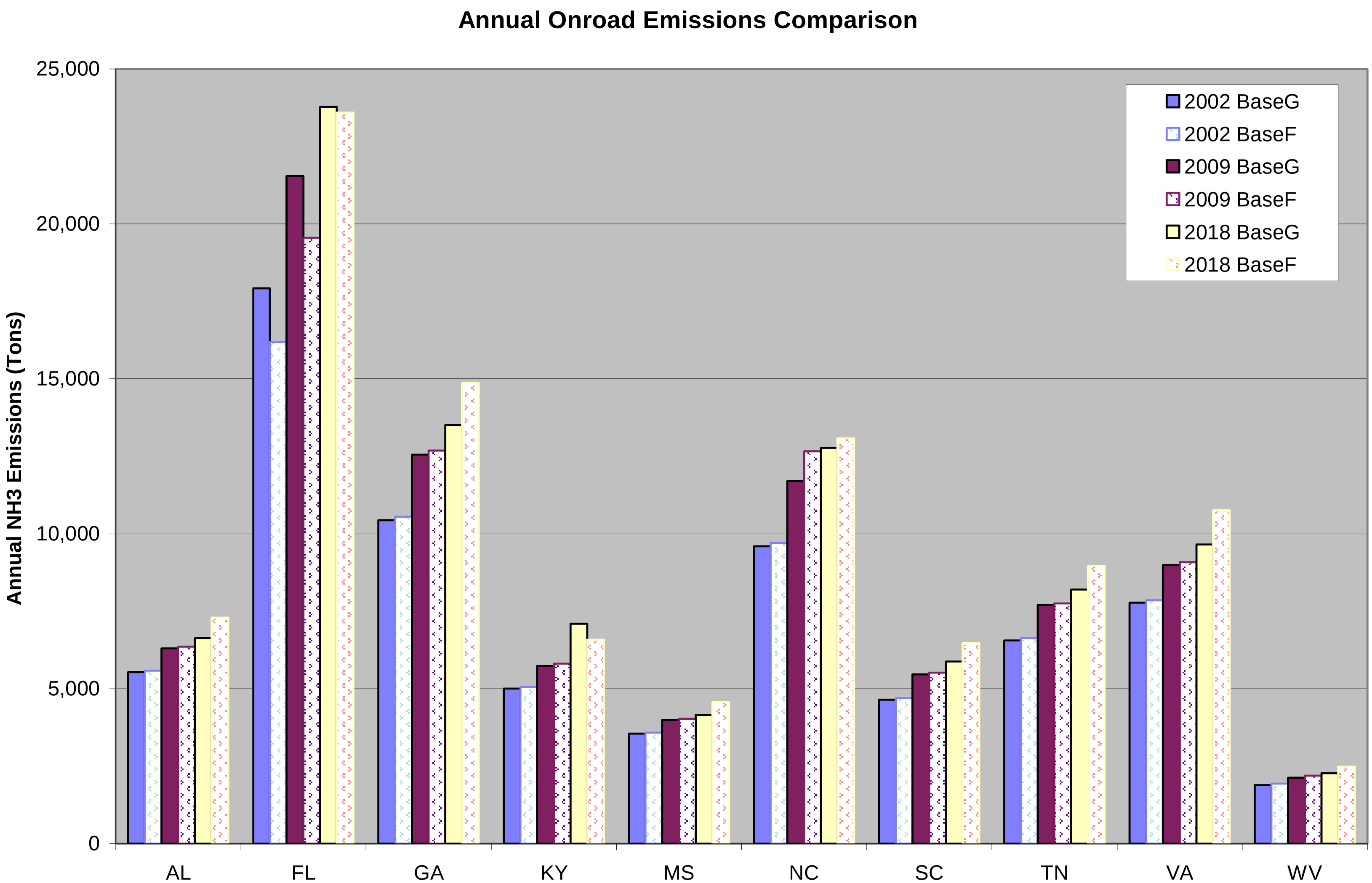

Annual Onroad Emissions Comparison
Annual CO Emissions (Tons)
Thousands
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 BaseG
2002 BaseF
2009 BaseG
2009 BaseF
2018 BaseG
2018 BaseF


Annual Onroad Emissions Comparison
Annual NOx Emissions (Tons)
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 BaseG
2002 BaseF
2009 BaseG
2009 BaseF
2018 BaseG
2018 BaseF


Annual Onroad Emissions Comparison
Annual SO2 Emissions (Tons)
25,000
20,000
15,000
10,000
5,000
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 BaseG
2002 BaseF
2009 BaseG
2009 BaseF
2018 BaseG
2018 BaseF


Annual Onroad Emissions Comparison
Annual PM-10 Emissions (Tons)
12,000
10,000
8,000
6,000
4,000
2,000
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 BaseG
2002 BaseF
2009 BaseG
2009 BaseF
2018 BaseG
2018 BaseF


Annual Onroad Emissions Comparison
Annual PM-2.5 Emissions (Tons)
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 BaseG
2002 BaseF
2009 BaseG
2009 BaseF
2018 BaseG
2018 BaseF


Annual Onroad Emissions Comparison
Annual NH3 Emissions (Tons)
25,000
20,000
15,000
10,000
5,000
0
AL
FL
GA
KY
MS
NC
SC
TN
VA
WV
2002 BaseG
2002 BaseF
2009 BaseG
2009 BaseF
2018 BaseG
2018 BaseF

APPENDIX G:

CONVERSION OF MRPO BaseM POINT SOURCE DATA TO SMOKE INPUT FORMAT

Atmospheric Sciences Group

MEMORANDUM

To: Pat Brewer, VISTAS
From: Gregory Stella, Alpine Geophysics, LLC
Re: Conversion of MRPO BaseM Point Source Data to SMOKE Input Format
Date: 13 February 2008

The Midwest Regional Planning Organization (MRPO) periodically produces a five State emission inventory for Illinois, Indiana, Michigan, Wisconsin, and Ohio. These data are used as the basis for various MRPO modeling and regulatory analyses. These data are prepared with the help of each State's emission inventory divisions and are felt to be the most representative account for emissions activities for those States at any one time.

The most recent version prepared and distributed by MRPO is currently called BaseM. Associated with this 2005 base year inventory release is a set of growth and control factors that are used to additionally simulate future year conditions under "On-The-Books" (base case or known control programs requirements to be implemented in future years) or incremental control situations to test sensitivity or strategies which would be implemented in whole or in part during the same future years.

The purpose of this document is to detail the technical steps that were made as part of the conversion of the MRPO BaseM point sources files (electric generating unit [EGU] and non-EGU) into IDA format for ASIP PM-2.5 CAMx modeling of the future year 2009. Because of the timing and complications relative to converting multiple and various emission files for all source types, it was determined that only point source emissions would be converted for processing at this time.

Data Sources and Description

A series of data files and associated documentation was obtained from MRPO staff in 2007. These files were the input data sets for base year 2005 and growth and control factors related to MRPO's BaseM and Round 5 inventories[6]. Because of the emission processing tools that MRPO currently executes for its analyses, these files are in formats that are not read by the SMOKE emissions processor currently in use by VISTAS/ASIP modelers (contract teams and participating states). Alpine Geophysics, under the Emissions Inventory Technical Advisor contract, was asked to obtain and convert these data into the formats that could be used by these modeling agencies.

Through additional contact with MRPO staff, the base year 2005 non-EGU point source files and associated growth and control factors necessary to forecast the data to 2009 base case conditions were identified and extracted from the originally provided data. EGU sources were identified to be already prepared for the future year (2010 substituted for 2009) and were based on recent IPM 3.0 model runs with incremental adjustment made by MRPO states to best reflect expected emission controls and operating conditions. The "will do" simulation series for EGUs was identified as "egu5b_2010."

The main purpose of the SMOKE conversion task was to prepare five state emission inventories provided in National Input Format (NIF) format into the IDA format required by the SMOKE model for the criteria pollutants VOC, NOx, CO, SO2, PM-10, PM-2.5, and NH3. Annual emissions were taken directly from the NIF structured inventories with no alternate temporal calculations performed (e.g., estimate seasonal emissions from annual or annual from seasonal). The temporal allocation module of the SMOKE emissions processor was intended to be used to further define temporal distribution of these emissions.

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[6] http://www.ladco.org/tech/emis/r5/round5_reports.htm

No quality assurance (QA) related to the reported values in the MRPO was conducted (e.g., it was assumed that reported emission levels were correct) and therefore the QA focus of these tasks was to maintain the integrity of the mass files in the conversion to IDA.

Each set of NIF structured data had a unique set of relational tables necessary to maintain the information required in each source sector based on its reporting requirements. Alpine had previously developed scripts to read the information from each of these relational data sets and convert them to the IDA structures required by this task. Prior to and after each major source sector was converted from NIF to IDA, we developed a list of emission summary reports to check that the emissions input into the conversion process were the same as output into the IDA formatted files.

Non-EGU Point Source Conversion

Non-EGU point source emissions from 2005 BaseM were converted to future year 2009 IDA format using the annual emission records directly from the NIF structured data sets and associated SCC growth factors and unit, facility, county, state, or nationally applied controls[7]. These controls were applied in a hierarchical fashion starting with the most defined (unit-segment-pollutant level) through least defined (national-SCC-pollutant) and when a match was found during the implementation, no additional controls were sought or applied to that emission record. In other words, if a match were found at the unit-segment level of control, no additional controls were applied to that segment/pollutant combination again in the forecast process. This prevented multiple control programs from being implemented when the intent of the originally provided control files were to assign a single applicable reduction.

The Round 5 factors for point sources provided by MRPO were in the RPO Data Exchange Format (RPODx) and had growth and control factors available at the State, county, plant, unit, segment, stack, and SCC level of detail. In order to apply these factors in a fashion consistent with that of the MRPO utilized processing system and duplicative of how MRPO would have generated its BaseM forecasts, a hierarchical approach was utilized to match and assign growth and control values.

Growth Factor Application

Using the 2005 EM table from the BaseM inventory files in NIF format, we first selected each emissions record for forecasting. In this conversion case, these EM records were limited to those emissions identified as annual using the NIF coding convention. As noted in the limitations section below, there oftentimes were emissions provided by MRPO in a summer season convention.

We next selected the base year for application as the RPODx for growth rates allows for the flexibility of input growth factors for multiple base year inventories. In this assignment, the base year was always 2005, as that was the base year provided by MRPO and the future year was 2009, as selected by ASIP.

The next step was to determine the growth basis for each individual emission record of the file. This "growth basis" is the key with which the growth factor is associated. For point sources, this key is based on a combination of FIPS, SCC, and pollutant codes. Multiple keys are calculated for each individual emission record and that key with the highest resolution of matching to the growth factor file using the hierarchy identified in Table 1 below is the one chosen to assign a growth rate to the base year emissions.

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7 http://www.ladco.org/tech/emis/r5/reports/LADCO%202005%20Base%20Yr%20Growth%20and%20Controls%20Report_Final.pdf

Table 1. Point Source Growth Factor Application Hierarchy.

Order	Key or "Growth/Control Basis"
1	state/county code, 10-digit SCC, pollutant
2	state/county code, 10-digit SCC
3	state code, 10-digit SCC, pollutant
4	state code, 10-digit SCC
5	state/county code, pollutant
6	state/county code
7	state code, pollutant
8	state code
9	10-digit SCC, pollutant
10	10-digit SCC
11	Pollutant

Using the hierarchical application, growth basis, and dates (base year and alternate year), we matched each emission record to the growth table to obtain a growth factor. The factors are defined in the growth table as a multiplier for the base year period that calculates the alternate year of interest. In other words, multiplying the base year emissions value by the growth factor provides you with the emissions for the alternate year of interest.

When no match from any of the hierarchical keys was identified, a growth rate of 1.00 (no growth) was assigned. This maintained the 2005 emission level in the future year inventory.

Control Factor Application

Similar to the process identified above for the assignment and application of growth factors, the control factor assignment was based on a hierarchical key, this time, however, using FIPS, plantid, pointid, stackid, segment, SCC, and pollutant codes applied in a parallel process to the growth factor assignment.

Using the 2005 EM table from the BaseM inventory files in NIF format, we selected each annual emissions record for forecasting. We next selected the base year for application, and again, the base year was always 2005, as that was the base year provided by MRPO.

Once the base year was identified, we determined the alternate year for our forecast. Depending on the specific year used in each conversion, growth rates were limited to those with a base year of 2005 and a future year *less than or equal to* that of our forecast. This variation in method is intended to allow us to identify all controls implemented prior to or during the year of interest and will consider them as viable options at the latest provided level of control.

In other words, since we selected 2009 as the future year of choice, we limit the control factor table to control strategies implemented during or prior to 2009. If in our matching to the control factor table we find that for a certain control basis key there is no match because a program may have been fully implemented in a prior year (say 2007), then we do not want to exclude this reduction from our forecast. Additionally, if we find that there are multiple entries in the control factor table because of incremental implementation of a rule, we select the closest year to that of our intended forecast. So if a particular rule was incrementally implemented from 2005 through 2009 and there were control records available for each year in between, we would select the record with the latest year to apply in our forecast.

The next step was to determine the control basis for each individual emission record of the file. This "control basis" is the key with which the control strategy or technology is associated. Although we developed code to support the hierarchical application of control factors for the BaseM emissions, all control factors provided by MRPO in the Round 5 files were segment-SCC-pollutant specific. This eliminated the need for a search on the key that has the greatest resolution as all matches were at the segment-SCC-pollutant level.

Using the control basis and dates (base year and alternate year), we matched each emission record to the control table to obtain a control factor. The factors are defined in the control table as a group of values (control efficiency, rule effectiveness, and rule penetration) for the future year period that gets assigned to an uncontrolled future year emission value. In other words, we first “backed out” existing base year controls from our future year emissions estimate and then multiplied this uncontrolled value by the control factors for the alternate year of interest. These calculations are defined in Equations 1 and 2 below.

Equation 1. Uncontrolled emissions calculation.

$$Emiss_{Unc} = Emiss_{Base} / (1-((CE_{Base}/100)*(RE_{Base}/100)*(RP_{Base}/100)))$$

Where,

$Emiss_{Unc}$ = Uncontrolled emissions

$Emiss_{Base}$ = Base year emissions

CE_{Base} = Base year control efficiency

RE_{Base} = Base year rule effectiveness

RP_{Base} = Base year rule penetration

Equation 2. Application of new control calculation.

$$Emiss_{New} = Emiss_{Unc} *(1-((CE_{New}/100)*(RE_{New}/100)*(RP_{New}/100)))$$

Where,

$Emiss_{New}$ = Future year emissions

$Emiss_{Unc}$ = Uncontrolled emissions

CE_{New} = Future year control efficiency

RE_{New} = Future year rule effectiveness

RP_{New} = Future year rule penetration

When no match from any of the hierarchical keys was identified, the same control efficiency, rule efficiency, and rule penetration values from the base year inventory were used in the calculation and the only change in emissions would have been the result of growth factor application. In instances where PM-10 annual emissions were found to be less than PM-2.5 annual emission values, the PM-2.5 emission values were changed to equal that of PM-10.

EGU Point Source Conversion

EGU point source emissions from the egu5b_2010 scenario (2010 IPM 3.0 run with modifications) were converted to year 2009 IDA format using the annual emission records directly from the NIF structured data sets. Since these emissions already accounted for growth and control application, no additional modifications were required.

One ASIP requested modification for its PM-2.5 CAMx modeling was to adjust the 2009 file to match W. H. Sammis facility’s planned response to the control requirements from the consent decree USA vs. Ohio Edison; Civil Action No: 2:99-CV-1181; March 18, 2005. These changes were not implemented in the ASIP 2009 CMAQ runs. These adjustments for SO2 are noted in Table 2 below.

Table 2. SO2 Control Requirements from USA vs. Ohio Edison Consent Decree

Units 1-4	Induct Scrubbing
	50% removal (1.1 lbs/MMBtu)
	At least one unit by Sept. 30, 2008
	Second unit by Dec. 31, 2008
	Other two units by Dec. 31, 2009
Unit 5	Flash Dryer Absorber or Electro-Catalytic Oxidation no later than Dec. 31, 2008
	50% removal (1.1 lbs/MMBtu)
Units 6/7	Scrubber no later than December 31, 2010
	95% removal (0.13 lbs/MMBtu)
Plantwide	Emission cap of 101,500 by end of 2009
	Emission cap of 101,500 by end of 2010
	Emission cap of 29,900 by end of 2011

Conversion Limitations

As noted above, Alpine limited our conversion to all records in the MRPO point source files that were identified as annual. In some cases the MRPO NIF files had additional non-annual summer season emission records configured as a higher percentage than the annual average that was used in our emissions comparison.

In other words, the MRPO file sometimes had two emission record types that it uses for its modeling; one for the summer period and one for the rest of the year. Since SMOKE uses temporal allocation factors to make this summer/winter split, our converted values do not match MRPO's summertime reports. We see a high percentage difference in the Alpine converted data compared to the MRPO output reports in these two States for the July 12 example for this reason.

Since we confirmed this difference and reason for this difference in the 2005 data sets with MRPO, our objective for QA on the projections also included delta emissions from the projection year to the base year. Although the absolute daily emission values (in tpd) were found to be different as noted above, in all cases, the difference between 2005 and the projection year calculations as made by Alpine was within confidence ranges of the ratio of future year to base year as posted by MRPO. See Table 3 below. For this reason, we were convinced that our projection methodology is capturing the growth and control factors that MRPO applied in its emissions modeling.

Table 3. Emissions Comparison of ASIP Converted and MRPO Non-EGU Emissions.

Comparison of ASIP Converted and MRPO Non-EGU Emissions

		ASIP 2009 Annual Emissions (Tons/Year)						
FIPSST	**State**	**VOC**	**NOX**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
17	Illinois	61,760	85,142	71,725	150,506	20,315	6,256	1,059
18	Indiana	48,287	65,132	339,642	82,040	22,118	12,774	782
26	Michigan	36,753	85,014	67,564	55,435	13,235	6,567	788
39	Ohio	31,530	67,275	212,626	116,942	15,930	10,443	3,239
55	Wisconsin	31,377	36,827	43,014	60,955	456	43	346
	MRPO	**209,707**	**339,390**	**734,570**	**465,878**	**72,054**	**36,082**	**6,214**

		ASIP 2009 July 12 Summer Daily Emissions (Tons/Day)						
FIPSST	**State**	**VOC**	**NOX**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
17	Illinois	222.3	315.1	250.9	412.3	55.6	17.1	2.9
18	Indiana	132.3	178.4	930.5	224.8	60.6	35.0	2.1
26	Michigan	115.8	232.4	193.6	144.9	40.8	19.3	2.4
39	Ohio	86.4	184.3	582.5	320.4	43.6	28.6	8.9
55	Wisconsin	86.0	100.9	117.8	167.0	1.3	0.1	0.9
	MRPO	**642.7**	**1,011.1**	**2,075.4**	**1,269.4**	**202.0**	**100.2**	**17.2**

		2009 July 12 Summer Daily Emissions (Tons/Day)						
FIPSST	**State**	**VOC**	**NOX**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
17	Illinois	218.1	217.8	255.7	335.0	56.0	16.8	2.8
18	Indiana	137.2	175.2	888.8	216.2	60.7	36.5	2.3
26	Michigan	119.1	242.0	206.5	148.6	43.6	20.3	2.4
39	Ohio	87.1	166.3	540.7	288.0	43.0	27.6	8.3
55	Wisconsin	87.7	92.9	120.0	152.1	23.2	0.1	1.0
	MRPO	**649.2**	**894.2**	**2,011.7**	**1,139.9**	**226.5**	**101.3**	**16.8**

		ASIP 2009 July 12 Summer Daily Emissions (% of MRPO Total)						
FIPSST	**State**	**VOC**	**NOX**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
17	Illinois	29.5%	25.1%	9.8%	32.3%	28.2%	17.3%	17.0%
18	Indiana	23.0%	19.2%	46.2%	17.6%	30.7%	35.4%	12.6%
26	Michigan	17.5%	25.0%	9.2%	11.9%	18.4%	18.2%	12.7%
39	Ohio	15.0%	19.8%	28.9%	25.1%	22.1%	28.9%	52.1%
55	Wisconsin	15.0%	10.9%	5.9%	13.1%	0.6%	0.1%	5.6%
	MRPO	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

		2009 July 12 Summer Daily Emissions (% of MRPO Total)						
FIPSST	**State**	**VOC**	**NOX**	**CO**	**SO2**	**PM-10**	**PM-2.5**	**NH3**
17	Illinois	33.6%	24.4%	12.7%	29.4%	24.7%	16.6%	16.7%
18	Indiana	21.1%	19.6%	44.2%	19.0%	26.8%	36.0%	13.7%
26	Michigan	18.3%	27.1%	10.3%	13.0%	19.2%	20.0%	14.3%
39	Ohio	13.4%	18.6%	26.9%	25.3%	19.0%	27.2%	49.4%
55	Wisconsin	13.5%	10.4%	6.0%	13.3%	10.2%	0.1%	6.0%
	MRPO	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

APPENDIX H:

COMPARISON OF EGU CONTROLS FOR COAL AND OIL/GAS UNITS BASED ON IPM MODELING AND STATE-PROVIDED INFORMATION FOR THE BASE G/G2 INVENTORY

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
01033	TVA COLBERT	47	1	0010	010	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	2	0010	011	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	3	0010	012	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	4	0010	013	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	5	0010	014	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
01055	ALABAMA POWER COMPANY GADSDEN	7	1	0002	002	Coal Steam	None	None	None	None	None	None	None	None
01055	ALABAMA POWER COMPANY GADSDEN	7	2	0002	003	Coal Steam	None	None	None	None	None	None	None	None
01063	ALABAMA POWER COMPANY GREENE COUNTY	10	1	0001	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
01063	ALABAMA POWER COMPANY GREENE COUNTY	10	2	0001	003	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
01071	TVA - WIDOWS CREEK	50	1	0008	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	2	0008	003	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	3	0008	004	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	4	0008	005	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	5	0008	006	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	6	0008	007	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	7	0008	008	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
01071	TVA - WIDOWS CREEK	50	8	0008	009	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	4	010730011	001	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	3	010730011	002	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	2	010730011	004	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	1	010730011	005	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01097	ALABAMA POWER COMPANY BARRY	3	1	1001	002	Coal Steam	SNCR	None	SNCR	SCR	None	None	None	None
01097	ALABAMA POWER COMPANY BARRY	3	2	1001	003	Coal Steam	SNCR	None	SNCR	SCR	None	None	None	None
01097	ALABAMA POWER COMPANY BARRY	3	3	1001	004	Coal Steam	SNCR	None	SNCR	SCR	None	None	None	None
01097	ALABAMA POWER COMPANY BARRY	3	4	1001	005	Coal Steam	SNCR	None	SNCR	SCR	None	None	Scrubber	Scrubber
01097	ALABAMA POWER COMPANY BARRY	3	5	1001	006	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	1	0005	002	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	2	0005	003	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	3	0005	004	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	4	0005	005	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	5	0005	006	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
01127	ALABAMA POWER COMPANY GORGAS	8	6	0001	004	Coal Steam	None	None	None	None	None	None	None	None
01127	ALABAMA POWER COMPANY GORGAS	8	7	0001	005	Coal Steam	None	None	None	None	None	None	None	None
01127	ALABAMA POWER COMPANY GORGAS	8	8	0001	006	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
01127	ALABAMA POWER COMPANY GORGAS	8	9	0001	007	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
01127	ALABAMA POWER COMPANY GORGAS	8	10	0001	008	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
01129	ALABAMA ELECTRIC COOP CHARLES R LOWMAN	56	1	0001	002	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
01129	ALABAMA ELECTRIC COOP CHARLES R LOWMAN	56	2	0001	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
01129	ALABAMA ELECTRIC COOP CHARLES R LOWMAN	56	3	0001	004	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12001	GAINESVILLE REGIONAL UTILITIES JOHN R KELLY	664	JRK6			O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12001	GAINESVILLE REGIONAL UTILITIES JOHN R KELLY	664	JRK7			O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12001	GAINESVILLE REGIONAL UTILITIES JOHN R KELLY	664	JRK8	0010005	7		O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12001	CITY OF GAINESVILLE, GRU DEERHAVEN	663	B1	0010006	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12001	CITY OF GAINESVILLE, GRU DEERHAVEN	663	B2	0010006	5	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
12005	GULF POWER COMPANY LANSING SMITH PLANT	643	1	0050014	1	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
12005	GULF POWER COMPANY LANSING SMITH PLANT	643	2	0050014	2	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
12009	FLORIDA POWER & LIGHT (PCC) CAPE CANAVERAL	609	PCC1	0090006	1	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12009	FLORIDA POWER & LIGHT (PCC) CAPE CANAVERAL	609	PCC2	0090006	2	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE1	0110036	1	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE2	0110036	2	O/G Steam	None	None	None	None	None	None	None	None
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE3	0110036	3	O/G Steam	None	None	None	None	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE4	0110036	4	O/G Steam	None	None	None	None	None	None	None	None
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	1	0170004	1	Coal Steam	None	None	None	None	None	None	None	None
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	2	0170004	2	Coal Steam	None	None	None	None	None	None	None	None
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	5	0170004	3	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	4	0170004	4	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	SAINT JOHNS RIVER	207	1	0310045-A	16		SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	SAINT JOHNS RIVER	207	2	0310045-A	17		SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	NORTHSIDE	667	2A	0310045-B	26	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	None	No Operation
12031	NORTHSIDE	667	1A	0310045-B	27	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	None	No Operation
12031	NORTHSIDE	667	3	0310045-B	3	O/G Steam	None	None	None	No Operation	None	None	None	None
12031	CEDAR BAY COGENERATION INC.	10672	GEN1	0310337	1	Coal Steam	None	SNCR	None	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	CEDAR BAY COGENERATION INC.			0310337	2									
12031	CEDAR BAY COGENERATION INC.			0310337	3									
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	1	0330045	1									
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	2	0330045	2	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	3	0330045	3	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	4	0330045	4	Coal Steam	None	None	None	None	None	None	Scrubber	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	5	0330045	5	Coal Steam	None	None	None	None	None	None	Scrubber	None
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	6	0330045	6	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	7	0330045	7	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
12053	Central Power and Lime Incorporated	10333	GEN1	0530021	18	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB01	0570039	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB02	0570039	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB03	0570039	3	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB04	0570039	4	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB01	0570040	1		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB02	0570040	2		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB03	0570040	3		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB04	0570040	4		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB05	0570040	5		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB06	0570040	6		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12061	CITY OF VERO BEACH	693		0610029	1	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12061	CITY OF VERO BEACH	693	3	0610029	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12061	CITY OF VERO BEACH	693	4	0610029	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12063	GULF POWER COMPANY SCHOLZ	642	1	0630014	1	Coal Steam	None	None	None	None	None	None	None	None
12063	GULF POWER COMPANY SCHOLZ	642	2	0630014	2	Coal Steam	None	None	None	None	None	None	None	None
12073	CITY OF TALLAHASSEE ARVAH B.HOPKINS	688	1	0730003	1	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12073	CITY OF TALLAHASSEE ARVAH B.HOPKINS	688	2	0730003	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12081	FLORIDA POWER & LIGHT (PMT) MANATEE POWER	6042	PMT1	0810010	1	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12081	FLORIDA POWER & LIGHT (PMT) MANATEE POWER	6042	PMT2	0810010	2	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12085	FLORIDA POWER & LIGHT (PMR) FPL / MARTIN	6043	PMR1	0850001	1	O/G Steam	None	None	No Operation	No Operation	None	None	No Operation	No Operation
12085	FLORIDA POWER & LIGHT (PMR) FPL / MARTIN	6043	PMR2	0850001	2	O/G Steam	None	None	No Operation	No Operation	None	None	No Operation	No Operation
12085	INDIANTOWN COGENERATION, L.P.	50976	GEN1	0850102	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12086	FLORIDA POWER & LIGHT (PCU) CUTLER POWER	610	PCU5	0250001	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12086	FLORIDA POWER & LIGHT (PCU) CUTLER POWER	610	PCU6	0250001	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12086	FLORIDA POWER & LIGHT (PTF) TURKEY POINT	621	PTP1	0250003	1	O/G Steam	None	None	No Operation	No Operation	None	None	No Operation	No Operation
12086	FLORIDA POWER & LIGHT (PTF) TURKEY POINT	621	PTP2	0250003	2	O/G Steam	None	None	No Operation	No Operation	None	None	No Operation	No Operation
12095	ORLANDO UTILITIES COMMISSION STANTON ENERGY	564	1	0950137	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12095	ORLANDO UTILITIES COMMISSION STANTON ENERGY	564	2	0950137	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12099	FLORIDA POWER & LIGHT (PRV) RIVIERA POWE	619	PRV3	0990042	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12099	FLORIDA POWER & LIGHT (PRV) RIVIERA POWE	619	PRV4	0990042	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12099	CITY OF LAKE WORTH UTILITIES TOM G. SMITH	673	S-1	0990045	7	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12099	CITY OF LAKE WORTH UTILITIES TOM G. SMITH	673	S-3	0990045	9	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12101	PROGRESS ENERGY FLORIDA ANCLOTE	8048	1	1010017	1	O/G Steam	None	None	No Operation	No Operation	None	None	No Operation	No Operation
12101	PROGRESS ENERGY FLORIDA ANCLOTE	8048	2	1010017	2	O/G Steam	None	None	No Operation	No Operation	None	None	No Operation	No Operation
12103	PROGRESS ENERGY FLORIDA BARTOW	634	1	1030011	1	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	No Operation	No Operation
12103	PROGRESS ENERGY FLORIDA BARTOW	634	2	1030011	2	O/G Steam	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12103	PROGRESS ENERGY FLORIDA BARTOW	634	3	1030011	3	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	No Operation	No Operation
12105	LAKELAND ELECTRIC CHARLES LARSEN	675	7	1050003	4	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12105	LAKELAND ELECTRIC C.D. MCINTOSH, JR.	676	3	1050004	6	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12107	SEMINOLE ELECTRIC COOPERATIVE, INC.	136	1	1070025	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12107	SEMINOLE ELECTRIC COOPERATIVE, INC.	136	2	1070025	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12111	FT PIERCE UTILITIES AUTHORITY FT PIERCE	658	7	1110003	7	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12111	FT PIERCE UTILITIES AUTHORITY FT PIERCE	658	8	1110003	8	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12121	PROGRESS ENERGY FLORIDA SUWANNEE RIVER	638	1	1210003	1	O/G Steam	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12121	PROGRESS ENERGY FLORIDA SUWANNEE RIVER	638	2	1210003	2	O/G Steam	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12121	PROGRESS ENERGY FLORIDA SUWANNEE RIVER	638	3	1210003	3	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	No Operation	No Operation
12127	FLORIDA POWER & LIGHT (PSN) SANFORD POWER	620	PSN3	1270009	1	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	**Facility Name**	**ORIS ID**	**BLR ID**	**SITE ID**	**UNIT ID**	**Plant Type**	**VISTAS NOx 2009 Controls**	**IPM NOx 2009 Controls**	**VISTAS NOx 2018 Controls**	**IPM NOx 2018 Controls**	**VISTAS SO2 2009 Controls**	**IPM SO2 2009 Controls**	**VISTAS SO2 2018 Controls**	**IPM SO2 2018 Controls**
12127	FLORIDA POWER & LIGHT (PSN) SANFORD POWER	620	PSN4	1270009	2		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12129	TALLAHASSEE CITY PURDOM GENERATING STATION	689	7	1290001	7	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	1BLR	01500011	SG01	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	2BLR	01500011	SG02	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	3BLR	01500011	SG03	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	4BLR	01500011	SG04	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
13021	ARKWRIGHT	699	1	0002	1		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13021	ARKWRIGHT	699	2	0002	2		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13021	ARKWRIGHT	699	3	0002	3		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13021	ARKWRIGHT	699	4	0002	4		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	1	05100006	SG01	Coal Steam	None	None	None	None	None	None	None	None
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	2	05100006	SG02	Coal Steam	None	None	None	None	None	None	None	None
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	3	05100006	SG03	Coal Steam	None	None	None	SCR	None	None	None	None
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	4	05100006	SG04	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	11	05100018	11	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	12	05100018	12	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	4	05100018	4	O/G Steam	None	None	None	None	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	Post-Combustion Controls VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
13051	RIVERSIDE	734	5	05100018	5	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	6	05100018	6	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13067	GEORGIA POWER COMPANY, MCDONOUGH STEAM	710	MB1	06700003	SGM1	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13067	GEORGIA POWER COMPANY, MCDONOUGH STEAM	710	MB2	06700003	SGM2	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y1BR	07700001	SG01	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y2BR	07700001	SG02	Coal Steam	None	None	None	None	None	None	None	None
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y3BR	07700001	SG03	Coal Steam	None	None	None	None	None	None	None	None
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y4BR	07700001	SG04	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y5BR	07700001	SG05	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y6BR	07700001	SG06	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y7BR	07700001	SG07	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13095	GEORGIA POWER COMPANY, MITCHELL STEAM-ELECTRIC	727		09500002	SG01		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13095	GEORGIA POWER COMPANY, MITCHELL STEAM-ELECTRIC	727		09500002	SG02		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13095	GEORGIA POWER COMPANY, MITCHELL STEAM-ELECTRIC	727	3	09500002	SG03	Coal Steam	None	None	None	None	None	None	None	None
13103	SAVANNAH ELECTRIC: MCINTOSH STEAM - ELECTRIC	6124	1	10300003	SG01	Coal Steam	None	None	None	SCR	None	None	None	None
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	1	11500003	SG01	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	2	11500003	SG02	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	3	11500003	SG03	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	4	11500003	SG04	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
13127	GEORGIA POWER COMPANY, MCMANUS STEAM-ELECTRIC	715	1	12700004	SG01	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13127	GEORGIA POWER COMPANY, MCMANUS STEAM-ELECTRIC	715	2	12700004	SG02	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13149	GEORGIA POWER COMPANY, WANSLEY STEAM-ELECTRIC	6052	1	14900001	SG01	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
13149	GEORGIA POWER COMPANY, WANSLEY STEAM-ELECTRIC	6052	2	14900001	SG02	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	1	20700008	SG01	Coal Steam	None	None	None	None	None	None	Scrubber	None
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	2	20700008	SG02	Coal Steam	None	None	None	None	None	None	Scrubber	None
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	3	20700008	SG03	Coal Steam	None	None	None	None	None	None	Scrubber	None
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	4	20700008	SG04	Coal Steam	None	None	None	None	None	None	Scrubber	None
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	1	23700008	SG01	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	2	23700008	SG02	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	3	23700008	SG03	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	4	23700008	SG04	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
21015	CINCINNATI GAS & ELECTRIC EAST BEND STAT	6018	2	2101500029	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	1	2104100010	001	Coal Steam	SCR	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	2	2104100010	002	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	3	2104100010	003	Coal Steam	SCR	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	4	2104100010	004	Coal Steam	SCR	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	1	2104900003	001	Coal Steam	None	None	None	None	None	None	None	None
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	2	2104900003	002	Coal Steam	None	None	None	None	None	None	None	None
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	3	2104900003	003	Coal Steam	None	None	None	None	None	None	None	None
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	4	2104900003	004	Coal Steam	None	None	None	None	None	None	None	None
21059	OWENSBORO MUNICIPAL UTIL ELMER SMITH STATION	1374	1	2105900027	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21059	OWENSBORO MUNICIPAL UTIL ELMER SMITH STATION	1374	2	2105900027	002	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21091	WESTERN KY ENERGY CORP COLEMAN STATION	1381	C1	2109100003	001	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21091	WESTERN KY ENERGY CORP COLEMAN STATION	1381	C2	2109100003	002	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21091	WESTERN KY ENERGY CORP COLEMAN STATION	1381	C3	2109100003	003	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21101	HENDERSON MUN POW & LIGHT	1372	6	2110100012	002	Coal Steam	None	None	None	None	None	None	None	None
21101	HENDERSON MUN POW & LIGHT	1372	5	2110100012	5	Coal Steam	None	None	None	None	None	None	None	None
21111	LOU GAS & ELEC, CANE RUN	1363	4	0126	04	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, CANE RUN	1363	5	0126	05	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, CANE RUN	1363	6	0126	06	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, MILL CREEK	1364	1	0127	01	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21111	LOU GAS & ELEC, MILL CREEK	1364	2	0127	02	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, MILL CREEK	1364	3	0127	03	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, MILL CREEK	1364	4	0127	04	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21127	KENTUCKY POWER CO BIG SANDY PLANT	1353	BSU1	2112700003	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21127	KENTUCKY POWER CO BIG SANDY PLANT	1353	BSU2	2112700003	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	1	2114500006	001	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	2	2114500006	002	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	3	2114500006	003	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	4	2114500006	004	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	5	2114500006	005	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	6	2114500006	006	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	7	2114500006	007	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	8	2114500006	008	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	9	2114500006	009	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	10	2114500006	016	Coal Steam	None	None	None	None	None	None	None	None
21161	EAST KY POWER COOP SPURLOCK ST. MAYSVILLE	6041	1	2116100009	001	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21161	EAST KY POWER COOP SPURLOCK ST. MAYSVILLE	6041	2	2116100009	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
21167	KENTUCKY UTILITIES CO BROWN FACILITY	1355	1	2116700001	001	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
21167	KENTUCKY UTILITIES CO BROWN FACILITY	1355	2	2116700001	002	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21167	KENTUCKY UTILITIES CO BROWN FACILITY	1355	3	2116700001	003	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21177	KENTUCKY UTILITIES CO GREEN RIVER STATION	1357	4	2117700001	003	Coal Steam	None	None	None	None	None	None	None	None
21177	KENTUCKY UTILITIES CO GREEN RIVER STATION	1357	5	2117700001	004	Coal Steam	None	None	None	None	None	None	None	None
21177	TVA PARADISE STEAM PLANT	1378	1	2117700006	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21177	TVA PARADISE STEAM PLANT	1378	2	2117700006	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21177	TVA PARADISE STEAM PLANT	1378	3	2117700006	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21183	WESTERN KY ENERGY CORP WILSON STATION	6823	W1	2118300069	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21199	EAST KY POWER COOP JOHN SHERMAN COOPER	1384	1	2119900005	001	Coal Steam	None	None	None	None	None	None	None	None
21199	EAST KY POWER COOP JOHN SHERMAN COOPER	1384	2	2119900005	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
21223	LOUISVILLE GAS & ELECTRIC TRIMBLE CO GEN	6071	1	2122300002	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21233	HENDERSON STATION 2	1382	H1	2123300001-A	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21233	HENDERSON STATION 2	1382	H2	2123300001-A	003	Coal Steam	SCR	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21233	WESTERN KY ENERGY CORP REID	1383	R1	2123300001-B	001	Coal Steam	None	None	None	None	None	None	None	None
21233	WESTERN KY ENERGY CORP GREEN STATION	6639	G1	2123300052	001	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	Post-Combustion Controls VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21233	WESTERN KY ENERGY CORP GREEN STATION	6639	G2	2123300052	002	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21239	KENTUCKY UTILITIES TYRONE FACILITY	1361	5	2123900001	005	Coal Steam	None	None	None	None	None	None	None	None
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051	1	2801100031	001	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051		2801100031	002		O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051	2	2801100031	003	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051		2801100031	004		O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28019	CHOCTAW GENERATION LLP, RED HILLS GENERATING	55076	AA001	2801900011	001A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
28019	CHOCTAW GENERATION LLP, RED HILLS GENERATING	55076	AA002	2801900011	001B		None	None	None	None	None	None	None	None
28035	MISSISSIPPI POWER COMPANY, PLANT EATON	2046		2803500038	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28035	MISSISSIPPI POWER COMPANY, PLANT EATON	2046		2803500038	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28035	MISSISSIPPI POWER COMPANY, PLANT EATON	2046		2803500038	003	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	1	2804700055	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	2	2804700055	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	3	2804700055	003	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	4	2804700055	004	Coal Steam	None	SCR	SCR	SCR	None	None	None	Scrubber
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	5	2804700055	005	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	Post-Combustion Controls							
							VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
28049	ENTERGY MISSISSIPPI INC, REX BROWN PLANT	2053	4	2804900112	001	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28049	ENTERGY MISSISSIPPI INC, REX BROWN PLANT	2053	3	2804900112	002	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28059	MISSISSIPPI POWER COMPANY, PLANT DANIEL	6073	1	2805900090	001	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
28059	MISSISSIPPI POWER COMPANY, PLANT DANIEL	6073	2	2805900090	002	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
28067	MOSELLE SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	2070	1	2806700035	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28067	MOSELLE SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	2070	2	2806700035	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28067	MOSELLE SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	2070	3	2806700035	003	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28073	RD MORROW SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	6061	1	2807300021	001	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
28073	RD MORROW SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	6061	2	2807300021	002	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
28075	MISSISSIPPI POWER COMPANY, PLANT SWEATT	2048	1	2807500032	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28075	MISSISSIPPI POWER COMPANY, PLANT SWEATT	2048	2	2807500032	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28083	GREENWOOD UTILITIES, HENDERSON STATION	2062	H1	2808300048	001	O/G Steam	None	None	None	None	No Operation	No Operation	No Operation	No Operation
28083	GREENWOOD UTILITIES, HENDERSON STATION	2062	H3	2808300048	003	O/G Steam	None	None	None	None	No Operation	No Operation	No Operation	No Operation
28149	ENTERGY MISSISSIPPI INC, BAXTER WILSON	2050	1	2814900027	001	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28149	ENTERGY MISSISSIPPI INC, BAXTER WILSON	2050	2	2814900027	002	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
28151	ENTERGY MISSISSIPPI INC, GERALD ANDRUS	8054	1	2815100048	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
28163	YAZOO CITY PUBLIC SERVICE COMMISSION	2067	3	2816300005	001	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
37017	ELIZABETHTOWN POWER, LLC	10380	UNIT1	3701700043	G-17A	Coal Steam	None	None	None	None	None	None	None	None
37017	ELIZABETHTOWN POWER, LLC	10380	UNIT2	3701700043	G-17B		None	None	None	None	None	None	None	None
37019	COGENTRIX OF NORTH CAROLINA INC - SOUTHPORT	10378	GEN1	3701900067	G-29	Coal Steam	None	None	None	None	None	None	None	None
37019	COGENTRIX OF NORTH CAROLINA INC - SOUTHPORT	10378	GEN2	3701900067	G-30	Coal Steam	None	None	None	None	None	None	None	None
37021	CAROLINA POWER & LIGHT ASHEVILLE STEAM	2706	1	628	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37021	CAROLINA POWER & LIGHT ASHEVILLE STEAM	2706	2	628	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37025	KANNAPOLIS ENERGY PARTNERS LLC			3702500113	G-2	Coal Steam	None	None	None	None	None	None	None	None
37025	KANNAPOLIS ENERGY PARTNERS LLC			3702500113	G-3	Coal Steam	None	None	None	None	None	None	None	None
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	3	3703500073	G-1	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	4	3703500073	G-2	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	1	3703500073	G-4	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	2	3703500073	G-5	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37037	PROGRESS ENERGY CAROLINAS CAPE FEAR	2708	5	3703700063	G-1	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	Scrubber
37037	PROGRESS ENERGY CAROLINAS CAPE FEAR	2708	6	3703700063	G-2	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	1	3707100039	G-14	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	2	3707100039	G-15	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	3	3707100039	G-16	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	4	3707100039	G-17	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	5	3707100039	G-18	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	7	3707100040	G-17	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	8	3707100040	G-18	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	9	3707100040	G-19	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	10	3707100040	G-20	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37083	ROANOKE VALLEY ENERGY FACILITY			3708300174	G-27	Coal Steam	None	None	None	None	None	None	None	None
37083	ROANOKE VALLEY ENERGY FACILITY			3708300174	G-7	Coal Steam	None	None	None	None	None	None	None	None
37129	L V SUTTON STEAM ELECTRIC PLANT	2713	1	3712900036	G-187	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37129	L V SUTTON STEAM ELECTRIC PLANT	2713	2	3712900036	G-188	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
37129	L V SUTTON STEAM ELECTRIC PLANT	2713	3	3712900036	G-189	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	1	3714500029	G-29	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	2	3714500029	G-30	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	3A	3714500029	G-35A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	3B	3714500029	G-35B	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	4A	3714500029	G-36A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	4B	3714500029	G-36B	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - MAYO FACILITY	6250	1A	3714500045	G-46A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - MAYO FACILITY	6250	1B	3714500045	G-46B	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37155	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON	2716	1	3715500147	G-24	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37155	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON	2716	2	3715500147	G-25	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37155	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON	2716	3	3715500147	G-26	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37155	LUMBERTON POWER, LLC	10382	UNIT1	3715500166	G-17A	Coal Steam	None	None	None	None	None	None	None	None
37155	LUMBERTON POWER, LLC	10382	UNIT2	3715500166	G-17B		None	None	None	None	None	None	None	None
37157	DUKE ENERGY CORP DAN RIVER STEAM	2723	3	3715700015	G-21	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37157	DUKE ENERGY CORP DAN RIVER STEAM	2723	1	3715700015	G-22	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37157	DUKE ENERGY CORP DAN RIVER STEAM	2723	2	3715700015	G-23	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	5	3715900004	G-1	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	6	3715900004	G-2	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	7	3715900004	G-3	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	8	3715900004	G-4	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	9	3715900004	G-5	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	1	3716100028	G-82	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	2	3716100028	G-83	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	3	3716100028	G-84	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	4	3716100028	G-85	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	5	3716100028	G-86	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	6	3716100028	G-87		No Operation	Not in IPM	SCR	Not in IPM	No Operation	Not in IPM	Scrubber	Not in IPM
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	7	3716100028	G-88		No Operation	Not in IPM	SCR	Not in IPM	No Operation	Not in IPM	Scrubber	Not in IPM
37169	DUKE ENERGY CORP BELEWS CREEK STEAM	8042	1	3716900004	G-17	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37169	DUKE ENERGY CORP BELEWS CREEK STEAM	8042	2	3716900004	G-18	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37191	PROGRESS ENERGY F LEE PLANT	2709	1	3719100017	G-2	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37191	PROGRESS ENERGY F LEE PLANT	2709	2	3719100017	G-3	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37191	PROGRESS ENERGY F LEE PLANT	2709	3	3719100017	G-4	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	None	Scrubber
45003	SCE&G:URQUHART	3295	URQ3	0080-0011	003	Coal Steam	None	None	None	None	None	None	None	None
45003	SCE&G:SRS AREA D			0080-0044	001	Coal Steam	None	None	None	None	None	None	None	None
45003	SCE&G:SRS AREA D			0080-0044	002		None	None	None	None	None	None	None	None
45003	SCE&G:SRS AREA D			0080-0044	003		None	None	None	None	None	None	None	None
45003	SCE&G:SRS AREA D			0080-0044	004		None	None	None	None	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
45007	DUKE ENERGY:LEE	3264	1	0200-0004	001	Coal Steam	None	None	None	None	None	None	None	None
45007	DUKE ENERGY:LEE	3264	2	0200-0004	002	Coal Steam	None	None	None	None	None	None	None	None
45007	DUKE ENERGY:LEE	3264	3	0200-0004	003	Coal Steam	None	None	None	None	None	None	None	None
45015	SANTEE COOPER JEFFERIES	3319	1	0420-0003	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
45015	SANTEE COOPER JEFFERIES	3319	2	0420-0003	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
45015	SANTEE COOPER JEFFERIES	3319	3	0420-0003	003	Coal Steam	None	SCR	None	SCR	None	None	None	None
45015	SANTEE COOPER JEFFERIES	3319	4	0420-0003	004	Coal Steam	None	None	None	None	None	None	None	None
45015	SCE&G:WILLIAMS	3298	WIL1	0420-0006	001	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
45015	SANTEE COOPER CROSS	130	1	0420-0030	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45015	SANTEE COOPER CROSS	130	2	0420-0030	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45015	SANTEE COOPER CROSS	130	3	0420-0030	3	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
45015	SANTEE COOPER CROSS	130	4	0420-0030	4		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
45029	SCE&G:CANADYS	3280	CAN1	0740-0002	001	Coal Steam	None	None	None	None	None	None	None	None
45029	SCE&G:CANADYS	3280	CAN2	0740-0002	002	Coal Steam	None	None	None	None	None	None	None	None
45029	SCE&G:CANADYS	3280	CAN3	0740-0002	003	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
45031	PROGRESS ENERGY ROBINSON STATION	3251	1	0820-0002	001	Coal Steam	None	None	None	None	None	None	None	None
45043	SANTEE COOPER WINYAH	6249	1	1140-0005	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
45043	SANTEE COOPER WINYAH	6249	2	1140-0005	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
45043	SANTEE COOPER WINYAH	6249	3	1140-0005	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45043	SANTEE COOPER WINYAH	6249	4	1140-0005	004	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45051	SANTEE COOPER GRAINGER	3317	1	1340-0003	001	Coal Steam	None	None	None	None	None	None	None	None
45051	SANTEE COOPER GRAINGER	3317	2	1340-0003	002	Coal Steam	None	None	None	None	None	None	None	None
45063	SCE&G:MCMEEKIN	3287	MCM1	1560-0003	001	Coal Steam	None	None	None	None	None	None	None	None
45063	SCE&G:MCMEEKIN	3287	MCM2	1560-0003	002	Coal Steam	None	None	None	None	None	None	None	None
45075	SCE&G:COPE	7210	COP1	1860-0044	001	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
45079	SCE&G:WATEREE	3297	WAT1	1900-0013	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	None
45079	SCE&G:WATEREE	3297	WAT2	1900-0013	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
47001	TVA BULL RUN FOSSIL PLANT	3396	1	0009	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	1	0007	001	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	2	0007	002	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	3	0007	003	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	4	0007	004	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	1	0011	001	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	2	0011	002	Coal Steam	None	SCR	SCR	SCR	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	3	0011	003	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	4	0011	004	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	5	0011	005	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	6	0011	006	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	7	0011	007	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	8	0011	008	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	9	0011	009	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	10	0011	010	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47145	TVA KINGSTON FOSSIL PLANT	3407	1	0013	001	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	2	0013	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	3	0013	003	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	4	0013	004	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	5	0013	005	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	6	0013	006	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	7	0013	007	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	8	0013	008	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	9	0013	009	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
47157	ALLEN FOSSIL PLANT	3393	1	00528	Boilr1	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
47157	ALLEN FOSSIL PLANT	3393	2	00528	Boilr2	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
47157	ALLEN FOSSIL PLANT	3393	3	00528	Boilr3	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
47161	TVA CUMBERLAND FOSSIL PLANT	3399	1	0011	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
47161	TVA CUMBERLAND FOSSIL PLANT	3399	2	0011	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	1	0025	001	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	2	0025	002	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	3	0025	003	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	4	0025	004	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
51031	DOMINION - ALTAVISTA POWER STATION	10773	1	00156	1	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
51031	DOMINION - ALTAVISTA POWER STATION	10773	2	00156	2		None	None	None	None	None	None	None	None
51041	DOMINION - CHESTERFIELD POWER STATION	3797	3	00002	3	Coal Steam	None	None	None	None	None	None	Scrubber	None
51041	DOMINION - CHESTERFIELD POWER STATION	3797	4	00002	4	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
51041	DOMINION - CHESTERFIELD POWER STATION	3797	5	00002	6	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
51041	DOMINION - CHESTERFIELD POWER STATION	3797	6	00002	8	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
51065	DOMINION - BREMO POWER STATION	3796	3	00001	1	Coal Steam	None	None	None	None	None	None	None	None
51065	DOMINION - BREMO POWER STATION	3796	4	00001	2	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	**Facility Name**	**ORIS ID**	**BLR ID**	**SITE ID**	**UNIT ID**	**Plant Type**	**VISTAS NOx 2009 Controls**	**IPM NOx 2009 Controls**	**VISTAS NOx 2018 Controls**	**IPM NOx 2018 Controls**	**VISTAS SO2 2009 Controls**	**IPM SO2 2009 Controls**	**VISTAS SO2 2018 Controls**	**IPM SO2 2018 Controls**
51071	AMERICAN ELECTRIC POWER GLEN LYN	3776	51	00002	1	Coal Steam	None	None	None	None	None	None	None	None
51071	AMERICAN ELECTRIC POWER GLEN LYN	3776	52	00002	2	Coal Steam	None	None	None	None	None	None	None	None
51071	AMERICAN ELECTRIC POWER GLEN LYN	3776	6	00002	3	Coal Steam	None	None	None	None	None	None	None	Scrubber
51083	DOMINION - CLOVER POWER STATION	7213	1	00046	1	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
51083	DOMINION - CLOVER POWER STATION	7213	2	00046	2	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
51099	BIRCHWOOD POWER PARTNERS, L.P.	54304	1	00012	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
51117	Mecklenburg Cogeneration Facility	52007	GEN1	00051	1	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
51117	Mecklenburg Cogeneration Facility	52007	GEN2	00051	2	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
51153	DOMINION - POSSUM POINT	3804	3	00002	3	Coal Steam	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle
51153	DOMINION - POSSUM POINT	3804	4	00002	4	Coal Steam	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle
51153	DOMINION - POSSUM POINT	3804	5	00002	5	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
51153	DOMINION - POSSUM POINT	3804	6	00002		Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle
51167	AMERICAN ELECTRIC POWER CLINCH RIVER PLANT	3775	1	00003	1	Coal Steam	None	None	None	SCR	None	None	None	Scrubber
51167	AMERICAN ELECTRIC POWER CLINCH RIVER PLANT	3775	2	00003	2	Coal Steam	None	None	None	SCR	None	None	None	Scrubber
51167	AMERICAN ELECTRIC POWER CLINCH RIVER PLANT	3775	3	00003	3	Coal Steam	None	None	None	SCR	None	None	None	Scrubber
51175	LG&E Westmoreland Southampton	10774	GEN1	00051	1	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
51175	LG&E Westmoreland Southampton			00051	2		None	None	None	None	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
51175	LG&E Westmoreland Southampton			00051	4		None	None	None	None	None	None	None	None
51199	DOMINION - YORKTOWN POWER STATION	3809	3	00001	3	O/G Steam	SNCR	No Operation	SNCR	No Operation	None	No Operation	Scrubber	No Operation
51199	DOMINION - YORKTOWN POWER STATION	3809	2	00001	5	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
51199	DOMINION - YORKTOWN POWER STATION	3809	1	00001	6	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
51510	POTOMAC RIVER GENERATING STATION	3788	1	00003	1	Coal Steam	SNCR	Coal Early Retirement	SNCR	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement
51510	POTOMAC RIVER GENERATING STATION	3788	2	00003	2	Coal Steam	SNCR	Coal Early Retirement	SNCR	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement
51510	POTOMAC RIVER GENERATING STATION	3788	3	00003	3	Coal Steam	SNCR	None	SNCR	None	None	None	None	None
51510	POTOMAC RIVER GENERATING STATION	3788	4	00003	4	Coal Steam	SNCR	None	SNCR	None	None	None	None	None
51510	POTOMAC RIVER GENERATING STATION	3788	5	00003	5	Coal Steam	SNCR	None	SNCR	None	None	None	None	None
51550	DOMINION - CHESAPEAKE	3803	1	00026	1	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
51550	DOMINION - CHESAPEAKE	3803	2	00026	2	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
51550	DOMINION - CHESAPEAKE	3803	3	00026	3	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
51550	DOMINION - CHESAPEAKE	3803	4	00026	4	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
54023	MOUNT STORM POWER PLANT	3954	1	0003	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54023	MOUNT STORM POWER PLANT	3954	2	0003	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54023	MOUNT STORM POWER PLANT	3954	3	0003	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54023	NORTH BRANCH POWER STATION	7537	1A	0014	001	Coal Steam	None	None	None	None	None	None	None	None

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
54023	NORTH BRANCH POWER STATION	7537	1B	0014	002	Coal Steam	None	None	None	None	None	None	None	None
54033	MONONGAHELA POWER CO HARRISON	3944	1	0015	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54033	MONONGAHELA POWER CO HARRISON	3944	2	0015	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54033	MONONGAHELA POWER CO HARRISON	3944	3	0015	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54039	APPALACHIAN POWER KANAWHA RIVER PLANT	3936	1	0006	001	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54039	APPALACHIAN POWER KANAWHA RIVER PLANT	3936	2	0006	002	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54049	MONONGAHELA POWER CO. RIVESVILLE POWER	3945	7	0009	001	Coal Steam	None	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement
54049	MONONGAHELA POWER CO. RIVESVILLE POWER	3945	8	0009	002	Coal Steam	None	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement
54049	AMERICAN BITUMINOUS POWER GRANT TOWN PLT	10151		0026	001		None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
54049	GRANT TOWN POWER PLANT	10151	GEN1	ORIS10151	GEN1	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
54051	OHIO POWER MITCHELL PLANT	3948	1	0005	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54051	OHIO POWER MITCHELL PLANT	3948	2	0005	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54051	OHIO POWER KAMMER PLANT	3947	1	0006	001	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54051	OHIO POWER KAMMER PLANT	3947	2	0006	002	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54051	OHIO POWER KAMMER PLANT	3947	3	0006	003	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	11	0001	001	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	21	0001	002	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	Post-Combustion Controls							
							VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	31	0001	003	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	41	0001	004	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	51	0001	005	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER MOUNTAINEER PLANT	6264	1	0009		Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54061	MONONGAHELA POWER CO. FORT MARTIN POWER	3943	1	0001	001	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	Scrubber
54061	MONONGAHELA POWER CO. FORT MARTIN POWER	3943	2	0001	002	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	Scrubber
54061	MORGANTOWN ENERGY ASSOCIATES			0027	043		None	None	None	None	None	None	None	None
54061	MORGANTOWN ENERGY FACILITY	10743	GEN1	ORIS10743	GEN1	Coal Steam	None	None	None	None	None	None	None	None
54073	MONONGAHELA POWER CO. WILLOW ISLAND	3946	1	0004	001	Coal Steam	None	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement
54073	MONONGAHELA POWER CO. WILLOW ISLAND	3946	2	0004	002	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54073	MONONGAHELA POWER CO PLEASANTS POWER STATION	6004	1	0005	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54073	MONONGAHELA POWER CO PLEASANTS POWER STATION	6004	2	0005	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber Upgrade	Scrubber
54077	MONONGAHELA POWER CO ALBRIGHT	3942	1	0001	001	Coal Steam	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement
54077	MONONGAHELA POWER CO ALBRIGHT	3942	2	0001	002	Coal Steam	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement
54077	MONONGAHELA POWER CO ALBRIGHT	3942	3	0001	003	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54079	APPALACHIAN POWER JOHN E AMOS PLANT	3935	1	0006	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54079	APPALACHIAN POWER JOHN E AMOS PLANT	3935	2	0006	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX H: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE BASE G/G2 INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
54079	APPALACHIAN POWER JOHN E AMOS PLANT	3935	3	0006	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX I:

COMPARISON OF EGU CONTROLS FOR COAL AND OIL/GAS UNITS BASED ON IPM MODELING AND STATE-PROVIDED INFORMATION FOR THE B&F INVENTORY

APPENDIX I: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE B&F INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
01033	TVA COLBERT	47	1	0010	010	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	2	0010	011	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	3	0010	012	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	4	0010	013	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01033	TVA COLBERT	47	5	0010	014	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
01055	ALABAMA POWER COMPANY GADSDEN	7	1	0002	002	Coal Steam	None	None	None	None	None	None	None	None
01055	ALABAMA POWER COMPANY GADSDEN	7	2	0002	003	Coal Steam	None	None	None	None	None	None	None	None
01063	ALABAMA POWER COMPANY GREENE COUNTY	10	1	0001	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
01063	ALABAMA POWER COMPANY GREENE COUNTY	10	2	0001	003	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
01071	TVA - WIDOWS CREEK	50	1	0008	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	2	0008	003	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	3	0008	004	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	4	0008	005	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	5	0008	006	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	6	0008	007	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
01071	TVA - WIDOWS CREEK	50	7	0008	008	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

APPENDIX I: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE B&F INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
01071	TVA - WIDOWS CREEK	50	8	0008	009	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	4	010730011	001	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	3	010730011	002	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	2	010730011	004	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01073	ALABAMA POWER COMPANY (MILLER POWER PLANT)	6002	1	010730011	005	Coal Steam	SCR All Year	SCR Summer	SCR All Year	SCR Summer	None	None	Scrubber	None
01097	ALABAMA POWER COMPANY BARRY	3	1	1001	002	Coal Steam	SNCR	None	SNCR	SCR	None	None	None	None
01097	ALABAMA POWER COMPANY BARRY	3	2	1001	003	Coal Steam	SNCR	None	SNCR	SCR	None	None	None	None
01097	ALABAMA POWER COMPANY BARRY	3	3	1001	004	Coal Steam	SNCR	None	SNCR	SCR	None	None	None	None
01097	ALABAMA POWER COMPANY BARRY	3	4	1001	005	Coal Steam	SNCR	None	SNCR	SCR	None	None	Scrubber	Scrubber
01097	ALABAMA POWER COMPANY BARRY	3	5	1001	006	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	1	0005	002	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	2	0005	003	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	3	0005	004	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	4	0005	005	Coal Steam	None	SCR	None	SCR	None	None	Scrubber	Scrubber
01117	ALABAMA POWER COMPANY E C GASTON	26	5	0005	006	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber

APPENDIX I: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE B&F INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
01127	ALABAMA POWER COMPANY GORGAS	8	6	0001	004	Coal Steam	None	None	None	None	None	None	None	None
01127	ALABAMA POWER COMPANY GORGAS	8	7	0001	005	Coal Steam	None	None	None	None	None	None	None	None
01127	ALABAMA POWER COMPANY GORGAS	8	8	0001	006	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
01127	ALABAMA POWER COMPANY GORGAS	8	9	0001	007	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
01127	ALABAMA POWER COMPANY GORGAS	8	10	0001	008	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
01129	ALABAMA ELECTRIC COOP CHARLES R LOWMAN	56	1	0001	002	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
01129	ALABAMA ELECTRIC COOP CHARLES R LOWMAN	56	2	0001	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
01129	ALABAMA ELECTRIC COOP CHARLES R LOWMAN	56	3	0001	004	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12001	GAINESVILLE REGIONAL UTILITIES JOHN R KELLY	664	JRK6			O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12001	GAINESVILLE REGIONAL UTILITIES JOHN R KELLY	664	JRK7			O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12001	GAINESVILLE REGIONAL UTILITIES JOHN R KELLY	664	JRK8	0010005	7		O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12001	CITY OF GAINESVILLE, GRU DEERHAVEN	663	B1	0010006	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12001	CITY OF GAINESVILLE, GRU DEERHAVEN	663	B2	0010006	5	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
12005	GULF POWER COMPANY LANSING SMITH PLANT	643	1	0050014	1	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
12005	GULF POWER COMPANY LANSING SMITH PLANT	643	2	0050014	2	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
12009	FLORIDA POWER & LIGHT (PCC) CAPE CANAVERAL	609	PCC1	0090006	1	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation

APPENDIX I: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE B&F INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12009	FLORIDA POWER & LIGHT (PCC) CAPE CANAVERAL	609	PCC2	0090006	2	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE1	0110036	1	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE2	0110036	2	O/G Steam	None	None	None	None	None	None	None	None
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE3	0110036	3	O/G Steam	None	None	None	None	None	None	None	None
12011	FLORIDA POWER & LIGHT (PPE) PORT EVERGLADES	617	PPE4	0110036	4	O/G Steam	None	None	None	None	None	None	None	None
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	1	0170004	1	Coal Steam	None	None	None	None	None	None	None	None
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	2	0170004	2	Coal Steam	None	None	None	None	None	None	None	None
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	5	0170004	3	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
12017	PROGRESS ENERGY FLORIDA CRYSTAL RIVER	628	4	0170004	4	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	SAINT JOHNS RIVER	207	1	0310045-A	16		SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	SAINT JOHNS RIVER	207	2	0310045-A	17		SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	NORTHSIDE	667	2A	0310045-B	26	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12031	NORTHSIDE	667	1A	0310045-B	27	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12031	NORTHSIDE	667	3	0310045-B	3	O/G Steam	None	None	None	No Operation	None	None	None	None
12031	CEDAR BAY COGENERATION INC.	10672	GEN1	0310337	1	Coal Steam	None	SNCR	None	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
12031	CEDAR BAY COGENERATION INC.			0310337	2		None		None					

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12031	CEDAR BAY COGENERATION INC.			0310337	3		None		None					
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	1	0330045	1									
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	2	0330045	2	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	3	0330045	3	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	4	0330045	4	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	5	0330045	5	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	6	0330045	6	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	None	Scrubber	None
12033	GULF POWER COMPANY CRIST ELECTRIC GENERATION	641	7	0330045	7	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
12053	Central Power and Lime Incorporated	10333	GEN1	0530021	18	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB01	0570039	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB02	0570039	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB03	0570039	3	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY BIG BEND STATION	645	BB04	0570039	4	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB01	0570040	1		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB02	0570040	2		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB03	0570040	3		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation

APPENDIX I: EGU CONTROLS FOR COAL AND OIL/GAS UNITS FOR THE B&F INVENTORY

							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB04	0570040	4		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB05	0570040	5		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12057	TAMPA ELECTRIC COMPANY F.J. GANNON STATION	646	GB06	0570040	6		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12061	CITY OF VERO BEACH	693		0610029	1	O/G Steam	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt
12061	CITY OF VERO BEACH	693	3	0610029	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12061	CITY OF VERO BEACH	693	4	0610029	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12063	GULF POWER COMPANY SCHOLZ	642	1	0630014	1	Coal Steam	None	None	Shut Down	None	None	None	Shut Down	None
12063	GULF POWER COMPANY SCHOLZ	642	2	0630014	2	Coal Steam	None	None	Shut Down	None	None	None	Shut Down	None
12073	CITY OF TALLAHASSEE ARVAH B.HOPKINS	688	1	0730003	1	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12073	CITY OF TALLAHASSEE ARVAH B.HOPKINS	688	2	0730003	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12081	FLORIDA POWER & LIGHT (PMT) MANATEE POWER	6042	PMT1	0810010	1	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12081	FLORIDA POWER & LIGHT (PMT) MANATEE POWER	6042	PMT2	0810010	2	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12085	FLORIDA POWER & LIGHT (PMR) FPL / MARTIN	6043	PMR1	0850001	1	O/G Steam	None	None	None	No Operation	None	None	None	No Operation
12085	FLORIDA POWER & LIGHT (PMR) FPL / MARTIN	6043	PMR2	0850001	2	O/G Steam	None	None	None	No Operation	None	None	None	No Operation
12085	INDIANTOWN COGENERATION, L.P.	50976	GEN1	0850102	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12086	FLORIDA POWER & LIGHT (PCU) CUTLER POWER	610	PCU5	0250001	3	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12086	FLORIDA POWER & LIGHT (PCU) CUTLER POWER	610	PCU6	0250001	4	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12086	FLORIDA POWER & LIGHT (PTF) TURKEY POINT	621	PTP1	0250003	1	O/G Steam	None	None	None	No Operation	None	None	None	No Operation
12086	FLORIDA POWER & LIGHT (PTF) TURKEY POINT	621	PTP2	0250003	2	O/G Steam	None	None	None	No Operation	None	None	None	No Operation
12095	ORLANDO UTILITIES COMMISSION STANTON ENERGY	564	1	0950137	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12095	ORLANDO UTILITIES COMMISSION STANTON ENERGY	564	2	0950137	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12099	FLORIDA POWER & LIGHT (PRV) RIVIERA POWE	619	PRV3	0990042	3	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12099	FLORIDA POWER & LIGHT (PRV) RIVIERA POWE	619	PRV4	0990042	4	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12099	CITY OF LAKE WORTH UTILITIES TOM G. SMITH	673	S-1	0990045	7	O/G Steam	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt
12099	CITY OF LAKE WORTH UTILITIES TOM G. SMITH	673	S-3	0990045	9	O/G Steam	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt
12101	PROGRESS ENERGY FLORIDA ANCLOTE	8048	1	1010017	1	O/G Steam	None	None	None	No Operation	None	None	None	No Operation
12101	PROGRESS ENERGY FLORIDA ANCLOTE	8048	2	1010017	2	O/G Steam	None	None	None	No Operation	None	None	None	No Operation
12103	PROGRESS ENERGY FLORIDA BARTOW	634	1	1030011	1	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	No Operation	No Operation
12103	PROGRESS ENERGY FLORIDA BARTOW	634	2	1030011	2	O/G Steam	O/G Early Retireme nt	O/G Early Retireme nt	None	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt
12103	PROGRESS ENERGY FLORIDA BARTOW	634	3	1030011	3	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	No Operation	No Operation
12105	LAKELAND ELECTRIC CHARLES LARSEN	675	7	1050003	4	O/G Steam	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt
12105	LAKELAND ELECTRIC C.D. MCINTOSH, JR.	676	3	1050004	1	Coal Steam	None	Combine d Cycle	None	Combine d Cycle	None	Combine d Cycle	None	Combine d Cycle

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
12105	LAKELAND ELECTRIC C.D. MCINTOSH, JR.	676	3	1050004	5	Coal Steam	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle
12105	LAKELAND ELECTRIC C.D. MCINTOSH, JR.	676	3	1050004	6	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12107	SEMINOLE ELECTRIC COOPERATIVE, INC.	136	1	1070025	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12107	SEMINOLE ELECTRIC COOPERATIVE, INC.	136	2	1070025	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
12111	FT PIERCE UTILITIES AUTHORITY FT PIERCE	658	7	1110003	7	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12111	FT PIERCE UTILITIES AUTHORITY FT PIERCE	658	8	1110003	8	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12121	PROGRESS ENERGY FLORIDA SUWANNEE RIVER	638	1	1210003	1	O/G Steam	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement
12121	PROGRESS ENERGY FLORIDA SUWANNEE RIVER	638	2	1210003	2	O/G Steam	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	None	O/G Early Retirement
12121	PROGRESS ENERGY FLORIDA SUWANNEE RIVER	638	3	1210003	3	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
12127	FLORIDA POWER & LIGHT (PSN) SANFORD POWER	620	PSN3	1270009	1	O/G Steam	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement	O/G Early Retirement
12127	FLORIDA POWER & LIGHT (PSN) SANFORD POWER	620	PSN4	1270009	2		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
12129	TALLAHASSEE CITY PURDOM GENERATING STATION	689	7	1290001	7	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	1BLR	01500011	SG01	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	2BLR	01500011	SG02	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	3BLR	01500011	SG03	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
13015	GEORGIA POWER COMPANY, BOWEN STEAM-ELECT	703	4BLR	01500011	SG04	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
13021	ARKWRIGHT	699	1	0002	1		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13021	ARKWRIGHT	699	2	0002	2		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13021	ARKWRIGHT	699	3	0002	3		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13021	ARKWRIGHT	699	4	0002	4		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	1	05100006	SG01	Coal Steam	None	None	None	None	None	None	None	None
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	2	05100006	SG02	Coal Steam	None	None	None	None	None	None	None	None
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	3	05100006	SG03	Coal Steam	None	None	None	SCR	None	None	None	None
13051	SAVANNAH ELECTRIC: KRAFT STEAM	733	4	05100006	SG04	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	11	05100018	11	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	12	05100018	12	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	4	05100018	4	O/G Steam	None	None	None	None	None	None	None	None
13051	RIVERSIDE	734	5	05100018	5	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13051	RIVERSIDE	734	6	05100018	6	O/G Steam	None	No Operation	No Operation	No Operation	None	No Operation	No Operation	No Operation
13067	GEORGIA POWER COMPANY, MCDONOUGH STEAM	710	MB1	06700003	SGM1	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13067	GEORGIA POWER COMPANY, MCDONOUGH STEAM	710	MB2	06700003	SGM2	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y1BR	07700001	SG01	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y2BR	07700001	SG02	Coal Steam	None	None	None	None	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y3BR	07700001	SG03	Coal Steam	None	None	None	None	None	None	None	None
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y4BR	07700001	SG04	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y5BR	07700001	SG05	Coal Steam	None	None	SCR	SCR	None	None	None	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y6BR	07700001	SG06	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13077	GEORGIA POWER COMPANY, YATES STEAM-ELECTRIC	728	Y7BR	07700001	SG07	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13095	GEORGIA POWER COMPANY, MITCHELL STEAM-ELECTRIC	727		09500002	SG01		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13095	GEORGIA POWER COMPANY, MITCHELL STEAM-ELECTRIC	727		09500002	SG02		No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13095	GEORGIA POWER COMPANY, MITCHELL STEAM-ELECTRIC	727	3	09500002	SG03	Coal Steam	None	None	None	None	None	None	None	None
13103	SAVANNAH ELECTRIC: MCINTOSH STEAM - ELECTRIC	6124	1	10300003	SG01	Coal Steam	None	None	None	SCR	None	None	None	None
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	1	11500003	SG01	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	2	11500003	SG02	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	3	11500003	SG03	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
13115	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC	708	4	11500003	SG04	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
13127	GEORGIA POWER COMPANY, MCMANUS STEAM-ELECTRIC	715	1	12700004	SG01	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13127	GEORGIA POWER COMPANY, MCMANUS STEAM-ELECTRIC	715	2	12700004	SG02	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
13149	GEORGIA POWER COMPANY, WANSLEY STEAM-ELECTRIC	6052	1	14900001	SG01	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
13149	GEORGIA POWER COMPANY, WANSLEY STEAM-ELECTRIC	6052	2	14900001	SG02	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	1	20700008	SG01	Coal Steam	None	None	None	None	None	None	Scrubber	None
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	2	20700008	SG02	Coal Steam	None	None	None	None	None	None	Scrubber	None
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	3	20700008	SG03	Coal Steam	None	None	None	None	None	None	Scrubber	None
13207	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC	6257	4	20700008	SG04	Coal Steam	None	None	None	None	None	None	Scrubber	None
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	1	23700008	SG01	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	2	23700008	SG02	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	3	23700008	SG03	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13237	GEORGIA POWER COMPANY, HARLLEE BRANCH	709	4	23700008	SG04	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
13297	GENERIC UNIT	9001 13	GSC1 3	ORIS900 113	GSC13	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
21015	CINCINNATI GAS & ELECTRIC EAST BEND STAT	6018	2	2101500029	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	1	2104100010	001	Coal Steam	SCR	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	2	2104100010	002	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	3	2104100010	003	Coal Steam	SCR	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21041	KENTUCKY UTILITIES CO GHENT GENERATING STATION	1356	4	2104100010	004	Coal Steam	SCR	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	1	2104900003	001	Coal Steam	None	None	None	None	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	2	2104900003	002	Coal Steam	None	None	None	None	None	None	None	None
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	3	2104900003	003	Coal Steam	None	None	None	None	None	None	None	None
21049	EAST KY POWER COOP WILLIAM C DALE PLANT	1385	4	2104900003	004	Coal Steam	None	None	None	None	None	None	None	None
21059	OWENSBORO MUNICIPAL UTIL ELMER SMITH STATION	1374	1	2105900027	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21059	OWENSBORO MUNICIPAL UTIL ELMER SMITH STATION	1374	2	2105900027	002	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21091	WESTERN KY ENERGY CORP COLEMAN STATION	1381	C1	2109100003	001	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21091	WESTERN KY ENERGY CORP COLEMAN STATION	1381	C2	2109100003	002	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21091	WESTERN KY ENERGY CORP COLEMAN STATION	1381	C3	2109100003	003	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21091	GENERIC UNIT	900121	GSC21	ORIS900121	GSC21	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21101	HENDERSON MUN POW & LIGHT	1372	6	2110100012	002	Coal Steam	None	None	None	None	None	None	None	None
21101	HENDERSON MUN POW & LIGHT	1372	5	2110100012	5	Coal Steam	None	None	None	None	None	None	None	None
21111	LOU GAS & ELEC, CANE RUN	1363	4	0126	04	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, CANE RUN	1363	5	0126	05	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, CANE RUN	1363	6	0126	06	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, MILL CREEK	1364	1	0127	01	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, MILL CREEK	1364	2	0127	02	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21111	LOU GAS & ELEC, MILL CREEK	1364	3	0127	03	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21111	LOU GAS & ELEC, MILL CREEK	1364	4	0127	04	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21127	KENTUCKY POWER CO BIG SANDY PLANT	1353	BSU1	2112700003	001	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
21127	KENTUCKY POWER CO BIG SANDY PLANT	1353	BSU2	2112700003	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	1	2114500006	001	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	2	2114500006	002	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	3	2114500006	003	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	4	2114500006	004	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	5	2114500006	005	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	6	2114500006	006	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	7	2114500006	007	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	8	2114500006	008	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	9	2114500006	009	Coal Steam	None	None	None	None	None	None	None	None
21145	TVA-ENVIRONMENTAL AFFAIRS SHAWNEE PLANT	1379	10	2114500006	016	Coal Steam	None	None	None	None	None	None	None	None
21161	EAST KY POWER COOP SPURLOCK ST. MAYSVILLE	6041	1	2116100009	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21161	EAST KY POWER COOP SPURLOCK ST. MAYSVILLE	6041	2	2116100009	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21167	KENTUCKY UTILITIES CO BROWN FACILITY	1355	1	2116700001	001	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
21167	KENTUCKY UTILITIES CO BROWN FACILITY	1355	2	2116700001	002	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21167	KENTUCKY UTILITIES CO BROWN FACILITY	1355	3	2116700001	003	Coal Steam	None	None	SCR	SCR	Scrubber	None	Scrubber	Scrubber
21177	KENTUCKY UTILITIES CO GREEN RIVER STATION	1357	4	2117700001	003	Coal Steam	None	None	None	None	None	None	None	None
21177	KENTUCKY UTILITIES CO GREEN RIVER STATION	1357	5	2117700001	004	Coal Steam	None	None	None	None	None	None	None	None
21177	TVA PARADISE STEAM PLANT	1378	1	2117700006	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21177	TVA PARADISE STEAM PLANT	1378	2	2117700006	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21177	TVA PARADISE STEAM PLANT	1378	3	2117700006	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21183	WESTERN KY ENERGY CORP WILSON STATION	6823	W1	2118300069	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21199	EAST KY POWER COOP JOHN SHERMAN COOPER	1384	1	2119900005	001	Coal Steam	None	None	None	None	None	None	Scrubber	None
21199	EAST KY POWER COOP JOHN SHERMAN COOPER	1384	2	2119900005	002	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
21223	LOUISVILLE GAS & ELECTRIC TRIMBLE CO GEN	6071	1	2122300002	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21233	HENDERSON STATION 2	1382	H1	2123300001 -A	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21233	HENDERSON STATION 2	1382	H2	2123300001 -A	003	Coal Steam	SCR	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21233	WESTERN KY ENERGY CORP REID	1383	R1	2123300001 -B	001	Coal Steam	None	None	None	None	None	None	None	None
21233	WESTERN KY ENERGY CORP GREEN STATION	6639	G1	2123300052	001	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
21233	WESTERN KY ENERGY CORP GREEN STATION	6639	G2	2123300052	002	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
21239	KENTUCKY UTILITIES TYRONE FACILITY	1361	5	2123900001	005	Coal Steam	None	None	None	None	None	None	None	None
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051	1	2801100031	001	O/G Steam	None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051		2801100031	002		None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051	2	2801100031	003	O/G Steam	None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement
28011	ENTERGY MISSISSIPPI INC, DELTA PLANT	2051		2801100031	004		None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement	None	O/G Early Retirement
28019	CHOCTAW GENERATION LLP, RED HILLS GENERATING	55076	AA001	2801900011	001A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
28019	CHOCTAW GENERATION LLP, RED HILLS GENERATING	55076	AA002	2801900011	001B									
28035	MISSISSIPPI POWER COMPANY, PLANT EATON	2046		2803500038	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28035	MISSISSIPPI POWER COMPANY, PLANT EATON	2046		2803500038	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28035	MISSISSIPPI POWER COMPANY, PLANT EATON	2046		2803500038	003	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	1	2804700055	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	2	2804700055	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	3	2804700055	003	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	4	2804700055	004	Coal Steam	None	SCR	SCR	SCR	None	None	None	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
28047	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	2049	5	2804700055	005	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
28049	ENTERGY MISSISSIPPI INC, REX BROWN PLANT	2053	4	2804900112	001	O/G Steam	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt
28049	ENTERGY MISSISSIPPI INC, REX BROWN PLANT	2053	3	2804900112	002	O/G Steam	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt
28059	MISSISSIPPI POWER COMPANY, PLANT DANIEL	6073	1	2805900090	001	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
28059	MISSISSIPPI POWER COMPANY, PLANT DANIEL	6073	2	2805900090	002	Coal Steam	None	SCR	SCR	SCR	None	None	Scrubber	Scrubber
28067	MOSELLE SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	2070	1	2806700035	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28067	MOSELLE SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	2070	2	2806700035	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28067	MOSELLE SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	2070	3	2806700035	003	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28073	RD MORROW SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	6061	1	2807300021	001	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
28073	RD MORROW SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION	6061	2	2807300021	002	Coal Steam	None	None	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
28075	MISSISSIPPI POWER COMPANY, PLANT SWEATT	2048	1	2807500032	001	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28075	MISSISSIPPI POWER COMPANY, PLANT SWEATT	2048	2	2807500032	002	O/G Steam	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation	No Operation
28083	GREENWOOD UTILITIES, HENDERSON STATION	2062	H1	2808300048	001	O/G Steam	None	None	None	None	No Operation	No Operation	No Operation	No Operation
28083	GREENWOOD UTILITIES, HENDERSON STATION	2062	H3	2808300048	003	O/G Steam	None	None	None	None	No Operation	No Operation	No Operation	No Operation
28149	ENTERGY MISSISSIPPI INC, BAXTER WILSON	2050	1	2814900027	001	O/G Steam	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
28149	ENTERGY MISSISSIPPI INC, BAXTER WILSON	2050	2	2814900027	002	O/G Steam	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt	None	O/G Early Retireme nt
28151	ENTERGY MISSISSIPPI INC, GERALD ANDRUS	8054	1	2815100048	001	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
28163	YAZOO CITY PUBLIC SERVICE COMMISSION	2067	3	2816300005	001	O/G Steam	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt	O/G Early Retireme nt
37017	ELIZABETHTOWN POWER, LLC	10380	UNIT1	3701700043	G-17A	Coal Steam	None	None	None	None	None	None	None	None
37017	ELIZABETHTOWN POWER, LLC	10380	UNIT2	3701700043	G-17B		None	None	None	None	None	None	None	None
37019	COGENTRIX OF NORTH CAROLINA INC - SOUTHPORT	10378	GEN1	3701900067	G-29	Coal Steam	None	None	None	None	None	None	None	None
37019	COGENTRIX OF NORTH CAROLINA INC - SOUTHPORT	10378	GEN2	3701900067	G-30	Coal Steam	None	None	None	None	None	None	None	None
37021	CAROLINA POWER & LIGHT ASHEVILLE STEAM	2706	1	628	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37021	CAROLINA POWER & LIGHT ASHEVILLE STEAM	2706	2	628	2	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37025	KANNAPOLIS ENERGY PARTNERS LLC			3702500113	G-2	Coal Steam	None	None	None	None	None	None	None	None
37025	KANNAPOLIS ENERGY PARTNERS LLC			3702500113	G-3	Coal Steam	None	None	None	None	None	None	None	None
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	3	3703500073	G-1	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	4	3703500073	G-2	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	1	3703500073	G-4	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37035	DUKE ENERGY CORPORATION MARSHALL STEAM	2727	2	3703500073	G-5	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37037	PROGRESS ENERGY CAROLINAS CAPE FEAR	2708	5	3703700063	G-1	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Furnace Sorbent Injection	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
37037	PROGRESS ENERGY CAROLINAS CAPE FEAR	2708	6	3703700063	G-2	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Furnace Sorbent Injection	Scrubber
37045	GENERIC UNIT	9001 37	GSC3 7	ORIS900 137	GSC37	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
37055	GENERIC UNIT	9002 37	GSC3 7	ORIS900 237	GSC37	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
37055	GENERIC UNIT	9003 37	GSC3 7	ORIS900 337	GSC37	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
37061	GENERIC UNIT	9004 37	GSC3 7	ORIS900 437	GSC37	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
37083	GENERIC UNIT	9005 37	GSC3 7	ORIS900 537	GSC37	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
37083	GENERIC UNIT	9006 37	GSC3 7	ORIS900 637	GSC37	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	1	3707100039	G-14	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	2	3707100039	G-15	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	3	3707100039	G-16	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	4	3707100039	G-17	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION ALLEN STEAM	2718	5	3707100039	G-18	Coal Steam	SNCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	7	3707100040	G-17	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	8	3707100040	G-18	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	9	3707100040	G-19	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37071	DUKE ENERGY CORPORATION RIVERBEND STEAM	2732	10	3707100040	G-20	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
37083	ROANOKE VALLEY ENERGY FACILITY			3708300174	G-27	Coal Steam	None	None	None	None	None	None	None	None
37083	ROANOKE VALLEY ENERGY FACILITY			3708300174	G-7	Coal Steam	None	None	None	None	None	None	None	None
37129	L V SUTTON STEAM ELECTRIC PLANT	2713	1	3712900036	G-187	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37129	L V SUTTON STEAM ELECTRIC PLANT	2713	2	3712900036	G-188	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
37129	L V SUTTON STEAM ELECTRIC PLANT	2713	3	3712900036	G-189	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	1	3714500029	G-29	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	2	3714500029	G-30	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	3A	3714500029	G-35A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	3B	3714500029	G-35B	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	4A	3714500029	G-36A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - ROXBORO STEAM ELECTRIC PLANT	2712	4B	3714500029	G-36B	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - MAYO FACILITY	6250	1A	3714500045	G-46A	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37145	CP&L - MAYO FACILITY	6250	1B	3714500045	G-46B	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37155	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON	2716	1	3715500147	G-24	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37155	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON	2716	2	3715500147	G-25	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37155	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON	2716	3	3715500147	G-26	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
37155	LUMBERTON POWER, LLC	10382	UNIT1	3715500166	G-17A	Coal Steam	None	None	None	None	None	None	None	None
37155	LUMBERTON POWER, LLC	10382	UNIT2	3715500166	G-17B		None	None	None	None	None	None	None	None
37157	DUKE ENERGY CORP DAN RIVER STEAM	2723	3	3715700015	G-21	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37157	DUKE ENERGY CORP DAN RIVER STEAM	2723	1	3715700015	G-22	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37157	DUKE ENERGY CORP DAN RIVER STEAM	2723	2	3715700015	G-23	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	5	3715900004	G-1	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	6	3715900004	G-2	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	7	3715900004	G-3	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	8	3715900004	G-4	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37159	DUKE ENERGY CORPORATION BUCK STEAM	2720	9	3715900004	G-5	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	1	3716100028	G-82	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	2	3716100028	G-83	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	3	3716100028	G-84	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	4	3716100028	G-85	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	5	3716100028	G-86	Coal Steam	SCR	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
37161	DUKE ENERGY CORPORATION	2721	6	3716100028	G-87	Coal Steam	No Operation	Not in IPM	SCR	Not in IPM	No Operation	Not in IPM	Scrubber	Not in IPM

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
	CLIFFSIDE STEAM													
37161	DUKE ENERGY CORPORATION CLIFFSIDE STEAM	2721	7	3716100028	G-88		No Operation	Not in IPM	No Operation	Not in IPM	No Operation	Not in IPM	No Operation	Not in IPM
37169	DUKE ENERGY CORP BELEWS CREEK STEAM	8042	1	3716900004	G-17	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37169	DUKE ENERGY CORP BELEWS CREEK STEAM	8042	2	3716900004	G-18	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
37191	PROGRESS ENERGY F LEE PLANT	2709	1	3719100017	G-2	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37191	PROGRESS ENERGY F LEE PLANT	2709	2	3719100017	G-3	Coal Steam	None	SNCR	SNCR	SNCR	None	None	None	None
37191	PROGRESS ENERGY F LEE PLANT	2709	3	3719100017	G-4	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	None	Scrubber
45003	SCE&G:URQUHART	3295	URQ3	0080-0011	003	Coal Steam	None	None	None	None	None	None	None	None
45003	SCE&G:SRS AREA D			0080-0044	001	Coal Steam	None	None	None	None	None	None	None	None
45003	SCE&G:SRS AREA D			0080-0044	002		None	None	None	None				
45003	SCE&G:SRS AREA D			0080-0044	003		None	None	None	None				
45003	SCE&G:SRS AREA D			0080-0044	004		None	None	None	None				
45007	DUKE ENERGY:LEE	3264	1	0200-0004	001	Coal Steam	None	None	None	None	None	None	None	None
45007	DUKE ENERGY:LEE	3264	2	0200-0004	002	Coal Steam	None	None	None	None	None	None	None	None
45007	DUKE ENERGY:LEE	3264	3	0200-0004	003	Coal Steam	None	None	None	None	None	None	None	None
45015	SANTEE COOPER JEFFERIES	3319	1	0420-0003	001	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	None	No Operation

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
45015	SANTEE COOPER JEFFERIES	3319	2	0420-0003	002	O/G Steam	No Operation	No Operation	None	No Operation	No Operation	No Operation	None	No Operation
45015	SANTEE COOPER JEFFERIES	3319	3	0420-0003	003	Coal Steam	None	SCR	None	SCR	None	None	None	None
45015	SANTEE COOPER JEFFERIES	3319	4	0420-0003	004	Coal Steam	None	None	None	None	None	None	None	None
45015	SCE&G:WILLIAMS	3298	WIL1	0420-0006	001	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
45015	SANTEE COOPER CROSS	130	1	0420-0030	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45015	SANTEE COOPER CROSS	130	2	0420-0030	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45015	SANTEE COOPER CROSS	130	3	0420-0030	3	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
45015	SANTEE COOPER CROSS	130	4	0420-0030	4	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
45029	SCE&G:CANADYS	3280	CAN1	0740-0002	001	Coal Steam	None	None	None	None	None	None	None	None
45029	SCE&G:CANADYS	3280	CAN2	0740-0002	002	Coal Steam	None	None	None	None	None	None	None	None
45029	SCE&G:CANADYS	3280	CAN3	0740-0002	003	Coal Steam	None	None	None	None	Scrubber	None	Scrubber	None
45031	PROGRESS ENERGY ROBINSON STATION	3251	1	0820-0002	001	Coal Steam	None	None	None	None	None	None	None	None
45043	SANTEE COOPER WINYAH	6249	1	1140-0005	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
45043	SANTEE COOPER WINYAH	6249	2	1140-0005	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
45043	SANTEE COOPER WINYAH	6249	3	1140-0005	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45043	SANTEE COOPER WINYAH	6249	4	1140-0005	004	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
45051	SANTEE COOPER GRAINGER	3317	1	1340-0003	001	Coal Steam	None	None	None	None	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
45051	SANTEE COOPER GRAINGER	3317	2	1340-0003	002	Coal Steam	None	None	None	None	None	None	None	None
45063	SCE&G:MCMEEKIN	3287	MCM1	1560-0003	001	Coal Steam	None	None	None	None	None	None	None	None
45063	SCE&G:MCMEEKIN	3287	MCM2	1560-0003	002	Coal Steam	None	None	None	None	None	None	None	None
45075	SCE&G:COPE	7210	COP1	1860-0044	001	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
45079	SCE&G:WATEREE	3297	WAT1	1900-0013	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	None
45079	SCE&G:WATEREE	3297	WAT2	1900-0013	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	None	Scrubber	Scrubber
45029	GENERIC UNIT	900145	GSC45	ORIS900145	GSC45	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
45031	GENERIC UNIT	900245	GSC45	ORIS900245	GSC45	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
45031	GENERIC UNIT	900345	GSC45	ORIS900345	GSC45	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
45039	GENERIC UNIT	900445	GSC45	ORIS900445	GSC45	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
45043	GENERIC UNIT	900545	GSC45	ORIS900545	GSC45	Coal Steam	No Operation	No Operation	Cross Unit 4	SCR	No Operation	No Operation	Cross Unit 4	Scrubber
47001	TVA BULL RUN FOSSIL PLANT	3396	1	0009	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	1	0007	001	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	2	0007	002	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	3	0007	003	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47073	TVA JOHN SEVIER FOSSIL PLANT	3405	4	0007	004	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	1	0011	001	Coal Steam	None	SCR	SCR	SCR	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	2	0011	002	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	3	0011	003	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	4	0011	004	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	5	0011	005	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	6	0011	006	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	7	0011	007	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	8	0011	008	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	9	0011	009	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47085	TVA JOHNSONVILLE FOSSIL PLANT	3406	10	0011	010	Coal Steam	None	SCR	SCR	SCR	None	None	None	None
47145	TVA KINGSTON FOSSIL PLANT	3407	1	0013	001	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	2	0013	002	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	3	0013	003	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	4	0013	004	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	5	0013	005	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	6	0013	006	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	7	0013	007	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber
47145	TVA KINGSTON FOSSIL PLANT	3407	8	0013	008	Coal Steam	SCR	SCR	SCR	SCR	None	None	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
47145	TVA KINGSTON FOSSIL PLANT	3407	9	0013	009	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
47157	ALLEN FOSSIL PLANT	3393	1	00528	Boilr1	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
47157	ALLEN FOSSIL PLANT	3393	2	00528	Boilr2	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
47157	ALLEN FOSSIL PLANT	3393	3	00528	Boilr3	Coal Steam	SCR	SCR	SCR	SCR	None	None	None	None
47161	TVA CUMBERLAND FOSSIL PLANT	3399	1	0011	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
47161	TVA CUMBERLAND FOSSIL PLANT	3399	2	0011	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	1	0025	001	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	2	0025	002	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	3	0025	003	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
47165	TVA GALLATIN FOSSIL PLANT	3403	4	0025	004	Coal Steam	None	None	None	None	None	None	Scrubber	Scrubber
51031	DOMINION - ALTAVISTA POWER STATION	10773	1	00156	1	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
51031	DOMINION - ALTAVISTA POWER STATION	10773	2	00156	2		0	0	0	0	0	0	0	0
51041	DOMINION - CHESTERFIELD POWER STATION	3797	3	00002	3	Coal Steam	None	None	None	None	None	None	Scrubber	None
51041	DOMINION - CHESTERFIELD POWER STATION	3797	4	00002	4	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
51041	DOMINION - CHESTERFIELD POWER STATION	3797	5	00002	6	Coal Steam	SCR	None	SCR	SCR	None	None	Scrubber	Scrubber
51041	DOMINION - CHESTERFIELD POWER STATION	3797	6	00002	8	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
51065	DOMINION - BREMO POWER STATION	3796	3	00001	1	Coal Steam	None	None	None	None	None	None	None	None

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
51065	DOMINION - BREMO POWER STATION	3796	4	00001	2	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	None	None
51071	AMERICAN ELECTRIC POWER GLEN LYN	3776	51	00002	1	Coal Steam	None	None	None	None	None	None	None	None
51071	AMERICAN ELECTRIC POWER GLEN LYN	3776	52	00002	2	Coal Steam	None	None	None	None	None	None	None	None
51071	AMERICAN ELECTRIC POWER GLEN LYN	3776	6	00002	3	Coal Steam	None	None	None	None	None	None	None	Scrubber
51083	DOMINION - CLOVER POWER STATION	7213	1	00046	1	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
51083	DOMINION - CLOVER POWER STATION	7213	2	00046	2	Coal Steam	SNCR	SNCR	SNCR	SNCR	Scrubber	Scrubber	Scrubber	Scrubber
51099	BIRCHWOOD POWER PARTNERS, L.P.	54304	1	00012	1	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
51117	Mecklenburg Cogeneration Facility	52007	GEN1	00051	1	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
51117	Mecklenburg Cogeneration Facility	52007	GEN2	00051	2	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
51153	DOMINION - POSSUM POINT	3804	3	00002	3	Coal Steam	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle
51153	DOMINION - POSSUM POINT	3804	4	00002	4	Coal Steam	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle	None	Combined Cycle
51153	DOMINION - POSSUM POINT	3804	5	00002	5	O/G Steam	None	No Operation	None	No Operation	None	No Operation	None	No Operation
51153	DOMINION - POSSUM POINT	3804	6	00002		Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle	Combined Cycle
51167	AMERICAN ELECTRIC POWER CLINCH RIVER PLANT	3775	1	00003	1	Coal Steam	None	None	SNCR	SCR	None	None	Emission Cap	Scrubber
51167	AMERICAN ELECTRIC POWER CLINCH RIVER PLANT	3775	2	00003	2	Coal Steam	None	None	SNCR	SCR	None	None	Emission Cap	Scrubber
51167	AMERICAN ELECTRIC POWER CLINCH RIVER PLANT	3775	3	00003	3	Coal Steam	None	None	SNCR	SCR	None	None	Emission Cap	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
51175	LG&E Westmoreland Southampton	10774	GEN1	00051	1	Coal Steam	None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
51175	LG&E Westmoreland Southampton			00051	2		None	None	None	None	0	0	0	0
51175	LG&E Westmoreland Southampton			00051	4		None	None	None	None	0	0	0	0
51199	DOMINION - YORKTOWN POWER STATION	3809	3	00001	3	O/G Steam	SNCR	No Operation	SNCR	No Operation	None	No Operation	Scrubber	No Operation
51199	DOMINION - YORKTOWN POWER STATION	3809	2	00001	5	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
51199	DOMINION - YORKTOWN POWER STATION	3809	1	00001	6	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	None
51510	POTOMAC RIVER GENERATING STATION	3788	1	00003	1	Coal Steam	SNCR	Coal Early Retirement	SNCR	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement
51510	POTOMAC RIVER GENERATING STATION	3788	2	00003	2	Coal Steam	SNCR	Coal Early Retirement	SNCR	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement
51510	POTOMAC RIVER GENERATING STATION	3788	3	00003	3	Coal Steam	SNCR	None	SNCR	None	None	None	None	None
51510	POTOMAC RIVER GENERATING STATION	3788	4	00003	4	Coal Steam	SNCR	None	SNCR	None	None	None	None	None
51510	POTOMAC RIVER GENERATING STATION	3788	5	00003	5	Coal Steam	SNCR	None	SNCR	None	None	None	None	None
51550	DOMINION - CHESAPEAKE	3803	1	00026	1	Coal Steam	SNCR	SNCR	SNCR	SNCR	Low S Coal	None	Scrubber	None
51550	DOMINION - CHESAPEAKE	3803	2	00026	2	Coal Steam	SNCR	SNCR	SNCR	SNCR	Low S Coal	None	Scrubber	None
51550	DOMINION - CHESAPEAKE	3803	3	00026	3	Coal Steam	SCR	None	SCR	SCR	Low S Coal	None	Scrubber	Scrubber
51550	DOMINION - CHESAPEAKE	3803	4	00026	4	Coal Steam	SCR	None	SCR	SCR	Low S Coal	None	Scrubber	Scrubber
51159	GENERIC UNIT	900151	GSC51	ORIS900151	GSC51	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
51167	GENERIC UNIT	900251	GSC51	ORIS900251	GSC51	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
51195	GENERIC UNIT	900251	GSC51	ORIS900251	GSC51	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
51175	GENERIC UNIT	900351	GSC51	ORIS900351	GSC51	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
51175	GENERIC UNIT	900451	GSC51	ORIS900451	GSC51	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
51181	GENERIC UNIT	900551	GSC51	ORIS900551	GSC51	Coal Steam	No Operation	No Operation	SCR	SCR	No Operation	No Operation	Scrubber	Scrubber
54023	MOUNT STORM POWER PLANT	3954	1	0003	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54023	MOUNT STORM POWER PLANT	3954	2	0003	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54023	MOUNT STORM POWER PLANT	3954	3	0003	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54023	NORTH BRANCH POWER STATION	7537	1A	0014	001	Coal Steam	None	None	None	None	None	None	None	None
54023	NORTH BRANCH POWER STATION	7537	1B	0014	002	Coal Steam	None	None	None	None	None	None	None	None
54025	WESTERN GREENBRIER			00066	GEN1	Coal Steam	No Operation	No Operation	SCR	No Operation	No Operation	No Operation	SCR	No Operation
54033	MONONGAHELA POWER CO HARRISON	3944	1	0015	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54033	MONONGAHELA POWER CO HARRISON	3944	2	0015	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54033	MONONGAHELA POWER CO HARRISON	3944	3	0015	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54039	APPALACHIAN POWER KANAWHA RIVER PLANT	3936	1	0006	001	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54039	APPALACHIAN POWER KANAWHA RIVER PLANT	3936	2	0006	002	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54049	MONONGAHELA POWER CO. RIVESVILLE POWER	3945	7	0009	001	Coal Steam	None	Coal Early	None	Coal Early	None	Coal Early	Coal Early	Coal Early

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
								Retirement		Retirement		Retirement	Retirement	Retirement
54049	MONONGAHELA POWER CO. RIVESVILLE POWER	3945	8	0009	002	Coal Steam	None	Coal Early Retirement	None	Coal Early Retirement	None	Coal Early Retirement	Coal Early Retirement	Coal Early Retirement
54049	AMERICAN BITUMINOUS POWER GRANT TOWN PLT	10151		0026	001		None	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
54049	GRANT TOWN POWER PLANT	10151	GEN1	ORIS10151	GEN1	Coal Steam	SNCR	None	None	None	Scrubber	Scrubber	Scrubber	Scrubber
54051	OHIO POWER MITCHELL PLANT	3948	1	0005	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54051	OHIO POWER MITCHELL PLANT	3948	2	0005	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54051	OHIO POWER KAMMER PLANT	3947	1	0006	001	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54051	OHIO POWER KAMMER PLANT	3947	2	0006	002	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54051	OHIO POWER KAMMER PLANT	3947	3	0006	003	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	11	0001	001	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	21	0001	002	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	31	0001	003	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	41	0001	004	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER CO. PHILIP SPORN PLANT	3938	51	0001	005	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54053	APPALACHIAN POWER MOUNTAINEER PLANT	6264	1	0009		Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54061	MONONGAHELA POWER CO. FORT MARTIN POWER	3943	1	0001	001	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	Scrubber

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							Post-Combustion Controls							
FIPS	Facility Name	ORIS ID	BLR ID	SITE ID	UNIT ID	Plant Type	VISTAS NOx 2009 Controls	IPM NOx 2009 Controls	VISTAS NOx 2018 Controls	IPM NOx 2018 Controls	VISTAS SO2 2009 Controls	IPM SO2 2009 Controls	VISTAS SO2 2018 Controls	IPM SO2 2018 Controls
54061	MONONGAHELA POWER CO. FORT MARTIN POWER	3943	2	0001	002	Coal Steam	SNCR	SNCR	SNCR	SNCR	None	None	Scrubber	Scrubber
54061	MORGANTOWN ENERGY ASSOCIATES			0027	043		None	None	None	None	None	None	None	None
54061	MORGANTOWN ENERGY FACILITY	10743	GEN1	ORIS10743	GEN1	Coal Steam	None	None	None	None	None	None	None	None
54061	LONGVIEW			00134	GEN1	Coal Steam	No Operation	No Operation	SCR	No Operation	No Operation	No Operation	Scrubber	No Operation
54061	GENERIC UNIT	9001 54	GSC5 4	ORIS900 154	GSC54	Coal Steam	No Operation	No Operation	No Operation	SCR	No Operation	No Operation	No Operation	Scrubber
54073	MONONGAHELA POWER CO. WILLOW ISLAND	3946	1	0004	001	Coal Steam	None	Coal Early Retireme nt	None	Coal Early Retireme nt	None	Coal Early Retireme nt	Coal Early Retireme nt	Coal Early Retireme nt
54073	MONONGAHELA POWER CO. WILLOW ISLAND	3946	2	0004	002	Coal Steam	None	SCR	SCR	SCR	None	Scrubber	Scrubber	Scrubber
54073	MONONGAHELA POWER CO PLEASANTS POWER STATION	6004	1	0005	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
54073	MONONGAHELA POWER CO PLEASANTS POWER STATION	6004	2	0005	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber Upgrade	Scrubber	Scrubber Upgrade	Scrubber
54077	MONONGAHELA POWER CO ALBRIGHT	3942	1	0001	001	Coal Steam	None	Coal Early Retireme nt	Coal Early Retireme nt	Coal Early Retireme nt	None	Coal Early Retireme nt	Coal Early Retireme nt	Coal Early Retireme nt
54077	MONONGAHELA POWER CO ALBRIGHT	3942	2	0001	002	Coal Steam	None	Coal Early Retireme nt	Coal Early Retireme nt	Coal Early Retireme nt	None	Coal Early Retireme nt	Coal Early Retireme nt	Coal Early Retireme nt
54077	MONONGAHELA POWER CO ALBRIGHT	3942	3	0001	003	Coal Steam	None	None	SCR	SCR	None	None	Scrubber	Scrubber
54079	APPALACHIAN POWER JOHN E AMOS PLANT	3935	1	0006	001	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54079	APPALACHIAN POWER JOHN E AMOS PLANT	3935	2	0006	002	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber
54079	APPALACHIAN POWER JOHN E AMOS PLANT	3935	3	0006	003	Coal Steam	SCR	SCR	SCR	SCR	Scrubber	Scrubber	Scrubber	Scrubber

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MEMORANDUM

To: VISTAS State Point Source Contacts and VISTAS EGU Special Interest Workgroup
From: Gregory Stella, VISTAS Technical Advisor - Emission Inventories
Date: June 13, 2005
Re: EGU Emission Factors and Emission Factor Assignment

Purpose

The purpose of this memorandum is to discuss the differences currently known to exist in the base year (2002) and future year (2009 and 2018) forecasts of EGU emission factors for PM and NH3. In particular, it has been identified that E.H. Pechan & Associates, Inc. (Pechan) in their development of post-processed IPM output into NIF structure uses a set of PM and NH3 emission factors that are "the most recent EPA approved uncontrolled emission factors" and which are most likely not the same emission factors used by States and emission inventory preparation contractors for estimating these emissions in 2002 for EGUs in the VISTAS domain. Additionally, through review of the code used to post-process the IPM parsed files, it has also been determined that emission factors are assigned in future years based on Pechan assigned SCCs and not necessarily initial base year SCCs as coded in the original VISTAS NIF files.

A second objective of this memorandum is to propose a resolution to the issues at hand and to recommend a set of modifications to be made to the base year PM and NH3 emission estimates for this source category.

Background

VISTAS Base Year EGU Emissions Preparation

A major component to the development of the VISTAS point source sector of the inventory was the incorporation of data submitted by the VISTAS States and local (S/L) agencies to the United States Environmental Protection Agency (EPA) as part of the Consolidated Emissions Reporting Rule (CERR). Work on incorporating the CERR data into the revised base year involved: 1) obtaining the data from EPA or the S/L agency, 2) evaluating the emissions and pollutants reported in the submittal, 3) augmenting CERR data with annual emission estimates for PM10-PRI and PM25-PRI; 4) evaluating the emissions from electric generating units, and 5) completing quality assurance reviews for each component of the point source inventory.

Data from several sources were used: 1) the inventories that the S/L submitted to EPA from May through July 2004; 2) supplemental data supplied by the S/L agencies that may have been revised or finalized after submittal to EPA, and 3) the original VISTAS 2002 inventory in cases where S/L CERR data were not available.

Particulate matter emissions can be reported in many different forms, as follows:

PM Category	Description
PM-PRI	Primary PM (includes filterable and condensable)
PM-CON	Primary PM, condensable portion only (all less than 1 micron)
PM-FIL	Primary PM, filterable portion only
PM10-PRI	Primary PM10 (includes filterable and condensable)
PM10-FIL	Primary PM10, filterable portion only
PM25-PRI	Primary PM25 (includes filterable and condensable)
PM25-FIL	Primary PM25, filterable portion only

State/local agencies did not report PM emissions in a consistent manner. The State/local inventories submitted for VISTAS included emissions data for either PM-FIL, PM-PRI, PM10-FIL, PM10-PRI, PM25-FIL, PM25-PRI, and/or PM-CON. From any one of these pollutants, EPA has developed augmentation procedures to estimate PM10-PRI, PM10-FIL, PM25-PRI, PM25-FIL, and PM-CON. If not included in a State/local inventory, PM10-PRI and PM25-PRI were calculated by adding PM10-FIL and PM-CON or PM25-FIL and PM-CON, respectively. The procedures for augmenting point source PM emissions are documented in detail in Appendix C of *Documentation for the Final 1999 National Emissions Inventory (Version 3) for Criteria Air Pollutants and Ammonia – Point Sources*, January 31, 2004[1].

Briefly, the PM data augmentation procedure includes the following five steps:

- Step 1: Prepare S/L/T PM and PM10 Emissions for Input to the PM Calculator
- Step 2: Develop and Apply Source-Specific Conversion Factors
- Step 3: Prepare Factors from PM Calculator
- Step 4: Develop and Apply Algorithms to Estimate Emissions from S/L/T Inventory Data
- Step 5: Review Results and Update the NEI with Emission Estimates and Control Information.

Ammonia (NH3) emissions from these sources were assigned using direct incorporation of S/L/T provided emission estimates or via the application of emission factors using ratios of NH3 emission factors to other reported pollutants (e.g., VOC, CO, etc.).

IPM Post Processing

ICF via VISTAS contracts provided an initial spreadsheet file containing unit-level records of both (1) "existing" units and (2) committed or new generic aggregates. All records have unit and fuel type data; existing, retrofit (for SO_2 and NO_x), and separate NO_x control information; annual SO_2 and NO_x emissions and heat input; summer season (May-September) NO_x and heat input; July day NO_x and heat input; coal heat input by coal type; nameplate capacity (MW), and State FIPS code. Existing units also have county FIPS code, a unique plant identifier (ORISPL) and unit ID (also called boiler ID) (BLRID); generic units do not have these data.

[1] ftp://ftp.epa.gov/EmisInventory/finalnei99ver3/criteria/documentation/point/point_99nei_finalv3_0204.pdf

The IPM data were further processed by Pechan using data files and methodology recently approved by EPA. The most current documentation related to this subject is the EPA report titled, *Documentation for the 2002 Electric Generating Unit (EGU) National Emissions Inventory (NEI),* September 2004[2]. The processing includes estimating various types of emissions and adding in control efficiencies, stack parameters, latitude-longitude coordinates, and State identifiers (plant ID, point ID, stack ID, process ID). Additionally, the generic units were sited in a county and given IDs.

Pechan developed SCC assignments for all units; unit/fuel/firing/bottom type data were used for existing units' assignments, while only unit and fuel type were used for generic units' assignments. Additional review of the source code used in developing these post-processed files confirmed this fact. In actuality, not only does it exist that the post-processing code assigns different emission factors for the same SCC but that SCCs assigned in future year IPM output are potentially different than those assigned in the base year inventory, leading to additional, propagating differences in the base year and future year estimates. The full extent of these issues is currently under review by VISTAS and MRPO.

Stack parameters were attached, first using matches to data in the VISTAS 2002 NIF files, secondly using the EPA-provided data files, thirdly using a March 9, 2004 Pechan in-house stack parameter file based on previous EIA-767 data, and lastly using an EPA June 2003 SCC-based default stack parameter file.

Plant ID (within State and county), point ID, process ID, and stack ID were then attached, first using the VISTAS-provided data files, or secondly using EPA or Pechan-generated defaults. Default stack IDs within a plant were assigned for each unique stack height-diameter combination. The process ID and stack ID default data were only used when the data were not matched to the original VISTAS 2002 NIF files.

Additional data were required for estimating VOC, CO, filterable primary PM_{10} and $PM_{2.5}$, PM condensable, and NH_3 emissions for all units. Thus, ash and sulfur contents were assigned by first using 2002 EIA-767 values for existing units or SCC-based defaults; filterable PM_{10} and $PM_{2.5}$ efficiencies were obtained from the 2002 EGU NEI that were based on 2002 EIA-767 control data and the PM Calculator program (a default of 99.2% was used for coal units if necessary); fuel use was back calculated from the given heat input and a default SCC-based heat content; and emission factors were obtained from an EPA-approved October 7, 2004 Pechan emission factor file based on AP-42 emission factors. Table 1 provides the emission factor differences between the "old" emission factor file (used in development of EPA's 1999 NEI v.3) and the updated factors as used in VISTAS latest IPM conversion. Note that this updated file was not the one used for estimating emissions for previous EPA post-processed IPM files (including estimates for CAIR). It should also be noted that this component of emission estimation is only for the filterable component of PM and that the emission factors used for condensable PM did not change between the two versions.

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[2] ftp://ftp.epa.gov/EmisInventory/draftnei2002/point/documentation/egu2002doc.pdf

Issue Identification

During a VISTAS TAWG meeting held at the Solution Center in Durham, NC on April 5 and 6, 2005, emission summaries were presented as comparisons of 2002 to 2018 forecasts. Table 2 presents the slide originally used in identifying the increase in PM and NH3 emissions. In this comparison, it was noted that PM and NH3 emissions (highlighted in Table 2) from EGUs were significantly higher in 2018 than in 2002 and based on known regulation and activity, no reason could be identified for this increase. After an initial review of the data, it was determined that the PM and NH3 emission factors used between the base year and future year were most likely the culprit. In fact, for some SCCs, the NH3 emission factor increased by over 5,000% (0.000565 to 0.03 lbs/ton coal burned). Changes in PM emission factors were not as large and limited to only a few SCCs. However, this emissions increase was simply an artifact of the change in emission factor, not anything to do with changes in activity or control technology application.

Additionally, after further review of the post-processing code by VISTAS, it was determined that not only were differing emission factors being used for similar SCCs between the base and future year estimates for those SCCs identified in Table 2, but that the same SCCs were not necessarily being used for emission factor assignment in the base and post-processed IPM scenarios. This issue has implications not only for the different PM and NH3 factors, but for other pollutants (CO, VOC) not initially estimated by IPM.

Table 3 presents those unit-segment (SCC) combinations which have been identified in the 2018 OTW run to have been assigned SCCs in the IPM post-processing step different than those in the 2002 base case. In some instances, the SCCs are comparable enough that the emission factors assigned were the same. However, there are additional instances where significant enough difference exists that review and correction may be warranted. An analysis of the differences in assignment of these SCCs and associated factors has not yet been completed.

Proposed Solution

There are two issues which need to be resolved in the estimation of relative differences in EGU emissions between VISTAS base year 2002 emissions inventory and any forecasts of this source sector using IPM and post-processing steps applied using existing programs provided by Pechan; (1) consistent use of emission factors between the base and future years, and (2) the consistent use of SCCs for determining emission factors between the base and future years.

These issues can be resolved using a variety of ways but the proposal provided here positions VISTAS to regenerate some specific pollutant 2002 emissions for the EGU sector in a fashion consistent, and presumably, more up-to-date, than the estimates provided in the 2002 base year inventory. Additionally, this proposal allows for the existing process to be completed in the post-processing steps but adjusts the resulting non-IPM generated emissions using correct SCCs and emission factors.

Base Year Emissions Adjustment

The first step is the adjustment of the 2002 base year emissions inventory. Using the latest "EPA-approved" uncontrolled emission factors by SCC, VISTAS contactors will utilize CERR or VISTAS reported annual heat input, fuel throughput, heat, ash and sulfur content to estimate annual uncontrolled emissions for units identified as output by IPM. This step will be conducted for non-CEM pollutants (CO, VOC, PM, and NH3) only. For PM emissions, the condensable component of emissions will also be calculated and added to the resulting PM primary estimations. When these fuel characteristic variables are found to be zero, out of range (as identified by AP-42 factors), or invalid, average fuel data collected from EPA's AP-42 documentation on heat, sulfur, and/or ash content will be used. The resulting emissions will then be adjusted by any control efficiency factors reported in the CERR or VISTAS data collection effort.

Future Year Scenario Adjustment

Because the assignment of the SCCs to IPM output is a post-processing step which involves the cross-reference file developed to match IPM units to VISTAS 2002 base year inventory, it should be relatively straightforward to modify the code to assign the same base year SCC to the future year. Then, through assignment of SCCs and associated emission factors (via another cross-reference), similar base year and future year emission factor assignments could be made; just using the projected controls and fuel throughput as predicted by IPM. If modifications can not be made directly to the code for this cross-reference step, VISTAS can modify the resulting post-processed NIF files for those sources identified with alternate SCCs assigned in the future year. Using the same methods as described for the 2002 revisions, those non-IPM generated pollutants would be estimated using IPM predicted fuel characteristics and base year 2002 SCC assignments.

Alpine Geophysics, LLC ▪ 387 Pollard Mine Road ▪ Burnsville, NC 28714 ▪ (828) 675-9045 ▪ (828) 675-5801 FAX

Table 1. Comparison of "Old" vs. "New" Emission Factors for IPM Post-Processing

SCCEMFACforMRPOoldvsnew.xls -- PM+NH3 EF, 12/17/04

This file lists the "Old" and "New" EPA-approved Uncontrolled PM_{10}, $PM_{2.5}$, and NH_3 Emission Factors for the SCCs in the MRPO Scenarios.

SCC[1]	FUEL	"New" PM10EF[4]	"Old" PM10EF[3]	"New" PM25EF[4]	"Old" PM25EF[3]	PMFLAG[2]	"New" NH3EF[4]	"Old" NH3EF[3]
10100201	BIT	2.6000	2.6000	1.4800	1.4800	A	0.030000	0.000565
10100202	BIT	2.3000	2.3000	0.6000	0.6000	A	0.030000	0.000565
10100203	BIT	0.2600	0.2600	0.1100	0.1100	A	0.030000	0.000565
10100204	BIT	13.2000	13.2000	4.6000	4.6000		0.030000	0.000565
10100211	BIT	2.6000	2.6000	1.4800	1.4800	A	0.030000	0.000565
10100212	BIT	2.3000	2.3000	0.6000	0.6000	A	0.030000	0.000565
10100217	BIT	12.4000	12.4000	1.3640	3.2000		0.030000	0.000565
10100221	SUB	2.6000	2.6000	1.4800	1.4800	A	0.030000	0.000565
10100222	SUB	2.3000	2.3000	0.6000	0.6000	A	0.030000	0.000565
10100223	SUB	0.2600	0.2600	0.1100	0.1100	A	0.030000	0.000565
10100224	SUB	13.2000	13.2000	4.6000	4.6000		0.030000	0.000565
10100226	SUB	2.3000	2.3000	0.6000	0.6000	A	0.030000	0.000565
10100238	SUB	16.1000	16.1000	4.2000	4.2000		0.030000	0.000565
10100301	LIG	1.8170	1.8170	0.5214	0.5214	A	0.030000	0.000565
10100302	LIG	2.3000	2.3000	0.6600	0.6600	A	0.030000	0.000565
10100303	LIG	0.8710	0.8700	0.3690	0.1100	A	0.030000	0.000565
10100317	LIG	12.0000	12.0000	1.4000	1.4000		0.030000	0.000565
10100601	NG	1.9000	1.9000	1.9000	1.9000		3.200000	3.200000
10100801	PC	7.9000	7.9000	4.5000	4.5000	A	0.397000	---
10102018	WC	12.0000	12.0000	1.4000	1.4000		0.030000	0.000565
20100201	NG	1.9380	1.9380	1.9380	1.9380		6.560000	---
20100301	IGCC	11.5500	11.5500	11.5500	11.5500		6.560000	---

Notes:

1. SCCs beginning with 101002 (coal), 101003 (coal), 101008 (coke), or 101020 (waste coal), emission factors in LB/TON; SCCs beginning with 101006 (natural gas), 201002 (natural gas), or 201003 (IGCC), emission factors are in LB/E6FT3.
2. If PMFLAG = 'A', then apply ash content to PM emission factor.
3. "Old" emission factors are used for latest EPA IPM post-processing.
4. "New" emission factors are used for MRPO IPM post-processing.

Table 2. Annual Emissions Comparison of 2002 Typical with 2018 OTW; VISTAS Tier 1 Category Totals.

Annual 2018 OTW - 2002 Typical Emissions (Percent)

Source Category	VOC	NOx	CO	SO2	PM-10	PM-2.5	NH3
Fuel Comb. Elec. Util.	13%	-68%	53%	-63%	69%	82%	3024%
Fuel Comb. Industrial	12%	0%	15%	7%	5%	7%	28%
Fuel Comb. Other	-55%	19%	-28%	15%	-16%	-8%	23%
Chemical & Allied Product Mfg	50%	29%	32%	31%	36%	36%	27%
Metals Processing	43%	27%	29%	37%	20%	20%	60%
Petroleum & Related Industries	-19%	23%	15%	11%	35%	33%	12%
Other Industrial Processes	22%	15%	21%	19%	28%	25%	16%
Solvent Utilization	22%	48%	36%	23%	34%	32%	20%
Storage & Transport	-19%	28%	46%	34%	-4%	2%	40%
Waste Disposal & Recycling	11%	13%	9%	37%	11%	10%	52%
Highway Vehicles	-47%	-70%	-19%	-89%	-34%	-53%	36%
Off-highway	-40%	-30%	23%	-61%	-29%	-29%	35%
Miscellaneous	2%	0%	0%	0%	14%	5%	15%
VISTAS Total	**-19%**	**-52%**	**-8%**	**-50%**	**13%**	**9%**	**19%**

Table 3. Differences in VISTAS Base Year 2002 and IPM Post-Processed SCC Emission Factor Assignments

FIPS	Plant ID	Plant Name	Point ID	Stack ID	Segment	2002 SCC	IPM SCC
01039	0001	ALABAMA ELECTRIC COOPERATIVE - MCWILLIAMS	005	002	01	10100201	20100201
01055	0002	ALABAMA POWER COMPANY - GADSDEN	002	001	01	10100202	20100201
01055	0002	ALABAMA POWER COMPANY - GADSDEN	003	001	01	10100201	20100201
01063	0001	ALABAMA POWER COMPANY - GREENE COUNTY	002	001	01	10100201	10100202
01063	0001	ALABAMA POWER COMPANY - GREENE COUNTY	003	001	01	10100201	10100202
01071	0008	TVA - WIDOWS CREEK	008	002	01	10100202	10100212
01071	0008	TVA - WIDOWS CREEK	009	003	01	10100202	10100212
01085	0008	GENERAL ELECTRIC CO	001	001	01	10200602	20100201
01097	1001	ALABAMA POWER COMPANY - BARRY	002	001	01	10100201	10100212
01097	1001	ALABAMA POWER COMPANY - BARRY	003	001	01	10100201	10100212
01097	1001	ALABAMA POWER COMPANY - BARRY	004	001	01	10100201	10100212
01097	1001	ALABAMA POWER COMPANY - BARRY	005	002	01	10100201	10100212
01097	1001	ALABAMA POWER COMPANY - BARRY	006	003	01	10100201	10100212
01097	1001	ALABAMA POWER COMPANY - BARRY	007	005	01	20200203	20100201
01097	1001	ALABAMA POWER COMPANY - BARRY	008	006	01	20200203	20100201
01097	1001	ALABAMA POWER COMPANY - BARRY	009	007	01	20200203	20100201
01097	1001	ALABAMA POWER COMPANY - BARRY	010	008	01	20200203	20100201
01127	0001	ALABAMA POWER COMPANY - GORGAS	004	003	01	10100201	10100202
01127	0001	ALABAMA POWER COMPANY - GORGAS	005	003	01	10100201	10100202
01127	0001	ALABAMA POWER COMPANY - GORGAS	006	004	01	10100201	10100212
01127	0001	ALABAMA POWER COMPANY - GORGAS	007	004	01	10100201	10100212
01127	0001	ALABAMA POWER COMPANY - GORGAS	008	004	01	10100201	10100212
12001	0010001	PROGRESS ENERGY FLORIDA, INC. U OF FL COGEN	1	1	1	20200203	20100201
12009	0090006	FLORIDA POWER & LIGHT (PCC) CAPE CANAVERAL	1	1	2	10100401	20100201
12009	0090006	FLORIDA POWER & LIGHT (PCC) CAPE CANAVERAL	2	2	2	10100401	20100201
12027	0270016	DESOTO COUNTY GENERATING COMPANY, LLC	2	2	1	20100101	20100201
12031	0310047	JEA KENNEDY	3	3	1	20100101	20100201
12031	0310047	JEA KENNEDY	4	4	1	20100101	20100201
12031	0310047	JEA KENNEDY	5	5	1	20100101	20100201
12031	0310485	JEA BRANDY BRANCH FACILITY	2	2	1	20100101	20100201
12033	0330045	GULF POWER COMPANY CRIST ELECTRIC GENERATING PLANT	2	1	1	10100601	20100201
12033	0330045	GULF POWER COMPANY CRIST ELECTRIC GENERATING PLANT	3	1	2	10100601	20100201

FIPS	Plant ID	Plant Name	Point ID	Stack ID	Segment	2002 SCC	IPM SCC
12049	0490043	VANDOLAH POWER COMPANY, LLC	1	1	1	20100101	20100201
12095	0950203	ORLANDO COGEN LIMITED, L.P.	1	1	1	20200203	20100201
12097	0970014	PROGRESS ENERGY FLORIDA, INC. INTERCESSION CITY PLANT	11	11	1	20100101	20100201
12097	0970014	PROGRESS ENERGY FLORIDA, INC. INTERCESSION CITY PLANT	18	18	2	20100101	20100201
12099	0990042	FLORIDA POWER & LIGHT (PRV) RIVIERA POWER PLANT	3	3	3	10100401	20100201
12099	0990042	FLORIDA POWER & LIGHT (PRV) RIVIERA POWER PLANT	4	4	3	10100401	20100201
12099	0990045	CITY OF LAKE WORTH UTILITIES TOM G. SMITH POWER PLANT	9	9	1	10100601	20100201
12103	1030011	PROGRESS ENERGY FLORIDA, INC. BARTOW PLANT	1	1	2	10100401	20100201
12103	1030011	PROGRESS ENERGY FLORIDA, INC. BARTOW PLANT	2	2	2	10100404	20100201
12103	1030011	PROGRESS ENERGY FLORIDA, INC. BARTOW PLANT	3	3	2	10100404	20100201
12105	1050003	LAKELAND ELECTRIC CHARLES LARSEN MEMORIAL POWER PLANT	4	4	2	10100401	20100201
12105	1050221	CALPINE/AUBURNDALE POWER PARTNERS, LP	6	6	2	20100101	20100201
12105	1050223	PROGRESS ENERGY FLORIDA, INC. TIGER BAY COGENERATION FACILITY	3	3	1	10200602	20100201
12105	1050233	TAMPA ELECTRIC COMPANY POLK POWER STATION	1	1	2	20100201	20100301
12121	1210003	PROGRESS ENERGY FLORIDA, INC. FL POWER SUWANNEE RVR PLANT	1	1	3	10100404	20100201
12121	1210003	PROGRESS ENERGY FLORIDA, INC. FL POWER SUWANNEE RVR PLANT	2	2	3	10100401	20100201
12121	1210003	PROGRESS ENERGY FLORIDA, INC. FL POWER SUWANNEE RVR PLANT	3	3	3	10100401	20100201
12127	1270009	FLORIDA POWER & LIGHT (PSN) SANFORD POWER PLANT	1	1	3	10100401	20100201
12127	1270020	PROGRESS ENERGY FLORIDA, INC. TURNER PLANT	10	10	1	20100101	20100201
12127	1270020	PROGRESS ENERGY FLORIDA, INC. TURNER PLANT	9	9	1	20100101	20100201
12127	1270028	PROGRESS ENERGY FLORIDA, INC. DEBARY FACILITY	17	17	1	20100101	20100201
12127	1270028	PROGRESS ENERGY FLORIDA, INC. DEBARY FACILITY	18	18	1	20100101	20100201
13051	05100006	KRAFT STEAM - ELECTRIC GENERATING PLANT	SG01	CS1	1	10100212	20100201
13051	05100006	KRAFT STEAM - ELECTRIC GENERATING PLANT	SG02	CS1	1	10100212	20100201
13067	06700003	GEORGIA POWER COMPANY, MCDONOUGH STEAM-ELECTRIC GENERATING PLANT	CT6M	ST6M	1	20100101	20100201
13067	06700003	GEORGIA POWER COMPANY, MCDONOUGH STEAM-ELECTRIC GENERATING PLANT	CT7M	ST7M	1	20100101	20100201
13115	11500003	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC GENERATING PLANT	SG01	ST1	1	10100212	10100202
13115	11500003	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC GENERATING PLANT	SG02	ST1	1	10100212	10100202
13115	11500003	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC GENERATING PLANT	SG03	ST1	1	10100212	10100202

FIPS	Plant ID	Plant Name	Point ID	Stack ID	Segment	2002 SCC	IPM SCC
13115	11500003	GEORGIA POWER COMPANY, HAMMOND STEAM-ELECTRIC GENERATING PLANT	SG04	ST2	1	10100212	10100202
13207	20700008	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC GENERATING PLANT	SG01	ST1	1	10100212	10100226
13207	20700008	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC GENERATING PLANT	SG02	ST2	1	10100212	10100226
13207	20700008	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC GENERATING PLANT	SG03	ST3	1	10100212	10100226
13207	20700008	GEORGIA POWER COMPANY, SCHERER STEAM-ELECTRIC GENERATING PLANT	SG04	ST4	1	10100212	10100226
13237	23700008	GEORGIA POWER COMPANY, BRANCH STEAM-ELECTRIC GENERATING PLANT	SG01	ST1	1	10100212	10100202
13237	23700008	GEORGIA POWER COMPANY, BRANCH STEAM-ELECTRIC GENERATING PLANT	SG02	ST1	1	10100212	10100202
13237	23700008	GEORGIA POWER COMPANY, BRANCH STEAM-ELECTRIC GENERATING PLANT	SG03	ST2	1	10100212	10100202
13237	23700008	GEORGIA POWER COMPANY, BRANCH STEAM-ELECTRIC GENERATING PLANT	SG04	ST2	1	10100212	10100202
21111	0126	LOU GAS & ELEC, CANE RUN	06	06	01	10100212	10100202
21111	0127	LOU GAS & ELEC, MILL CREEK	03	03	01	10100212	10100202
21111	0127	LOU GAS & ELEC, MILL CREEK	04	04	01	10100212	10100202
21157	2115700053	DUKE ENERGY MARSHALL COUNTY,LLC	001A	1	2	20100101	20100201
21223	2122300002	LOUISVILLE GAS & ELECTRIC TRIMBLE CO GEN STATION	001	1	1	10100202	10100212
28007	2800700032	ATTALA GENERATING COMPANY, LLC	003	3	1	10100602	20100201
28047	2804700055	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	004	4	1	10100101	10100202
28047	2804700055	MISSISSIPPI POWER COMPANY, PLANT JACK WATSON	005	5	1	10100101	10100202
28059	2805900090	MISSISSIPPI POWER COMPANY, PLANT DANIEL	001	1	1	10100223	10100212
28059	2805900090	MISSISSIPPI POWER COMPANY, PLANT DANIEL	002	2	1	10100223	10100212
28059	2805900090	MISSISSIPPI POWER COMPANY, PLANT DANIEL	003	3	1	20100101	20100201
28059	2805900090	MISSISSIPPI POWER COMPANY, PLANT DANIEL	004	4	1	20100101	20100201
28059	2805900090	MISSISSIPPI POWER COMPANY, PLANT DANIEL	005	5	1	20100101	20100201
28059	2805900090	MISSISSIPPI POWER COMPANY, PLANT DANIEL	006	6	1	20100101	20100201
37017	3701700043	ELIZABETHTOWN POWER, LLC	G-17A	S-1	8	10101202	10100204
37035	3703500073	DUKE ENERGY CORPORATION - MARSHALL STEAM STATION	G-1	S-3	5	10100202	10100212
37035	3703500073	DUKE ENERGY CORPORATION - MARSHALL STEAM STATION	G-2	S-4	13	10100202	10100212
37035	3703500073	DUKE ENERGY CORPORATION - MARSHALL STEAM STATION	G-4	S-1	11	10100202	10100212

FIPS	Plant ID	Plant Name	Point ID	Stack ID	Segment	2002 SCC	IPM SCC
37035	3703500073	DUKE ENERGY CORPORATION - MARSHALL STEAM STATION	G-5	S-2	12	10100202	10100212
37071	3707100039	DUKE ENERGY CORPORATION - ALLEN STEAM STATION	G-14	S-1	1	10100202	10100212
37071	3707100039	DUKE ENERGY CORPORATION - ALLEN STEAM STATION	G-15	S-2	3	10100202	10100212
37071	3707100039	DUKE ENERGY CORPORATION - ALLEN STEAM STATION	G-16	S-3	5	10100202	10100212
37071	3707100039	DUKE ENERGY CORPORATION - ALLEN STEAM STATION	G-17	S-4	7	10100202	10100212
37071	3707100039	DUKE ENERGY CORPORATION - ALLEN STEAM STATION	G-18	S-5	9	10100202	10100212
37071	3707100040	DUKE ENERGY CORPORATION - RIVERBEND STEAM STATION	G-17	S-5	20	10100202	10100212
37145	3714500029	CP&L - ROXBORO STEAM ELECTRIC PLANT	G-29	S-1	1	10100212	10100202
37145	3714500029	CP&L - ROXBORO STEAM ELECTRIC PLANT	G-35A	S-3	5	10100212	10100202
37145	3714500029	CP&L - ROXBORO STEAM ELECTRIC PLANT	G-35B	S-3	5	10100212	10100202
37145	3714500029	CP&L - ROXBORO STEAM ELECTRIC PLANT	G-36A	S-4	7	10100212	10100202
37145	3714500029	CP&L - ROXBORO STEAM ELECTRIC PLANT	G-36B	S-4	7	10100212	10100202
37145	3714500045	CP&L - MAYO FACILITY	G-46A	S-1	1	10100212	10100202
37145	3714500045	CP&L - MAYO FACILITY	G-46B	S-1	1	10100212	10100202
37155	3715500147	PROGRESS ENERGY CAROLINAS, INC., W.H. WEATHERSPOON PLANT	G-26	S-2	9	10100202	10100212
37155	3715500166	LUMBERTON POWER, LLC	G-17A	S-1	7	10101202	10100204
37159	3715900004	DUKE ENERGY CORPORATION - BUCK STEAM STATION	G-4	S-6	8	10100202	10100212
37159	3715900163	ROWAN COUNTY POWER LLC	G-1	S-1	1	10100604	20100201
37159	3715900163	ROWAN COUNTY POWER LLC	G-2	S-2	3	10100604	20100201
37159	3715900163	ROWAN COUNTY POWER LLC	G-3	S-3	5	10100604	20100201
37169	3716900004	DUKE ENERGY CORP - BELEWS CREEK STEAM STATION	G-17	S-1	1	10100215	10100202
37169	3716900004	DUKE ENERGY CORP - BELEWS CREEK STEAM STATION	G-18	S-2	2	10100215	10100202
37191	3719100017	PROGRESS ENERGY - F LEE PLANT	G-3	S-1	3	10100212	10100202
37191	3719100017	PROGRESS ENERGY - F LEE PLANT	G-4	S-2	5	10100212	10100202
45021	0600-0081	DUKE ENERGY:MILL CREEK	CA1	1	2	20100101	20100201
45021	0600-0081	DUKE ENERGY:MILL CREEK	CA2	2	2	20100101	20100201
45021	0600-0081	DUKE ENERGY:MILL CREEK	CA3	3	2	20100101	20100201
47145	0013	TVA KINGSTON FOSSIL PLANT	001	S-1	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	002	S-1	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	003	S-1	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	004	S-1	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	005	S-1	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	006	S-2	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	007	S-2	1	10100202	10100212

FIPS	Plant ID	Plant Name	Point ID	Stack ID	Segment	2002 SCC	IPM SCC
47145	0013	TVA KINGSTON FOSSIL PLANT	008	S-2	1	10100202	10100212
47145	0013	TVA KINGSTON FOSSIL PLANT	009	S-2	1	10100202	10100212
47157	00528	ALLEN FOSSIL PLANT	CTrb10	CTrb10	13	20100101	20100201
47161	0011	TVA CUMBERLAND FOSSIL PLANT	001	S-01	1	10100215	10100202
47161	0011	TVA CUMBERLAND FOSSIL PLANT	002	S-02	1	10100215	10100202
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1A	1	1	20100101	20100201
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1B	1	2	20100101	20100201
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1C	1	3	20100101	20100201
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1D	1	4	20100101	20100201
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1E	1	5	20100101	20100201
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1F	1	6	20100101	20100201
51001	00030	COMMONWEALTH CHESAPEAKE POWER STATION	1G	1	7	20100101	20100201
51083	00046	DOMINION - CLOVER POWER STATION	1	1	4	10100501	10100212
51083	00046	DOMINION - CLOVER POWER STATION	2	2	4	10100501	10100212
51153	00002	DOMINION - POSSUM POINT	3	3	1	10100212	20100201
51175	00051	DOMINION - SOUTHAMPTON POWER STATION	1	1	1	10200219	10100204
51191	00180	WOLF HILLS ENERGY LLC	21	1	1	20100209	20100201
51191	00180	WOLF HILLS ENERGY LLC	22	2	1	20100202	20100201
51191	00180	WOLF HILLS ENERGY LLC	23	3	1	20100202	20100201
51191	00180	WOLF HILLS ENERGY LLC	24	4	1	20100202	20100201
51191	00180	WOLF HILLS ENERGY LLC	25	5	1	20100202	20100201
51760	00389	DOMINION - BELLEMEADE	20	1	1	20100101	20100201
51760	00389	DOMINION - BELLEMEADE	21	2	1	20100101	20100201
54023	0014	NORTH BRANCH POWER STATION	002	001	01	10100217	10100202

Methodology to Estimate the Transportable Fraction (TF) of Fugitive Dust Emissions for Regional and Urban Scale Air Quality Analyses

Thompson G. Pace, US EPA (8/3/2005 Revision)

Background and Introduction

For a number of years air quality analysts have recognized that the ambient impact of fugitive dust sources is substantially lower than emissions inventories would suggest. Analysis of the chemical species collected by ambient air samplers suggests that the modeling process may overestimate PM2.5 from fugitive dust sources by as much as an order of magnitude. This overestimation creates problems for those involved in both PM2.5 and regional haze planning and the determination of conformity budgets and significance determinations. Most experts agree that this overestimation is due to a combination of shortcomings in the inventory-modeling process: 1) faulty emission factor algorithms, 2) imprecise or difficult to obtain activity data to apply these algorithms (including inability to account for the effect of actual meteorological conditions on emissions), 3) the multiplier used to infer PM2.5 from PM10 emissions, and 4) modeling deficiencies (especially in the treatment of particles near their point of emissions). The ambient air sample collection and analysis is believed to be a better estimate of overall fugitive dust impact on the environment because of these issues with the inventory-modeling process.

Fugitive dust categories of interest include unpaved and paved road dust, dust from highway, commercial and residential construction and agricultural tilling. Of these, unpaved roads are the highest single emissions category, accounting for about one third of non-windblown fugitive dust emissions. This is followed in importance by dust from tilling, quarrying and other earthmoving. Note: windblown dust from agricultural and other exposed land is also important, but the transport fraction values suggested in this paper are not recommended for application to windblown dust sources.

In the mid 1990's, the U.S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards (OAQPS) began to use a factor to "adjust" the fugitive dust emission estimates in regional modeling analyses to obtain better agreement between the regional model results and ambient data. This adjustment was an ad hoc "divide-the inventory-by-four" approach to reduce the discrepancy between modeling and ambient data. The adjustment factor was conceived as an interim approach until a thorough investigation could identify which specific problems in the inventory and model were causing the discrepancy. Since the late '90s, the EPA has been actively working to understand the nature of those specific problems. This paper discusses some recent studies and proposes a conceptual model to approximate the dust removal near the source that is not accounted for in either the current emissions inventories or commonly used regional scale air quality models.

DRI / EPA Workshop

The EPA/OAQPS and the Desert Research Institute (DRI) conducted a workshop in 2000 to begin the process of understanding why modeled and monitored crustal material fractions do not agree. OAQPS documented that the field measurements underlying the dust emission estimates were generally taken within 5-10 meters of the source and that on average, about two-thirds of the dust plume is less than 2 meters above ground level at the location where the measurements are made. Based on this information and other workshop discussions, the workshop concluded that since the dust plume is still turbulent and very close to the ground, substantial dust removal processes can occur near the source (probably within several hundred meters), including impaction on land cover (vegetation and structures) and other processes that may enhance deposition on a local scale. It also concluded that regional air quality models (as they are currently applied) do not adequately account for injection height, deposition losses and impaction losses near fugitive dust emission sources. They noted that in practice, the fraction removed by surface cover is variable and that additional testing is needed (Watson and Chow 2000).

WRAP Expert Panel on Fugitive Dust

The DRI / EPA Workshop was followed by the formation of an Expert Panel on Fugitive Dust, sponsored by the Western Regional Air Partnership (WRAP) and chaired by Dr. Richard Countess. The panel concluded that not all suspended particles are transported long distances. Specifically, the report supported the conclusion of the DRI Workshop which was that much of the ground level fugitive dust emissions from soil disturbed by man's activities are likely to be removed close to the source. The low release height and turbulence leaves the particles temporarily close to the ground where they are subject to removal by impaction on nearby horizontal and vertical surfaces, including vegetation and structures. The Countess report recommended field studies to expand upon the current knowledge of the removal effectiveness of trees, desert shrub and buildings (Countess 2001) and several studies were conducted in response to this recommendation.

The Role of Surface Cover (Vegetation & Structures) in Removal of Airborne Dust

Early research into the general area of dust removal was done by Slinn for the U. S. Dept. of Energy. Much of Slinn's work focused on particle removal from air flowing above a tree canopy, but he also discussed the concept of a "stilling zone" within and below the canopy. Within the stilling zone, wind velocity is so much reduced that particles have ample time to settle to the ground or impact on the canopy or groundcover (Slinn 1982).

Windbreaks have long been a staple of soil erosion prevention, although most of the research has focused on the use of windbreaks placed upwind of a field to reduce the wind speed (and thus erosion) over the field. More recent work has focused on the effectiveness of vegetation as a removal mechanism. Anecdotally, researchers feel that the forest is a very good filter, both horizontally and vertically. Moreover, field tests suggest that the transmittance of dust through a windbreak is close to the optical transmittance. In other words, if the foliage is dense enough to block light, it also effectively filters particles (Cionco 2002, Raupach 1999, Raupach 2001).

Thus, the combined work of Slinn, Cionco and Raupach, the DRI workshop and the WRAP Expert Panel on Fugitive Dust suggests that fugitive dust particles have ample opportunity to be removed near the source, through impaction or filtration onto vegetation or structures or by other deposition mechanisms. The effect of land cover is expected to be highly variable, depending on the nature and proximity of vegetation to dust sources. They note that surface cover that is taller, denser and closer to the source captures a larger amount of the particles, with the most capture occurring when a narrow source is surrounded on both sides by tall, dense vegetation such as a road within a forest. However, Cowherd and Pace (2002) note that particles transported toward (not generated among) non-porous surfaces such as buildings or very dense vegetation may be diverted above or around those surfaces.

Mechanisms other than impaction and filtration by surface cover may also reduce particles very near the source, while the plume is compact and close to the ground. These mechanisms include electrostatic forces and thermophoresis (which could enhance deposition onto the earth's surface and low ground cover very near the source) and particle agglomeration within the compact plume (which could enhance gravitational settling). These mechanisms aren't as likely to capture particles in thermally buoyant or elevated plumes because those plumes rise above the land cover more quickly. Field testing is needed to quantify these mechanisms. (Cowherd and Gebhart 2003, Flagan 2001, Gieseke 1972).

Fugitive Dust Emissions, Surface Cover Particle Removal and Air Quality Models

As noted above, ground level fugitive dust emissions are measured adjacent to their point of emission; thus, as with emissions from all types of sources, they may be modified or even removed from the atmosphere before they reach receptors. Thus, emission estimates are only meaningful on a very local scale around their release point. In general, this does not present problems if one is concerned with effects on this local scale or when models are available to treat the potential modification or removal. However, these emissions are often used to support analyses on an urban or even larger scale. This could involve inventory tracking budgets (e.g., conformity) but they are also used in grid models whereby they are immediately introduced into model grids much larger than the scale of the removal processes discussed above.

Recently, several researchers and modeling practitioners have identified issues associated with how air quality models treat ground level fugitive dust emissions and how current models and modeling practices can lead to an underestimate of particle removal. Some of these issues were recently documented by staff at the Idaho Department of Environmental Quality (Idaho DEQ 2003). They concluded that Eulerian grid models generally over-predict coarse particle (2.5 ~ 10μm) concentrations, due primarily to the fact that these models artificially re-mix the particles in the lowest modeling layer at each time step (Dong, 2003). DRI, in their work for DOD, also evaluated the removal mechanisms in the Atmospheric Diffusion Equation and in ISC3. They found the ISC better suited to analyze near field dispersion (Etyemezian 2003).

Irwin (2003) noted that both grid and Gaussian models can be configured to estimate particle removal by surface cover, but that many of the parameters are empirical and there is little guidance or supporting research on how to set the input parameters in these models for a range of particle types and surface covers. He also noted that grid models ignore all removal processes in the grid cell into which they are first emitted, so unless the grid size is very small (100 to 1000 times smaller than currently used in regional modeling), they would not be sensitive to removal on the scales (10's to 100's of meters) discussed in this paper (Irwin 2003).

The above discussion suggests that any removal that may occur near the source (on a scale of 10's to100's of meters) is beyond the capability of current grid models, which are intended for use in regional scale analyses, as discussed below. A method is needed to adjust ground level emissions of fugitive dust when they are used to support analyses on a scale larger than 10's to 100's of meters. This paper describes a method to adjust the emissions inventory used in such larger scale analyses as a way to compensate for the model's inability to treat removal by surface cover near the emission source. Note that the adjustment of emissions inventories would be unnecessary if very small grids were used and if the appropriate removal mechanisms were incorporated explicitly into these models. However, use of grid models in this way would be well beyond current computer capabilities. Thus, the method described in this paper may be useful for the foreseeable future, until models are modified / developed to treat near-source particle removal by surface cover.

Conceptual Model: Near Source Capture (NSC) of Dust Emissions by Surface Cover

As an extension of the work begun by DRI and the WRAP Expert Panel, Cowherd and Pace (2002) suggest the use of a "limiting cases" conceptual model as a way to bound the dust removal potential by surfaces near the source of emissions. An unpaved road in the forest would represent one extreme or limiting case whereby most, if not essentially all of the road dust would be captured within the vegetation canopy. At the other extreme or limit, road emissions in barren areas of the arid southwest would be subject to virtually no capture or removal due to vegetation. Other surface characteristics would fall between these limits. Cowherd and Pace refer to the fraction of a source's mass emissions captured by the vegetation (or other surface obstructions) as the "Capture Fraction (CF)" where 0 <= CF <= 1, where 0 is a barren landscape and 1.0 is within a dense forest. They adapt the term "Transportable Fraction" (TF) from the DRI Workshop and use it to describe those particles remaining airborne and available for transport away from the vicinity of the source, after localized removal has occurred (Watson and Chow 2000, Cowherd and Pace 2002).

(1) Transportable Fraction (TF) = TE /SE
= {SE – [SE * CF]} /SE

Where:

Transportable Emissions (TE) =

Source Emissions (SE) – Locally Captured Emissions, and

Locally Captured Emissions = Source Emissions (SE) * CF

Figure 1 illustrates the conceptual model for near source particle removal by vegetation and structures. In this simple model, capture is assumed to increase as the density, leafiness and height of the vegetation increases. Urban areas are considered to be similar to mixed surroundings, on average. This model does not include any enhanced deposition that might occur due to gravitational, thermal or electrostatic forces. Also note that the exact relationship between capture and the nature of the surroundings cannot be known without further testing.

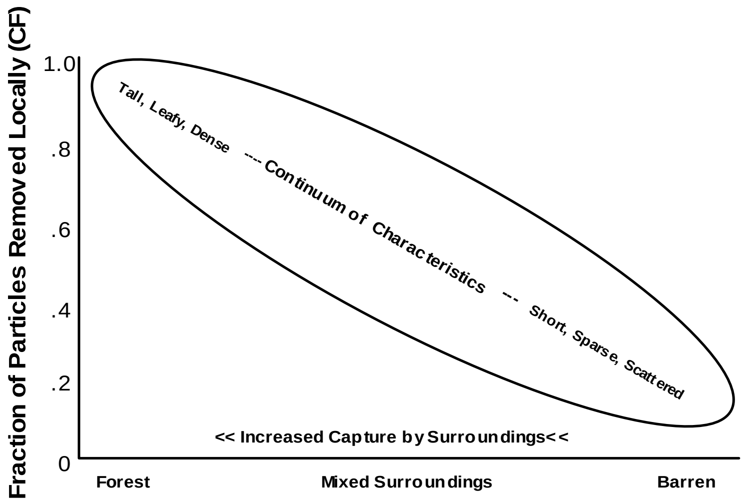

Figure 1. Conceptual Model – Near Source Capture (NSC) of Dust Particles by Surface Cover

Recent and Ongoing Work to Evaluate Near Source Capture (NSC) by Surface Cover

Field work was conducted for the Western States Air Resources (WESTAR) Council by a team of scientists including Dr. Vic Etyemezian at the Desert Research Institute (DRI). The effect of vegetation and structures on nearby unpaved road emissions was documented in this report. The report supports the Countess findings, noting a wide range of downwind removal rates depending on surface conditions. The DRI results showed little removal in daytime tests in a sparse, barren environment, but a nighttime removal rate of 85 percent was found at a distance of 95 meters downwind when structures were present between the road and the sampling apparatus (Etyemezian 2003a).

A field study conducted by the Midwest Research Institute (MRI) for the U.S. Department of Defense (DOD) measured the effect of groundcover on particle removal near an unpaved road. Initial tests were done over an open field 20 meters wide. In this test, the particles were depleted minimally as they passed over the field, but the depletion was about 57 percent when a bank of cedar trees was added downwind about 8 meters from the unpaved road. The amount of particle depletion was comparable for both PM2.5 and PM10 over these distances and test conditions (Cowherd and Gebhart 2003).

The data from these tests is limited and more testing is needed to improve the confidence in the results. However, substantial near source removal of the particles is apparent, even during the daytime for particles passing over an open field. Cowherd suggested that other factors may enhance the deposition process, even over flat surfaces very near the source. However, Etyemezian saw no apparent effect of deposition over barren land.

Note that the effect of atmospheric stability on CF should also be considered in future work to refine the NSC model. The CF would likely be reduced under unstable atmospheric conditions, which can cause the plume to rise above the earth's surface more quickly. Conversely, the removal due to capture could be even higher under very stable conditions such as were present during the nighttime test around buildings (Etyemezian 2003a). In general, one would expect the role of atmospheric stability in near source particle removal to be less important when vegetation or structures are tall and/or are located near the dust source (Etyemezian 2003b).

Figure 2 compares the results of the MRI and DRI field studies with the conceptual model in Figure 1. Test results from the two field studies were added to the schematic of the conceptual model based on descriptions of land cover between the source and the test instruments. The NSC conceptual model shows reasonable agreement with these field tests and thus, it appears to provide a useful framework for making preliminary estimates of CF based on local land cover characteristics.

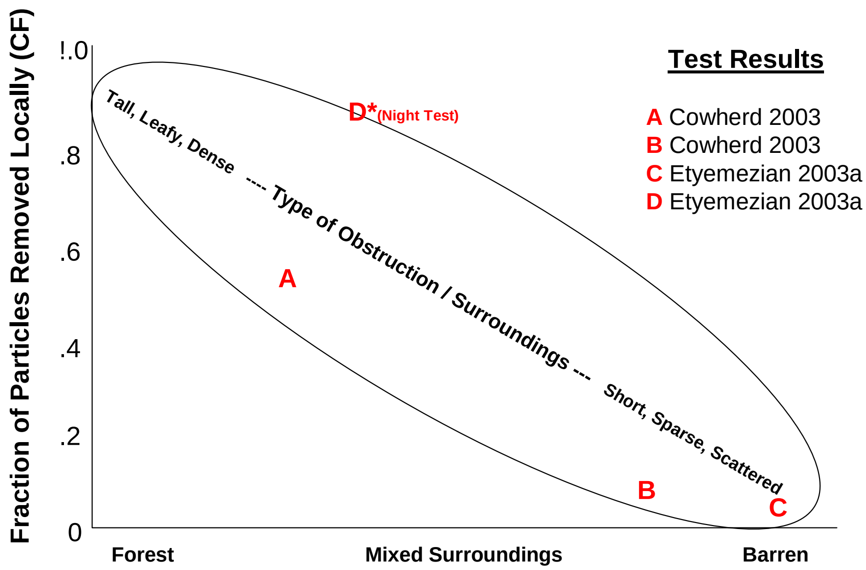

Figure 2. Comparison of Test data with NSC Conceptual Model

Default Recommendations for CF

Estimation of values of CF for specific geographic areas requires use of a land cover dataset such as the Biogenic Emission Land cover Database (BELD). BELD is a compendium of surface cover (mainly vegetation) characteristics used by the Biogenic Emission Inventory System (BEIS) biogenic emission model (Birth & Geron 1995). It contains data on several hundred species of vegetation at a 1 km cell size.

In the analysis presented in this paper, the land cover described in BELD was grouped into five cover type groups, e.g., barren & water; agricultural; grasses, scrub and sparsely wooded; urban; and forested. The estimated ranges and recommended values for CF are given in Table 1 along with the average vegetation heights assumed in BELD. (Urban structures were assumed to range from 5 to over 50 meters). Ranges for the CF for each cover type are based on field work and observations available from Watson and Chow, Raupach, Etyemezian and Cowherd, the height of the ground cover relative to the plume and seasonal changes in the cover characteristics. The ranges conform to the linear conceptual model in Figure 1 in that the CF is assumed to increase linearly with the seasonal presence, height and density of the surface cover. The recommended CF values assigned to Barren and Water (0) and Forest (1) are chosen to be consistent with the limits (extreme values) in the conceptual model, although as noted, the values could in fact be less than 1 for forest and greater than 0 for water & barren. The mid-points of the estimated ranges are used as the recommended CF for the other land cover types. The ranges and recommended CF values should be considered a first approximation and further refinement is welcomed.

Note that the CF's in Table 1 are only generalized defaults and should be modified by local data or as further research becomes available. Also, the estimated CF's herein are believed to be too high for windblown dust events because the wind's turbulence will usually lift particles higher more quickly, and the opportunity for vegetative removal is likely reduced.

Land Cover Type	Average Height (m)	Recommended CF (%)	Estimated CF Range (%)	COMMENT
Forest	18-20	100%	80 to 100%	Forested areas will capture dust effectively
Urban	5 – 50+	50%	25 to 75%	Structures are interspersed with open areas
Scrub, Sparsely Wooded & Grasses	1 – 2	25%	10 to 40%	Portion of plume is below sparse vegetation
Agricultural	1 - 2	25%	10 to 40%	Portion of plume is below crop (seasonally)
Barren / Water	0	0%	0 to 10%	Impediment-free surfaces are ineffective to capture dust

Table 1. Recommended CF (%) for Five Land Cover Types

Method to Estimate the Transportable Fraction in Specific Geographic Areas
The fraction of land area assigned to each land cover type in each US County was obtained from the BELD dataset. The county average transportable fraction was estimated by combining the CF's in Table 1 with the corresponding fractional surface

cover in each county and computing a weighted average CF for each county. The TF for each county is then estimated using equation 1 above. The results are shown in Figure 3. Note that these same surface cover data are available in the BELD dataset at a 1 km resolution detail, and the accuracy of the method could be improved by using grid- instead of county-weighted CF's.

Figure 3 shows how the TF varies by county across the US, depending on the variation in surface cover. The differences are apparent across the heavily forested areas in the southeast and the Pacific NW, the arid areas of the Southwest, the agricultural breadbaskets of the Central US and the San Joaquin Valley in CA. Note that nationally, the county average TF ranges from 0 to 0.92. The TF averages approximately 0.49 across all counties in the US, which is less of a reduction in dust emissions than was realized in the old "divide-by-four: approach. Recent analysis by Pace (2005) suggests that additional reduction in PM2.5 fugitive dust emissions may occur when the EPA completes their investigation of apparent errors in the multiplier used to derive PM2.5 emission factors from old PM10 emission factor field measurements.

The county average TF's in Figure 3 represent the first attempt to apply the conceptual model to estimate how dust removal by ground level airflow obstructions might vary across the US; they will be revised as more information becomes available. The transportable fraction concept can be extended to finer spatial resolution using an emissions processor such as SMOKE (Pace and Cowherd 2003). In fact, the WRAP has estimated the TF at a 2 km resolution in support of some of their analyses (Mansell 2005). In Figure 3, the county-level TF is displayed in five ranges, each containing an equal number of counties.

A preliminary estimate of the county-level TF was provided to the WRAP by OAQPS for use with their unpaved road dust emissions inventory. Countess recently applied the NSC concept to modeling in the San Joaquin Valley. He used the method posed by Pace and Cowherd to develop county specific TF's based on weighted average land use and ground cover information for the SJV counties. He found that use of those TF's resulted in adjusted emission estimates that agree well with ambient measurements in these SJV counties (Countess 2003).

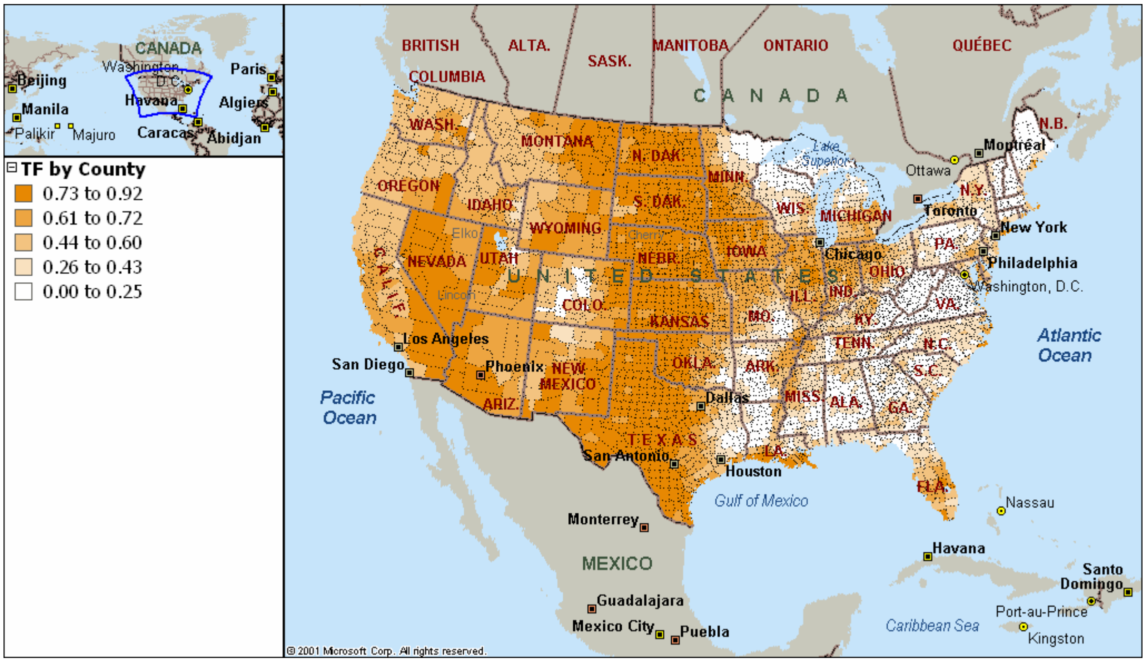

Figure 3. Geographic Variability of the Transportable Fraction

Recommendations and Limitations for Use of the Near Source Capture Adjustment

Based on the discussion above, it is recommended that the NSC adjustment be applied to emission estimates for paved roads, unpaved roads, construction, tilling and quarrying in grid model analyses, until near-source particle removal mechanisms are incorporated into the models (U. S. EPA 2004). EPA has applied the NSC adjustment in regional modeling applications and county-level TF adjustment capability has been incorporated into the SMOKE emissions processor. An important consideration in the application of the NSC concept is the scale represented by the land cover data. Land cover interacts with the source plumes over a scale of several hundred meters from the emission point. Thus, land cover data will be much more representative if it is obtained on a 1 km grid for example instead of the county-level as discussed herein. This is quite practical to do when one is using emission processors to prepare emissions for grid-based modeling since the BELD dataset is available at a 1 km resolution. However, county-level land cover data may be useful to adjust regional and county-level emission inventories for summary reporting and may be useful for use with grid models if finer resolution isn't available.

Note that the NSC adjustment should NOT be used to adjust emission estimates (e.g., permit applications) where local scale impacts are important. Also, the adjustment should not be applied to emissions input to Gaussian models. For Gaussian model applications, one should adjust the appropriate input parameters contained in these models to account for near source dust removal. The NSC adjustment is not applicable to elevated emissions of fugitive dust such as material transfer points, dust generated by wind erosion or low level emissions of buoyant plumes such as open fires or vehicle exhaust since in such cases, the particles are assumed to be above or rapidly rise above the height of the surface cover. Also, the adjustment doesn't currently attempt to account for enhanced deposition on the ground due to thermal, electrostatic or inertial forces.

Future Work

Many refinements have been made to the dust emissions estimation and air quality modeling methodologies over the years. However, significant issues remain and much work is still needed:

1) Improve the emission estimation algorithms, such as correcting (reducing) the emissions for lower vehicle speeds and re-estimating the relationship of PM2.5 to PM10;
2) Improve activity data, such as vehicle miles traveled (VMT), silt content and soil moisture on unpaved roads, surface loading on paved roads and soil conditions during agricultural tilling operations and windblown dust events;
3) Investigate ways to reduce reliance on such difficult to obtain activity data as silt content, surface loading and soil conditions;
4) Improve both the physical and empirical understanding of the near-source enhanced deposition processes (e.g., thermal and electrostatic forces, agglomeration);
5) Compare and critically review the various models for the transmission and removal of suspended particles by different obstructions and surface cover and refine the NSC methodology accordingly;
6) Incorporate the effect of atmospheric stability into the concept of the capture fraction (CF) concept;
7) Extend the NSC methodology to windblown dust models to incorporate removal by NSC;
8) More guidance is needed on the specification of specialized input parameters required by plume models;
9) Continue to improve the removal mechanisms in both grid and Gaussian models.

Conclusions

Our understanding of factors affecting particle removal near ground level fugitive dust sources has improved because of work begun at the EPA-sponsored Fugitive Dust Workshop held at DRI. Models are limited in their ability to fully account for near source removal of particles for a variety of physical and practical reasons, and this limitation is a major reason for the disparity between modeled and monitored estimates of fugitive dust. The recognition that vegetation captures some of this dust has led to a useful, albeit emerging methodology to account for the near source removal of particles in regional and urban scale analyses. This method is an improvement upon the national divide-by-four adjustment that has been used for about ten years. It may be applied in regional scale analyses where fugitive dust is emitted from paved and unpaved roads, construction, agricultural tilling, quarrying and earthmoving. Note that as research in this area evolves, other approaches or assumptions may be deemed more appropriate so it will be prudent to review the NSC adjustment methodology as new studies are published. Also, local knowledge about surface cover should be incorporated when available.

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Note: The 080305 revision made minor changes in the values assigned for the capture fractions for several land cover types. Overall effect was to reduce the county-level transport fraction (national grand average) from 0.49 to 0.46. However, some individual county TF's changed by as much as +/- 20%.

The original document, published August 3, 2003, was titled "Conceptual Model to Adjust Fugitive Dust Emissions to Account for Near Source Particle Removal in Grid Model Applications."

Final Report

Technical Support Document for the Association for Southeastern Integrated Planning (ASIP) Emissions and Air Quality Modeling to Support $PM_{2.5}$ and 8-Hour Ozone State Implementation Plans

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ACCRONYMS

ACM	Asymmetric Convective Mixing
AIRS	Aerometric Information Retrieval System
Ap	Accuracy of paired peak
AQS	Air Quality System
ARS	Air Resource Specialists
ASCII	American Standard Code for Information Interchange
ASIP	Association of the Southeast for Integrated Planning
BAMS	Baron Advanced Meteorlogical Systems
BART	Best Available Retrofit Technology
BCs	Boundary Conditions
BEIS3	Biogenic Emission Inventory System, version 3
BELD	Biogenic Emissions Landcover Database
bext	Extinction coefficient
BF	Bias Factor
BRAVO	Big Bend Regional Aerosol and Visibility Observations Study
CAAA	Clean Air Act Amendments
CACR	Caney Creek Wilderness Area
CAIR	Clean Air Interstate Rule
CAMx	Comprehensive Air Quality Model with extensions
CARB	California Air Resources Board
CASTNet	Clean Air Status and Trends Network
CB-IV	Carbon Bond IV
CBM-IV	Carbon Bond Mechanism IV
CCRS+CPRM	Coarse matter (coarse crustal & coarse primary)
CEM	Continuous Emissions Monitoring Data
CENRAP	Central Regional Air Planning Association
CFR	Code of Federal Regulations
CHAS	Chassahowitzka Wildlife Refuge
CHIEF	Clearinghouse for Inventories and Emissions Factors
CM	Coarse Mass
CMAQ	Community Multiscale Air Quality modeling system
CMU	Carnegie Mellon University
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CSN	Chemical Speciation Network (formally STN)
DDM	Decoupled direct method
dv	deciview
EBI	Euler Backward Iterative
EC	Elemental Carbon
EFIG	Emissions Factors and Inventory Group

EGAS	Economic Growth Analysis System
EGUs	Electrical Generating Units
EMFAC	California Air Resources Board mobile source emissions model
EPA	U.S. Environmental Protection Agency
EPM	Emission Production Model
EPRI	Electric Power Research Institute
ERG	Energy Resources Group
Eta	Eta model - a hydrostatic mesoscale model.
FCRS+FPRM	Fine Particulate Matter (fine crustal & fine primary)
FDDA	Four Dimensional Data Assimilation
FE	Fractional Gross Error
FIP	Federal Implementation Plan
FLM	Federal Land Managers
FRM	Federal Reference Method
GA DNR	Georgia Department of Natural Resources
GE	Goddard Earth Observing System
GEOS-CHEM	Goddard Earth Observing Systems – Chemistry model
GIS	Geographic Information System
GMAO	Global Modeling and Assimilation Office
GMT	Greenwich Mean Time
HI	Haze index
HNO3	Nitric acid
ICs	Initial concentrations
IDA	Inventory Data Analyzer
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
ISHALLO=	No Shallow Convection
ISORROPIA	ISORROPIA aerosol equilibrium model.
JPROC	Models 3 Photolysis Rates processors
Kh	Horizontal diffusivity coefficient
km	Kilometer
Kzmin	Minimum vertical diffusivity coefficient
LAC	Light Absorbing Carbon
LITTLE_R	MM5 meteorology processor
LPG	Liquefied petroleum gas
LSM	Land-surface model
MAGE	Mean Absolute Gross Error
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Air Management Association
MATS	EPA's Modeled Attainment Test Software
MB	Mean Bias
MCIP	Meteorological Chemistry Interface Processor
MEGAN	Model of emissions of gases and aerosols from nature
MFB	Mean Fractionalized Bias

MIMS	Multimedia Integrated Modeling System
Mm-1	Inverse megameters
MM5	Mesoscale Meteorological Model
MMS	Minerals Management Service
MNB	Mean Normalized Bias
MNGE	Mean Normalized Gross Error
MOBILE6	EPA's latest computer program for compiling emissions from mobile sources
MPE	Model performance evaluation
MPI	Message passing interface
MRPO	Midwest Regional Planning Organization
MWSS	Monday-weekday-Saturday-Sunday
NAA	Nonattainment Area
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NARSTO	North American Research Strategy for Tropospheric Ozone
NCEP	National Centers for Environmental Prediction
NEI	National Emissions Inventory
NH3	Ammonia
NIA	New IMPROVE Algorithm
NIF	National Emission Inventory Input Format
NO3	Nitrate
NMB	Normalized Mean Bias
NME	Normalized Mean Error
NO	Nitrogen Oxide
NO2	Nitrogen dioxide
NOAA	National Oceanic & Atmospheric Administration
NOx	Nitrogen Oxides
O3	Ozone
OAQPS	Office of Air Quality and Planning Standards
OIA	Old IMPROVE Algorithm
OCM	Organic Carbon Mass
PA	Process Analysis
PBL	Planetary Boundary Layer
PBW	Particle Bound Water
PEC	Primary elemental carbon
PinG	Plume-in-Grid
PM	Particulate matter
PM2.5	Particulate matter of 2.5 microns and less
PMC	Particulate Matter Coarse
PNO3	Particulate nitrate
POA	Primary Organic Aerosol
POC	Primary Organic carbon
POG	Policy Oversight Group

PPM	Piecewise Parabolic Method
PSAT	PM Source Apportionment Technology
PSO4	Particulate sulfate
PSU/NCAR	Pennsylvania State University/National Center for Atmospheric Research
P-X	Pleim-Xiu
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
r2	Coefficient of determination
RADM	Regional Acid Deposition Model
RAMS	Regional Atmospheric Modeling System
RHR	Regional Haze Rule
RICE MACT	Reciprocating Internal Combustion Engine Maximum Available Control Technology
RMSE	Root Mean Square Error
ROG	Reactive Organic Gas
ROMA	Cape Romain Wildlife Refuge
RPGs	Reasonable Progress Goals
RPOs	Regional Planning Organizations
RRFs	Relative Response Factors
RRTM	Rapid Radiative Transfer Model
SA	Source Apportionment
SANDWICH	Sulfate Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance
SCC	Source Classification Code
SEARCH	Southeastern Aerosol Research and Characterization
SECA	Sulphur Emissions Control Area
SESARM	Southeastern States Air Resources Managers, Inc.
SHEN	Shenandoah National Park
SHRO	Shining Rock Wilderness Area
SIC	Source Industrial Classification
SIP	State Implementation Plan
SIPS	Sipsey Wilderness Area
SMAT	Speciated Model Attainment Test
SMOKE	Sparse Matrix Operator Kernel Emissions
SOA	Secondary Organic Aerosol
SOAA	Secondary Organic Aerosol from Anthropogenic Sources
SOAB	Secondary organic Aaerosol from biogenic sources
SORGAM	Secondary Organic Aerosol Model
SST	Sea Surface Temperature
STI	Sonoma Technology, Inc.
STN	Speciation Trends Network (now called CSN)
SO4	Sulfate
TIPs	Tribal Implementation Plans
TOG	Total Organic Gas

TOMS	Total Ozone Mapping Spectrometer
TPY	Tons Per Year
TSD	Technical Support Document
TSS	Technical Support System
TUV	Tropospheric Ultraviolet and Visible Radiation Model
Typ02G	Base G Typical Version 2
UCR	University of California at Riverside
UH	University of Houston
UPBU	Upper Buffalo Wilderness Area
URP	Uniform Rate of Progress
VIEWS	Visibility Information Exchange Web Site
VISTAS	Visibility Improvements State and Tribal Association of the Southeast
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
VR	Visual Range
WRAP	Western Regional Air Partnership
$\mu g/m^3$	Micrograms per cubic meter (concentration)

1.0 INTRODUCTION

This is the Technical Support Document (TSD) for the Association for Southeastern Integrated Planning (ASIP) regional emissions and air quality modeling to support the southeastern states $PM_{2.5}$ and 8-hour ozone State Implementation Plans (SIPs). The ASIP 2002, 2009 and 2012 annual emissions and air quality modeling was performed by the contractor team of ENVIRON International Corporation (ENVIRON) and Alpine Geophysics, LLC (Alpine). The methods used in this ASIP TSD are the same as reported in the TSD prepared by the Visibility Improvements States and Tribal Association of the Southeast (VISTAS) for the regional haze SIPs (Morris et al., 2009), even though the two TSDs were written and updated at different times. Several interim emissions inventories have been developed and modeled during the course of the ASIP and VISTAS studies. The Base G2 or Base G4 Best and Final inventories were used by states for their SIPs. Both ASIP and VISTAS used the same 2002 Base G2 inventory as the basis for making projections to 2009, 2012 and 2018. The same meteorological, emissions, and air quality modeling methods and assumptions were used to project ozone, fine particle mass, and regional haze for 2009, 2012, and 2018, unless specifically noted otherwise in this document. Note that after the Base G4 Best and Final modeling was completed, in July 2008 the DC Circuit Court vacated the Clean Air Interstate Rule (CAIR), which was the basis for many of the utility controls that were modeled. However, in December 2008 the Court reinstated CAIR. This document addresses modeling results assuming that CAIR is implemented.

1.1 BACKGROUND

On December 17, 2004, EPA made fine particle ($PM_{2.5}$) nonattainment determinations for at least one area in seven of the states participating in the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regional haze project. VISTAS is one of five Regional Planning Organizations (RPOs) that consists of groups of states and tribes. The seven VISTAS states with $PM_{2.5}$ nonattainment areas are Alabama, Georgia, North Carolina, Kentucky, Tennessee, Virginia, and West Virginia. In addition, South Carolina has one three-county area that was designated as unclassifiable. The $PM_{2.5}$ compliance date is April 2010 unless a state demonstrates that more time is necessary in which case up to five additional years may be granted. Thus, future-year modeling of the 2012 year was also conducted. The nonattainment designations triggered the requirement for development of State Implementation Plans (SIPs) that are due in April 2008.

In April of 2004, EPA determined areas that were not meeting the 1997 0.08 ppm 8-hour ozone standard. States having one or more 8-hour ozone nonattainment areas in the Southeast are Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. EPA will require attainment of the 8-hour ozone standard in basic nonattainment areas by June 15, 2009 and in moderate nonattainment areas by June 15, 2010. This will require states with basic 8-hour ozone nonattainment areas to model 2008 as the SIP modeling demonstration year while moderate nonattainment areas will require 2009 as the modeling year. Given that North Carolina and Virginia have two year SIP approval processes, there was an immediate need to complete an analysis of ozone attainment using air quality modeling. Note that on March 12, 2008 EPA promulgated a new 8-hour ozone standard with a lower threshold (0.075 ppm) than the current standard (0.08 ppm) that will be addressed in future SIP actions.

The states participating in the VISTAS project (the SESARM EPA Region 4 states plus Virginia and West Virginia from Region 3) have concluded that a collaborative process will be the most efficient approach for the collective states to develop information upon which to base the $PM_{2.5}$ and 8-hour ozone attainment demonstrations. The name of this collaborative effort is the Association for Southeastern Integrated Planning (ASIP). SESARM was awarded a grant from EPA on February 8, 2005 to conduct what was originally called the fine particle SIP development support project but is now known as ASIP.

ASIP is performing the technical analysis needed to support 8-hour ozone and $PM_{2.5}$ attainment demonstrations for nonattainment areas (NAAs) in the ASIP region. ASIP and VISTAS have adopted a "one-atmosphere" modeling approach where the basic modeling results can be used to address ozone, $PM_{2.5}$ and regional haze issues. ASIP and VISTAS are modeling different future years, with ASIP addressing the 2009 and 2012 future years to demonstrate compliance of the 8-hour ozone and $PM_{2.5}$ standards and VISTAS is modeling the 2018 future year to demonstrate reasonable progress in achieving visibility improvements. The VISTAS modeling was initiated first in 2003, so much of the early model set up and sensitivity modeling that was conducted under VISTAS has been adopted by ASIP. ASIP initiated their modeling in 2005 with a contracting team led by ENVIRON International Corporation and Alpine Geophysics, LLC as a subcontractor. Thus, the ASIP modeling is intricately connected to the VISTAS modeling, which is described next.

1.1.1 VISTAS Emissions and Air Quality Modeling

VISTAS is one of five Regional Planning Organizations (RPOs) that have responsibility for coordinating development of SIPs and Tribal Implementation Plans (TIPs) in selected areas of the U.S. to address the requirements of the Regional Haze Rule (RHR). VISTAS is a regional partnership of states, tribes, federal agencies, stakeholders and citizen groups established to initiate and coordinate activities associated with the management of regional haze and other air quality issues within the VISTAS region. The VISTAS region includes the states of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. Figure 1-1 identifies the states included in each of the five RPOs in the U.S, including VISTAS. The VISTAS States and Class I areas within the VISTAS region are shown in Figure 1-2.

VISTAS is performing emissions and air quality modeling to project visibility to 2018 to determine the level of visibility improvements expected in 2018 under various emission strategies and assist states to determine their 2018 Reasonable Progress Goal (RPG) toward achieving natural conditions in 2064.

The VISTAS Modeling Team is funded through the Southeastern States Air Resource Managers (SESARM) and has implemented a regional air quality planning process to provide the necessary technical and policy tools needed by states to comply with the Section 308 of the RHR. In March 2003, VISTAS contracted with ENVIRON International Corporation, with Alpine Geophysics, LLC (Alpine) and the University of California at Riverside (UCR) as Subcontractors, to be the VISTAS Modeling Team to perform the emissions and air quality modeling needed to develop the technical basis for the RHR SIPs.

Figure 1-1. Regional Planning Organizations engaged in regional haze planning.

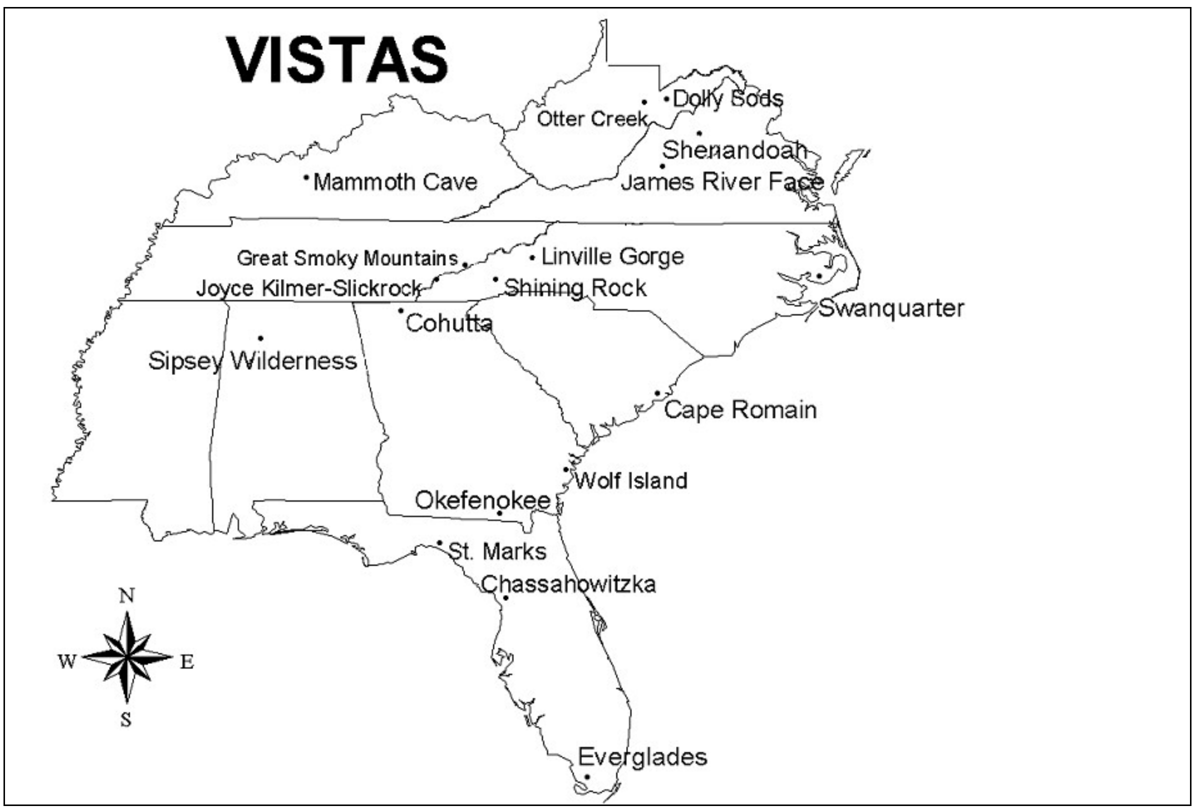

Figure 1-2. VISTAS states and Class I areas within the VISTAS region.

1.2 ASIP/VISTAS Modeling Approach

The ASIP and VISTAS Emissions and Air Quality Modeling Team performs regional ozone, particulate matter (PM) and haze analyses by operating regional scale, three-dimensional air quality models that simulate the emissions, chemical transformations, and transport of gaseous and PM species and consequently effects on ozone and $PM_{2.5}$ attainment in NAAs and visibility in Class I Areas in the southeastern U.S. A key element of this work includes the integration of emissions inventories and models with chemical transport models. The general services provided by the ASIP/VISTAS Emissions and Air Quality Modeling Team include, but are not limited to:

- Emissions processing and modeling;
- Air quality and visibility modeling simulations;
- Analysis, display, and reporting of modeling results; and
- Storage/quality assurance of the modeling input and output files.

1.2.2 VISTAS Two-Phased Approach

The VISTAS Emissions and Air Quality Modeling activities were performed in two Phases. Phase I, which occurred primarily during the 2003 calendar year before the ASIP modeling was initiated, consisted of emissions and regional air quality modeling for three episodes to identify the optimal model configuration(s) for simulating regional ozone, PM and haze in the southeastern U.S. Phase II, initiated in 2004, consists of operating the emissions and air quality models for the 2002 calendar year to develop the regional air quality modeling databases needed to address the requirements of the Section 308 RHR SIPs that can also be used to address the requirements of the 8-hour ozone and $PM_{2.5}$ SIPs.

1.2.2.1 VISTAS Phase I

The objective of VISTAS Phase I was to determine the optimal modeling configuration for use in the subsequent Phase II regional modeling assessment. Accordingly, Phase I entailed a comprehensive literature review of recent relevant visibility studies using various photochemical/aerosol modeling platforms in order to assess and identify appropriate model configurations, data bases, and model testing methodologies that were appropriate for use in conducting the VISTAS Phase I emissions and air quality modeling assessment. Key elements of Phase I included:

- Review all relevant air quality model simulations that have been completed related to regional haze and $PM_{2.5}$ modeling and document the relevant sensitivity analyses, model configuration testing, and performance evaluations that have been performed (ENVIRON, 2003b);

- Review the current science in regional emissions modeling (e.g., EPS, EMS and SMOKE) and PM air quality modeling (e.g., CMAQ, CMAQ-MADRID, CMAQ-AIM, REMSAD, UAM-V/PM, CAMx and PMCAMx) to determine the most appropriate model(s) for use by VISTAS (ENVIRON, 2003b);

- Review available ambient data for evaluating one-atmosphere PM/ozone models (ENVIRON, 2003c);

- Develop and implement a plan or Modeling Protocol for testing and evaluating alternative science configurations of the recommended Phase I model(s) and document the results (ENVIRON, 2003a); and

- Prepare a report prescribing the model set-up, data base development, performance testing, and control strategy evaluation procedures to be implemented in VISTAS Phase II (ENVIRON, 2004a).

The VISTAS Technical Analysis Workgroup provided oversight for the comprehensive model evaluation. In Phase II the modeling system (models and databases) identified and tested in Phase I was implemented following the procedures set forth in the Phase II Modeling Protocol (ENVIRON, 2004a).

For the meteorological component of the Phase I modeling, SESARM contracted with Baron Advanced Meteorological Systems (BAMS) to apply the PSU/NCAR Mesoscale Model (MM5) in multiple configurations and to evaluate its performance against surface and aloft meteorological observations (Olerud, 2003a-f). The emissions modeling component of VISTAS Phase I was carried out by the research team of ENVIRON/Alpine/UCR with staff at Alpine Geophysics taking the lead role in setting up, testing, and applying the emissions modeling system. The air quality modeling component was performed by the team at the ENVIRON/Alpine/UCR modeling centers. A dominant theme during Phase I was the exchange of modeling codes, databases, and evaluation software between the three modeling centers as the air quality modeling was carried out.

1.2.2.2 VISTAS Phase II

The VISTAS Phase II modeling, initiated in 2004, included annual regional ozone, PM and haze simulations with the objective of demonstrating model performance for the selected modeling year, 2002. After detailed model review, testing and performance evaluation, the modeling system was exercised with a variety of emissions scenarios to enable VISTAS to assess the effects of future year emissions on visibility impairment at Class I areas in the VISTAS and nearby states. The modeling system allows VISTAS to estimate 2018 visibility to assist in tracking progress toward regional haze goals. The VISTAS Phase II program applied the SMOKE emissions and CMAQ air quality modeling systems for calendar year 2002 over the same 36/12 km horizontal grid system used in Phase I to estimate 2018 visibility improvements at VISTAS and nearby Class I areas. A number of annual model simulations were performed that included the following:

- **<u>2002 Initial Annual "Actual" Emissions Runs</u>.** Initial 2002 annual model simulations and performance evaluations using the 2002 inventory for VISTAS and non-VISTAS states, Canada and Mexico were performed to confirm the appropriateness of the model science configuration(s) recommended by the Phase I work, to evaluate updates to the model and model inputs and to refine model performance. The 2002 Actual emission scenarios used day-specific fire emissions and emissions from Electric Generating Units (EGUs) using continuous emissions monitoring (CEM) data. The initial CMAQ 2002

36/12 km Base A Actual base case simulation used CMAQ Version 4.4beta and was performed during the summer of 2004. The results of the initial model performance evaluation are documented in Morris et al., (2004b).

- **2002 Revised Annual "Actual" Emissions Runs.** The 2002 emissions inventories for VISTAS and non-VISTAS states, Canada and Mexico were updated with improved assumptions. The CMAQ model was updated to version 4.5 and a modified CMAQ module for Secondary Organics Aerosols (SOA) was developed and tested (Morris et. al., 2006a). Additional annual 2002 simulations were performed using the revised 2002 modeling inventories and revised CMAQ configurations to evaluate model performance. The final VISTAS 2002 Actual Base G2 CMAQ simulation was also used in the ASIP modeling. The ASIP model performance evaluation for the final 2002 Actual Base G2 base case focused on PM model performance is discussed in Chapter 3 and Appendices B and C of this report. The CMAQ 2002 Base G2 actual base case model performance evaluation related to regional haze is described in the VISTAS TSD (Morris et al,. 2007a).

- **2002 Annual Run with "Typical Year" EGU/Fire Inventory.** Typical year emissions inventories were developed for EGU and fire to avoid atypical EGU outages or atypical fire activity in the 2002 modeling year from influencing the assumptions used in the projection year. Continuous emissions monitoring (CEM) data for the 2000-2004 baseline period for EGUs were used to develop the 2002 typical EGU inventories. Available fire activity data in the period 2000-2004 was used to develop 2002 typical fire emissions. All other sectors used the same 2002 actual inventory for the 2002 typical inventory The 2002 typical inventories provide the baseline modeled air quality condition against which future year modeling runs were compared to develop relative response factors (RRFs) for each pollutant species used in the visibility projections.

- **Future Year Annual Base Case Runs.** Future year simulations for 2018 were based on a projected base case inventory of typical EGU emissions and current year baseline typical fire emissions for 2018. The objective of the future year model base case runs was to project 2018 visibility conditions under conditions of growth and current (on-the-books) regulated control measures. These 2018 projections were compared to the Uniform Rate of Progress for 2018 in the VISTAS TSD (Morris et al., 2007a) as one part of VISTAS states' determination of reasonable progress goals for 2018.

- **Future Year Emission Sensitivity Simulations.** VISTAS performed future year sensitivity simulations were performed to assess the effects alternative future year emission assumptions and potential control measures would have on visibility in Class I areas.

Details on the VISTAS modeling results are provided in the VISTAS regional haze SIP Technical Support Document (Morris et al., 2009).

1.2.2.3 ASIP Emissions and Air Quality Modeling

The ASIP emissions and air quality modeling leveraged off of the VISTAS 2002 annual CMAQ 36/12 km modeling set up, only ASIP projected emissions to the 2009 and 2012 future years.

The ASIP model performance evaluation also focused on the performance of ozone and $PM_{2.5}$ mass and components in urban areas and the NAAs, rather than the performance of PM species at Class I areas as studied in VISTAS (Morris et al., 2007a). ASIP also developed projection software to project 8-hour ozone and annual $PM_{2.5}$ Design Values using results from the CMAQ Version 4.5 SOAmods model from the joint ASIP/VISTAS 2002 36/12 km Typical Base G2 base case and ASIP 2009 and 2012 36/12 km Base G4 CMAQ simulations. The ASIP future year 8-hour ozone and $PM_{2.5}$ projection procedures followed the approach in the latest EPA modeling guidance (EPA, 2007a). The final 2009 and 2012 8-hour ozone and $PM_{2.5}$ projections presented in this TSD were made using Version 2.01 of EPA's Modeled Attainment Test Software (MATS) and is presented in Chapter 4 of this TSD. The 8-hour ozone and $PM_{2.5}$ projects using the ASIP projection procedures are presented in Chapter 5 and are used to corroborate the MATS projections.

1.3 AIR QUALITY MODELING OVERVIEW OF 2002 ANNUAL EMISSIONS AND APPROACH

The VISTAS Phase II annual 2002 emissions and air quality modeling was initiated in 2004 and the modeling approach was adopted by ASIP in 2005. It involved the preparation of numerous databases, model simulations, presentations and reports. There were numerous versions and iterations of the modeling with interim results. The results presented in this ASIP $PM_{2.5}$ TSD focus on the final 2002 Base G2 and 2009, 2012 and 2018 Base G2 and Base G4 CMAQ modeling results.

1.3.1 Modeling Protocol

Modeling Protocols were prepared at the outset of both the VISTAS Phase II (ENVIRON, 2004) and ASIP (Morris et al., 2006b) studies. The Modeling Protocols served as a road map for performing the VISTAS and ASIP emissions and air quality modeling and are a form of communication of the modeling plans to the VISTAS and ASIP participants. The Modeling Protocols were prepared following EPA guidance at the time they were prepared (EPA, 1991; 1999, 2001a) and the modeling needs of the Regional Haze Rule (RHR), 8-hour ozone and $PM_{2.5}$ SIPs. The first version of the VISTAS Modeling Protocol was released in March 2004. Based on comments received from VISTAS, the Modeling Protocol was updated to the current version that was dated May 6, 2004.

Under a separate EPA grant and contract from VISTAS, for the ASIP, the modeling team is also performing emissions and air quality modeling for 2009 and 2012 to support southeastern states' demonstration of attainment of the 8-hour ozone and $PM_{2.5}$ national ambient air quality standards. The same model configuration and methods and the 2002 modeling results that are used for VISTAS are also being used for the ASIP modeling. The ASIP Modeling Protocol is dated January 31, 2006 (Morris et al., 2006b) and updated the methods described in the VISTAS Modeling Protocol including procedures for projecting future year 8-hour ozone and $PM_{2.5}$ Design Values.

1.3.2 Quality Assurance Project Plan (QAPP)

Separate Quality Assurance Project Plans (QAPPs) were prepared for the VISTAS (Morris, Tesche and Tonnesen, 2004) and ASIP (Morris and Stella, 2005) annual emissions and air quality modeling studies that described the quality management functions performed by the modeling team. The VISTAS and ASIP QAPPs were finalized November 17, 2004 and November 28, 2005, respectively. The QAPPs were based on the national consensus standards for quality assurance (ANSI/ASQC, 1994), followed EPA's guidelines for quality assurance project plans for modeling (EPA, 2002), for QAPPs (EPA, 2001b) and EPA modeling guidelines (EPA, 1991; 1999; 2001a; 2007) and took into account the recommendations from the North American Research Strategy for Tropospheric Ozone (NARSTO) Quality Handbook for modeling projects (NARSTO, 1998). The EPA and NARSTO guidance documents were developed specifically for modeling projects, which have different quality assurance concerns than environmental monitoring data collection projects. The work performed in this project involves modeling at the basic research level and for regulatory/policy applications. In order to utilize model outputs for these purposes, it must be established that each model is scientifically sound, robust, and defensible. This is accomplished by following a project planning process that incorporates the following elements as described in the EPA guidance document for modeling:

- A systematic planning process including identification of assessments and related performance criteria;
- Peer reviewed theory and equations;
- A carefully designed life-cycle development process that minimizes errors;
- Documentation of any changes from original plans;
- Clear documentation of assumptions, theory, and parameterization that is detailed enough so others can understand the model output;
- Input data and parameters that are accurate and appropriate for the problem; and
- Output data that can be used to help inform decision makers.

A key component of the VISTAS and ASIP emissions and air quality modeling QAPPs were the graphical display of model inputs and outputs and multiple peer-review of each step of the modeling process. This was accomplished through use of the project's modeling Website that posted displays of products (e.g., emissions plots, model outputs, etc.) for review by the VISTAS modeling team, workgroups and others and frequent meetings with the VISTAS/ASIP participants.

1.3.3 Model Selection

The selection of the meteorological, emissions and air quality models for the ASIP/VISTAS annual regional modeling was based on EPA guidance (EPA, 1991; 1999; 2001a; 2005b; 2007), a review of previous modeling studies and the VISTAS Phase I episodic model testing and evaluation (ENVIRON, Alpine and UCR, 2003a,b,c; 2004). The ASIP/VISTAS annual emissions and air quality Modeling Protocols (ENVIRON, 2004; Morris, et. al., 2006b) provide details on the justification for model selection and the formulation of the different models. Based on the VISTAS Phase I comprehensive model testing and evaluation and other work, ASIP/VISTAS selected the following set of models as the primary totals for modeling ozone, particulate matter (PM) and regional haze in the southeastern states:

- **<u>MM5:</u>** The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5 Version 3.6 MPP) is a non-hydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate, and regional haze regulatory modeling studies (Anthes and Warner, 1978; Chen and Dudhia, 2001; Stauffer and Seaman, 1990, 1991; Xiu and Pleim, 2000).

- **SMOKE**: The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, non-road, area, point, fire and biogenic emission sources for photochemical grid models. (Coats, 1995; Houyoux and Vukovich, 1999). As with most 'emissions models', SMOKE is principally an *emission processing system* and not a true *emissions modeling system* in which emissions estimates are simulated from 'first principles'. This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting an existing base emissions inventory data into the hourly gridded speciated formatted emission files required by an air quality simulation model.

- **CMAQ:** EPA's Models-3/Community Multiscale Air Quality (CMAQ) modeling system is a 'One-Atmosphere' photochemical grid model capable of addressing ozone, particulate matter (PM), visibility and acid deposition at the regional scale for periods up to one year (Dennis, et al., 1996; Byun et al., 1998a; Byun and Ching, 1999, Pleim et al., 2003).

The comprehensive air-quality model with extensions (CAMx; ENVIRON, 2008) was also used to corroborate the CMAQ modeling results and to provide source apportionment.

1.3.3.1 MM5 Meteorological Model Configuration for VISTAS Annual Modeling

Application of the MM5 for the 2002 annual modeling on a 36 km grid for the continental U.S. and a 12 km grid for the eastern U.S. was performed by Barons Advanced Meteorological Systems (BAMS). As part of Phase I of VISTAS, BAMS performed numerous MM5 simulations to identify the optimal configuration for simulating meteorology to support regional PM and visibility modeling of the eastern U.S. (Olerud, 2003a,b,c,d). Details of the 2002 36/12 km MM5 model application and evaluation are available on the BAMS VISTAS project website (www.baronams.com/projects/VISTAS). ASIP has adopted the VISTAS MM5 modeling results.

Based on the extensive sensitivity testing carried out by Olerud and Sims (2003) as part of VISTAS, the MM5 (Version 3.6, MMP) configuration used by BAMS modelers for the VISTAS Phase II modeling consisted of the following (see Table 1-1 or www.baronams.com/projects/VISTAS for more details):

- Nested 36/12 km grids, with 34 vertical layers;
- Two way nesting, no feedback;
- Initialization and boundary conditions from Eta analysis fields;
- Pleim-Xiu (P-X) land soil model (LSM);
- Asymmetric Convective Mixing (ACM) planetary boundary layer (PBL) model;
- Kain-Fritsch 2 cumulus parameterization;
- Mixed phase (Reisner 1) cloud microphysics;
- Rapid Radiative Transfer Model (RRTM) radiation;

- Snow effect turned on;
- Eta model sea surface temperature;
- 24-category USGS vegetation data sets;
- Thermal roughness by the Garratt method; and
- Standard FDDA analysis nudging on 36 km and 12 km grid nests.

The emissions and air quality modeling team also performed their own independent evaluation and quality assurance of the MM5 (Morris et al., 2004b) to assure that the MM5 modeling fields prepared by BAMS were transferred and processed correctly for input into CMAQ using the Meteorological-Chemical transport model Interface Program (MCIP). MCIP Version 3.0 was used in the processing which invoked the Pleim M3DRY dry deposition scheme in CMAQ that uses the MM5 P-X LSM parameters. MCIP Version 3.0 included a significant update from previous versions in the calculation of layer collapsing. MCIP was also run using the option to specify land-use dependent minimum vertical turbulent exchange coefficients (Kz) that ranged from 0.1 to 2.0 m^2/s.

Table 1-1. MM5 Meteorological Model Configuration for ASIP/VISTAS (Olerud, 2003a,b,c,d).

Science Options	Configuration	Details/Comments
Model Code	MM5 Version 3.6 (MPP)	Grell et al., 1994
Horizontal Grid Mesh	36/12 km	
36 km grid	164 x 128 cells	Continental U.S.
12 km grid	180 x 189 cells	Eastern U.S.
Vertical Grid Mesh	34 layers	Vertically varying; sigma pressure coord.
Grid Interaction	No Feedback	IFEED=0
Initialization	Eta first guess fields/LittleR	
Boundary Conditions	Eta first guess fields/LittleR	
Microphysics	Reisner I Mixed Ice	Look up table
Cumulus Scheme	Kain-Fritsch 2	On both 36/12 Grids
Planetary Boundary Layer	ACM PBL	
Radiation	RRTM	
Vegetation Data	USGS	24 Category Scheme
Land Surface Model	P-X Land Surface Model (LSM)	Cold restart every 5.5 days
Shallow Convection	None	
Sea Surface Temperature	Eta Skin	Spatially varying
Thermal Roughness	Garratt	
Snow Cover Effects	None	
4D Data Assimilation	Analysis Nudging on 36/12	
Integration Time Step	90 seconds	
Simulation Periods	Annual 2002	
Platform	Linux Cluster	Done at BAMS

1.3.3.2 SMOKE Emissions Model Configuration for VISTAS Annual Modeling

SMOKE supports area, mobile, fire and point source emission processing and also includes biogenic emissions modeling through a rewrite of the Biogenic Emission Inventory System, version 3 (BEIS3) (see, http://www.epa.gov/ttn/chief/software.html#pcbeis). SMOKE has been available since 1996, and it has been used for emissions processing in a number of regional air quality modeling applications. In 1998 and 1999, SMOKE was redesigned and improved with the support of the U.S. Environmental Protection Agency (EPA), for use with EPA's Models-3/CMAQ (http://www.epa.gov/asmdnerl/models3) and is currently maintained and available from the CMAS center (www.cmascenter.org).

As an emissions processing system, SMOKE has far fewer 'science configuration' options compared with the MM5 and CMAQ models. Table 1-2 summarizes the version of the SMOKE system to be used and the sources of data to be employed in constructing the required modeling inventories. Details on the SMOKE emissions modeling for the ASIP 2002 annual modeling is presented in Chapter 2 with emissions summary reports available in Appendix A.

Table 1-2. SMOKE Emissions Model Configuration for ASIP/VISTAS.

Emissions Component	Configuration	Details/Comments
Emissions Model	SMOKE Version 2.1	Errors in SMOKE Version 2.1 conversion of lat/lon coordinates to Lambert Conformal modeling grid resulted in displacement of sources and receptors. Discovered in Aug 2007. Receptor locations corrected for Base G2 results.
Horizontal Grid Mesh	36/12 km	
36 km grid	148 x 112 cells	RPO Unified Grid
12 km grid	168 x 177 cells	VISTAS/ASIP eastern US 12 km grid
Area Source Emissions	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction MRPO Base K, CENRAP Base F, MANE-VU Version 3.1 and WRAP Plan02b
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
On-Road Mobile Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction MRPO Base K, CENRAP Base F, MANE-VU Version 3.1 and WRAP Plan02b
	Mexico/Canada Emissions:	1999 Mexico from BRAVO. 2000 Canada
Point Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states and stakeholders Last update Base G2.
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction MRPO Base K, CENRAP Base F, MANE-VU Version 3.1 and WRAP Plan02b
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Off-Road Mobile Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states Last update Base F
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction MRPO Base K, CENRAP Base F, MANE-VU Version 3.1 and WRAP Plan02b
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Biogenic Sources	VISTAS Domain: VISTAS State 2002 EI	Updated '02 developed by VISTAS states
	Other States: EPA '02 NEI augmented with other 2002	Generated from EPA NEI02 v.1 and RPO interaction
	Mexico/Canada Emissions:	Same as Phase I w/ revisions based on available updates
Temporal Adjustments	Seasonal, day, hour	Based on latest collected information and CEM-based profiles
Chemical Speciation	Revised CB4 Chemical Speciation	Revised in 2004
Gridding	Revised EPA Spatial Surrogates Used	Gridding of surrogates from http://www.epa.gov/ttn/chief/emch/spatial/
Growth and Controls	MACTEC (2006)	MRPO Base K (Base M for point sources), CENRAP Base F, MANE-VU Version 3.1 and WRAP Plan02b
Quality Assurance	QA Tools in SMOKE 2.1	Independent QA following QAPP (Morris and Stella, 2005)
Simulation Periods	Annual 2002	
Platform	Dual Athelon 2600 \+	Local 1.8 terabyte Ultra 320 RAID 5 system processing and storage

1.3.3.3 CMAQ Air Quality Model Configuration for ASIP/VISTAS Annual Modeling

ASIP/VISTAS used Version 4.51 of the Community Multi-scale Air Quality (CMAQ) modeling system with an enhanced secondary organic aerosol (SOA) module (SOAmods) using the model configuration shown in Table 1-3. The model was set up and exercised on the 36 km grid continental U.S. Inter-RPO modeling domain that was also used by WRAP and CENRAP. ASIP/VISTAS also performed annual 2002 12 km modeling for an eastern U.S. modeling domain that included all of the ASIP/VISTAS states as well as adjacent states to the west (CENRAP), in the Midwest (MRPO) and the Northeast (MANE-VU).

Initial CMAQ 2002 simulations performed by VISTAS found that the model greatly underestimate Organic Carbon Mass (OCM) concentrations, especially in the summer (Morris et al., 2004b). A review of the CMAQ formulation found that it failed to treat Secondary Organic Aerosol (SOA) formation from sesquiterpenes and isoprene and also failed to account for polymerization of SOA so that it is no longer volatile and stays in the particle form. The standard versions of CMAQ V4.51 assume that SOA is always volatile so that once an aerosol is formed it can evaporate from particle to gaseous form depending on atmospheric conditions (e.g., temperature and humidity). After a detailed literature review, VISTAS updated the CMAQ SOA module to include these missing processes and found that the updated CMAQ V4.5 SOAmods produced much better OCM model performance in the summer (Morris et al., 2006c). As this SOAMODS enhancement was developed specifically for VISTAS/ASIP, it is described next. Details in the other components of CMAQ V4.51 are provided elsewhere (e.g., Byun and Ching, 1999).

1.3.3.3.1 CMAQ V4.5 SOAmods Enhancement

The formulation of the CMAQ standard SOA module is described in Binkowski and Roselle (2003). In the CMAQ standard SOA module, SOA is formed primarily from aromatic VOCs and biogenic terpenes. The biogenic SOA precursor emissions were modeled with the Biogenic Emissions Information System – Version 3 (BEIS3) model (Pierce et al., 2002). BEIS3 generates three biogenic VOC species: isoprene (ISOP), monoterpenes (TERP) and other biogenic VOC (OVOC). After testing of alternative gas-phase chemical mechanisms available in CMAQ (SAPRC99 and CBM-IV; ENVIRON, Alpine and UCR, 2003c)), VISTAS selected the Carbon Bond IV photochemical mechanism (Gery et al., 1989) for use in the annual air quality modeling since it produced essentially identical model performance as SAPRC99 and was more computationally efficient. CBM-IV represents VOC compounds based on their carbon bond structure. The BEIS3 ISOP, TERP and OVOC species are speciated into the CB4 species for photochemical modeling in CMAQ as follows (molar speciation):

- ISOP = ISOP (isoprene is an explicit species)
- ALD2 = 1.5 x TERP
- OLE = 0.5 x TERP
- PAR = 6.0 x TERP
- NR = 0.5 x OVOC
- OLE = 0.5 x OVOC
- PAR = 8.5 x OVOC
- TERPB = TERP

Here, ALD2, OLE, PAR and NR are the CBM-IV chemical mechanism representations of the biogenic VOC emissions as high molecular weight aldehydes, olefinic carbon bond, paraffin carbon bond and non-reactive functional groups. In CMAQ, the TERPB species is specified in the emissions inputs, along with its CBM-IV representation of ALD2, OLE and PAR, but does not participate in the photochemical mechanism and is only used in the SOA formation module. The TERPB species forms a SGTOT species based on oxidation parameters extracted from the photochemical module. SGTOT consists of the combined gaseous condensable gas (CG) plus particle SOA that are assumed to be in equilibrium. CMAQ transports the SGTOT species and splits it to a CG gaseous and particle SOA for output.

The CMAQ TERB SOA formation rate is based on a two-product fit to smog chamber data collected at the California Institute of Technology for several biogenic monoterpene species (Binkowski and Roselle, 2003). A review of recent literature of biogenic SOA measurements identified several processes that may be important to biogenic SOA formation that are not treated by the BEIS3 biogenic emissions model and the CMAQ SOA module:

Polymerization: Recent measurements indicate that some SOA species may polymerize, resulting in species that are no longer volatile and cannot evaporate back to a CG. In this case, the equilibrium assumption between the CG and SOA will understate the amount of particle SOA present in the atmosphere (Kalberer et al., 2004; Jang et al., 2002).

Sesquiterpenes: Sesquiterpenes are not accounted for in the BEIS3/CMAQ SOA modeling system (Guenther et al., 2000; Vizuete et al., 2004).

Isoprene: More recent evidence suggests that isoprene can also form particle SOA compounds that are not accounted for in CMAQ (Claeys et al., 2004; Matsunaga et al., 2003; 2005).

Acid Catalyzation: Recent literature also suggests that some SOA formation may have acid catalyzed reactions (Claeys et al., 2004; Jang et al., 2005).

Heterogeneous Reactions: Recent evidence suggests that some SOA formation may occur during heterogeneous aqueous-phase chemical reactions (Yu et al., 2005).

An enhanced SOA module was added to CMAQ that accounted for the first three processes listed above. The last two processes were not included in this work because there are not enough quantitative experimental data yet to establish a parameterization. Modules were added to the CMAQ SOA module under the following constraints:

- The existing CMAQ SOA module for monoterpenes would remain unchanged;
- The same CMAQ model inputs would be used; and
- The basic CMAQ model formulation would remain unchanged, modules would be added to account for polymerization and SOA from sesquiterpenes and isoprene.

Figure 1-3 displays how the enhanced SOA module represented the new processes that were added to the CMAQSOA module to represent SOA polymerization and SOA formation from sesquiterpenes and isoprene along with the existing CMAQ SOA module structure and inputs. The new components of the SOA module are indicated in bold italic, whereas the existing

CMAQ SOA components (Binkowski and Roselle, 2002) use a regular font. There are several parameters that must be defined in the new elements of the enhanced SOA module: emission factors (EF), canopy escape efficiencies for gases (EEG) and aerosols (EEA) and SOA yields (Y). Based on an analysis of recent measurements, primarily from a recent biogenic emissions field study in Duke Forest, North Carolina (Stroud et al., 2005; Matsunaga et al., 2005), a range of values for the factors in Figure 1-3 were developed as shown in Table 1-4. The enhanced SOA module used the mid-point of the range values for the factors from the measurements (Table 1-4), which represent the best estimates of these parameters given the information when they were developed. No attempt was made to optimize the parameters in Table 1-5 for OC/TCM model performance.

The emission factors, EF1 and EF2, relate the monoterpene emissions estimated by BEIS3 to emissions of monoterpenes, EF1 (e.g., α-pinene), and sesquiterpenes (EF2). Table 1-4 displays the range of EF1 and EF2 factors based on recent field study data (Stroud et al., 2005). Using the midpoint of the range results in emission factors of 0.7 for EF1 and 0.4 for EF2. EF1 is assigned a value of 0.7 based on field observations that indicate that the BEIS3 terpene emission factors are likely overestimated due to a tendency of earlier measurements approaches to artificially increase the emissions due to disturbance when leaves were enclosed in the measurement system. Sesquiterpene emissions were included using an EF2 value of 0.4 based on the ratio of the observed sesquiterpene emission from the Duke Forest field study to terpene emissions that are provided by BEIS2 TERP species (Stroud et al, 2005). The net result is that BEIS3 TERP emissions are increased by 10% and split 64% as monoterpenes and 36% as sesquiterpenes. The CG yields from the sesquiterpenes are assumed to partly condense into a non-volatile SOA particle that is modeled in CMAQ using the new secondary organic carbon species (SOC2) species and only some of the gas and aerosol species associated with sesquiterpenes are assumed to escape from the canopy using the mid-range of the Escape Efficiencies (EE) estimated by Stroud et al. (2005). The fraction of BEIS3 TERP emissions that are assumed to be monoterpenes (i.e., 64% of the emissions) are treated with the standard CMAQ two-product SOA module (Binkowski and Roselle, 2003) assuming equilibrium between the CG and SOA with the SOA output in the standard AORGB species (Binkowski and Roselle, 2003). The isoprene SOA formation pathway forms a CG using the mid-point yield rate based on the range of recent measurements (Stroud et al., 2005) and a CG/SOA partitioning rate based on the mid-point of measurements from Matsunaga et al. (2003, 2005) (Table 1-4). The isoprene SOA is assumed to be volatile and is modeled as a new secondary organic carbon species in CMAQ SOAmods (SOC3). Finally, all SOA species, with the exception of the already non-volatile SOC1 (polymerized SOA) and SOC2 (sesquiterpene product) species, are assumed to partially polymerize into non-volatile particles that are stored in the SOC1 species. The polymerization rate is based on the results of Kalberer et al (2004) who found that 50% of the SOA polymerized in 20 hours.

Several levels of Quality Assurance and Quality Control of the enhanced SOAmods module in the CMAQ model were conducted as follows.

<u>QA/QC of SOAmods Coding</u>: The SOAmods implementation was conducted at ENVIRON. Staff at the University of California at Riverside performed independent QA/QC of the SOAmods code implementation and independent testing and evaluation.

<u>QA of SOAmods Formulation</u>: The new processes being added to the CMAQ SOA module were discussed with researchers at EPA's Office of Research and Development

(ORD). Although they have not completed all the laboratory tests, the inclusion of SOA from sesquiterpene and isoprene has been observed and are supported by their preliminary measurements.

Peer Review of SOAmods: The formulation of the SOAmods enhancement to the CMAQ SOA module was documented, reviewed by many parties and comments were provided. The results were also published in a peer-reviewed journal (Morris et al., 2006c).

Model Performance Evaluation of SOAmods: The final level of QA of the SOAmods was comparisons of CMAQ V4.4 model performance with and without including the SOAmods enhancement. Table 1-5 displays fractional bias error for Organic Carbon Mass (OCM) at IMPROVE and STN monitoring sites in the VISTAS, MRPO, MANE-VU and CENRAP states using the standard CMAQ Version 4.4 (V4.4) and then CMAQ V4.4 with the SOAmods enhancement. Here the original IMPROVE equation was used to adjust the IMPROVE measured OC to OCM (i.e., OCM = 1.4 x OC). Whereas the standard CMAQ V4.4 underestimates OCM across IMPROVE sites from –76% (MRPO) to –102% (VISTAS), with the SOAmods enhancement the fractional biases centered on zero and ranged from –14% to +8%. Similar results are seen for OCM fractional bias across the more urban STN sites where the CMAQ V4.4 exhibits an underestimation bias of –67% to –105%, when using SOAmods the under-prediction bias is –27% to –44%. Note that the continued underestimation of OCM across the urban STN sites is likely due to missing primary OCM emissions and uncertainties in the STN OCM measurements. Also note that a 1.4 multiple was used to convert the measured OC to OCM; if a 1.8 factors was used for such conversion, as given in the new IMPROVE equation, than the OCM underprediction bias would be even greater.

With the release of CMAQ Version 4.5 in October 2005, the SOAmods enhancement was added to the AERO3 aerosol module in CMAQ Version 4.5 that was compared against the standard CMAQ Versions 4.5 and SOAmods was found to produce similar improvements in OCM model performance as seen with CMAQ Version 4.4. In March 2006 Version 4.51 of CMAQ was released that included active Sea Salt chemistry and Sea Salt emissions. Given that many of the VISTAS Class I areas are located in the coastal environment then Sea Salt may be important. Consequently, the SOAmods enhancement was implemented in the AERO4 (AE4) aerosol module in CMAQ V4.51 and that was the version used in the final 2002 Base G2 and 2009, 2012 and 2018 Base G4 modeling.

Table 1-3. CMAQ Air Quality Model Configuration for ASIP/VISTAS.

Science Options	Configuration	Details/Comments
Model Code	CMAQ Version 4.51 with SOAmods enhancement	Pleim et al., (2005); Morris et al., (2006c)
Horizontal Grid Mesh	36/12 km	36 km covering cont. U.S; 12 km covering eastern US
36 km grid	148 x 112 cells	RPO National Grid
12 km grid	168 x 177 cells	VISTAS 12 km EUSA grid
Vertical Grid Mesh	19 Layers	First 17 layers sync'd w/ MM5
Grid Interaction	One-way nesting	
Initial Conditions	~15 days full spin-up	Separately run 4 quarters of 2002
Boundary Conditions	2002 3-hourly GEOS-CHEM annual run	Day-specific 3-hour BCs from Global Climate Model
Emissions		
Baseline Emissions Processing	SMOKE (Ver 2.2)	MM5 Meteorology input to SMOKE, CMAQ
Dust Transport Fraction	Applied in emissions before SMOKE	Tom Pace updates
NH3 Inventory Adjustment	Applied in emissions before SMOKE	
Sub-grid-scale Plumes	No Plume-in-Grid (PinG)	
Chemistry		
Gas Phase Chemistry	CBM-IV	
Aerosol Chemistry	AE4/ISORROPIA	Includes active Sea Salt
Secondary Organic Aerosols	Secondary Organic Aerosol Model (SORGAM) w/ SOAmods enhancement	Schell et al., (2001); Morris et al, (2006c)
Aerosol Mass Conservation Patch	Yes	Georgia Institute of Technology Update
Cloud Chemistry	RADM-type aqueous chemistry	Includes subgrid cloud processes
N2O5 Reaction Probability	0.01 – 0.001	
Meteorological Processor	MCIP Version 3.0	Includes dry deposition for Sea Salt and percent urban minimum Kz (PURB)
Horizontal Transport		
Eddy Diffusivity Scheme	K-theory with Kh grid size dependence	Multiscale Smagorinsky (1963) approach
Vertical Transport		
Advection Scheme	Yamartino	V4.5 Mass Conservation (Yamartino)
Eddy Diffusivity Scheme	K-theory	
Diffusivity Lower Limit	Kzmin = 0.1 to 2.0	PURB option in Ver 4.5
Planetary Boundary Layer	No Patch	
Deposition Scheme	M3dry	Directly linked to Pleim-Xiu Land Surface Model parameters
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) solver	Hertel et al (1993) EBI solver ~ 2x faster than MEBI
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	
Simulation Periods	Annual 2002	With~15 day spin-up in December 2001
Integration Time Step	Determined by met conditions	15 minute coupling time step
Platform	Athlon MP 2600+	MPI using 6 processors per quarter

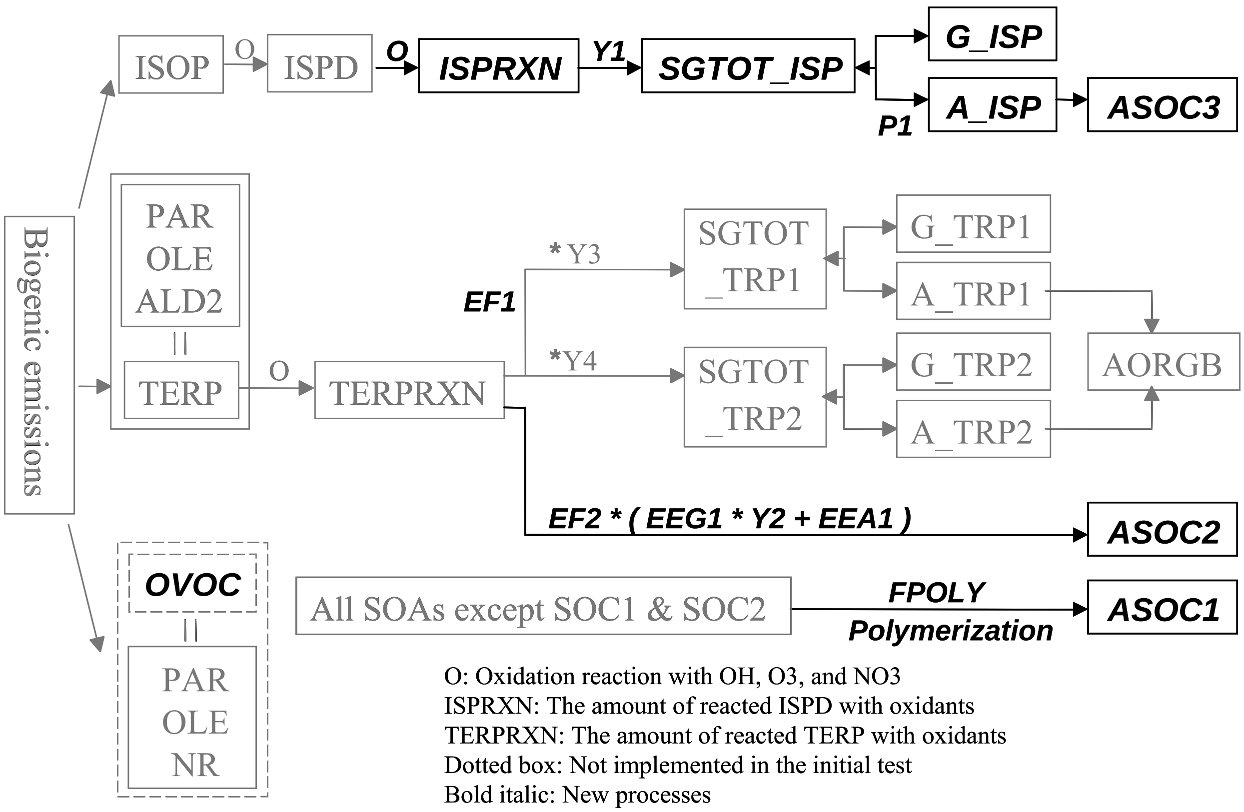

Figure 1-3. Schematic describing the addition of new SOAmods processes (bold italic) to the existing CMAQ SOA module (regular font) to treat polymerization and SOA formation from sesquiterpenes and isoprene (see Table 1-4 for parameters).

Table 1-4. Parameters use in SOAmods module to enhance CMAQ (see Figure 1-3).

Parameter	Mid-Point	Range
EF1	0.7	0.4 ~ 1.0
EF2	0.4	0.2 ~ 0.6
EEG1	0.325	0.2 ~ 0.45
EEA1	0.2	0.05 ~ 0.35
Y2	0.875	0.75 ~ 1.0
Y1	0.11	0.06 ~ 0.16
P1	0.45	0.15 ~ 0.75

EF1 = emission factor of monoterpenes to the TERP emissions estimated by BEIS3
EF2 = emission factor of sesquiterpenes relative to the TERP emissions estimated by BEIS3
EEG1 = escape efficiency of gas phase precursor of sesquiterpenes from canopy
EEA1 = escape efficiency of SOA from sesquiterpenes from canopy
Y1 = SOA yield of oxidated isoprenes
Y2 = SOA yield of sesquiterpenes

Table 1-5. Results of initial evaluation of the SOAmods enhancement comparison of fractional bias performance metric for Organic Carbon Mass (OCM) using the standard CMAQ Version 4.4 (V4.4) and CMAQ V4.4 with the SOAmods enhancement (observed OCM = 1.4 x OC).

July 2002 Fractional Bias	IMPROVE OCM		STN OCM	
	V4.4	SOAmods	V4.4	SOAmods
Southeastern U.S.	-102%	-2%	-105%	-32%
Midwestern U.S.	-76%	+12%	-67%	-24%
Northeast U.S.	-82%	-14%	-95%	-44%
Central U.S.	-98%	+8%	-81%	-27%

1.3.4 Horizontal Modeling Domains

ASIP/VISTAS used the same 36 km continental U.S. and 12 km eastern U.S. modeling domains in the VISTAS Phase I and II modeling. The 36 km Inter-RPO coarse grid continental United States horizontal modeling domain is the same domain used for CENRAP and WRAP modeling. The CMAQ domain is nested in the MM5 domain. The selection of the MM5 domain is described in the VISTAS MM5 modeling protocol (Olerud, 2003a,b,c,d). Figure 1-4 displays the MM5 horizontal domain as the outer bluest grid. Also shown in Figure 1-4 is the CMAQ 36 km domain nested in the MM5 domain. To achieve finer spatial resolution in the eastern U.S., including the ASIP/VISTAS region, ASIP/VISTAS also used a one-way nested higher resolution grid with a 12 km grid resolution. Figure 1-5 displays the 36 km CMAQ continental grid and the high resolution, nested 12 km grid for the eastern U.S. Figure 1-6 shows in more detail the 12 km grid for the eastern U.S. region that is the focus of ASIP/VISTAS.

Both MM5 and CMAQ employ the Regional Planning Organization (RPO) unified grid definition for the 36 km continental domain. The RPO unified grid consists of a Lambert-Conformal map projection using the map projections parameters listed in Table 1-6.

Table 1-6. RPO Lambert Conformal Projection (LCP) unified grid definition.

PARAMETER	VALUE
projection	Lambert-conformal
alpha	33 degrees
beta	45 degrees
x center	97 degrees
y center	40 degrees

The MM5 36 km grid includes 164 cells in the east-west dimension and by 128 cells in the north-south dimension. The CMAQ 36 km grid includes 148 cells in the east-west dimension and 112 cells in the north-south dimension. Because the MM5 model is also nested in the Eta model, there is a possibility of boundary effects near the MM5 boundary that occur as the Eta meteorological variables are being simulated by MM5 and must come into dynamic balance with MM5's algorithms. Thus, a larger MM5 domain was selected to provide a buffer of 8 to 9 grid cells around each boundary of the CMAQ 36 km domain. This is designed to eliminate any errors in the meteorology from boundary effects in the MM5 simulation at the interface of the MM5 and Eta models. The buffer region used here exceeds the EPA suggestion of at least 5 grid cell buffer at each boundary.

Table 1-7 lists the number of rows and columns and the definition of the X and Y origin (i.e., the southwest corner) for the 36 km and 12 km grids for both MM5 and CMAQ. Note that the CMAQ grid is rotated 90 degrees relative to the MM5 grid, so rows and columns are reversed. In Table 4-2 "Dot" refers to the grid mesh defined at the vertices of the grid cells while "cross" refers to the grid mesh defined by the grid cell centers. Thus, the dimension of the dot mesh is equal to the cross mesh plus one. Finally, we note that the grid definition for the CMAQ Meteorology Chemistry Interface Processor (MCIP) and CMAQ Chemical Transport Model (CCTM) are identical. The SMOKE emissions modeling used the same domain definition as CMAQ.

Table 1-7. Grid definitions for MM5 and CMAQ using the RPO LCP unified grid coordinate system.

MODEL	COLUMNS DOT(CROSS)	ROWS DOT(CROSS)	XORIGIN	YORIGIN
MM5 36km	129 (128)	165 (164)	-2952000	-2304000
CMAQ 36km	149 (148)	113 (112)	-2736000	-2088000
MM5 12km	190 (189)	181 (180)	7200	-1656000
CMAQ 12km	169 (168)	178 (177)	108000	-1620000

In Aug 2007 it was discovered that the I/O API subroutine used in SMOKE provided incorrect coordinate transformations from lat/long coordinates to Lambert Conformal coordinates. This error results in a displacement of stack locations of approximately 2-3 km, so point sources in the modeling inventories could be displaced spatially by one 12 km or 36 km grid cell to another. In general, this displacement was of a few kilometers so had a minimal effect on the location of grid cells for the point sources in the ASIP/VISTAS 36/12 km modeling. This error was discovered after the 2002 Base G2 CMAQ base case simulation. ASIP discussed whether this error should be corrected in the 2009 Base G4 modeling and decided not to in order for the 2009 modeling to be consistent with 2002. However, the I/O API coordinate transformation error was corrected for extracting modeling results at monitoring locations for use in the model performance evaluation and $PM_{2.5}$ projections.

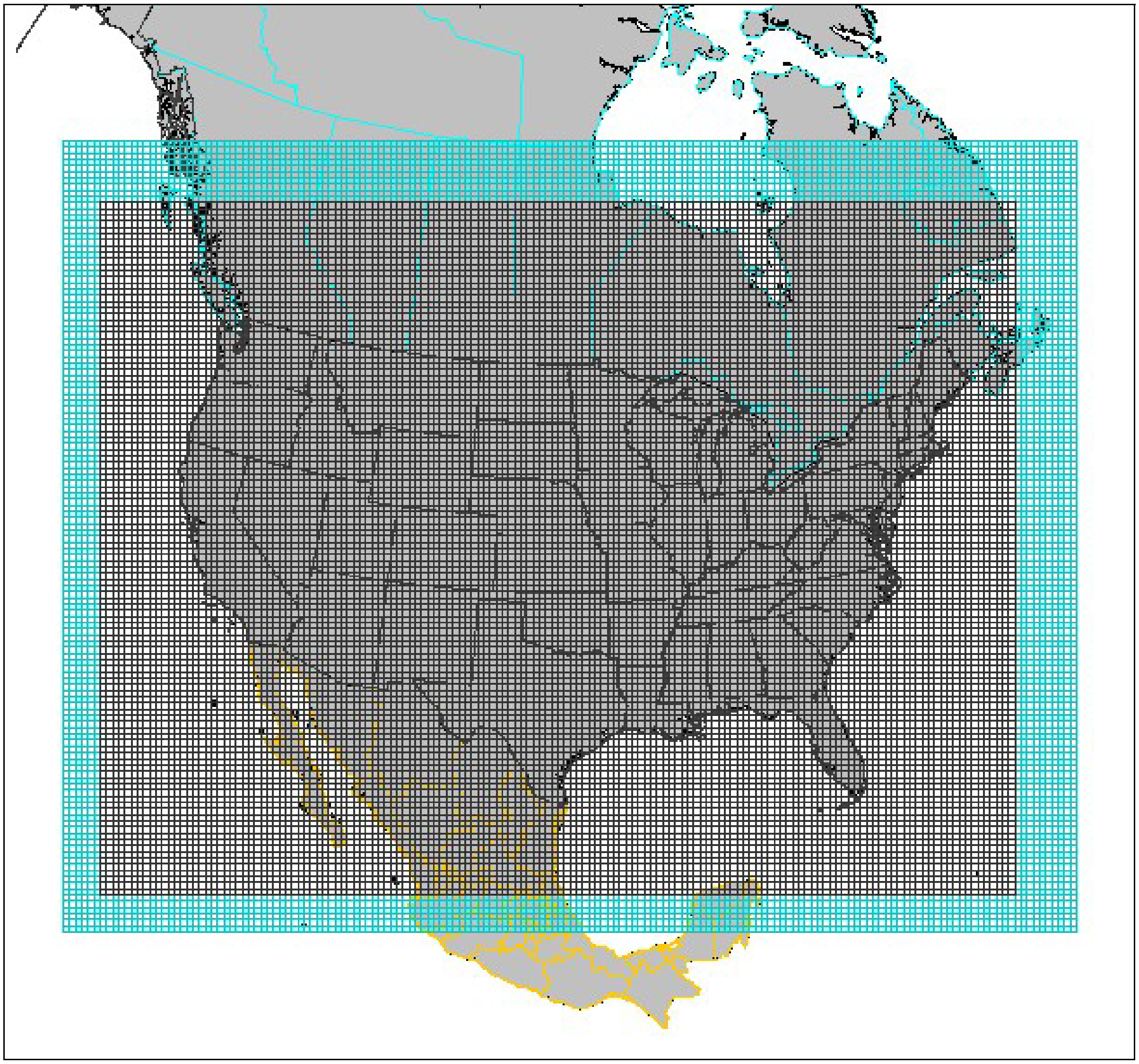

Figure 1-4. Nesting of ASIP/VISTAS 36-km CMAQ grid (black) in the MM5 36-km grid (blue).

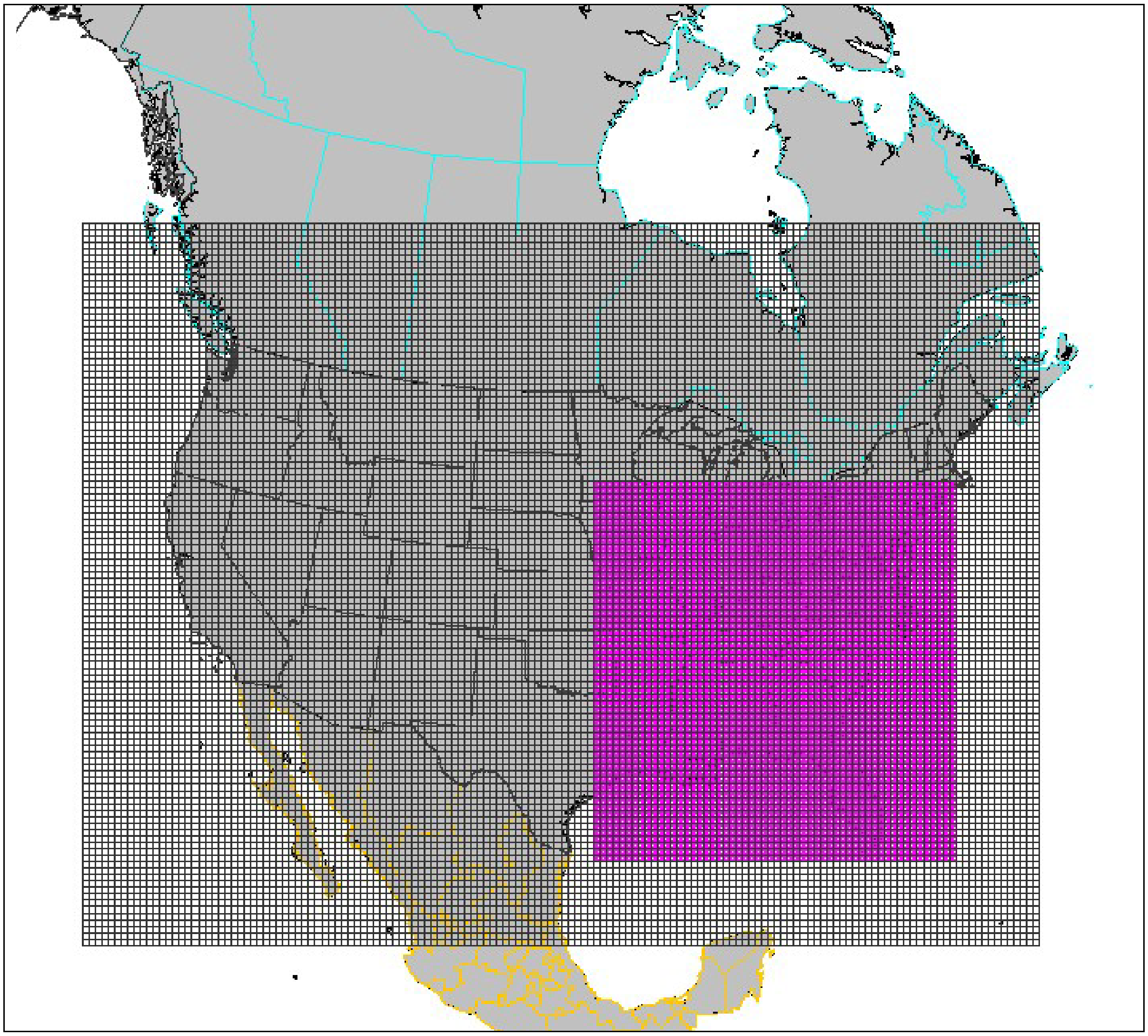

Figure 1-5. Nesting of CMAQ 12-km grid (violet) in the CMAQ 36 km grid (black).

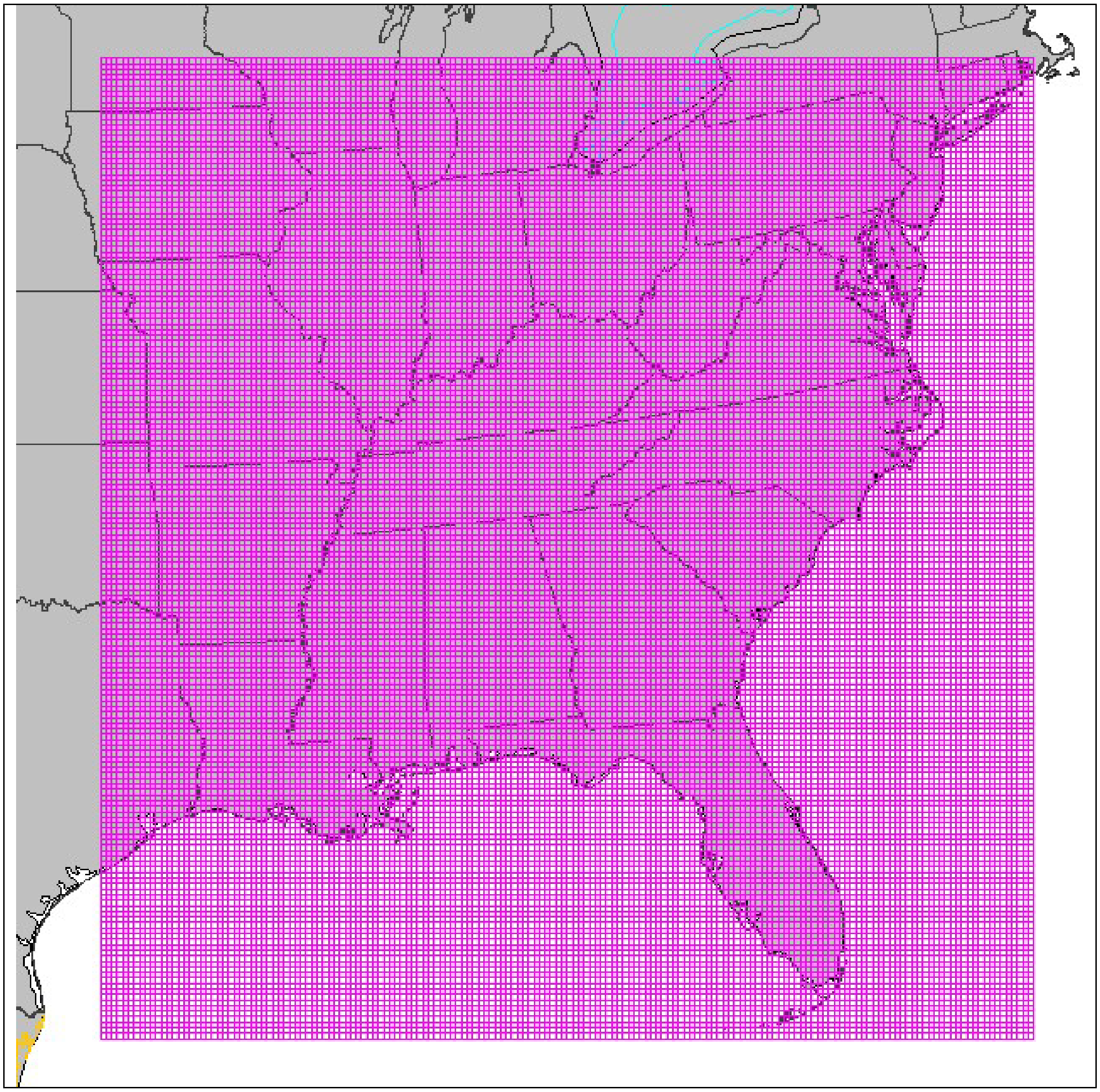

Figure 1-6. Domain definition for the ASIP/VISTAS higher resolution CMAQ 12 km eastern U.S. grid.

1.3.5 Vertical Domain Definition

The CMAQ vertical layer structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employed a terrain following coordinate system defined by pressure, using 34 layers that extend from the surface to the 100 mb pressure level. Table 1-8 lists the layer definitions for both MM5 and for CMAQ. A layer averaging scheme is adopted for CMAQ to reduce the computational time of the CMAQ simulations. The effects of layer averaging were evaluated in the VISTAS Phase I modeling effort and found to have a relatively minor effect on the model performance metrics when both the 34 layer and a 19 layer CMAQ models were compared to ambient monitoring data (ENVIRON, Alpine and UCR, 2003c).

Table 1-8. Vertical layer definition for the VISTAS MM5 simulations (left most columns) using 34 layers and approach for reducing CMAQ layers by collapsing multiple MM5 layers (right columns).

MM5					CMAQ 19L				
Layer	Sigma	Pressure (mb)	Height (m)	Depth (m)	Layer	Sigma	Pressure (mb)	Height (m)	Depth (m)
34	**0.000**	**100**	**14662**	**1841**	**19**	**0.000**	**100**	**14662**	**6536**
33	0.050	145	12822	1466		0.050	145		
32	0.100	190	11356	1228		0.100	190		
31	0.150	235	10127	1062		0.150	235		
30	0.200	280	9066	939		0.200	280		
29	**0.250**	**325**	**8127**	**843**	**18**	**0.250**	**325**	**8127**	**2966**
28	0.300	370	7284	767		0.300	370		
27	0.350	415	6517	704		0.350	415		
26	0.400	460	5812	652		0.400	460		
25	**0.450**	**505**	**5160**	**607**	**17**	**0.450**	**505**	**5160**	**1712**
24	0.500	550	4553	569		0.500	550		
23	0.550	595	3984	536		0.550	595		
22	**0.600**	**640**	**3448**	**506**	**16**	**0.600**	**640**	**3448**	**986**
21	0.650	685	2942	480		0.650	685		
20	**0.700**	**730**	**2462**	**367**	**15**	**0.700**	**730**	**2462**	**633**
19	0.740	766	2095	266		0.740	766		
18	**0.770**	**793**	**1828**	**259**	**14**	**0.770**	**793**	**1828**	**428**
17	0.800	820	1569	169		0.800	820		
16	**0.820**	**838**	**1400**	**166**	**13**	**0.820**	**838**	**1400**	**329**
15	0.840	856	1235	163		0.840	856		
14	**0.860**	**874**	**1071**	**160**	**12**	**0.860**	**874**	**1071**	**160**
13	0.880	892	911	158	**11**	**0.880**	**892**	**911**	**158**
12	**0.900**	**910**	**753**	**78**	**10**	**0.900**	**910**	**753**	**155**
11	0.910	919	675	77		0.910	919		
10	**0.920**	**928**	**598**	**77**	**9**	**0.920**	**928**	**598**	**153**
9	0.930	937	521	76		0.930	937		
8	**0.940**	**946**	**445**	**76**	**8**	**0.940**	**946**	**445**	**76**
7	**0.950**	**955**	**369**	**75**	**7**	**0.950**	**955**	**369**	**75**
6	**0.960**	**964**	**294**	**74**	**6**	**0.960**	**964**	**294**	**74**
5	**0.970**	**973**	**220**	**74**	**5**	**0.970**	**973**	**220**	**74**
4	**0.980**	**982**	**146**	**37**	**4**	**0.980**	**982**	**146**	**37**
3	**0.985**	**986.5**	**109**	**37**	**3**	**0.985**	**986.5**	**109**	**37**
2	**0.990**	**991**	**73**	**36**	**2**	**0.990**	**991**	**73**	**36**
1	**0.995**	**995.5**	**36**	**36**	**1**	**0.995**	**995.5**	**36**	**36**
0	**1.000**	**1000**	**0**	**0**	**0**	**1.000**	**1000**	**0**	**0**

1.3.6 2002 Calendar Year Selection

The calendar year 2002 was selected for ASIP/VISTAS ozone, PM and regional haze annual modeling as described in the ASIP/VISTAS Modeling Protocols (ENVIRON, Alpine, UCR and UCD, 2004; Morris et. al., 2006b). EPA recommends that the selection of a modeling period for annual $PM_{2.5}$ modeling be based on the following four criteria (EPA, 2007a):

1. Choose time periods from each quarter which reflect a variety of meteorological conditions that represent average concentrations for that quarter and year;
2. Model time periods in which observed concentrations are close to the appropriate baseline design value;
3. Model time periods fort which extensive air quality/meteorological data bases exist; and
4. Model a sufficient number of days so that the modeled attainment test applied at each monitor violating the NAAQS is base on multiple days.

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EPA also lists several ‘other considerations’ to bear in mind when choosing potential PM episodes including: (a) choose periods which have already been modeled, (b) choose periods which are drawn from the years upon which the current design values are based, (c) include weekend days among those chosen, and (d) choose modeling periods that meet as many episode selection criteria as possible in the maximum number of nonattainment or Class I areas as possible.

ASIP elected to model a complete single Calendar Year (CY) to assure that sufficient days are present to represent each quarter of the Year, which follows EPA recommendations (page 149, EPA, 2007a). The 2002 calendar year was selected by ASIP for annual $PM_{2.5}$ and 8-hour modeling for the following reasons:

- Based on available information, 2002 appears to be a fairly typical year in terms of meteorology;
- 2003 and 2004 appeared to be colder and wetter than typical in the eastern US;
- The enhanced IMPROVE and IMPROVE Protocol and Supersite PM monitoring data were fully operational by 2002 with much less IMPROVE monitoring data available during 2000-2001;
- The STN speciated $PM_{2.5}$ and FRM $PM_{2.5}$ mass monitors were fully operational in 2002.
- Includes the entire summer ozone season of 2002 so is also suitable for 8-hour ozone modeling;
- 2002 was being modeled by VISTAS and other RPOs.

1.3.7 Initial Concentrations and Boundary Conditions

The CMAQ model was operated separately for each of four quarters of the 2002 year using a ~15 day spin up period (i.e., the model was started approximately 15 days before the first day of interest in each quarter in order to limit the influence of the assumed initial concentrations, e.g., start June 15 for quarter 3 whose first day of interest is July 1). Sensitivity simulations demonstrated that with ~15 initialization days, the influence of initial concentrations (ICs) was minimal using the 36 km Inter-RPO continental U.S. modeling domain. Consequently, clean ICs were specified in the CMAQ modeling using a ~15 day spin up period.

Boundary Conditions (BCs) (i.e., the assumed concentrations along the later edges of the 36 km modeling domain, see Figure 1-4) were based on a 2002 simulation by the GEOS-CHEM global circulation/chemistry model. GEOS-CHEM is a three-dimensional global chemistry model driven by assimilated meteorological observations from the Goddard Earth Observing System (GEOS) of the NASA Global Modeling and Assimilation Office (GMAO). It is applied by research groups around the world to a wide range of atmospheric composition problems, including future climates and planetary atmospheres using general circulation model meteorology to drive the model. Central management and support of the model is provided by the Atmospheric Chemistry Modeling Group at Harvard University.

A joint RPO study was performed coordinated by VISTAS in which Harvard University applied the GEOS-CHEM global model for the 2002 calendar year (Jacob, Park and Logan, 2005). The University of Houston (UH) was retained to process the 2002 GEOS-CHEM output into BCs for the CMAQ model (Byun, 2004). The GEOS-CHEM simulations for the RPOs used GEOS meteorological observations for the year 2002. These were obtained from GMAO as a 6-hourly archive (3-hour for surface quantities such as mixing depths). The data through August 2002 were from the GEOS-3 assimilation, with horizontal resolution of $1^o x 1^o$ and 55 vertical layers. The data after August 2002 were from the updated GEOS-4 assimilation, with horizontal resolution of $1^o x 1.25^o$ and 48 vertical layers (note 1^o latitude is equally to approximately 110 km). The horizontal resolution was 4° x 5°. The emissions used in GEOS-CHEM included U.S. anthropogenic emissions from the EPA NEI 1999 inventory, except for ammonia; international emissions for the most recent year available, and forest fire information specific to 2002. Emissions were aggregated to monthly average in acknowledgement that greater accuracy is not feasible for international emissions. This GEOS-CHEM run included the secondary organic aerosol (SOA) formation mechanism from Chung and Seinfeld (2002), prototype soil dust and sea salt simulations, and application of surface emissions and dry deposition to the entire mixed layer column rather than to just the surface layer of the model.

The GEOS-CHEM output was processed by mapping the GEOS-CHEM chemical compounds to the species in the CBM-IV chemical mechanism used by CMAQ and mapping the GEOS-CHEM vertical layers to the 19 layer vertical layer structure used by CMAQ in the VISTAS modeling (Byun, 2004). The results were day-specific three-hourly BC inputs for the CMAQ model.

The BCs generated from the 2002 GEOS-CHEM were subjected to QA/QC. The first QA/QC check was a range check to assure reasonable values. The BCs were compared against the GEOS-CHEM outputs to assure the mapping and interpolation was performed correctly. The code used to map the GEOS-CHEM output to the CMAQ BC format was obtained from UH, reviewed and the BC generation duplicated for several time periods during 2002.

1.3.8 Emissions Input Preparation

Emissions for the CMAQ model were prepared using the SMOKE emissions modeling system with the configuration given in Table 1-2. Four types of emissions inventories were prepared:

- 2002 Actual Base Case;
- 2002 Typical Base Case;
- 2009 Base Case;
- 2012 Base Case; and
- 2018 Base Case.

The differences between the 2002 Actual and Typical Base Cases were emissions from Electrical Generating Units (EGUs) and fires. For the 2002 Actual Base Case day-specific emissions for the EGUs based on measurements from continuous emissions monitoring (CEM) data and day-specific fire emissions were used. For the 2002 Typical Base Case the EGU and fire emissions intensity are representative of the 2000-2004 5-year Baseline period. The 2002 Actual Base Case was used when comparing the CMAQ modeling results to the 2002 measurements in the model performance evaluation (See Chapter 3), whereas the 2002 Typical Base Case results were used with the 2009, 2012 and 2018 modeling results to make $PM_{2.5}$ Design Value projections (see Chapter 4).

The base emissions for the ASIP/VISTAS states were provided by the ASIP/VISTAS emissions contractor (MACTEC, 2008). Emissions for Non-VISTAS states were obtained from the other RPOs during late 2006. These data were either provided in the SMOKE IDA format or in the case of the MRPO converted to the IDA format for input into SMOKE. Emissions for Mexico were based on the EPA Phase II 1999 Mexico inventory and a year 2000 inventory was used for Canada. Emissions for stationary point, area, on-road mobile, non-road mobile, fires and biogenic sources were processed. Day-specific biogenic emissions were generated using the SMOKE-BEIS3 program and the hourly 2002 36/12 km MM5 data discussed previously. In order to account for seasonal and day-of-week effects, on-road mobile sources were simulated for a week from each month of 2002 using the SMOKE-MOBILE6 module and the MM5 meteorological data as input. Holidays were modeled as a Sunday. Similarly, area and non-road emissions were modeled for a Thursday, Friday, Saturday, Sunday and Monday from each month with emissions for Thursday used to represent Tuesday and Wednesday and Holidays used Sunday emissions. More details on the emissions modeling are provided in Chapter 2 and Appendix A.

1.3.9 Meteorological Input Preparation

The VISTAS 2002 36/12 km MM5 modeling was conducted by Barons Advanced Meteorological Systems (BAMS) as described previously (Olerud, 2003a,b,c,d). The VISTAS annual emissions and air quality modeling team processed the 2002 36/12 km MM5 data using the MCIP processor version 3.0 (September 2005) for input into CMAQ and conducted QA/QC on the CMAQ meteorological input files. ASIP used the same 2002 36/12 km MM5 meteorological data as VISTAS.

1.3.10 Photolysis Rates Model Inputs

Several chemical reactions in the atmosphere are initiated by the photo dissociation of various trace gases. To accurately represent the complex chemical transformations in the atmosphere, accurate estimates of these photodissociation rates must be made. The Models-3 CMAQ system includes the JPROC processor, which calculates a table of clear-sky photolysis rates (or J-values) for a specific date. JPROC uses default values for total aerosol loading and provides the option to use default ozone column data or to use measured total ozone column data. . These data come from the Total Ozone Mapping Spectrometer (TOMS) satellite data. TOMS data that is available at 24-hour averages and was obtained from http://toms.gsfc.nasa.gov/eptoms/ep.html. Day-specific TOMS data was used in the CMAQ radiation model (JPROC) to calculate photolysis rates. The TOMS data were missing or bad for several periods in 2002: August 2-12; June 10; and November 18-19. Thus, the TOMS data for August 1, 2002 was used for August 2-7 and TOMS data for August 13 was used for August 8-12. Similarly, TOMS data for June 9 was used for June 10 and data for August 17 was used for August 18-19. Note that the total column of ozone in the atmosphere is dominated by stratospheric ozone which has very little day-to-day variability so the use of TOMS data within a week or two of an actual day introduces minimal uncertainties in the modeling analysis.

JPROC produces a "look-up" table that provides photolysis rates as a function of latitude, altitude, and time (in terms of the number of hours of deviation from local noon, or hour angle). In the current CMAQ implementation, the J-values are calculated for six latitudinal bands (10º, 20º, 30º, 40º, 50º, and 60º N), seven altitudes (0 km, 1 km, 2 km, 3 km, 4 km, 5 km, and 10 km), and hourly values up to 8 hours of deviation from local noon. During model calculations, photolysis rates for each model grid cell are estimated by first interpolating the clear-sky photolysis rates from the look-up table using the grid cell latitude, altitude, and hour angle, followed by applying a cloud correction (attenuation) factor based on the cloud inputs from MM5.

The photolysis rates input file was prepared as separate look-up tables for each simulation day. Photolysis files are ASCII files that were visually checked for selected days to verify that photolysis rates are within the expected ranges.

1.3.11 Air Quality Input Preparation

Air quality data used with the CMAQ modeling system include: (1) Initial Concentrations (ICs) that are the assumed three-dimensional concentrations through the modeling domain at the very start of the simulation; (2) the Boundary Conditions (BCs) that are the concentrations assumed along the lateral edges of the 36 km inter-RPO continental U.S. modeling domain; and (3) air quality observations that are used in the model performance evaluation discussed in Section 3 of this TSD.

The CMAQ default clean Initial Concentrations (ICs) were used along with an approximately 15 day spin up (initialization) period to eliminate any significant influence of the ICs on the modeled concentrations for the days of interest.

The CMAQ Boundary Conditions (BCs) for the Inter-RPO 36 km continental U.S. grid were based on day-specific 3-hour averages from the output of the GEOS-CHEM global simulation model of 2002 (Jacob, Park and Logan, 2005). The 2002 GEOS-CHEM output was mapped to the species and vertical layer structure of CMAQ and interpolated to the lateral boundaries of the 36 km grid shown in Figure 1-4 (Byun, 2004).

1.3.12 2002 Base Case Modeling and Model Performance Evaluation

The CMAQ model was evaluated against ambient measurements of PM species, ozone, gas-phase species and wet deposition within and outside of the ASIP/VISTAS region. Ambient measurements from the IMPROVE, STN, CASTNet, NADP, SEARCH, AQS and FRM monitoring networks were used in the ASIP and VISTAS CMAQ model performance evaluation.

The CMAQ 2002 Base G2 Actual model performance for PM species can be summarized as follows:

- Nitrate (NO3) Underprediction Tendency: NO3 is routinely underpredicted during the summer and adjacent months throughout the ASIP region. This underprediction is due to modeled NO3 concentrations near zero, when observed values are low, but above zero (typically < 1 $\mu g/m^3$). However, NO3 is almost always a very minor to insignificant contributor to total $PM_{2.5}$ mass at FRM monitors in the ASIP region. In fact, the maximum NO3 contribution to a 2009 projected $PM_{2.5}$ Design Value is 1.0 $\mu g/m^3$with a median value of 0.2 $\mu g/m^3$. Thus, the NO3 performance issues are not a big concern in the $PM_{2.5}$ projections.

- Organic Carbon Mass (OCM) Underpredictions: The OCM underprediction bias is a cause for concern since it is a major component of the $PM_{2.5}$ mass at ASIP NAAs with maximum contributions to the 2009 $PM_{2.5}$ Design Values of ~8 $\mu g/m^3$, minimum values of ~3 $\mu g/m^3$ and a median value of ~4 $\mu g/m^3$. The reasons for the underestimation of OCM are unclear, but the fact that the underpredictions are higher in the urban than rural areas suggest that there may be missing anthropogenic emission sources, or possibly the urban OCM emissions are over diluted across the 12 km grid resolution used in the ASIP modeling, or both. The changes in projected OCM concentrations between the current and projected $PM_{2.5}$ Design Values are mostly less than 5% (i.e., $0.95 < RRF_{OCM} < 1.05$). Thus, the changes in OCM between the current and future year are having a minor influence on the projected $PM_{2.5}$ Design Values.

- Elemental Carbon (EC) Performance Issues: The EC underprediction bias at the urban sites is partly due to over dilution of the urban EC emissions due to the coarse (12 km) grid used. For the most part, the CMAQ model performed well for EC and the underprediction would not affect the relative changes in the model response to anthropogenic EC emissions changes. Therefore, any EC performance issues are not a cause for concern, although the model performance for EC was generally good.

- Sulfate (SO4) Underprediction Bias: Although SO4 is performing well, it does have an underprediction bias that is largest in the summer months. But this underprediction is not severe and the model appears to be capturing the temporal and spatial variations in the observed sulfate well and is responding to the SO2 emission reductions between 2002 and 2009 in a manner as expected. Thus the model performance indicates that the modeled relative changes in SO4 concentrations are likely a valid response.

- Soil Performance Issues: The CMAQ performance for the Soil species is quite poor. This Soil component of the 2009 projected $PM_{2.5}$ Design Value ranges from 0.4 to 1.8 $\mu g/m^3$. The RRFs for Soil indicate that it is mostly increasing, with summer (Q3) Soil RRFs typically ranging from 1.0 to 1.3.

SO4 reductions dominate the changes in $PM_{2.5}$ Design Values between 2002 and 2009, 2012 and 2018. SO4 performance is quite good in the CMAQ 2002 Base G2 Actual base case simulation almost always achieving the PM performance goal and frequently also achieving the more stringent ozone performance goal. These factors provide confidence in the $PM_{2.5}$ Design Value projections using the CMAQ Base G modeling results.

The CMAQ 2002 Base G2 base case simulation was also evaluated for ozone concentrations, separately within each ASIP state and combined across all states in the ASIP region. Over most months, the CMAQ ozone model performance achieved EPA's ozone performance goals, albeit with an underestimation tendency. The CMAQ ozone model performance was comparable to ozone model performance of photochemical grid models used in past ozone SIPs so was deemed adequate for making future year 8-hour ozone projections.

More details on the CMAQ 2002 Base G2 model performance evaluation for $PM_{2.5}$ and ozone can be found in Chapter 3 and Appendices B and C. Performance focusing on the constituents that make up regional haze can be found in Morris and co-workers (2009) and detailed model performance for $PM_{2.5}$ ozone and regional haze are available on the VISTAS website (http://www.vistas-sesarm.org/documents/ENVIRON_Air_Quality_Modeling_Technical_Support_Document_11-14-07.pdf). In addition, comparison of the CMAQ performance with CAMx is provided in Appendix D.

1.3.13 Future-Year Modeling and $PM_{2.5}$ and Ozone Projections

Emissions for the 2009, 2012 and 2018 Base G4 base cases were generated following the procedures discussed in Chapter 2 and in the Emissions Inventory report by MACTEC (2008). 2009, 2012 and 2018 emissions for Electrical Generating Units (EGUs) were based on simulations of the Integrated Planning Model (IPM) for the year 2010 and 2018 that took into account the effects of the Title IV controls, NOx SIP Call and Clean Air Interstate Rule (CAIR) on emissions from EGUs. In some cases the IPM projected EGU emissions did not agree with the state projections so those EGU emissions were adjusted to match state expectations for three future years (MACTEC, 2008). Emissions for on-road and non-road mobile sources were based on activity growth and emissions factors from the EPA MOBILE6 and NONROAD models, respectively. Area sources and non-EGU point sources were grown to 2018 levels using assumptions from EPA and DOE. The following controls were assumed in the 2009, 2012 and 2018 Base G4 modeling scenarios:

- Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR) for EGUs using IPM output.
- NOx SIP Call.
- North Carolina Clean Smokestack Act.
- Various Consent Agreements (e.g., TECO, VEPCO, Gulf Power Crist 7).
- 1-Hour Ozone SIPS (Atlanta / Birmingham / Northern Kentucky).
- NOx RACT.
- Heavy Duty Diesel Rule.
- Tier 2 Tailpipe Rule.
- Large Spark Ignition and Recreational Vehicle Nonroad Rule.
- Nonroad Diesel Rule.
- Industrial Boiler/Process Heater/RICE MACT.
- Combustion Turbine MACT.
- VOC 2-, 4-, and 10-year MACT Standards.

The following sources were assumed to remain unchanged between the 2002 base case and the future-years (2009, 2012 and 2018) base cases base case simulations:

- Biogenic VOC and NOx emissions from the BEIS3 biogenic emissions model;
- Off-shore emissions associated with off-shore marine vessels and oil and gas production activities;
- Emissions from wildfires;
- Emissions from Mexico; and
- Global transport (i.e., emissions due to BCs from the 2002 GEOS-CHEM global chemistry model.

The results from the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ simulations were used to project future-year annual $PM_{2.5}$ and 8-hour ozone Design Values levels that were compared against the NAAQS. The current and future year modeling results were used in a relative sense to scale the observed current year $PM_{2.5}$ and 8-hour ozone Design Values (DVCs) from the 2000-2004 period to obtain the future-year $PM_{2.5}$ and 8-hour ozone projections (DVFs). The ratio of modeling results of the future year model simulations to the 2002 model simulation is called the Relative Response Factor (RRF). EPA guidance for $PM_{2.5}$ projections recommends developing RRFs specific to each PM component and each FRM monitoring site area based on the ratio of the quarterly average modeled PM species concentrations for the future year to 2002 model simulations. Ozone projections are made using RRFs based on modeled high ozone days at ozone monitoring sites. In addition to making future year $PM_{2.5}$ and 8-hour ozone Design Value projections using the ASIP CMAQ 2009 and 2012 Base G4 base cases, future year projections were also made using the VISTAS CMAQ 2018 Base G4 base case results. All future-year projections were made using EPA's Modeled Attainment Test Software (MATS; http://www.epa.gov/scram001/modelingapps_mats.htm).

1.3.13.1. $PM_{2.5}$ Projections

Table 1-9 summarizes the FRM monitoring sites within and adjacent to the ASIP region for which projected 2009 $PM_{2.5}$ Design Values are 14.5 µg/m^3 or higher using the ASIP CMAQ 12 km modeling results and EPA MATS projection approach. EPA guidance has a weight of evidence (WOE) zone where additional analysis is needed to support a modeled attainment demonstration when the projected $PM_{2.5}$ Design Values are close to the $PM_{2.5}$ NAAQS (EPA, 2007a). EPA recommends that a WOE analysis be conducted if the modeled future-year $PM_{2.5}$ Design Value is in the 14.5 to 15.5 µg/m^3 range. If the future-year projected $PM_{2.5}$ Design Value is 15.5 µg/m^3 or higher, EPA notes that no amount of additional analysis is likely to be convincing that attainment would be achieved.

There are three FRM monitors within or adjacent to the ASIP region whose 2009 projected $PM_{2.5}$ Design Values are 15.5 µg/m^3 or greater:

- The North Birmingham monitor (17.0 µg/m^3) in the City of Birmingham in Jefferson County, Alabama;
- The Wylam monitor (15.8 µg/m^3) in the City of Birmingham in Jefferson County, Alabama; and
- An Atlanta, Georgia monitor in Fulton County (16.6 µg/m^3).

An additional two monitors are above the $PM_{2.5}$ NAAQS but within the WOE range (14.5-15.5 μg/m^3):

- A monitor in Clayton County, Georgia (15.1 μg/m^3) in the Atlanta area.
- And a monitor in Hamilton County, Ohio that is part of the Cincinnati NAA (15.5 μg/m^3).

An additional seven FRM monitors have projected $PM_{2.5}$ Design Values that are below the NAAQS but within the WOE zone. These monitors are located in the Atlanta NAA, southern Indiana in the Louisville NAA, southern Ohio in the Cincinnati NAA, the greater Charleston-Huntington NAA and the Knoxville NAA.

The two monitors in Birmingham that are projected to violate the annual $PM_{2.5}$ NAAQS in 2009 are influenced by local sources that are not captured well by the ASIP 12 km CMAQ modeling. Thus, the Alabama Department of Environmental Management (ADEM) and Jefferson County Department of Health (JCDH) are performing the Birmingham Air Pollution Study (BAPS). BAPS is using the ASIP 12 km CMAQ modeling results to provide boundary conditions (BCs) for 4 km urban CMAQ modeling and are also performing AERMOD near-source modeling to address $PM_{2.5}$ attainment issues (ENVIRON and Alpine, 2007; ENVIRON, Alpine and Envair, 2009).

The Georgia Environmental Protection Division (GEPD) is also performing subregional CMAQ modeling using BCs from the ASIP 12 km CMAQ results to address $PM_{2.5}$ attainment demonstration in Georgia.

Table 1-9. 2009, 2012 and 2018 projected $PM_{2.5}$ Design Values within and adjacent to the ASIP region that are 14.5 μg/m^3 or higher using the 2009 CMAQ 12 km Base G4 modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
Sites with 2009 DVF above the 14.5-15.5 μg/m^3 WOE Zone									
01-073-0023	**AL**	Jefferson	**18.4**	**17.0**	13.8	**15.6**	-1.4	-4.6	-2.8
01-073-2003	**AL**	Jefferson	**17.1**	**15.8**	12.8	14.7	-1.2	-4.3	-2.4
13-121-0039	**GA**	Fulton	**18.3**	**16.6**	**15.3**	14.9	-1.7	-3.0	-3.4
Sites with 2009 DVF above the NAAQS but Within the WOE Zone									
13-063-0091	**GA**	Clayton	**16.5**	**15.1**	13.9	13.4	-1.4	-2.6	-3.1
39-061-0014	**OH**	Hamilton	**17.8**	**15.5**	**15.5**	14.3	-2.3	-2.2	-3.4
Sites with 2009 DVF below the NAAQS but Within the WOE Zone									
01-113-0001	**AL**	Russell	**16.0**	14.8	14.0	13.4	-1.2	-2.1	-2.6
13-067-0003	**GA**	Cobb	**16.3**	14.6	13.2	12.6	-1.7	-3.1	-3.7
21-111-0044	**KY**	Jefferson	**16.6**	14.5	15.3	13.7	-2.1	-1.3	-2.9
54-039-1005	**WV**	Kanawha	**17.1**	14.7	13.7	13.2	-2.4	-3.4	-3.9
39-061-8001	**OH**	Hamilton	**17.3**	15.0	**15.1**	14.0	-2.2	-2.1	-3.3
39-081-0016	**OH**	Jefferson	**18.1**	14.9	14.5	13.8	-3.2	-3.6	-4.3
39-145-0013	**OH**	Scioto	**17.1**	14.7	14.2	13.5	-2.4	-2.9	-3.6

1.3.13.2 Ozone Projections

EPA's MATS was also used to make the 2009, 2012 and 2018 8-hour ozone Design Value projections using the 2002 Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results. The EPA default approach (EPA, 2007a) was used to make the future year ozone projections, which includes:

- Use of the modeled highest daily maximum 8-hour ozone concentration within a 3 x 3 array of 12 km grid cells centered on monitor site for the RRFs;
- Calculation of RRFs using modeling results for days in which the model estimated 2002 Base G2 daily maximum 8-hour ozone concentration near the monitor is greater than an Ozone Threshold where:
    - An Ozone Threshold of 85 ppb is used initially that is reduced by 1 ppb until either: (1) 10 modeling days are obtained for the RRF; or (2) a 70 ppb Ozone Threshold floor is achieved.
- If the 70 ppb Ozone Threshold floor is achieved and there are less than 10 modeling days for the RRFs then:
    - If there are 5 or more days the future year ozone Design Value is accepted; or
    - If there are less than 5 modeling days for the RRFs then no future year ozone projection is obtained for that monitoring site.

The modeled ozone attainment test is passed when the future year projected 8-hour ozone Design Value (DVF) is less than 85.0 ppb (i.e., 84.9 ppb or lower). However, EPA requires that a weight of evidence (WOE) analysis be performed to support the attainment demonstration if the projected modeled DVF is between 82.0 ppb and 87.0 ppb. Table 1-10 lists the current year (DVC) and future year (DVF) 8-hour ozone Design Values for all monitoring sites within and adjacent to the ASIP region for which the projected 2009 DVF is above the 82.0 ppb WOE threshold.

There are 20 ozone monitoring sites within and near the ASIP region with 2009 Base G4 DVFs are above the 82.0 ppb WOE threshold. Of these, there are six with 2009 DVFs that are 85.0 or greater so do not pass the modeled 8-hour ozone attainment test. Of these 6 monitors, three are in Maryland, two are in Virginia and one is in Atlanta, Georgia. By 2012, all ozone monitoring sites within and near the ASIP region are not only estimated to attain the 0.08 ppm 8-hour ozone NAAQS, but are also estimated to be below the 82.0 ppb WOE threshold. By 2018 the modeling estimates that not only the 0.08 ppm 1997 8-hour ozone NAAQS is continued to be attained, but that the new 0.075 ppm 2008 8-hour ozone NAAQS is attained at all sites except three each in Maryland and Virginia. The 0.075 ppm 2008 8-hour ozone NAAQS will be addressed in future SIP actions.

Table 1-10. Current year (DVF) and 2009, 2012 and 2018 projected (DVF) 8-hour ozone Design Values for monitoring sites in which the 2009 DVF is above the 82.0 WOE threshold using the 2002 Base G2 and 2009, 2012 and 2018 Base G4 12 km CMAQ modeling results.

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
11_001_0043	DC	DC	**92.7**	84.0	78.3	74.2
13_089_3001	Georgia	DeKalb	**91.0**	82.9	77.7	70.2
13_121_0055	Georgia	Fulton	**94.3**	**85.6**	80.3	73.0
18_019_0003	Indiana	Clark	**90.0**	82.0	81.4	73.4
21_037_0003	Kentucky	Campbell	**90.7**	82.7	80.5	74.6
24_003_0014	Maryland	Anne Arundel	**98.3**	**86.1**	78.7	75.1
24_003_0019	Maryland	Anne Arundel	**97.0**	**85.8**	78.7	75.5
24_025_1001	Maryland	Harford	**100.3**	**87.1**	79.4	76.8
24_025_9001	Maryland	Harford	**97.0**	83.4	75.7	72.9
24_033_0002	Maryland	Prnc George's	**94.0**	83.3	76.8	73.2
24_033_8003	Maryland	Prnc George's	**94.0**	82.6	75.6	71.8
37_119_0041	North Carolina	Mecklenburg	**95.3**	84.1	80.3	73.0
37_119_1009	North Carolina	Mecklenburg	**97.3**	84.6	80.0	72.0
37_159_0021	North Carolina	Rowan	**97.3**	83.4	78.6	71.6
37_159_0022	North Carolina	Rowan	**97.0**	83.9	79.1	71.5
39_027_1002	Ohio	Clinton	**94.3**	82.5	80.1	71.6
51_013_0020	Virginia	Arlington	**96.7**	**87.0**	81.2	77.0
51_059_0018	Virginia	Fairfax	**96.7**	**86.8**	81.0	77.0
51_059_0030	Virginia	Fairfax	**94.7**	84.4	79.2	75.2
51_059_1005	Virginia	Fairfax	**94.0**	83.8	78.6	74.7

1.3.14 Additional Supporting Analysis for $PM_{2.5}$

ASIP performed additional supporting analysis of its modeling results and $PM_{2.5}$ projections to help verify the validity of the future-year $PM_{2.5}$ projections. These additional supporting analyses are discussed in Chapter 5 and include the following:

- Verification of the MATS 2009 $PM_{2.5}$ projections using an alternative projection software. Because EPA's MATS projection tool was not available early on in the ASIP study, ASIP developed their own $PM_{2.5}$ projection tool using Excel spreadsheets. 2009 $PM_{2.5}$ Design Values generated using the ASIP Excel spreadsheet projection approach were compared with those generated by the EPA MATS projection tool and the two methods agreed on which NAAs are estimated to have 2009 $PM_{2.5}$ Design Values above the NAAQS and which ones have projected $PM_{2.5}$ Design Values below the NAAQS across all the monitors in the NAA.

- Use of an alternative model (CAMx) for some sites to corroborate the CMAQ projections. The 2009 $PM_{2.5}$ Design Value projections using the CAMx were slightly higher (0.1 to 0.3 µg/m3) than CMAQ, but the two models agreed on which NAAs would have monitors with 2009 $PM_{2.5}$ Design Values above the NAAQS and which NAAs would have projected 2009 $PM_{2.5}$ Design Values below the NAAQS at all of their monitors.

- Use of PM Source Apportionment Technology (PSAT) to assess contributions of specific facilities to 2009 $PM_{2.5}$ concentrations. CAMx was run using a 12/4 km grid domain and PSAT was used to obtain the $PM_{2.5}$ contributions due to SO2 and primary PM emissions from 31 separate facilities. The maximum contribution of the 31 facilities to projected 2009 $PM_{2.5}$ Design Values was 2.5 $\mu g/m^3$, with the maximum single source contribution 2.1 $\mu g/m^3$. A source's close proximity to an FRM monitor was as important a factor to its contribution as its emissions strength.

2.0 DEVELOPMENT OF EMISSIONS MODEL INPUTS

The 2002 base year emissions inventory for Base G2, 2009 Base G4 and 2012 Base G4 of the ASIP modeling is founded on revised 2002 emissions developed by ASIP emission inventory contractors in NEI Input Format (NIF) 3.0. These revised Base G emissions were reviewed by ASIP stakeholders and considered complete as of April of 2008[1]. Control assumptions, growth rates, and other inputs used to develop the 2009 and 2012 forecasts were initially developed in 2004, many of them carried forward into these documented inventories. Additional growth and control modifications have since been identified or analyzed by ASIP and its participating States or contractors, but for reasons of maintaining consistency between the various scenarios, have not been included in these documented files and associated runs. For purposes of the remainder of this section, Base G refers to the 2002 G2, 2009 G4, and 2012 G4 inventories, also commonly called ASIP's "Best and Final" emissions.

Non-ASIP state emissions for the 2002 episode year were based on inventories obtained by the Study Team during late 2006 through early 2008. Emission inventories for 2002 and 2009 for each of the other four RPOs (MANE-VU, MRPO, CENRAP, and WRAP) were directly acquired from the RPOs or prepared using growth and control files and either converted from their native format into structures or temporal basis consistent with ASIP modeling or used directly in the SMOKE IDA formats provided. The exceptions were for CENRAP, MRPO, and WRAP's 2009 base case, which were not available in the required format, and therefore were prepared using the latest available 2002 base year data and growth and control factors consistent with RPO 2018 inventory preparation. Inventory versions for these emission files are noted in Table 1-2 of this document.

Non-ASIP emissions for the 2012 episode year base case were obtained from individual inventories developed by EPA or other RPOs in support of modeling for ozone and PM SIPs. These inventories were largely developed in an alternate approach to the 2002 and 2009 inventories used previously by ASIP. MANE-VU had a set of 2012 emission files for all categories (which were used directly in their native model-ready format). MRPO had prepared non-road emissions for 2012 and the study team developed point source (EGU + non-EGU) 2012 for MRPO using their Base M 2005 base year, Round 5 growth and control factors and IPM v.3.0 output. The primary objective of the 2012 ASIP modeling was to provide an evaluation of additional EGU controls in the ASIP/VISTAS states to support subregional modeling being performed by Alabama and Georgia for their $PM_{2.5}$ SIPs. In order to provide the 2012 information to the two states in a timely fashion, a simplified methodology for estimating 2012 emissions for the non-ASIP states was used for 2012 than used for the 2002, 2009 and 2018 emission inventories. For this reason, care should be taken in the interpretation of the ASIP 2012 modeling results, especially near the ASIP region border areas where emissions from the non-ASIP states have a larger influence.

For MRPO region, 2012 area, dust, and MAR (marine, aircraft, locomotive) sources as well as for all non-EGU and non-road sources for CENRAP and WRAP, the study team developed interpolated inventories based on EPA's latest release of 2009/2014 emissions used for their

1 "Documentation of the Base G2 and Best & Final 2002 Base Year, 2009 and 2018 Emission Inventories for VISTAS; Revision 1," April 9, 2008." MACTEC.

ozone NAAQS simulations[2]. These files are not entirely consistent with the 2002 emissions ASIP are currently using for 2002 and 2009 in these domains, but were readily available, developed within the scope of the available resources and documented by EPA. For other State EGU and on-road sources, we used IPM v.3.0 output and a national MOBILE6/SMOKE run to generate emissions.

Mexican and Canadian emissions used for 2002 are based on the latest available inventories obtainable by the Study Team in formats lending themselves to emissions modeling. Mexican emissions are based on the EPA Phase II 1999 Mexican National Emission Inventory (MNEI)[3]. 2000 (representing 2002), 2010 (representing 2009) and 2010 (representing 2018) Canadian emissions are based on EPA releases of Environment Canada inventories in SMOKE IDA or preprocessed CMAQ formats[4]. These inventories were collected in the December 2006 timeframe.

For purposes of air quality model validation, actual 2002 calendar year emissions for EGU and fire activity were used within the ASIP domain, whereas for strategy and future-year emission runs, "typical year" emissions for these categories were used. Outside of the VISTAS RPO, 2002 emissions obtained from the non-VISTAS RPOs were used in an "as-is" format with no modification made for actual or typical operation.

All emissions were converted to Inventory Data Analyzer (IDA) format and the data were processed for air quality modeling using Version 2.1 (except for elevated fires where Version 2.0 was used) of the Sparse Matrix Operating Kernel Emissions (SMOKE) model. Included in these runs is the temporal, spatial, and speciation profiles and cross-reference data currently provided with the 2.0 release of the model augmented with recommended and approved emission profile data provided by the ASIP stakeholders or emissions inventory contractor or obtained from EPA prior to initial emissions modeling. The processing was adjusted for each run to account for the specific air quality model (AQM) input required by CMAQ and/or CAMx.

Because of the timing of various air quality simulations and continued review of the input parameters used by ASIP for its 2002, 2009, and 2012 episodes, a number of inconsistencies between inventory years and model runs were introduced. These variations are documented throughout his section.

2.1 EMISSIONS MODELING METHODOLOGY

Emissions inventory development for photochemical modeling must address several source categories including: (a) stationary point sources, (b) area sources, (c) on-road mobile sources, (d) non-road mobile sources, (e) biogenic, and (f) fire sources. For this analysis, inventories were developed for 2002 actual, 2002 typical, 2009 and 2012.

Development of an emissions inventory customized for the ASIP region requires a merging of: (a) the most recent pertinent regional inventory and (b) available high-resolution, locale-specific emissions estimated by local, state, and regional agencies in the ASIP region. Local air

2 http://www.epa.gov/scram001/reports/Emissions%20TSD%20Vol1_02-28-08.pdf
3 http://www.epa.gov/ttn/chief/net/mexico.html
4 http://www.epa.gov/ttn/chief/net/canada.html

regulatory and transportation planning agencies are generally the best sources of domain specific activity and control factors to use in developing the base year emissions. Often, these local emissions data sets come from a variety of sources, frequently in different formats.

Contacts with ASIP's emission inventory contractors and the RPOs were established and formal requests made for inventory corrections, updates and ancillary data pertinent to the modeling of emissions in their jurisdictions. Where feasible and consistent with project resources and schedule, these updated data sets were acquired and used to create day-specific modeling inventories specific to the ASIP domain for the base year modeled.

2.2 SET-UP OF SMOKE OVER THE ASIP DOMAIN

SMOKE was configured to generate point, area, nonroad, highway, and biogenic source emissions. In addition, certain subcategories, such as fires and EGUs were maintained in separate source category files in order to allow maximum flexibility in producing alternate strategies. Settings for each of the source categories are discussed in relevant sections below. With the exception of biogenic and highway mobile source emissions, which are generated using the, respectively, BEIS and MOBILE6 modules in SMOKE, pre-computed annual emissions were processed using the month, day, and hour specific temporal (for point sources with CEM data) profiles of the SMOKE model.

To produce an emissions inventory to support annual modeling, representative time periods were selected and modeled. Area, nonroad, and point sources were modeled as a block of Thursday, Friday, Saturday, Sunday, Monday one per month (total of 60 days modeled). On-Road motor vehicles were represented by an entire single week for each month. This selection criterion allows for the representation of day-of-the-week variability in the on-road motor vehicles, and models a representation of the meteorological variability in each month. EGU sources which mapped to continuous emissions monitoring (CEM) data were processed using CEM-based temporal profiles. Holidays were modeled as Sundays. A list of modeled holidays is provided in Table 2-1. The biogenic emissions were modeled on a day specific basis using the hourly MM5 meteorological data (365 days).

Table 2-1. SMOKE modeled holidays.

Date	Julian Day	Holiday Description
January 1, 2002	2002001	New Year's Day
March 29, 2002	2002089	Good Friday
May 27, 2002	2002147	Memorial Day
July 4, 2002	2002185	July 4th
September 2, 2002	2002245	Labor Day
November 28, 2002	2002332	Thanksgiving Thurs
November 29, 2002	2002333	Thanksgiving Fri
December 24, 2002	2002358	Christmas Eve
December 25, 2002	2002359	Christmas Day

Population was used as a gridding default for all source categories when the assigned surrogate would cause SMOKE to drop emissions. This can be a case when the county-level emission inventories are prepared using surrogates other than those available for modeling purposes.

The domain for the ASIP emissions modeling is based on the Inter-RPO 36-km continental U.S., CMAQ domain, illustrated in Figure 2-1 below.

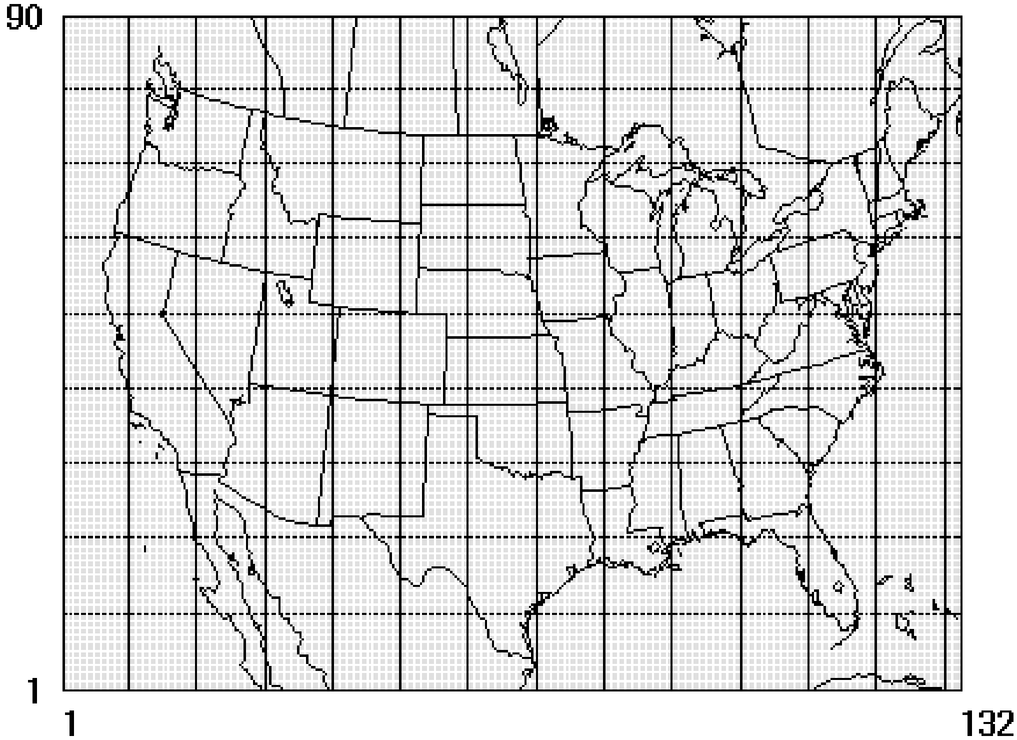


Figure 2-1. Inter-RPO 36-km Continental U.S. CMAQ Domain.

The parameters for the SMOKE runs are as follows:

Episodes:
2002 Calendar Base Year (Actual and Typical)

Future Years:
2009 and 2012.

Output Time Zone:
Greenwich Mean Time (zone 0)

Projection:
Lambert Conformal with Alpha=33, Beta=45, Gamma=-97, and center at (-97,40).

Domain:
36 Kilometer Grid Domain: Origin at (-2736, -2088) kilometers with 148 rows by 112 columns and 36-km square grid cells.

12 Kilometer Grid Domain: Origin at (108, -1620) kilometers with 168 rows by 177 columns and 12-km square grid cells.

Layer Structure:

The CMAQ layer structure is 19 layers, with specific layer positions defined in the meteorology files (see Chapter 1).

CMAQ Model Species:

The CMAQ initial configuration is for the CB-IV chemical mechanism with particulate matter (PM). The model species in the emission input files are: CO, NO, NO2, ALD2, ETH, FORM, ISOP, NR, OLE, PAR, TERPB, TOL, XYL, NH3, SO2, SULF, PEC, PMFINE, PNO3, POA, PSO4, and PMC.

Meteorology Data:

Daily (25-hour). SMOKE requires the following five types of MCIP outputs: (1) Grid cross 2-d, (2) Grid cross 3-d, (3) Met cross 2-d, (4) Met cross 3-d, and (5), Met dot 3-d. These files need to match the grid projection and overlap with the emissions modeling region but can be larger in the horizontal directions than the modeling region shown in Figure 2-1. Therefore, the data files for the 36 Kilometer grid domain were at least 90 columns by 132 rows

Elevated Sources:

All sources were treated by SMOKE as potentially elevated. No plume-in-grid sources were modeled. Where day specific and location specific wildfire data was provided by states and Federal Land Managers, wildfire emissions were handled as point sources.

Producing 365 day-specific input files for all source categories places a burden on available computing facilities, data management systems, and would have adversely affected the modeling schedule. Selecting representative model days for some or all of the source categories reduces the processing and file handling requirements to a more manageable level and in most cases does not compromise the accuracy of the emissions files.

Other current or recent projects undertaken by EPA, WRAP and LADCo have used a selection approach for all of the source categories (except biogenics) that use a representative weekday/Saturday/Sunday either for each month or each season to model all of the emissions files. In an attempt to better represent the level of temporal and spatial detail available for each source category, we have developed and implemented a more detailed strategy.

Biogenic emissions were modeled for each episode day, using the daily meteorology and the SMOKE-BEIS module. Point sources, including CEM and elevated fire emissions, were modeled for each episode day to take advantage of the available day-specific emissions and meteorology. Area sources, including non-road mobile, low level fires and dust emissions, do not utilize meteorological data, and are temporally allocated by monthly, daily and hourly profiles. Reviewing these profiles indicate that maximum temporal definition can be achieved by selecting representative Thursday, Friday, Saturday, Sunday, and Monday profiles for each month.

Motor vehicle emissions are influenced by meteorological variability, but the processing requirements for daily motor vehicle emissions were determined to be prohibitive under the current schedule. Rather than utilizing averaged meteorological data or pre-calculated motor vehicle emissions, a single week per month was selected for modeling. This week was selected from mid-month, to try to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would require atypical processing. The area source modeling dates were also selected from these ranges to simplify data handling procedures.

Emissions for on-road mobile sources were represented by modeling the following weeks within each month of the year:

January 13-19
February 10-16
March 10-16
April14-20
May 12-18
June 9-15
July 14-20
August 11-17
September 15-21
October 13-19
November 10-16
December 15-21

2.2.1 Processing of Point Source Emissions

Stack parameters are often more important to the reliability of the air quality modeling results than the emissions rates themselves. Stack parameter data are frequently incorrect, especially in some of the current regional modeling inventories and careful QA is required to assure that the point source emissions are properly located both horizontally and vertically on the modeling grid. To screen for simple, but potentially serious inventory errors such as these, the study team has modified procedures originally developed by EPA[5] to quality assure, augment, and where necessary, revise, stack parameters to examine the accuracy of the point source emissions, as well as standardize procedures to identify and correct stack data errors. These procedures were implemented in the NIF to IDA conversion step of the inventory development. Additionally, SMOKE has a number of built-in QA procedures designed to catch missing or out-of-range stack parameters. These procedures were also invoked in the processing of the point source data.

For the final baseline modeling, we separated the point source emissions into EGU and non-EGU categories. The non-EGU category was not processed using any day or hour-specific emissions inputs. All non-EGU point source emissions were temporally allocated to month, day, and hours using annual emissions and source category code (SCC) based allocation factors. These factors were based on the cross-reference and profile data supplied with the utilized SMOKE version

5 ftp://ftp.epa.gov/EmisInventory/2002finalnei/documentation/point/augmentation_point/2002nei_qa_augmentation_report0206.pdf

and were supplemented with relevant data provided to the study team by ASIP and its contractors.

For EGU sources with EPA reported continuous emissions monitoring (CEM) data for 2000-2004 or with hourly emissions provided by stakeholders, actual hourly data were used. For those sources where EPA CEM data are utilized, NOx, SO2, and heat input-based hour-specific profiles were developed and applied to NOx, SO2, and all other emissions, respectively. This ensured that the annual emission values provided by the EI contractor were maintained, but distributed using hourly to annual profiles. For sources providing hour-specific data and where they were approved by the State in which they operated, those data were substituted for EPA CEM-based emissions and distributions.

To temporally allocate the remaining EGU point sources (those which do not report under the CEM program), the NOx, SO2, and heat input data were collected from the 2000-2004 CEM datasets, and used to develop unit-level typical temporal distributions. CEM data from 2002 were used to develop comparable profiles and emission distributions during the actual 2002 model validation runs. The hour, day of week, and monthly specific temporal profiles were used in conjunction with the EI supplied emissions data to calculate hourly EGU emissions by unit.

All point sources were spatially allocated in the domain based on the stationary source geographic coordinates. If a point source was missing its latitude/longitude coordinates and data could not be found to properly site the unit within the domain, the source was placed in the center of its reported county.

2.2.2 Processing of Area and Non-Road Source Emissions

All area and non-road source emissions were temporally allocated to month, day, and hours using annual emissions and source category code (SCC) based allocation factors. These factors were based on the cross-reference and profile data supplied with the utilized SMOKE version and were supplemented with relevant data provided to the study team by ASIP or its contractors. Area and non-road sources were spatially allocated in the domain based on SCC-matched spatial allocation factor files. If an area or non-road source SCC did not have an existing cross-reference profile assigned to it, the county-level emissions were allocated by population density in the respective county.

A county-specific crustal PM transport factor was applied to fugitive dust emission sources that had been identified in U.S. EPA modeling to have only a portion of its mass transportable from the source of the emission generation. These EPA's studies[6] indicate that 60 to 90 percent of PM emissions from fugitive dust sources do not reach an elevated level necessary to be transported out of the grid cell where they were emitted. For this reason, the modeling team applied county-specific fugitive dust emissions transport factors to these sources to adjust PM emissions during the conversion of emission input files from the raw mass emissions. These adjusted PM emissions are reported in summary emissions tables.

6 http://www.epa.gov/ttn/chief/emch/invent/index.html#dust

2.2.3 Processing of On-Road Mobile Source Emissions

The MOBILE6 module of SMOKE was used to develop the base and future-year on-road mobile source emissions estimates for CO, NH3 NOx, PM and VOC emissions. The MOBILE6 parameters, vehicle fleet descriptions, and VMT estimates were combined with gridded, episode-specific temperature data to calculate the gridded, temporalized emission estimates. Typically on-network emissions estimates are spatially allocated based on link location and subsequently summed to the grid cell level, the off-network emissions estimates are spatially allocated based on a combination of the FHWA version 2.0 highway networks and population. For the ASIP 36/12 km modeling, no link based data was used. The MOBILE6 emissions factors are based on episode-specific temperatures predicted by the meteorological model. Further, the MOBILE6 emissions factors model accounts for the following:

- Hourly and daily minimum/maximum temperatures;
- Facility speeds;
- Locale-specific inspection/maintenance (I/M) control programs, if any;
- Adjustments for running losses;
- Splitting of evaporative and exhaust emissions into separate source categories;
- VMT, fleet turnover, and changes in fuel composition and Reid Vapor Pressure (RVP).

The primary input to MOBILE6 is the MOBILE shell file. The MOBILE shell contains the various options (e.g. type of inspection and maintenance program in effect, type of oxygenated fuel program in effect, alternative vehicle mix profiles, RVP of in-use fuel, operating mode) that direct the calculation of the MOBILE6 emissions factors.

For the production of the MOBILE6 emission factors, SMOKE was run using hourly episode-specific meteorological data for temperature and humidity. SMOKE produces emission factors for state and county groups that are selected for regional similarities and consistent MOBILE6 option requirements (i.e. I/M programs, RVP, fuel programs). The hourly average temperature and humidity are calculated from the hourly temperatures in each grid cell in the state/county groups.

SMOKE was run using the daily average speed option for all states except North Carolina. The daily average speed was provided based on state, county, and roadway type. North Carolina provided hourly average speeds, also based on state, county and roadway type.

2.2.4 Processing of Biogenic Source Emissions

A revised version of a commonly used biogenic emissions model, the Biogenic Emissions Inventory System (BEIS), was developed and tested by EPA over two separate modeling domains/episodes. This version of the model (BEIS-3, v.0.9) contains several changes over BEIS-2, including the following:

- Vegetation input data -- are now based on a 1-km Biogenic Emissions Landuse Database (BELD3) vegetation data base,

- Emission factors – many updates including some recent NARSTO modifications,

- Environmental algorithm -- includes a sunlit/shaded leaf solar radiation model.

A series of sensitivity modeling simulations has been completed and concluded that the more recent BEIS-3 methodology will impact base case model ozone predictions in most parts of the U.S. The preliminary tests have also shown that the newer biogenic emissions do not appear to have a large effect on: 1) the control signal response, 2) relative reduction factors resulting from a projected emissions change, or 3) overall regional model performance in the eastern U.S.

For this particular application of BEIS-3, version 0.9 as currently incorporated in the SMOKE processor was used. This means that: (1) soil NO emissions were prepared without the input of specific soil moisture and precipitation data; and (2) MEOH emissions were not be modeled explicitly.

The BELD-3 landuse data on a Lambert conformal grid at 1-km resolution have already been developed, are available, and were used to estimate biogenic emissions in this study. The BEIS model also requires as input hourly, gridded temperature and solar radiation data to estimate biogenic emissions, and these data were provided by the MM5 meteorological model.

2.2.5 Processing of Wildfires and Prescribed Burns

Wildfire, agricultural, and prescribed burn emissions were processed separately from the standard area source input files. We used day specific or monthly estimates of fire emissions from ASIP, which include burn acreage and biomass loading information for the ASIP states. Depending on the completeness and quality of the data received, ASIP-specific calculations were made for spatial and temporal distributions of the fire emissions, rather than relying on standard distribution profiles. We calculated vertical distribution of the fire emissions, based on fire size and biomass involvement. SMOKE v2.0 can model fire plume rise when provided with the following variables:

- PTOP – Top of the fire plume profile (meters above ground level)
- PBOT – Bottom of the fire plume profile (meters above ground level)
- Lay1 – The percent of the emissions entrained in the first modeling layer

For those elevated fires having the necessary data elements with distinct time and space coordinates, these variables were prepared and included in the modeling files used to process this emission source type. For low level fires where these discrete spatial and temporal data were not available, we distributed emissions in the lowest modeled vertical layer using the month, day of week and diurnal temporal profiles calculated from the total ASIP state fire distribution files.

The WRAP Fire Emissions Joint Forum Emissions Inventory Report[7] has documented an approach for calculating these plume descriptors. In this method, which was also used in ASIP modeling, the fires are assigned to one of 5 size categories, based on the total burn acreage, and the biomass fuel loading. These categories are then used to calculate representative hourly plume profiles. These profiles are then used by SMOKE 2.0 to distribute the vertical emissions

7 http://www.wrapair.org/forums/fejf/documents/WRAP_2002_PhII_EI_Report_20050722.pdf

for the fires. To successfully model fires as elevated point sources, the data included both the day or days on which the fire occurs, and a spatial identifier of the fire location.

2.2.6 Windblown Dust

PM10 and PM2.5 emissions from wind erosion of natural geogenic sources (SCCs 2730100000 [total] and 2730100001 [dust devils]) were excluded from the resulting modeling files as these meteorological and episode specific categories could not be accurately reflected using the precalculated emission estimates and temporal profiles available at the time of the modeling.

2.2.7 Sea Salt

In March 2006, Version 4.51 of CMAQ was released that includes Sea Salt emissions and active Sea Salt chemistry. Given the number of ASIP states with coastal areas this could be important so ASIP updated the CMAQ V4.51 with the SOAmods enhancement and it was used for the final 2002 Base G2, 2009 and 2012 Base G4 simulations. CMAQ V4.51 internally generates Sea Salt emissions using a user supplied OCEAN file. Thus, Sea Salt emissions were not addressed in the SMOKE processing.

2.3 SMOKE-SPECIFIC PROCESSING CHARACTERISTICS

The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad mobile, area, point, fire and biogenic emission sources for photochemical grid models. SMOKE is one of the fastest emissions processing tools currently available to the air quality modeling community. The sparse matrix approach utilized throughout SMOKE permits both rapid and flexible processing of emissions data. The processing is rapid because SMOKE utilizes a series of matrix calculations instead of less efficient algorithms used in previous systems. The processing is flexible because the processing steps of temporal projection, controls, chemical speciation, temporal allocation, and spatial allocation have been separated into independent operations wherever possible. The results from these steps are merged together at a final stage of processing. Each of these emissions processing steps is detailed below.

2.3.1 Temporal Allocation

ASIP 2002, 2009 and 2012 annual emissions modeling were configured to generate point, area, non-road mobile, on-road mobile and biogenic source emissions. In addition, certain subcategories, such as fires and EGUs were maintained in separate source category files in order to allow maximum flexibility in producing alternate strategies. With the exception of biogenic and on-road mobile source emissions that are generated using the BEIS and MOBILE6 modules in SMOKE, pre-computed annual emissions were processed using the month, day, and hour specific temporal profiles of the SMOKE model. Area and nonroad sources were modeled as a block of Thursday, Friday, Saturday, Sunday, and Monday one per month (total of 60 days modeled). On-road motor vehicle sources were modeled for one seven-day week per month. Point sources and biogenics were modeled for each day of the annual period.

ASIP based its temporal profiles and source category cross-reference files on the EPA CAIR/CAMR/CAVR modeling platform with files located on EPA's CAIR file transfer website[8]. Modifications were made to reflect State specific profiles or updated state of knowledge application of these profiles. Some of these changes included the reallocation of North Carolina NONROAD generated emission categories to a regional set of temporal profiles more consistent with the operation of these source types in the State. Additionally, EGU CEM-based temporal profiles and onroad emissions modeling were prepared in manners deviating from EPA's original CAIR platform.

As noted previously, on-road mobile modeling in SMOKE was done for selected weeks (seven days) of each month - using these days as a "representative week" of the entire month. This selection allows for the representation of day-of-the-week variability in the on-road motor vehicles, and models a representation of the meteorological variability in each month. ASIP/VISTAS executed sensitivity tests to examine this "representative week" methodology versus an everyday on-road mobile modeling method[9]. ASIP/VISTAS determined that the use of representative week on-road mobile emissions produced ozone and particulate matter concentrations that were nearly indistinguishable from the "everyday" mobile method. ASIP determined that the difference in the modeled air quality resulting from the on-road mobile modeling methods were insignificant.

2.3.1.1 CEM-Based Temporal Profile Development and Application

Two sets of monthly profiles were developed for processing EGU emissions with CEM data:

1. Profiles based solely on actual 2002 CEM-based data at the state level. The 2002-only profiles are intended to be used by ASIP in developing model performance evaluation metrics necessary for configuring air quality models in attainment demonstration analyses.

2. Profiles based on historical averages of 2000 through 2004 CEM-based data. These historical 2000-2004 average profiles were developed and were used to represent consistent "typical" operating conditions at EGUs in the ASIP domain for the base year and future year emission estimates.

Analyses conducted by the modeling team[10] indicate an added benefit to the modeling results with the application of CEM-based day-of-week and diurnal profiles, in addition to the monthly profiles for each state. For the majority of EGU units processed in the ASIP domain, unit specific monthly, weekly, and diurnal profiles were developed and applied using historical CEM averages of heat input and emissions and as further described below. As an additional part of this analysis, specific day-of-week (Monday, Tuesday, Wednesday, etc.) and diurnal profiles were also developed for each month and State to better represent operating conditions at units within a State. These State specific day of week and diurnal profiles were developed from averages of CEM-based emissions and heat input activity occurring on that day-of-week or during that hour-

8 ftp://www.airmodelingftp.com/
9 http://www.epa.gov/ttn/chief/conference/ei15/session9/abraczinskas.pdf
10 http://www.epa.gov/ttn/chief/conference/ei14/session11/stella.pdf

of-day across all units within that State. These profiles were then applied to units were CEM specific matches could not be made to ASIP emission inventories.

Data Obtained

Five years (2000 through 2004) of hourly CEM information from EPA's CAMD website were obtained for each unit in the ASIP states[11]. The "Prepackaged Data" option allows the download of files containing emissions data for a specific state, quarter or month, and year. Each prepackaged data file is in .csv (comma delimited) format and contains the following fields: State, Facility Name, Facility ID (ORISPL), Unit ID, Date, Hour, SO_2 Emissions (lbs), CO_2 Emissions (tons), NO_x Emissions Rate (lb/mmBtu), NO_x Emissions (lbs), Heat Input (mmBtu), Operating Time (hours), Gross Load (MW), and Steam Load (1000 lb/hr). For this analysis, we obtained the prepackaged monthly unit-level hourly emissions data by state and year. Using these data, we reformatted the files and quality assured for applicability to this analysis.

File Contents

The reformatted files were prepared as identified in Table 2-2.

Quality Control / Quality Assurance

Each file was reviewed to determine if NOx, SO2 and heat input values were represented for each hour of every day for each unit in the obtained data. Zero values were considered to be valid if operating time identifiers indicated no operation during that hour (e.g., data value of zero but operating hours greater than zero).

Using the measurement flags and field values in the reformatted files, numerous spot checks were made of anomalous or missing variable data to ensure that data corruption was not impacting the statistical analyses. Additionally, each year's hourly total of NOx, SO2, and heat input (per state) were summed and compared to EPA annual summaries of the same data elements.

When there were facilities or units with no emissions data or unit characteristics, we verified that these sources are not required to report emissions data or had not yet reported emissions data to EPA. In some cases, certain months or quarters of the year were blank for individual units or facilities and using EPA data caveat reports, we verified these units were not in operation during those times.

Inventory Matching

Prior to the development of the unit-specific SO2, NOx, and heat input ratios for each hour, the step of matching CEM units to the ASIP 2002 modeling inventory started. Because naming convention and facility or unit numbering can be unique at the Federal, State, local, or facility level, the step of matching existing units from an emissions inventory to the CEM data base proved to be more complicated than anticipated.

11 http://cfpub.epa.gov/gdm/index.cfm?fuseaction=prepackaged.select

The ASIP EGU emission inventory accounted for approximately 3.7 million tons of SO2 and 1.5 million tons of NOx in calendar year 2002. There were 861 units reporting to the CEM database in 2002 for the ten ASIP States. The primary objective of the inventory matching steps was to account for as many units and tons as possible allowing for the unit-specific application of hourly temporal distribution profiles.

Table 2-2. CEM data file format.

Column	Description
State	State in which the facility is located.
Facility Name	The name given by the owners and operators to a facility.
Facility ID (ORISPL)	The unique six-digit facility identification number, also called an ORISPL, assigned by the Energy Information Administration, a component of the Department of Energy.
Unit ID	Each unit at a facility has a unique identification number. It is alphanumeric and may be from one to six characters in length. For utility units and other units that generate energy for sale, the unit ID used for Part 75 reporting is the same unit ID that appears in the National Allowance Database (NADB) (for Acid Rain Program units) or in the State's allowance allocation list.
Day	Day on which a unit was operating.
Hour	Hour on which a unit was operating.
Operating Hours	Percent of hour in which a unit was operating.
Gross Load (MW)	Gross load is the output of the unit as measured in megawatts.
Steam Load (1000 lb/hr)	Steam load is the output of the unit as measured in 1000 lb/hr of steam.
SO_2 Mass (lbs)	SO_2 released for the hour in pounds.
SO_2 Mass Measurement Flag	Indicates whether the value for SO_2 mass was measured or derived due to missing data.
SO_2 Rate (lbs/mmBtu)	SO_2 emissions rate in pounds per million British thermal units (lbs/mmBtu).
SO_2 Rate Measurement Flag	Indicates whether the value for SO_2 rate was measured or derived due to missing data.
NO_x Rate (lb/mmBtu)	NOx emissions rate in pounds per million British thermal units (lbs/mmBtu).
NO_x Rate Measurement Flag	Indicates whether the value for NO_x rate was measured or derived due to missing data.
NO_x Mass (lbs)	NO_x released for the hour in pounds.
NO_x Mass Measurement Flag	Indicates whether the value for NO_x mass was measured or derived due to missing data.
CO_2 Mass (lbs)	CO_2 released for the hour in pounds.
CO_2 Mass Measurement Flag	Indicates whether the value for CO_2 mass was measured or derived due to missing data.
CO_2 Rate (lbs/mmBtu)	CO_2 emissions rate in pounds per million British thermal units (lbs/mmBtu).
CO_2 Rate Measurement Flag	Indicates whether the value for CO_2 rate was measured or derived due to missing data.
Heat Input (mmBtu)	Heat per hour as calculated by multiplying the quantity of fuel by the fuel's heat content.

Under the direction of ASIP, emissions inventory contract staff prepared comparisons of the ASIP 2002 emission inventory of EGU sources to that of CEM-based emissions, heat input, and operating characteristics. For each unit identified as an EGU source in the ASIP inventory, an attempt was made to match it to a CEM unit and associated data.

Automated facility (ORIS) and unit identification was made for a majority of units who maintained the same numbering and nomenclature between the two data sets. This first computerized step captured the majority of emissions by matching some of the largest units in the ASIP domain. The remaining steps were followed in order to match the outstanding facilities and emissions as reported by ASIP states in the 2002 emission inventory.

Inventory contractors developed county-level reports of the remaining unmatched facilities and units from the ASIP inventory and made comparisons of annual emissions of SO2 and NOx to the CEM-based SO2 and NOx for sources also identified within the same county. This step of the matching process allowed an incremental amount of emissions and units to be accounted for and assigned unit-specific profiles for model performance evaluation.

Finally, remaining ASIP inventory and CEM sources were manually compared to each other in an effort to determine if reporting errors in State or county codes or facility or unit identification codes accounted for this reminder of unmatched sources. These manual matches were confirmed or revised with ASIP state and stakeholder participation and input. With this step, a few sources were identified to have facility identification changes or misreported county codes preventing automated matching from occurring and corrected for the final application of factors.

Once all methods of comparison were exhausted, the remaining unmatched ASIP emission inventory of EGU sources was excluded from the unit-specific profile assignment steps and was allocated more generalized facility or State temporal profiles as described in the following section.

This inventory comparison process allowed for the match of over 650 of the 861 CEM identified units (76%) to the ASIP EGU emission inventory for 2002. More importantly, however, was the match of 99.95 percent of the SO2 emissions and over 99.4 percent of the NOx emissions from these sources in the ASIP domain.

Profile Calculations

Two sets of profile types have been developed for modeling EGU emissions within the ASIP domain. The first set are to be applied to individual units able to be matched to CEM data, the second are to be applied to EGU sources within the ASIP domain where CEM-based matches could not be identified.

The first set of temporal profiles have been developed for specific hour-of-date periods based on historical actual 2002 or average NOx, SO2, and heat input data for sources reporting under EPA’s CEM program between 2000 and 2004. These profiles are based on the actual or statistical average of the CEM data variables (NOx, SO2, and heat input) for each hour-of-date (e.g., Hour 12 of March 3) during the year. In the typical profile calculation, variables are calculated for each hour when the operating time of the CEM is greater than 0 (e.g., the unit is in operation during that hour). In the case of 2002-only calculations, all reported NOx, SO2, and heat input data were used in the averaging, including those identified as non-operating hours. This allowed for the best representation of actual 2002 conditions for the expected use of these profiles for model validation studies.

In the second set of profiles, NOx, SO2, and heat input values were averaged over each unit to allow for the calculation of State level monthly, day-of-week, and diurnal profiles for ASIP states.

For the 2000-2004 averaging period, representation of typical operating conditions was desired, so in the averaging calculation only valid operating hour NOx, SO2, and heat input values were used. This prevented the introduction of equipment shutdown because of power outages, control installation, or planned maintenance into the temporal profile calculation.

Actual 2002 Profiles

Through the EPA's Clean Air Market's Data and Maps website, quarterly unit-level hourly emissions data by State and calendar year 2002 were obtained for purposes of developing temporal allocation factors applicable to EGU sources within the ASIP domain. Key elements in these data sets include the State where the unit is located, facility name, facility identification (ORISPL) code (assigned by the Department of Energy at the Energy Information Administration), unit identification code, date of record, hour of record, SO2, CO2, and NOx mass (in lbs per hour), heat input (million British thermal units [MMBtu]), and NOx emission rate (lbs/MMBtu).

SO2 and NOx mass and heat input values were summed for each unit to an annual level to allow for the calculation of an hour of date-to-annual ratio estimation. The equation below provides this calculation for heat input. Table 2-3 provides an example result of the ratio calculation.

$$hi_{ratio,hr,date} = hi_{hr,date} / \sum_{Dec31}^{Jan1} hi$$

where hi = heat input (MMBtu)

Since it was assumed that all sources in the ASIP EGU inventory would not be matched to individual CEM-based units, the same calculations were performed for each state so that a hierarchical application of ratios (unit first, state second) could be assigned as necessary. Table 2-3 shows example ratios calculated for each month by state. Table 2-4 reflects an example of the state-month-day of week ratio calculation and Table 2-6 shows a state-month-diurnal ratio calculation example. Each of these ratios were calculated for each state in the ASIP domain and used in instances where CEM unit matches could not be made to the ASIP base year emissions inventory.

Three parameter values (SO2 mass, NOx mass, heat input) were calculated at each aggregation as NOx and SO2 emissions vary due to fuel blend, sulfur content, or seasonal control and are not necessarily representative of the other variables' seasonal, daily, or even hourly variation. As seen in Figure 2-2, when viewed on a ASIP-domain total, the monthly variation in relative distribution of SO2, NOx, and heat input differs enough to justify calculating each parameter value set of temporal profiles with CEM data.

Table 2-3. Application of calculated ratios for actual 2002 by unit.

ORISPL	UnitID	Date	Hour	Actual Reported Values [2002]			Calculated Ratios		
				SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
3	2	01-01-2002	0	15.563	10.294	13.3	1.417E-06	1.915E-06	1.372E-06
3	2	01-01-2002	1	14.977	8.338	12.5	1.364E-06	1.551E-06	1.289E-06
3	2	01-01-2002	2	14.93	9.286	12.6	1.360E-06	1.728E-06	1.300E-06
3	2	01-01-2002	3	14.774	9.677	12.8	1.346E-06	1.800E-06	1.320E-06
…	…	…	…	…	…	…	…	…	…
3	2	07-01-2002	0	1084.017	717.467	995.1	9.873E-05	1.335E-04	1.026E-04
3	2	07-01-2002	1	1102.47	750.04	1012.2	1.004E-04	1.395E-04	1.044E-04
3	2	07-01-2002	2	1109.41	768.55	1016.6	1.010E-04	1.430E-04	1.049E-04
3	2	07-01-2002	3	1102.598	772.614	1012.6	1.004E-04	1.437E-04	1.044E-04
3	2	07-01-2002	4	1087.909	736.967	998.6	9.909E-05	1.371E-04	1.030E-04
3	2	07-01-2002	5	1099.375	731.888	1009.5	1.001E-04	1.362E-04	1.041E-04
3	2	07-01-2002	6	1127.007	693.779	1026.3	1.026E-04	1.291E-04	1.059E-04
3	2	07-01-2002	7	1203.814	644.008	1114.2	1.096E-04	1.198E-04	1.149E-04
…	…	…	…	…	…	…	…	…	…
3	2	12-31-2002	21	712.26	503.505	835	6.487E-05	9.367E-05	8.612E-05
3	2	12-31-2002	22	716.983	587.419	850.1	6.530E-05	1.093E-04	8.768E-05
3	2	12-31-2002	23	521.311	430.787	647.8	4.748E-05	8.014E-05	6.681E-05
3954	**3**	**Annual Sum**		**10979533.36**	**5375215.80**	**9695608.12**	**1.000**	**1.000**	**1.000**

Table 2-4. Application of calculated ratios for actual 2002 by example state and month.

State	Month	Actual Reported Values [2002]			Calculated Ratios		
		SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
FL	Jan	67,755,539	42,004,513	113,531,981	0.0726	0.0813	0.0733
FL	Feb	56,516,278	34,145,451	91,969,840	0.0605	0.0661	0.0594
FL	Mar	69,997,283	39,244,669	107,685,763	0.0750	0.0759	0.0695
FL	Apr	73,678,638	40,824,242	118,170,997	0.0789	0.0790	0.0763
FL	May	88,889,603	48,974,695	142,351,045	0.0952	0.0948	0.0919
FL	Jun	79,736,153	44,027,147	138,648,667	0.0854	0.0852	0.0895
FL	Jul	94,401,559	50,007,339	157,075,598	0.1011	0.0968	0.1014
FL	Aug	93,041,423	50,077,048	160,601,359	0.0996	0.0969	0.1037
FL	Sep	93,349,234	49,183,990	155,433,110	0.1000	0.0952	0.1003
FL	Oct	84,214,449	46,837,495	146,347,289	0.0902	0.0906	0.0945
FL	Nov	60,374,969	33,098,684	105,854,682	0.0647	0.0641	0.0683
FL	Dec	71,853,245	38,331,463	111,702,695	0.0769	0.0742	0.0721
FL	**Total**	**933,808,373**	**516,756,735**	**1,549,373,024**	**1.0000**	**1.0000**	**1.0000**

Table 2-5. Application of calculated ratios for actual 2002 by example state and month and day of week.

State	Month	Day of Week	Actual Reported Values [2002]			Calculated Ratios		
			SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
GA	Mar	Sun	13,057,959	4,005,097	10,089,522	0.1467	0.1437	0.1458
GA	Mar	Mon	11,937,355	3,841,172	9,564,295	0.1341	0.1378	0.1382
GA	Mar	Tue	11,860,749	3,766,317	9,351,652	0.1332	0.1351	0.1352
GA	Mar	Wed	12,020,458	3,764,653	9,232,574	0.1350	0.1351	0.1334
GA	Mar	Thu	11,560,778	3,677,100	9,056,011	0.1299	0.1319	0.1309
GA	Mar	Fri	14,572,757	4,616,042	11,368,579	0.1637	0.1656	0.1643
GA	Mar	Sat	14,005,730	4,197,929	10,522,180	0.1573	0.1506	0.1521
GA	**Mar**	**Total**	**89,015,786**	**27,868,311**	**69,184,812**	**1.0000**	**1.0000**	**1.0000**

Table 2-6. Application of calculated ratios for actual 2002 by example state and month and hour of day.

State	Month	Hour	Actual Reported Values [2002]			Calculated Ratios		
			SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
SC	Dec	0	1,356,270	556,321	1,309,476	0.0399	0.0399	0.0398
SC	Dec	1	1,332,499	540,268	1,279,485	0.0392	0.0387	0.0389
SC	Dec	2	1,324,618	536,330	1,275,732	0.0389	0.0384	0.0388
SC	Dec	3	1,330,924	538,908	1,284,514	0.0391	0.0386	0.0391
SC	Dec	4	1,335,158	545,819	1,296,880	0.0392	0.0391	0.0394
SC	Dec	5	1,385,906	565,695	1,340,759	0.0407	0.0405	0.0408
SC	Dec	6	1,436,829	586,536	1,387,329	0.0422	0.0420	0.0422
SC	Dec	7	1,488,961	611,648	1,440,753	0.0438	0.0438	0.0438
SC	Dec	8	1,491,509	613,176	1,444,956	0.0438	0.0440	0.0440
SC	Dec	9	1,501,425	618,516	1,447,916	0.0441	0.0443	0.0440
SC	Dec	10	1,484,685	610,879	1,431,441	0.0436	0.0438	0.0435
SC	Dec	11	1,459,697	593,638	1,395,938	0.0429	0.0426	0.0425
SC	Dec	12	1,423,246	578,669	1,365,957	0.0418	0.0415	0.0415
SC	Dec	13	1,391,851	570,939	1,345,091	0.0409	0.0409	0.0409
SC	Dec	14	1,352,161	557,078	1,319,068	0.0397	0.0399	0.0401
SC	Dec	15	1,344,643	551,497	1,312,670	0.0395	0.0395	0.0399
SC	Dec	16	1,369,024	559,569	1,333,589	0.0402	0.0401	0.0406
SC	Dec	17	1,449,587	595,765	1,398,917	0.0426	0.0427	0.0426
SC	Dec	18	1,493,742	621,423	1,438,833	0.0439	0.0445	0.0438
SC	Dec	19	1,473,502	611,050	1,427,712	0.0433	0.0438	0.0434
SC	Dec	20	1,479,504	608,223	1,424,664	0.0435	0.0436	0.0433
SC	Dec	21	1,475,680	608,049	1,421,202	0.0434	0.0436	0.0432
SC	Dec	22	1,450,119	597,906	1,401,208	0.0426	0.0429	0.0426
SC	Dec	23	1,391,087	573,310	1,351,539	0.0409	0.0411	0.0411
SC	**Dec**	**Daily**	**34,022,628**	**13,951,210**	**32,875,627**	**1.0000**	**1.0000**	**1.0000**

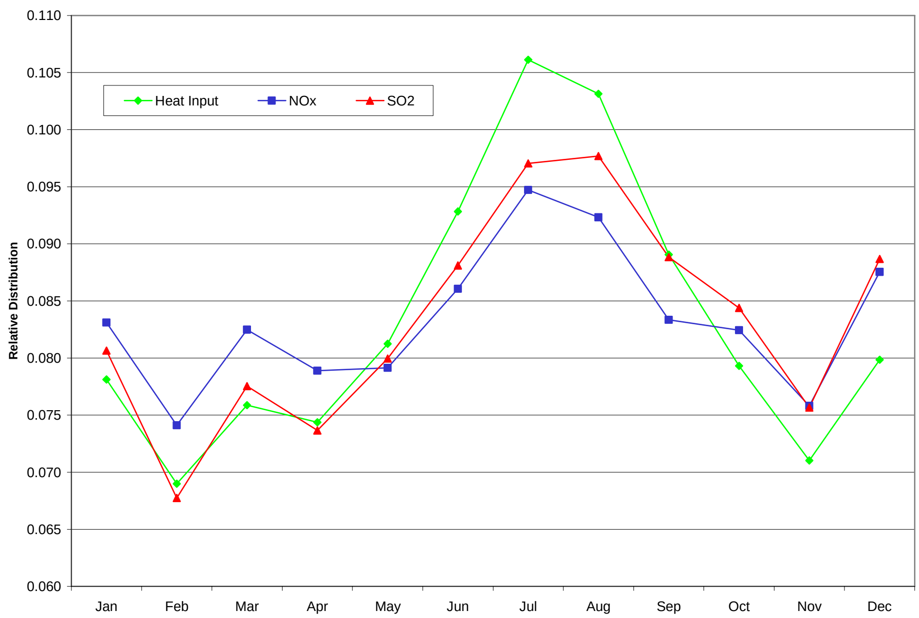


Figure 2-2. Monthly variation in 2002 of CEM reported heat input, NOx mass, and SO2 mass for ASIP domain.

When viewed on a state-by-state basis, the differences in monthly variation are even more pronounced as individual facilities within each state may be affected during any calendar year by extreme temperature variation, shutdowns, or regular maintenance or installation of equipment. As an example, Figure 2-3 represents CEM data from the state of Mississippi during calendar year 2002 and reveals that SO2 emissions increase throughout the year, NOx emissions stay relatively high during the summer months, and heat input peaks during the month of July. Although Figures 2-2 and 2-3 are roughly comparable in shape and monthly distribution, the relative distribution of these values is quite different. In Mississippi's case, close to thirteen percent of the State's CEM-based heat input occurs in July. This compares to the ASIP average of just over ten percent of CEM-based heat input in July.

Finally, when these data are reviewed at a unit level, the differences become incrementally more distinct due to the unique nature of individual facilities, their operating schedules, pollution regulation, fuel characteristics, and applied technologies. For example, a facility that is complying with summertime NOx regulation may have selective catalytic reduction (SCR) installed on its boiler(s) which in practice may only be run during ozone season months. During this period of time, heat input and SO2 emissions may remain consistent with State or regional monthly profiles, but the NOx emissions may drop significantly relative to the rest of the year.

Figure 2-4 represents an extreme unit-specific case for monthly differences from state or regional temporal allocation. The unit presented is a Mississippi baseload coal-fired boiler which in 2002 emitted over 4,000 tons of NOx and over 11,000 tons of SO2. This unit would typically run at consistent levels during the entire period, but due to a planned maintenance outage was not in operation in late January through the middle of April in 2002. Given the unique operation of this boiler during this year, the use of a regional or even state-level monthly temporal distribution would introduce significant inaccuracy to air quality modeling in the immediate or downwind area associated with this facility. While this may not be significant at great distance downwind of the source or for annual concentration estimates, more locally, and especially over shorter time scales (daily or weekly), such simplifications would have a noticeable effect on air quality model predictions.

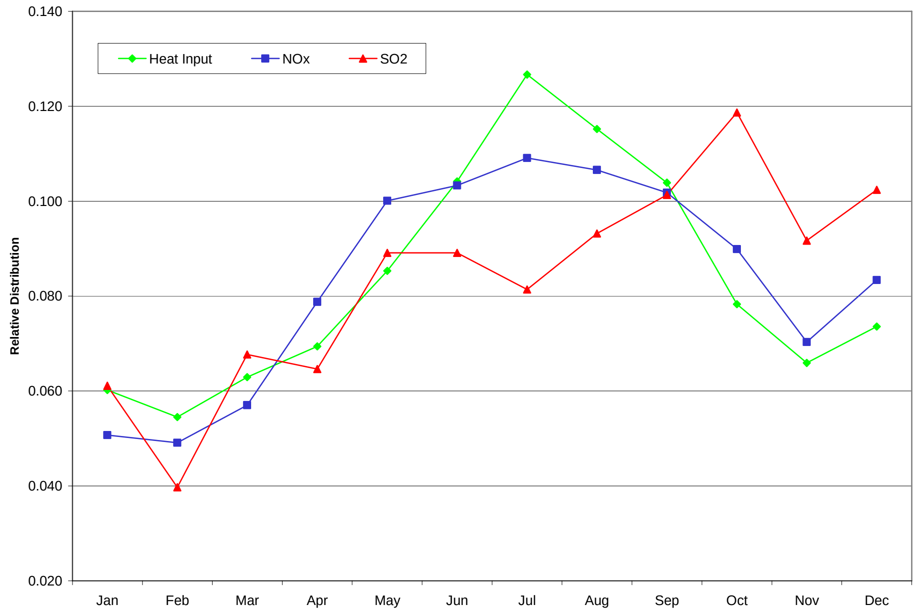


Figure 2-3. Monthly variation in 2002 of CEM reported heat input, NOx mass, and SO2 mass for Mississippi.

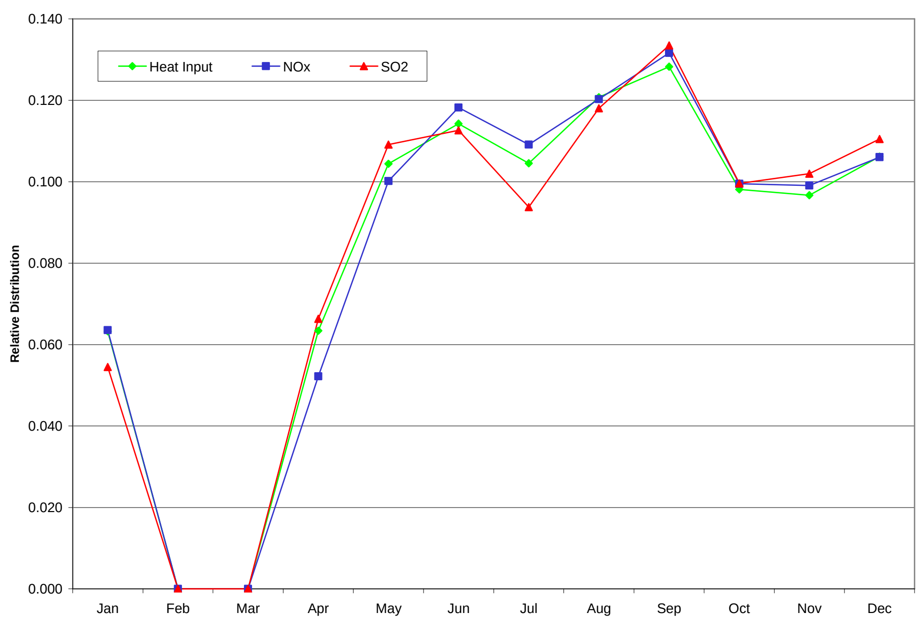


Figure 2-4. Monthly variation in 2002 of CEM reported heat input, NOx mass, and SO2 mass for specific baseload coal-fired unit in Mississippi with planned outage in late January through mid April.

Thus, while improving the representativeness of unit-specific monthly temporal profiles is desirable, providing day and hour-specific values are clearly better. For this reason, during the model performance evaluation process in the ASIP modeling, hour-specific temporal ratios were developed for every CEM reporting unit in the ASIP domain and used for the 2002 Base G2 Actual base case CMAQ 36/12 km simulation used in the model performance evaluation discussed in Chapter 3. These ratios allowed for the hour-by-hour accounting of emissions released at each unit at each facility within the ASIP domain that reported output under the CEM guidelines.

Figure 2-5 represents the actual daily distribution of SO2 and NOx emissions and heat input from the Mississippi baseload unit from the above example. As can been seen in this figure, not only is the planned January through April outage represented correctly, there are significant peaks and valleys throughout the calendar year which could not be accurately represented with the application of average monthly, day-of-week, or hourly distribution factors. In reality, only the actual operating characteristics of this unit could capture the differences from hour to hour which are potentially quite important in terms of correctly modeling the impact of the source on downwind oxidant and fine particulate concentrations[12].

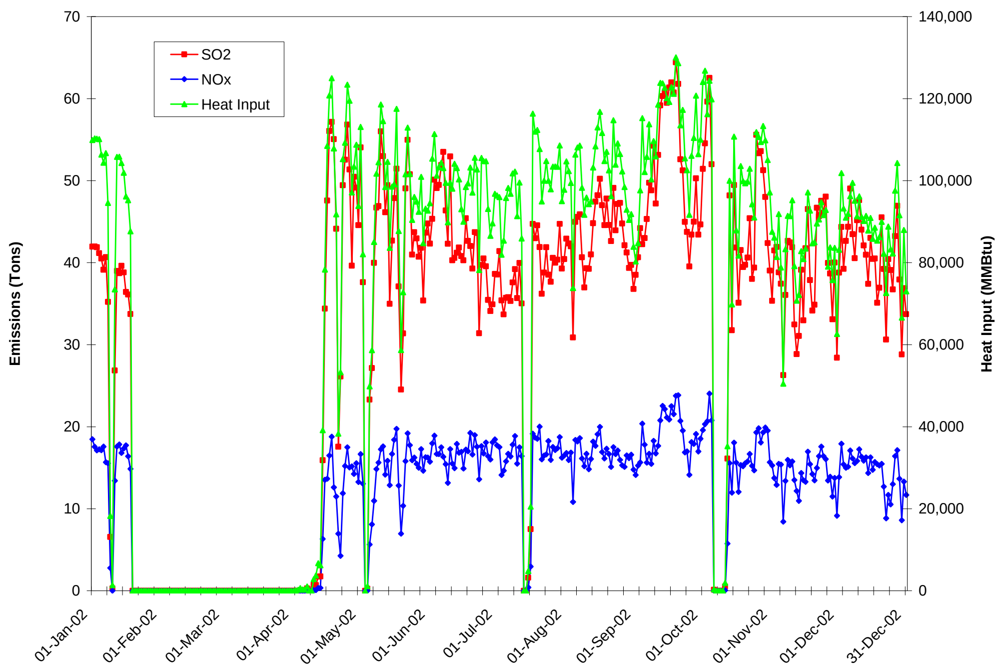


Figure 2-5. Actual daily unit-specific 2002 SO2 (tons), NOx, (tons), and heat input (MMBtu) distribution from CEM data.

12 http://www.epa.gov/ttn/chief/conference/ei14/session11/stella.pdf

Typical EGU Profiles

Hour of day, day of week and month specific temporal profiles were developed by calculating the arithmetic mean of each unit's NOx, SO2, and heat input by specific hour of day per month (e.g., Hour 21 of Wednesdays in July) from the data obtained from 2000 through 2004. In order to accomplish this calculation, each record of CEM data was first assigned a day of week. This assignment was based on the actual CEM's date of record and day of week of that record. An example of this assignment is shown in Table 2-7.

Table 2-7. Example day-of-week per month assignment.

Date	Day of Week
08/01/02	Thu
08/02/02	Fri
08/03/02	Sat
08/04/02	Sun
08/05/02	Mon
08/06/02	Tue
08/07/02	Wed

Once day of week were assigned to each record in the CEM data base, the arithmetic mean of each unit's NOx, SO2, and heat input were calculated for the ORISPL-UNITID-MONTH-DAY OF WEEK-HOUR combination. Only records where the CEMs were operating for more than half the recorded hour (OPTIME > 0.5) were used in the averaging calculation. An example of the averaged results can be seen in Table 2-8.

Table 2-8. Arithmetic mean of CEM-based variables for temporal profile calculation.

State	Facility	ORISPL	UnitID	Month	Day of Week	Hour	Calculated Average Values [2000 – 2004] SO2 Mass	NOx Mass	Heat Input
WV	Mount Storm Power Station	3954	3	1	Tue	0	406.0526	3384.074	5196.11
WV	Mount Storm Power Station	3954	3	1	Tue	1	389.6474	3287.845	5103.06
WV	Mount Storm Power Station	3954	3	1	Tue	2	395.2737	3342.848	5175.95
…	…	…	…	…	…	…	…	…	…
WV	Mount Storm Power Station	3954	3	7	Mon	4	524.7864	2505.9391	4654.34
WV	Mount Storm Power Station	3954	3	7	Mon	5	690.5636	2602.9887	4795.64
WV	Mount Storm Power Station	3954	3	7	Mon	6	912.4227	2572.0275	4727.08
WV	Mount Storm Power Station	3954	3	7	Mon	7	1060.3	2664.8686	4914.25
WV	Mount Storm Power Station	3954	3	7	Mon	8	850.2364	2678.231	5029.58
WV	Mount Storm Power Station	3954	3	7	Mon	9	415.3455	2716.8	5042.55
WV	Mount Storm Power Station	3954	3	7	Mon	10	408.8591	2876.5008	5123.71
WV	Mount Storm Power Station	3954	3	7	Mon	11	371.9909	2776.0361	5147.85
WV	Mount Storm Power Station	3954	3	7	Mon	12	327.2045	2785.5325	5129.66
WV	Mount Storm Power Station	3954	3	7	Mon	13	316.0364	2826.901	5172.29
WV	Mount Storm Power Station	3954	3	7	Mon	14	317.1136	2816.1328	5146.07
WV	Mount Storm Power Station	3954	3	7	Mon	15	329.6455	2789.0962	5121.75
WV	Mount Storm Power Station	3954	3	7	Mon	16	332.7773	2818.5379	5147.05
…	…	…	…	…	…	…	…	…	…
WV	Mount Storm Power Station	3954	3	12	Tue	21	806.7	3432.001	5375.49
WV	Mount Storm Power Station	3954	3	12	Tue	22	806.5778	3447.709	5377.68
WV	Mount Storm Power Station	3954	3	12	Tue	23	795.4667	3419.069	5359.43

These values were then applied to each unit and hour based on the 2002 calendar to match the meteorological data used in the emissions processing. An example of this application can be seen in Table 2-9. The date specific hourly averages were then summed to a unit summer (May – Sept) and winter months total and ratios were developed based on each daily hour's average value divided by the average sum total depending on the season of the day. This permitted the appropriate allocation of summertime NOx (as forecasted by IPM) when summer control only was predicted. Using the annual average ratios instead of the seasonal distributions would produce summertime emissions different than what was output from the model. These typical emissions were used in the 2002 Base G2 Typical base case CMAQ 36/12 km simulation used in the $PM_{2.5}$ projections discussed in Chapter 4.

Table 2-9. Application of calculated ratios to day of year by unit.

ORISPL	UnitID	Date	Day of Week	Hour	Calculated Average Values [2000 – 2004]			Calculated Ratios		
					SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
3797	4	09/30/02	Mon	19	2591.95	381.78	1527.26	2.899E-04	2.396E-04	2.863E-04
3797	4	09/30/02	Mon	20	2596.81	379.88	1525.60	2.904E-04	2.385E-04	2.860E-04
3797	4	09/30/02	Mon	21	2569.03	370.50	1506.74	2.873E-04	2.326E-04	2.824E-04
3797	4	09/30/02	Mon	22	2547.62	367.24	1498.66	2.849E-04	2.305E-04	2.809E-04
3797	4	09/30/02	Mon	23	2483.88	360.66	1465.68	2.778E-04	2.264E-04	2.747E-04
3797	4	10/01/02	Tue	0	1968.94	478.47	1170.76	1.587E-04	1.517E-04	1.604E-04
3797	4	10/01/02	Tue	1	1942.47	480.28	1160.68	1.565E-04	1.522E-04	1.590E-04
3797	4	10/01/02	Tue	2	1858.54	462.44	1122.29	1.498E-04	1.466E-04	1.537E-04
3797	4	10/01/02	Tue	3	1988.43	486.07	1187.56	1.602E-04	1.541E-04	1.627E-04
3797	4	10/01/02	Tue	4	2125.96	528.59	1263.00	1.713E-04	1.676E-04	1.730E-04
3797	4	10/01/02	Tue	5	2255.22	562.18	1325.40	1.818E-04	1.782E-04	1.815E-04
3797	4	10/01/02	Tue	6	2267.27	558.77	1337.81	1.827E-04	1.771E-04	1.832E-04
3797	4	10/01/02	Tue	7	2313.00	579.94	1370.73	1.864E-04	1.838E-04	1.878E-04
3797	**4**	**Summer**				**8941480.78**	**1593123.80**	**5334723.17**		
3797	**4**	**Winter**				**12408352.17**	**3154758.40**	**7300596.69**		
3797	**4**	**Annual Sum**				**21349832.95**	**4747882.21**	**12635319.86**		

The equation below reflects this calculation for heat input for a summer hour. Ratios were calculated for NOx, SO2, and heat input values. These ratios were then applied to each unit's seasonal (summer or winter) emission value for NOx, SO2, and all other pollutants, respectively.

$$hi_{ratio,hr,date,sum} = hi_{hr,date,sum} / \sum_{Sep30}^{May1} hi$$

where hi = heat input (MMBtu)

The actual hour-of-day-of-month averages calculated from the CEM data were not used directly as emissions for that hour, but were used only in the calculation of the ratios to be applied to a pre-calculated seasonal (summer or winter) emission value. This allowed for the retention of emission estimates calculated using means other than CEM data, if a State or local agency found them to be more appropriate or if it were derived by other means (e.g., IPM) but an improved distribution of emissions using CEM-based ratios.

As in the actual 2002 profiles calculations, these same calculations were additionally performed for each state so that a hierarchical application of ratios (unit first, state second) could be assigned as necessary. Instead of having variables at the unit level, however, state level values were used. These state value calculations were based on the sum of the unit-level variable averages to the level of aggregation required by the calculation (e.g., state-month. state-month-day-of-week, or state-month-hour). Table 2-10 shows example ratios calculated for each month by state. Table 2-11 reflects an example of the state-month-day of week ratio calculation and Table 2-12 shows a state-month-diurnal ratio calculation example. Each of these ratios were calculated for each state in the ASIP domain and used in instances where CEM unit matches could not be made to the ASIP base year emissions inventory.

Again, three parameter values (SO2 mass, NOx mass, heat input) were calculated at each aggregation as NOx and SO2 emissions vary due to fuel blend, sulfur content, or seasonal control and are not necessarily representative of the other variables' seasonal, daily, or even hourly variation.

Table 2-10. Application of calculated ratios for typical operation by example state and month.

State	Month	Calculated Average Values [2000 – 2004]			Calculated Ratios		
		SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
FL	Jan	116,011,253	62,989,958	198,751,048	0.0858	0.0875	0.0831
FL	Feb	93,958,786	50,831,818	164,949,702	0.0695	0.0706	0.0690
FL	Mar	111,505,553	60,285,972	196,705,697	0.0824	0.0838	0.0822
FL	Apr	107,015,438	59,071,792	195,338,204	0.0791	0.0821	0.0817
FL	May	118,589,361	61,811,604	207,803,996	0.0877	0.0859	0.0869
FL	Jun	116,068,987	59,801,640	202,716,214	0.0858	0.0831	0.0848
FL	Jul	123,868,749	62,500,169	212,478,437	0.0916	0.0868	0.0888
FL	Aug	125,384,940	64,572,843	214,637,218	0.0927	0.0897	0.0897
FL	Sep	113,080,789	59,913,723	206,712,956	0.0836	0.0832	0.0864
FL	Oct	109,960,828	61,551,310	206,924,170	0.0813	0.0855	0.0865
FL	Nov	101,781,383	55,861,718	186,984,665	0.0752	0.0776	0.0782
FL	Dec	115,588,740	60,566,444	197,592,133	0.0854	0.0841	0.0826
FL	**Total**	**1,352,814,807**	**719,758,990**	**2,391,594,439**	**1.0000**	**1.0000**	**1.0000**

Table 2-11. Application of calculated ratios for typical operation by example state and month and day of week.

State	Month	Day of Week	Calculated Average Values [2000 – 2004]			Calculated Ratios		
			SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
GA	Mar	Sun	15,495,089	4,641,883	12,167,666	0.1455	0.1403	0.1319
GA	Mar	Mon	14,334,901	4,513,847	13,362,335	0.1346	0.1365	0.1449
GA	Mar	Tue	14,420,895	4,532,750	13,463,600	0.1354	0.1370	0.1460
GA	Mar	Wed	14,170,345	4,489,531	13,057,182	0.1331	0.1357	0.1416
GA	Mar	Thu	14,004,649	4,446,853	12,249,119	0.1315	0.1344	0.1328
GA	Mar	Fri	17,177,952	5,357,920	14,842,639	0.1613	0.1620	0.1609
GA	Mar	Sat	16,881,455	5,096,281	13,100,433	0.1585	0.1541	0.1420
GA	**Mar**	**Total**	**106,485,284**	**33,079,065**	**92,242,973**	**1.0000**	**1.0000**	**1.0000**

Table 2-12. Application of calculated ratios for typical operation by example state and month and hour of day.

State	Month	Hour	Calculated Average Values [2000 – 2004]			Calculated Ratios		
			SO2 Mass	NOx Mass	Heat Input	SO2	NOx	Heat Input
SC	Dec	0	1,790,705	674,127	1,908,284	0.0401	0.0395	0.0375
SC	Dec	1	1,760,847	659,279	1,877,399	0.0395	0.0386	0.0369
SC	Dec	2	1,766,498	660,719	1,890,957	0.0396	0.0387	0.0372
SC	Dec	3	1,766,455	664,407	1,922,535	0.0396	0.0389	0.0378
SC	Dec	4	1,788,023	677,882	2,005,041	0.0401	0.0397	0.0394
SC	Dec	5	1,839,136	708,796	2,193,779	0.0412	0.0415	0.0431
SC	Dec	6	1,903,431	736,781	2,379,535	0.0427	0.0432	0.0468
SC	Dec	7	1,957,422	760,608	2,504,498	0.0439	0.0446	0.0492
SC	Dec	8	1,958,923	768,669	2,515,860	0.0439	0.0450	0.0494
SC	Dec	9	1,974,624	767,392	2,419,052	0.0443	0.0450	0.0475
SC	Dec	10	1,944,825	751,207	2,264,252	0.0436	0.0440	0.0445
SC	Dec	11	1,888,552	723,857	2,140,166	0.0423	0.0424	0.0421
SC	Dec	12	1,833,408	694,261	2,022,036	0.0411	0.0407	0.0397
SC	Dec	13	1,781,162	673,316	1,936,841	0.0399	0.0395	0.0381
SC	Dec	14	1,755,403	663,791	1,911,001	0.0393	0.0389	0.0376
SC	Dec	15	1,743,443	660,042	1,897,088	0.0391	0.0387	0.0373
SC	Dec	16	1,775,717	669,264	1,937,000	0.0398	0.0392	0.0381
SC	Dec	17	1,877,548	713,920	2,099,275	0.0421	0.0418	0.0413
SC	Dec	18	1,948,165	753,627	2,255,923	0.0437	0.0442	0.0443
SC	Dec	19	1,940,185	753,123	2,258,417	0.0435	0.0441	0.0444
SC	Dec	20	1,941,859	750,942	2,221,568	0.0435	0.0440	0.0437
SC	Dec	21	1,930,605	743,880	2,182,689	0.0433	0.0436	0.0429
SC	Dec	22	1,909,077	732,480	2,140,416	0.0428	0.0429	0.0421
SC	Dec	23	1,841,457	702,464	2,003,560	0.0413	0.0412	0.0394
SC	**Dec**	**Daily**	**44,617,469**	**17,064,833**	**50,887,170**	**1.0000**	**1.0000**	**1.0000**

Application of Factors

ASIP chose to prepare its air quality modeling inventories with Version 2.1 of the Sparse Matrix Operating Kernel Emissions (SMOKE) model. For this reason, all emissions were required to be converted to SMOKE's data formats. In particular, because hour specific temporal profiles for each day of a year are not accepted directly by the model, it was necessary to develop a set of hourly emissions inputs to circumvent this limitation. These were generated in the SMOKE PTHOUR format as described in SMOKE input file documentation[13].

The CEM format for individual hour-specific data files as available in SMOKE was not utilized for ASIP emissions processing as the emissions allowable by hour would have been limited to NOx, SO2, and CO2. If this file format and optional run configuration were exercised, the NOx, SO2, and CO2 emissions processed by the model would have been accurate for CEM reported emissions, but the remaining pollutants coupled with each CEM unit would have received the

13 University of North Carolina at Chapel Hill, *Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System*, http://cf.unc.edu/cep/empd/products/smoke/index.cfm.

monthly, daily, and diurnal temporal profiles associated with the source category codes from the unit. This could lead to potentially displaced emissions if a unit were operating at different times than the default profiles indicated. Additionally, in cases where states may not have reported annual emission estimates directly based on CEMs, these emissions would be slightly different that the original annual inventory.

In ASIP modeling, for those EGU sources where CEM data were utilized, NOx, SO2, and heat input-based hour-specific profiles were developed and applied to annual NOx, SO2, and all other emissions, respectively, for both the actual and typical 2002 modeling. Heat input was chosen as a surrogate for non-CEM reported pollutants as the majority of remaining compounds are not as significantly impacted by controls or fuel content, yet the distribution of these emissions would occur during the same times CEM reported pollutants were emitted.

The application of hourly ratios to annual emissions ensured that the annual values provided by states under the CERR were maintained, but distributed using actual hourly to annual profiles. Additionally, for stakeholder sources providing hour-specific data approved by the State in which they operated, data were substituted for state provided emissions and CEM-based distributions.

To temporally allocate the remaining EGU point sources, the NOx, SO2, and heat input data were collected from the 2002 or 2000-2004 CEM datasets, and used to develop State-level temporal distributions. These month-specific hour and day of week temporal profiles were used in conjunction with the emissions inventory to calculate hourly EGU emissions by unit.

Although not as accurate a distribution as the unit-specific factors, the state-based temporal distribution provided improved results to the default profiles provided with the emissions model. Figure 2-6 represents the monthly distribution comparisons of ASIP state heat input to the default monthly distribution from Version 2.0 of SMOKE for source category code (SCC) 10100201, representing External Combustion Boilers; Electric Generation; Bituminous/Subbituminous Coal; Pulverized Coal: Wet Bottom (Bituminous Coal), a relatively common boiler type and fuel configuration in the ASIP domain. This example is for the actual 2002 modeling exercise.

Much like the distinction in month to month variation of the profiles, day of week and diurnal patterns based on CEM data vary from unit to unit. Again, if one were to assign the same day of week or diurnal profile to every unit in the inventory, emissions from these sources would inappropriately be distributed during the episode of interest. In addition to the unique distribution provided by the unit-specific factors based on CEM data, aggregate State level daily and diurnal temporal distribution factors were developed and applied during this process. Figure 2-7 shows the variance in diurnal distribution from Tennessee's average CEM-based NOx emissions data for each of the twelve months of calendar year 2002 as would have been applied to units unmatched to CEM sources.

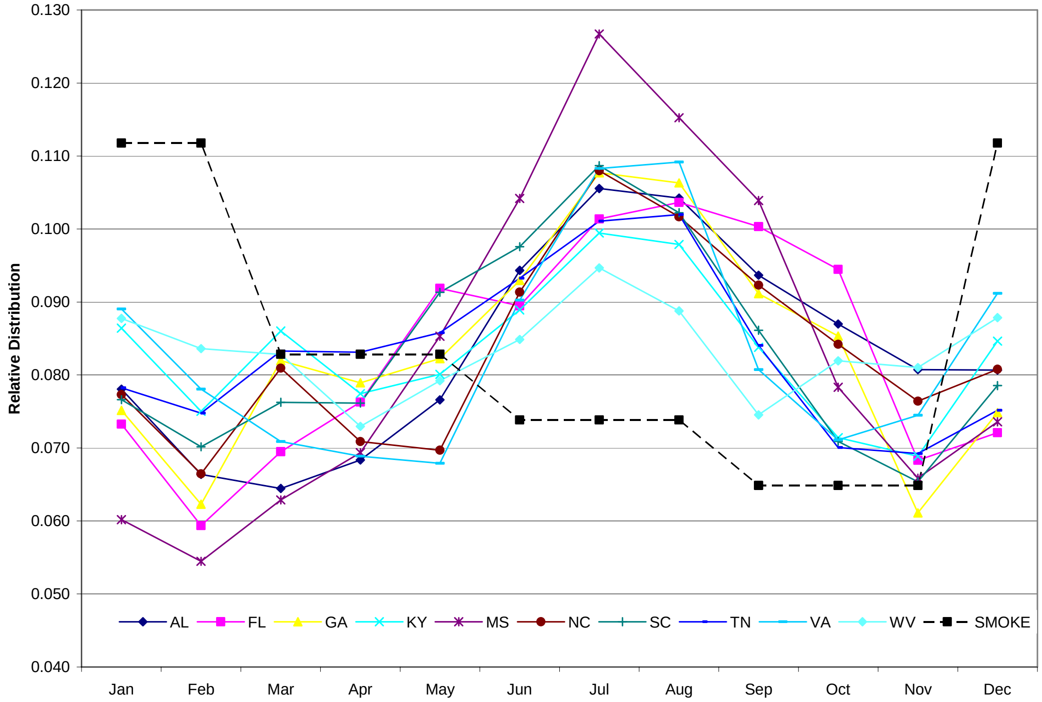


Figure 2-6. Relative distribution of actual 2002 monthly ASIP State CEM-based heat input.

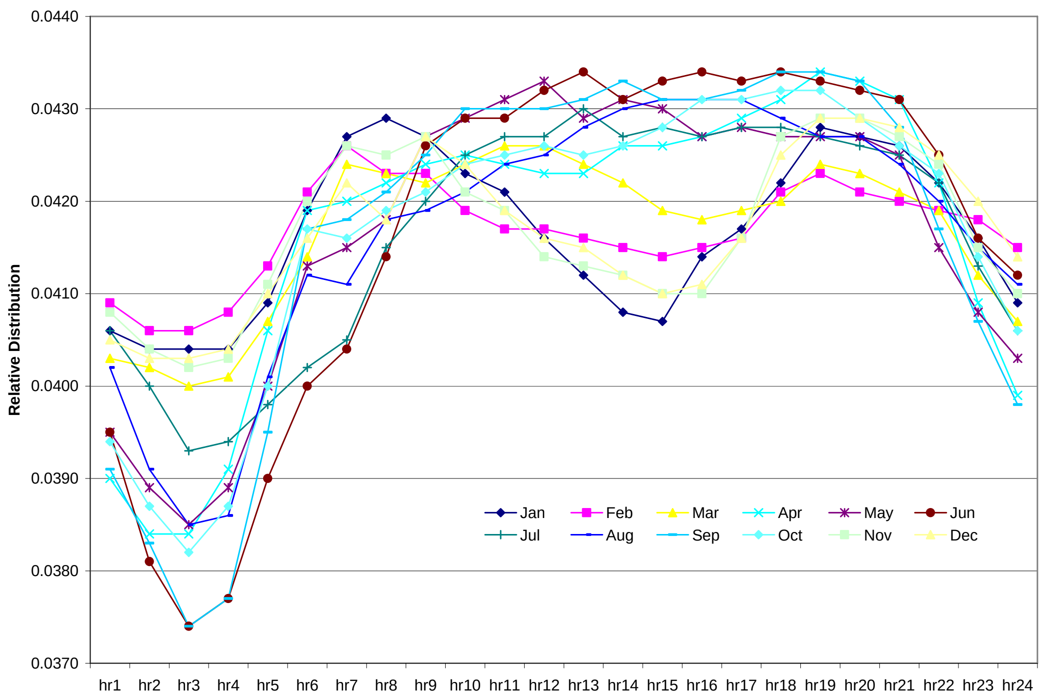


Figure 2-7. Relative distribution of diurnal actual 2002 CEM-based NOx emissions for Tennessee.

The work conducted in this process had the main objective of developing temporal profiles for ASIP EGUs necessary to apply in the generation of SMOKE PTHOUR formatted emissions. Additionally, state-level monthly, day-of-week, and diurnal profiles were developed for application to non-CEM matched units in the ASIP emissions inventory. These temporal distributions represent a significant improvement over the EPA defaults.

Speciation

Speciation is the process of disaggregating inventory pollutants into individual chemical species components or groups of species. The need for speciation is determined by the inventory purpose. Inventory applications that require detailed speciation include photochemical modeling, air toxics inventories, chemical mass balance modeling, and visibility modeling.

Depending on the purpose of a particular emissions inventory, the inventory may include TOG, NOx, sulfur oxides (SOx), CO, total suspended particulate matter (TSP), particulate matter less than 10 micrometers in aerodynamic diameter (PM10), or ammonia (NH3). However, modeling inventories may require these emissions to be expressed in terms of other pollutants. Additionally, for some models, NOx emissions may need to be specified as NO and NO2. Also, PM may need to be separated into various fractions, such as PM10 and PM less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$).

SMOKE was configured to speciate the emissions estimates according to the requirements of the Carbon Bond Mechanism version four (CBM-IV, CB-IV or CB4). The SMOKE model reformats the emissions estimates for use in CMAQ modeling based on source category code (SCC) and speciation profile cross-reference files. The speciation profiles and source category cross-references use in ASIP modeling are based on EPA's CAIR/CAVR/CAMR modeling platform with files located on EPA's CAIR file transfer website (ftp://www.airmodelingftp.com/). Minor modifications were made to reflect state specific profiles or updated state of knowledge application of these profiles. One major change made in the ASIP modeling was the modification of coal combustion cross-reference from speciation profile "NCOAL" to profile "22001."

Spatial Allocation

Because air quality modeling strives to replicate the actual physical and chemical processes that occur in an inventory domain, it is important that the physical location of emissions be determined as accurately as possible. In an ideal situation, the physical location of all emissions would be known exactly. In reality, however, the spatial allocation of emissions in a modeling inventory only approximates the actual location of emissions.

Gridding surrogates are used to spatially allocate emission sources from a coarse geographic area to finer grid cells used for modeling. There can be hundreds of unique source categories in an emissions inventory, which is typically developed for counties, states, or other areas. The exact location of most major emission sources is known and their geographic coordinates are usually contained in the inventory. These usually are referred to as major point sources and include electric utilities and major industrial facilities. However, other emission sources are estimated for the entire county or other area as an aggregate since the exact locations of each source are not included in the modeling inventory. Surrogates are human activities or land use information that are used to represent a more precise location of emission source category groups. A gridded surrogate ratio is the ratio of the amount of a surrogate in a modeling grid cell to the total amount of that surrogate in a county. Grid cell emissions are calculated by multiplying the cell's gridded surrogate ratio by the county emissions.

These surrogates and their associated SCC cross-references were originally developed by EPA (http://www.epa.gov/ttn/chief/emch/spatial/newsurrogate.html) and converted to the gridded domain definitions of the ASIP model requirements.

2.3.2 Development of Gridded Surrogate Files

The general process for creating the SMOKE-ready gridded surrogate files from the ArcGis shape files is as follows:

1. Overlay the grid on the surrogates. Generate the grid polygons (36/12 km) with the specifications of the ASIP domain and spatially overlay (intersect) the grid onto the surrogate area polygons or points. The resulting geodatabase contains, for each surrogate, the county FIPS code, the grid column and row number, and the amount (area, miles or count) of the county's portion of the surrogate in that cell.

2. Extract and convert each geodatabase table to a useful dataset. Each table contains the gridded area, miles or count in each county for a specific surrogate. The variables include FIPS code, column number, row number and area, miles or count.

3. Calculate surrogate ratios. Surrogate ratios are calculated for each surrogate using a series of program files. The programs sum the surrogates for each county and calculate each ratio by dividing the county cell surrogate value by the total county surrogate value. Combination surrogates where both are of the same type (i.e., Heavy and High Tech Industrial are both area data) were summed prior to calculating the ratio. Combination surrogates with unlike data (i.e., 3/4 Roadway Miles plus 1/4 Population are line and area data) were summed after calculating the ratios and then normalized. The surrogate cross-reference code was also assigned here.

4. Gap-fill surrogates for counties missing data. There will be many instances where inventory emissions exist for a particular county but there is no spatial data, for that county, for the surrogate assigned. For example, a county with class 1 locomotive emissions may not have data for the class 1 railroad surrogate. In this case we have selected to incorporate, within the assigned surrogate, a secondary source of data (a different surrogate) for that particular county. We incorporate secondary surrogates even if there is no emission source that requires it for that particular county. We denote this process as "gap-filling." All surrogates resulting from the gap-filling process have ratios for all counties.

   For each primary spatial surrogate, we assign a secondary or tertiary spatial surrogate where needed for gap filling. For the class 1 railroad example mentioned above, we chose total railroads as the secondary spatial surrogate since emissions had been estimated for class 1 railroads but no class 1 spatial surrogate was available in that county from our coverage files. The secondary or tertiary spatial surrogate chosen is the same across all counties for a particular primary spatial surrogate and applies to all SCCs that use the particular primary surrogate. We pull in and substitute the secondary surrogate for counties where the primary surrogate is missing to allow for an otherwise omitted spatial distribution of a pre-calculated emission value. Tertiary surrogates are assigned to those counties that are still without surrogates.

For identified counties having no values for each surrogate, we assign the data based on the appropriate secondary or tertiary surrogate to these counties. Checks to see that surrogate ratios for each county sum to approximately 1.00 were also performed in our surrogate development. Ratios will not always sum exactly to 1.00 due to rounding. However, SMOKE will normalize surrogates greater than 1.00.

5. Create SMOKE-formatted spatial surrogate files. The resulting data from the previous steps is then reconfigured into SMOKE-ready format and used in the spatial allocation process.

2.3.3 Development of Modeling Input Inventories/Run Scripts/ASSISGNS Files

The ASIP state emissions inventories modeled for the Base G runs were obtained from the emissions inventory contractor in NIF 3.0 format (exception of fires and onroad mobile inputs). These files were converted to SMOKE IDA format using procedures previously applied for the VISTAS Phase I and earlier Phase II modeling analysis and allocated to subcategory major source level (EGU, non-EGU point, area, nonroad, onroad, fires) for ease of processing and data management. Most of the 2002, 2009 and 2012 modeling files for non-ASIP states were obtained directly from EPA or other RPOs in SMOKE format (MANE-VU, CENRAP and WRAP) or converted from NIF 3.0 (MRPO) as necessary.

Additionally, with the annual episode required for modeling, certain source categories were prepared in a monthly format and the SMOKE model was run for each month of the year. For this reason, individual run scripts and ASSIGNS files were prepared and executed during each SMOKE year/scenario run. An example of the configurations used can be seen in Table 2-13 below. This particular example is for point source processing of the typical 2002 emissions episode. Comparable configurations were developed for stationary area, nonroad mobile, elevated fire, low-level fire, onroad mobile and fugitive dust sources for 2002 typical and actual, 2009 and 2012 episodes.

2.3.4 Products of the Emissions Inventory Development Process for QA

In addition to the CMAQ-ready input files generated for each hour of the days modeled in the annual runs, a number of quality assurance (QA) files will be prepared and used to check for gross errors in the emissions inputs. Importing the model-ready emissions into PAVE and looking at both the spatial and temporal distribution of the emission provides insight into the quality and accuracy of the emissions inputs.

- Visualizing the model-ready emissions with the scale of the plots set to a very low value, we can determine whether there are areas omitted from the raw inventory or if emissions sources are erroneously located in water cells.
- Spot-check the holiday emissions files to confirm that they are temporally allocated like Sundays.
- Normalizing the emissions by population for each state will illustrate where the inventories may be deficient and provide a reality check of the inventories.
- Spot check vertical allocation of point sources using PAVE.

We used state inventory summaries prepared prior to the emissions processing to compare against SMOKE output report totals generated after each major step of the emissions generation process.

To check the chemical speciation of the emissions to CB-IV terms and the vertical allocation of the emissions, we compared reports generated with SMOKE reports to target these specific areas of the processing. For speciation, we compared the inventory import state totals versus the same state totals with the speciation matrix applied.

For checking the vertical allocation of the emissions, we created reports by source, hour, and layer for randomly selected states in the domain. We created these reports for a representative weekday in each of the episodes for each of these selected states.

Table 2-13. Example SMOKE setup for 2002 typical point source processing.

Logical File Name	Directory Name	Actual File Name	Comments
PTINV	$SMKDAT/inventory/2002typ/point	ptinv_2002typ_*date*.ida	*date* typically indicates date of file preparation
PTHOUR	$SMKDAT/inventory/2002typ/point	pthour.typ.NNN.lst	NNN indicates the month abbreviation. The list file points to "pthour_rev2002typ_NNN_12nov04.ems"
PTPRO	$SMKDAT/inventory/2002typ /point	amptpro_typ_us_can_NNN_vistas_*date*.txt	*date* typically indicates date of file preparation
PTREF	$SMKDAT/inventory/2002typ /point	ptref_2002_us_can_vistas_*date*.txt	*date* typically indicates date of file preparation
PELVCONFIG	$SMKDAT/inventory/2002typ /point	pelvconfig.top50.txt	
REPCONFIG			
PSTK	$SMKDAT/ge_dat	pstk.m3.txt	
INVTABLE	$SMKDAT/inventory/2002typ /other	invtable_onroad.cb4.120202.txt.ag	
GRIDDESC	$SMKDAT/ge_dat	GRIDDESC	
COSTCY	$SMKDAT/ge_dat	costcy.txt	
HOLIDAYS	$SMKDAT/ge_dat	holidays.txt	
SCCDESC	$SMKDAT/ge_dat	scc_desc.txt	
SRGDESC	$SMKDAT/ge_dat	srg_desc.us36.txt	
ORISDESC	$SMKDAT/ge_dat	oris_info.txt	
GSCNV	$SMKDAT/ge_dat	gscnv.txt	
GSREF	$SMKDAT/ge_dat	gsref.cmaq.cb4p25.txt	
GSPRO	$SMKDAT/ge_dat	gspro.cmaq.cb4p25.txt	

Run Script: /scripts/run_rev/run_pnt_XXk_allmet.typical.bat (XX replace with 12 or 36 for desired grid)
ASSIGNS File: /assigns_pII_point/ASSIGNS.vistas.cmaq.cb4p25.rpoXX.phaseIIrev.ag

The quantitative QA analyses often reveal significant deficiencies in the input data or the model setup. It was necessary to tailor these procedures to track down the source of each major problem. As such, we only outline the basic quantitative QA steps that we performed in an attempt to reveal the underlying problems with the inventories or processing. Following are some of the reports that were generated to review the processed emissions:

- State and county totals from inventory for each source category
- State and county totals after spatial allocation for each source category
- State and county totals by day after temporal allocation for each source category for representative days
- State and county totals by model species after chemical speciation for each source category
- State and county model-ready totals (after spatial allocation, temporal allocation, and chemical speciation) for each source category and for all source categories combined
- Totals by source category code (SCC) from the inventory for area, mobile, and point sources
- Totals by state and SCC from the inventory for area, mobile, and point sources
- Totals by county and SCC from the inventory for area, mobile, and point sources
- Totals by SCC and spatial surrogates code for area and mobile sources
- Totals by speciation profile code for area, mobile, and point sources
- Totals by speciation profile code and SCC for area, mobile, and point sources
- Totals by monthly temporal profile code for area, mobile, and point sources
- Totals by monthly temporal profile code and SCC for area, mobile, and point sources
- Totals by weekly temporal profile code for area, mobile, and point sources
- Totals by weekly temporal profile code and SCC for area, mobile, and point sources
- Totals by diurnal temporal profile code for area, mobile, and point sources
- Totals by diurnal temporal profile code and SCC for area, mobile, and point sources
- PAVE plots of gridded inventory pollutants for all pollutants for area, mobile, and point sources

Examples of some of these reports are located in the Appendix A of this document.

2.4 2002 BASE G2 AND 2009/2018 BASE G4 BEST AND FINAL INVENTORIES

The current version of the ASIP future year emissions inventory is referred to as the Best and Final (BaF) or Base G4 inventory. After the release of the 2009 and 2018 Base G2 inventory in July 2007, states specified additional changes to the point source inventory to reflect improved information on controls and shutdowns in the 2009 and 2018 future year point source emissions. No changes to the other source sectors (e.g., on-road mobile, non-road mobile, area fires, etc.) were made in going from the 2009 and 2018 Base G2 to the Base G4/BaF emission inventories. The 2018 Base G4/BaF inventory was released in October 2007, and the 2009 Base G4/BaF inventory was released in December 2007. The development of the 2002 Base G2 and 2009 and 2018 Base G4/BaF inventories is given in MACTEC (2008).

Table 2-14 displays the point source SO2 and NOx emissions by ASIP State and ASIP region for the 2002 Base G2 and 2009 and 2018 Base G2 and Base G4 (BaF) emission scenarios. The largest changes in future-year EGU emissions between Base G2 and Base G4 occurred in Florida where SO2 EGU emissions were increased by 57% (2009) and 40% (2018) and NOx emissions were increased by 54% (2009) and 17% (2018). In the other ASIP States there were mostly small reductions or no change in EGU SO2 emissions. EGU NOx emissions were also increased in Mississippi.

With the exception of a 27% and 16% reduction in the 2018 Tennessee and Virginia, respectively, non-EGU SO2 emissions, the non-EGU SO2 and NOx emissions exhibited no or small (<±10%) changes between the future year Base G2 and Base G4 inventories.

Across all ASIP States, the total change in point source SO2 emissions between Base G2 and Base G4 was +1% and -1% for 2009 and 2018, respectively. There were larger changes in the future year Base G2 and Base G4 NOx point source inventories across the ASIP States that were increased by 5% in 2009 and 1% in 2018.

Table 2-14a. Point source SO2 emissions (tons per year) by ASIP State for the 2002 Base G2 and the 2009 and 2018 Base G2 and Base G4/BaF inventories and the differences between the 2009 and 2018 Base G2 and Base G4/BaF inventories.

EGU Point Sources									
State	2002 Base G2	2009 Base G2	2009 Base G4	2009 G4-G2	2009 G4-G2	2018 Base G2	2018 Base G4	2018 G4-G2	2018 G4-G2
AL	447,194	378,052	378,052	0	0%	135,851	135,851	0	0%
FL	453,631	186,055	291,831	105,776	57%	138,340	194,028	55,688	40%
GA	514,952	417,449	408,679	-8,770	-2%	79,430	68,515	-10,915	-14%
KY	484,057	290,193	271,669	-18,524	-6%	226,062	222,102	-3,960	-2%
MS	67,429	76,579	76,646	67	0%	15,146	15,213	67	0%
NC	477,990	242,286	242,286	0	0%	114,771	120,165	5,394	5%
SC	206,399	124,608	129,122	4,514	4%	93,274	95,377	2,103	2%
TN	334,151	255,410	255,410	0	0%	112,672	112,672	0	0%
VA	241,204	193,112	174,777	-18,335	-9%	114,255	98,988	-15,267	-13%
WV	516,084	277,489	268,952	-8,537	-3%	105,935	106,199	264	0%
Total	3,743,091	2,441,233	2,497,424	56,191	2%	1,135,736	1,169,110	33,374	3%
Non-EGU Point Sources									
State	2002 Base G2	2009 Base G2	2009 Base G4	2009 G4-G2	2009 G4-G2	2018 Base G2	2018 Base G4	2018 G4-G2	%
AL	96,481	101,246	101,246	0	0%	113,224	103,303	-9,921	-9%
FL	65,090	65,511	62,651	-2,860	-4%	75,047	71,810	-3,237	-4%
GA	53,778	53,987	53,987	0	0%	59,349	59,349	0	0%
KY	34,029	36,418	36,418	0	0%	40,682	40,682	0	0%
MS	35,960	25,564	25,564	0	0%	26,678	25,674	-1,004	-4%
NC	44,123	42,536	42,536	0	0%	46,314	46,314	0	0%
SC	53,518	48,324	47,193	-1,131	-2%	53,577	52,410	-1,167	-2%
TN	79,604	70,678	64,964	-5,714	-8%	77,247	56,682	-20,565	-27%
VA	63,903	62,560	58,039	-4,521	-7%	68,909	57,790	-11,119	-16%
WV	54,070	55,973	55,598	-375	-1%	62,193	61,702	-491	-1%
Total	580,556	562,797	548,196	-14,601	-3%	623,220	575,716	-47,504	-8%
Total Point Sources (EGU plus non-EGU)									
State	2002 Base G2	2009 Base G2	2009 Base G4	2009 G4-G2	2009 G4-G2	2018 Base G2	2018 Base G4	2018 G4-G2	%
AL	543,675	479,298	479,298	0	0%	249,075	239,154	-9,921	-4%
FL	518,721	251,566	354,482	102,916	41%	213,387	265,838	52,451	25%
GA	568,730	471,436	462,666	-8,770	-2%	138,779	127,864	-10,915	-8%
KY	518,086	326,611	308,087	-18,524	-6%	266,744	262,784	-3,960	-1%
MS	103,389	102,143	102,210	67	0%	41,824	40,887	-937	-2%
NC	522,113	284,822	284,822	0	0%	161,085	166,479	5,394	3%
SC	259,917	172,932	176,315	3,383	2%	146,851	147,787	936	1%
TN	413,755	326,088	320,374	-5,714	-2%	189,919	169,354	-20,565	-11%
VA	305,107	255,672	232,816	-22,856	-9%	183,164	156,778	-26,386	-14%
WV	570,154	333,462	324,550	-8,912	-3%	168,128	167,901	-227	0%
Total	4,323,647	3,004,030	3,045,620	41,590	1%	1,758,956	1,744,826	-14,130	-1%

Table 2-14b. Point source NOx emissions (tons per year) by ASIP State for the 2002 Base G2 and the 2009 and 2018 Base G2 and Base G4/BaF inventories and the differences between the 2009 and 2018 Base G2 and Base G4/BaF inventories.

EGU Point Sources									
State	2002 Base G2	2009 Base G2	2009 Base G4	2009 G4-G2	2009 G4-G2	2018 Base G2	2018 Base G4	2018 G4-G2	State
AL	161,038	82,305	82,305	0	0%	64,358	64,358	0	0%
FL	257,677	86,165	132,535	46,370	54%	74,640	87,645	13,005	17%
GA	147,517	98,497	98,497	0	0%	75,717	69,856	-5,861	-8%
KY	198,817	92,021	97,263	5,242	6%	64,378	64,378	0	0%
MS	43,135	36,011	47,276	11,265	31%	10,271	21,535	11,264	110%
NC	151,853	66,522	66,521	-1	0%	62,353	61,110	-1,243	-2%
SC	88,241	46,915	48,668	1,753	4%	51,456	51,751	295	1%
TN	157,307	66,405	66,405	0	0%	31,715	31,715	0	0%
VA	86,886	62,547	64,358	1,811	3%	66,074	64,344	-1,730	-3%
WV	230,977	86,328	85,476	-852	-1%	51,241	51,474	233	0%
Total	1,523,448	723,716	789,304	65,588	9%	552,203	568,166	15,963	3%
Non-EGU Point Sources									
State	2002 Base G2	2009 Base G2	2009 Base G4	2009 G4-G2	2009 G4-G2	2018 Base G2	2018 Base G4	2018 G4-G2	State
AL	83,310	69,409	69,409	0	0%	78,318	77,960	-358	0%
FL	45,156	46,020	47,125	1,105	2%	51,902	52,959	1,057	2%
GA	49,251	50,353	50,353	0	0%	55,824	55,824	0	0%
KY	38,392	37,758	37,758	0	0%	41,034	41,034	0	0%
MS	61,526	56,397	56,398	1	0%	61,533	61,252	-281	0%
NC	44,929	34,767	34,768	1	0%	37,801	37,802	1	0%
SC	42,153	40,019	39,368	-651	-2%	44,021	43,331	-690	-2%
TN	64,344	57,883	57,514	-369	-1%	63,453	62,519	-934	-1%
VA	60,415	51,046	51,001	-45	0%	55,945	55,734	-211	0%
WV	46,612	38,031	38,023	-8	0%	43,359	43,280	-79	0%
Total	536,088	481,683	481,717	34	0%	533,190	531,695	-1,495	0%
Total Point Sources (EGU plus non-EGU)									
State	2002 Base G2	2009 Base G2	2009 Base G4	2009 G4-G2	2009 G4-G2	2018 Base G2	2018 Base G4	2018 G4-G2	State
AL	244,348	151,714	151,714	0	0%	142,676	142,318	-358	0%
FL	302,833	132,185	179,660	47,475	36%	126,542	140,604	14,062	11%
GA	196,768	148,850	148,850	0	0%	131,541	125,680	-5,861	-4%
KY	237,209	129,779	135,021	5,242	4%	105,412	105,412	0	0%
MS	104,661	92,408	103,674	11,266	12%	71,804	82,787	10,983	15%
NC	196,782	101,289	101,289	0	0%	100,154	98,912	-1,242	-1%
SC	130,394	86,934	88,036	1,102	1%	95,477	95,082	-395	0%
TN	221,651	124,288	123,919	-369	0%	95,168	94,234	-934	-1%
VA	147,301	113,593	115,359	1,766	2%	122,019	120,078	-1,941	-2%
WV	277,589	124,359	123,499	-860	-1%	94,600	94,754	154	0%
Total	2,059,536	1,205,399	1,271,021	65,622	5%	1,085,393	1,099,861	14,468	1%

2.5 UNCERTAINTIES AND CAVEATS

Following the completion of ASIP Base G4 modeling, a number of issues were identified with the input emission inventories and emission processing modeling system that are identified here. Total impact to the overall processed results has not been quantified for these issues although individually each question is felt to have minimal impact on the estimated ozone and PM concentrations in the ASIP domain.

2.5.1 Jefferson County, Kentucky Area Source Correction

In December 2007, KY Division of Air Quality staff identified that Jefferson County, KY was showing zero area source SO_2 emissions. MACTEC was asked to investigate why there were zero emissions. MACTEC's investigation showed that some of the surrounding counties had area source SO_2 emissions, but that Jefferson County's were indeed zero. MACTEC determined that there were emissions in pre-Base F inventories which would have originated from the 1999 NEI grown to 2002. However under their Base F update procedure, they obtained a CERR submittal from Jefferson County. That file contained only emissions for Jefferson County including a limited number of non-ozone pollutant records. Thus under MACTEC's procedure for processing CERR submittals, the file was considered to be full and complete for purposes of inclusion in the Base F inventory and was processed as if it contained more than just ozone pollutant records (i.e., supplemental pollutant records were not required). The file provided, however did not have any SO_2 records. The lack of area source SO_2 emissions was not discovered during the normal State/local review process or during MACTEC's QA process performed on the initial version of the Base F inventory and was thus carried forward into the Base G2 (and thus the Best and Final) inventory and modeling effort where it remained undiscovered until December 2007.

After discovery of the lack of SO_2 records, MACTEC recovered the SO_2 (and some PM) records from the pre-Base F inventories and prepared updated records for 2002, 2009 and 2018. However, because of the timing of the release of these data (December 2007) and the fact that VISTAS could not rerun 2002 and 2009 in time for the final modeling needs with these data, these changes were not included in the final files (Base G2/Best and Final) used in simulations conducted with CMAQ. However, the Best and Final inventory files for 2002, 2009, and 2012 used in ASIP's CAMx simulations do include them.

2.5.2 Updated Non-VISTAS Inventories

As in the normal process among emissions and air quality analysis, non-VISTAS RPOs have continued to update and revise the base year and future year emission inventories used in the development of regional haze and visibility modeling simulations. The non-VISTAS 2002 and 2009 RPO data obtained or derived for this analysis were gathered during the late 2006 through late 2007 timeframe and it is recognized that each of the four sister RPOs to VISTAS has since modified either their 2002 base year and/or their 2009 base case projection inventories.

As noted earlier, additional inventories were obtained from EPA datasets or RPO updates and used for 2012 simulations. Interpolated inventories were derived when RPO specific data were not readily available during the time of this analysis. Development of 2012 emissions consistent with the non-VISTAS 2002 and 2009 would have been resource limited within the time and scope of this study. For this reason, inconsistencies in emission estimates among the three years are noted outside of the ASIP State domain and will have an impact on the direct comparison between future year modeling results for monitors close to non-ASIP State borders.

2.5.3 W.H. Sammis Consent Decree Modification

EGU point source emissions from the MRPO egu5b_2010 scenario (2010 IPM 3.0 run with modifications) were converted to year 2009 IDA format using the annual emission records directly from the NIF structured data sets. These emissions already accounted for growth and control application as specified by the IPM run.

One requested modification for ASIP's $PM_{2.5}$ CAMx modeling[14] was to adjust the 2009 file to match W. H. Sammis facility's planned response to the control requirements from the consent decree USA vs. Ohio Edison; Civil Action No: 2:99-CV-1181; March 18, 2005. The result of this consent decree was an addition of approximately 60,000 tons of SO2 in the 2009 base case inventory for this facility located in Ohio (Table 2-15). While these changes were included in the 2009 CAMx simulations, the changes were not implemented in the ASIP 2009 CMAQ runs.

Table 2-15. SO2 Control Requirements from USA vs. Ohio Edison Consent Decree.

Units 1-4	Induct Scrubbing
	50% removal (1.1 lbs/MMBtu)
	At least one unit by Sept. 30, 2008
	Second unit by Dec. 31, 2008
	Other two units by Dec. 31, 2009
Unit 5	Flash Dryer Absorber or Electro-Catalytic Oxidation no later than Dec. 31, 2008
	50% removal (1.1 lbs/MMBtu)
Units 6/7	Scrubber no later than December 31, 2010
	95% removal (0.13 lbs/MMBtu)
Plantwide	Emission cap of 101,500 by end of 2009
	Emission cap of 101,500 by end of 2010
	Emission cap of 29,900 by end of 2011

2.5.4 Revised IPM Output

During the course of ASIP's modeling efforts, EPA released a revised version of the Integrated Planning Modeling, which is used to forecast EGU emissions under specific environmental and economic constraints. While VISTAS state EGUs were a part of these revisions, VISTAS States

14 CAMx modeling is presented in the Chapter 5 discussions on additional analysis and is used to corroborate the CMAQ future-year PM projections.

chose to maintain the EGU forecasts that were initially developed with the RPO modified version of IPM 2.1.9. For non-VISTAS states, IPM 2.1.9 modified emissions were used for the 2009 simulation, while IPM 3.0 emissions were used for the 2012 simulation. Both instances included the model's forecast of CAIR implementation.

2.5.5 Low Level Fires

During the Base G modeling, a series of low level fire emissions were inadvertently omitted from the processing stream. These fires include emissions for six counties in Kentucky, and one county each in Tennessee and West Virginia for prescribed burning. These fires are data for prescribed burning that were only received from the USFS during the initial file development for these counties. No state data was received for this category in these counties and thus the NEI values from EPA's inventory were maintained for this fire type consistent with the replacement scheme developed when Base D inventories were prepared. During the update process of fire emissions from Base D to Base G, this file was not remerged with the other updated fire types.

2.5.6 MMS Offshore Shipping

During the update of emission inventories from Base D to Base G, ASIP obtained from MMS a set of updated 2000 emission files (GOADS[15]) which included off-shore marine vessel emissions in the Gulf of Mexico oil/gas development area and platform and platform support equipment that has always been included in past MMS inventories. When ASIP overlaid recently obtained offshore emission estimates from shipping lanes, we double counted some of the off-shore marine emissions in the Gulf of Mexico area.

2.5.7 Incorrect Location Parameters

During the quality assurance steps of the Base G emission inventories in preparation for ASIP's best and final modeling, a number of emission release points were identified to have stack location parameters that were of distances greater than 100 miles from the county centroid that the stack's FIPS codes indicated it was situated. Although many of these release points were sited at valid locations (in counties with outer boundaries greater than 100 miles from centroid), those that were incorrectly sited had emission values of very low (less than 80 tons per year) of any single pollutant.

2.5.8 SMOKE/IOAPI Coordinate Transformation Error

During emissions processing of inventories for an unassociated project, the modeling team became aware of an issue[16] with one of the IOAPI libraries used by SMOKE necessary to

15 http://www.gomr.mms.gov/homepg/regulate/environ/airquality/gulfwide_emission_inventory/2000GulfwideEmissionInventory.html
16 http://bugz.unc.edu/show_bug.cgi?id=511

convert input file coordinates into output file locations. This issue occurs with the precompiled version of SMOKE utilized by the modeling team in ASIP emissions processing. During the processing step of point source emissions, the latitude/longitude coordinates of the input files are transformed into Lambert conformal projection, consistent with the CMAQ setup. The error identified in the IOAPI library shifted this location by several kilometers. Although this error was corrected in subsequent versions of SMOKE and the IOAPI libraries, no corrections have been made to Base G modeling or earlier simulations.

3.0 MODEL PERFORMANCE EVALUATION

3.1 INTRODUCTION

This Chapter summarizes the CMAQ 2002 36 km and 12 km Base G2 Actual base case simulation model performance evaluation. The focus of the model performance evaluation is on $PM_{2.5}$ and its component species and ozone in the urban and $PM_{2.5}$ nonattainment areas (NAAs). The evaluation of the same CMAQ 2002 Base G2 base case simulation was also performed for PM species and visibility primarily at Class I areas as part of the VISTAS regional haze assessment. The VISTAS model evaluation focused on the performance of PM component species and visibility at more rural (e.g., IMPROVE) monitors. The VISTAS regional PM components and visibility model performance evaluation is directly relevant to the ASIP $PM_{2.5}$ evaluation as they share many of the same precursor and product species and atmospheric processes that produce elevated $PM_{2.5}$ levels in the urban and NAAs. Appendix B provides details on the ASIP urban and NAAs $PM_{2.5}$ mass and $PM_{2.5}$ component species model performance evaluation that are summarized for each ASIP state in Section 3.5 below. Appendix C provides a qualitative evaluation of the CMAQ base case for $PM_{2.5}$ components and total mass that is summarized in Section 3.6. Before presenting the urban and NAAs $PM_{2.5}$ and ozone model performance results, it is useful and informative to summarize the results of the VISTAS regional model performance evaluation (Morris et al., 2009), which is provided in Section 3.4.

3.2 CMAQ 2002 BASE G2 MODEL EVALUATION METHODOLOGY

VISTAS and ASIP share the same 2002 Base G2 Actual base case modeling results from the Community Multiscale Air Quality (CMAQ) modeling system Version 4.51 (Byun and Ching, 1999) with SOAmods enhancement (Morris et al., 2006a). The VISTAS regional model performance evaluation focused on monitoring sites within the VISTAS states and VISTAS 12 km grid (Morris et al., 2009). The VISTAS and ASIP CMAQ evaluation of the 2002 Base G2 Actual base case is the product of numerous evaluations of predecessor CMAQ base case simulations using interim versions of the modeling inputs and CMAQ model (e.g., Morris et al., 2004b,c; 2005; 2006). With the exception of Organic Carbon Mass (OCM), the basic features of model performance have essentially remained unchanged from the initial evaluations in Phase I and II of VISTAS (e.g., Morris et al., 2004a,b,c) to the current 2002 Base G2 actual base case model performance discussed below. During the course of the VISTAS Phase II and ASIP modeling, VISTAS updated the secondary organic aerosol (SOA) module in CMAQ to include important SOA processes missing in the standard CMAQ model that significantly improved the OCM performance in the summer (Morris et al., 2006a). The processes missing in the current standard versions of CMAQ (e.g., Versions 4.5 and 4.6) that were included as part of the SOAmods enhancement are described in Chapter 1 and included SOA from sesquiterpenes and isoprene and the polymerization of SOA so that it is no longer volatile. EPA updated the CMAQ SOA module in the fall 2008 release of CMAQ (Version 4.7) to include some of the missing SOA processes, which was too late for VISTAS regional haze or the ASIP $PM_{2.5}$ and ozone SIPs. Thus, both VISTAS and ASIP have adopted CMAQ version 4.51 with SOAmods updates (Morris et al., 2006a) as the core model for the modeling analysis.

In the VISTAS and ASIP model performance evaluation, the CMAQ results were compared with observational data from the **I**nteragency **M**onitoring of **PRO**tected **V**isual **E**nvironments

(IMPROVE), **S**peciated **T**rends **N**etwork (STN)[1], **C**lean **A**ir **S**tatus **T**rends **Net**work (CASTNet), **F**ederal **R**eference **M**ethod (FRM) $PM_{2.5}$ mass, **N**ational **A**cid **D**eposition **P**rogram (NADP), **S**outh **E**ast **A**erosol **R**esearch and **CH**aracterization (SEARCH) study and the EPA Air Quality System (AQS) ozone monitoring networks. The ASIP evaluation focuses primarily on the operational model evaluation of the air quality model's performance with respect to individual components of fine particulate matter ($PM_{2.5}$), as good model performance of the PM component species will dictate good model performance for total fine particulate matter ($PM_{2.5}$). The FRM network only collects total $PM_{2.5}$ mass and so is not as relevant for judging how well the model is predicting the components of light extinction so was not stressed in the VISTAS evaluation. However, it is an important component of the ASIP $PM_{2.5}$ evaluation so is included in this TSD. VISTAS also performed a diagnostic evaluation analyzing the ability of the model to reproduce gaseous PM precursor (e.g., SO2 and NOx) and product (e.g., HNO3) species.

The ASIP model performance evaluation focused on ozone and $PM_{2.5}$ performance in urban and nonattainment areas (NAAs). The ASIP $PM_{2.5}$ evaluation is summarized in Sections 3.5, 3.6 and 3.7 below, with more details provided in Appendices B and C. In addition, Appendix D includes a comparative evaluation of the CMAQ and CAMx models.

3.2.1 Evaluation Approach

EPA's integrated ozone, $PM_{2.5}$ and regional haze modeling guidance calls for a comprehensive, multi-layered approach to model performance testing, consisting of the four major components: operational, diagnostic, mechanistic (or scientific) and probabilistic (EPA, 2007a). The CMAQ model performance evaluation effort for $PM_{2.5}$ and ozone discussed in this Chapter focused on the first two components of the EPA's recommended evaluation approach, namely:

- **Operational Evaluation**: Tests the ability of the model to estimate ozone and $PM_{2.5}$ mass concentrations and the components of $PM_{2.5}$, that is sulfate, nitrate, ammonium, organic carbon matter, elemental carbon, and other inorganic $PM_{2.5}$. This evaluation examines whether the measurements are properly represented by the model predictions but does not necessarily ensure that the model is getting "the right answer for the right reason"; and

- **Diagnostic Evaluation:** Tests the ability of the model to predict visibility and extinction, PM chemical composition including PM and ozone precursors (e.g., SOx, NOx, VOC, and NH_3) and associated oxidants (e.g., nitric acid); PM size distribution; temporal variation; spatial variation; mass fluxes; and components of light extinction (i.e., scattering and absorption).

The diagnostic evaluation also includes the performance of diagnostic tests to better understand model performance and identify potential flaws in the modeling system that can be corrected.

In this final model performance evaluation for the ASIP/VISTAS 2002 Actual Base G2 CMAQ 36/12 km base case simulation, the operational evaluation has been given the greatest attention since this is the primary thrust of EPA's modeling guidance. However, we have also examined

[1] The STN network is now referred to as the Chemical Speciation Network (CSN). Throughout the document references to STN should be understood to mean CSN.

certain diagnostic features dealing with the model's ability to simulate sub-regional and monthly/diurnal gas phase and aerosol concentration distributions. In the course of the VISTAS/ASIP studies numerous diagnostic sensitivity tests were performed to investigate and improve model performance and test the model assumptions that are available on the VISTAS modeling website: http://pah.cert.ucr.edu/vistas/vistas2/ and reported by Morris and co-workers (2004a,b,c; 2005; 2006).

3.2.2 Particulate Matter and Component Species

$PM_{2.5}$ attainment is based on $PM_{2.5}$ mass measurements using Federal Reference Method (FRM) monitoring devices that consists of the following $PM_{2.5}$ components:

- Sulfate (SO4)
- Nitrate (NO3)
- Ammonium (NH4)
- Organic Carbon Matter (OCM)
- Elemental Carbon (EC) [also called Black Carbon (BC) and Light Absorbing Carbon (LAC)]
- Other Inorganic $PM_{2.5}$ that is also referred to as Soil (also known as crustal material, fine soil, major metal oxides, or other $PM_{2.5}$)
- Particle Bound Water (PBW)
- Sea Salt (that is mostly NaCl)
- Passive Mass (Blank Correction)

With the exception of the Passive Mass (that is assumed to be a constant 0.5 $\mu g/m^3$) and PBW (that is associated with SO4 and NO3) each of these components is evaluated.

3.2.3 Ambient Air Quality Data for Model Performance Evaluation

A ground-level model evaluation database for 2002 was compiled by the modeling team using several routine and research-grade databases. The focus of the VISTAS evaluation of the CMAQ model was on the PM components that can cause visibility impairment at (rural) Class I areas, whereas the ASIP model performance evaluation focus was on ozone, $PM_{2.5}$ mass and its components in urban areas. The primary monitoring networks available to evaluate this component of the CMAQ are: (a) Interagency Monitoring of Protected Visual Environments (IMPROVE); (b) Clean Air Status and Trends Network (CASTNET); (c) Southeastern Aerosol Research and Characterization (SEARCH); (d) EPA Federal Reference Method (FRM) $PM_{2.5}$ and PM_{10} Mass Networks (EPA-FRM); (e) EPA Speciation Trends Network (STN) of $PM_{2.5}$ species; (f) National Acid Deposition Network (NADP) and (g) EPA's Air Quality System (AQS) network that includes ozone and NOx . The PM monitoring networks may also provide ozone and other gas phase precursors and product species, and visibility measurements at some sites. Table 3-1 and Figure 3-1 summarizes the species collected and locations of the monitoring sites for the IMPROVE, STN, CASTNet, NADP, SEARCH and AQS monitoring networks use in the VISTAS and ASIP model evaluation.

Table 3-1. Ambient monitoring data available in the VISTAS/ASIP region during 2002.

Monitoring Network	Chemical Species Measured	Sampling Frequency
IMPROVE	Speciated $PM_{2.5}$ and PM_{10}	1 in 3 days; 24 hr
CASTNET	Speciated $PM_{2.5}$, Ozone	Hourly, Weekly; 1 hr, Week
SEARCH	24-hr PM_{25} (FRM Mass, OC, BC, SO_4, NO_3, NH_4, Elem.); 24-hr PM coarse (SO_4, NO_3, NH_4, elements); Hourly $PM_{2.5}$ (Mass, SO_4, NO_3, NH_4, EC, TC); and Hourly gases (O_3, NO, NO_2, NO_y, HNO_3, SO_2, CO)	Daily, Hourly;
NADP	WSO_4, WNO_3, WNH_4	Weekly
EPA-FRM	Only total fine mass ($PM_{2.5}$)	1 in 3 days; 24 hr
EPA-STN	Speciated $PM_{2.5}$	1 in 3 days; 24 hr
AIRS/AQS	CO, NO, NO_2, NO_x, O_3	Hourly

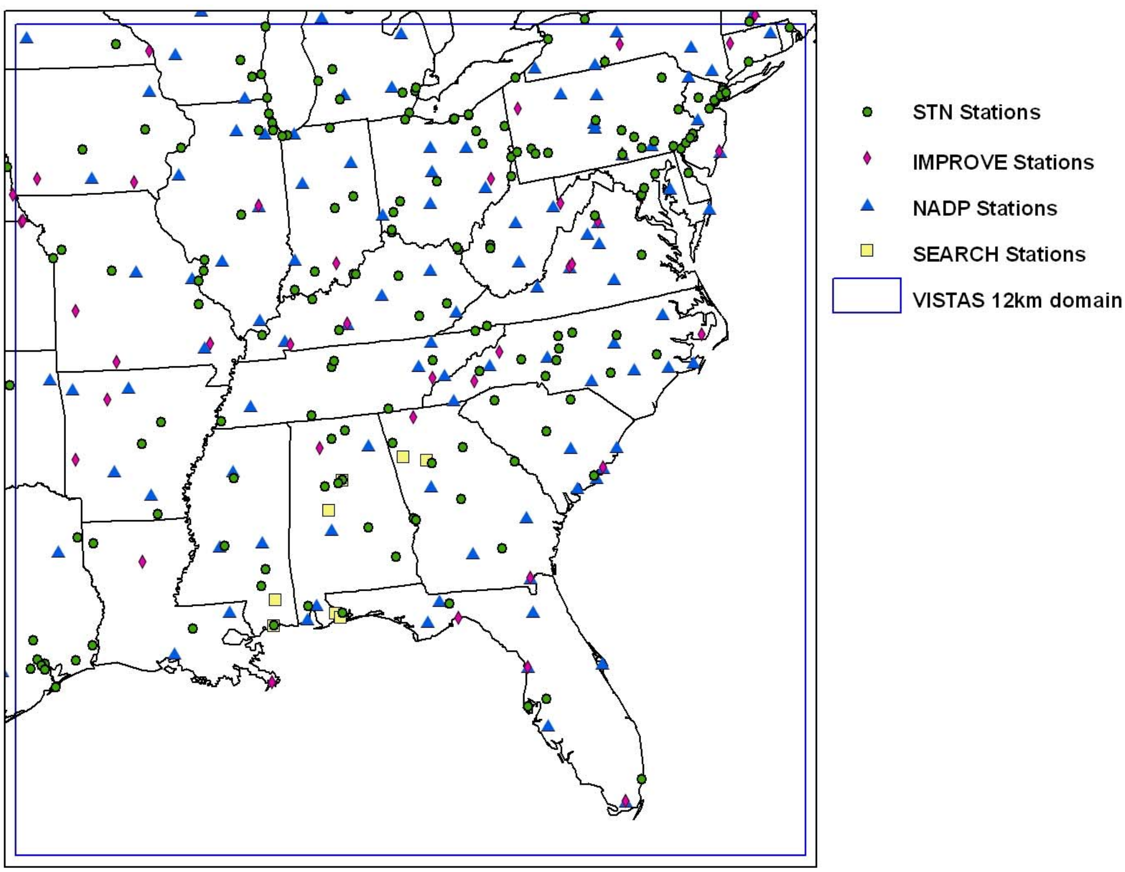


Figure 3-1a. Locations of IMPROVE, STN, SEARCH and NADP monitoring sites within the ASIP 12 km modeling domain.

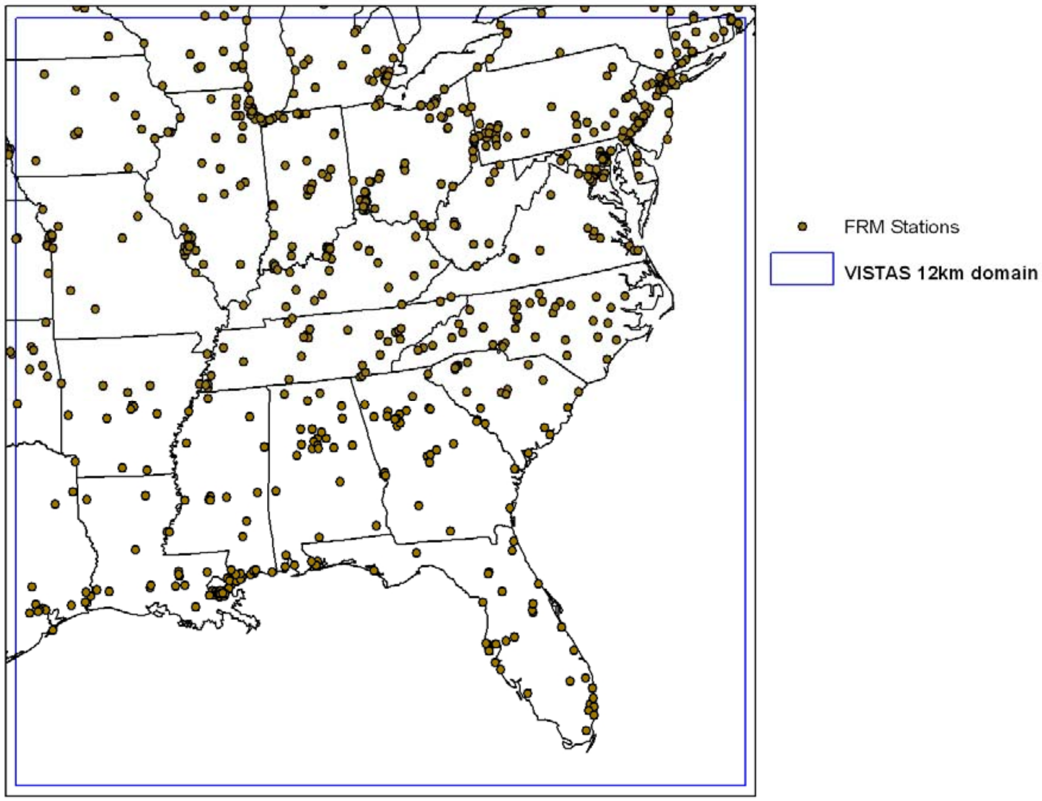


Figure 3-1b. Locations of FRM $PM_{2.5}$ mass monitoring sites within the ASIP 12 km modeling domain.

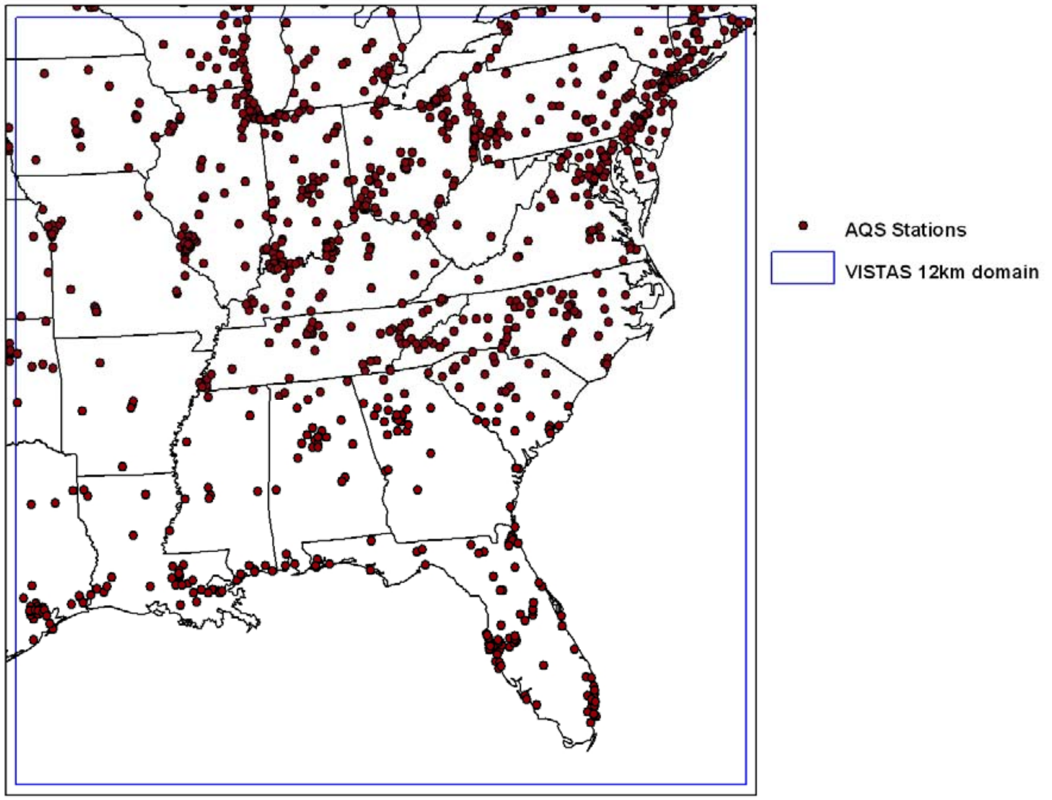


Figure 3-1c. Locations of AQS ozone monitoring sites within the ASIP 12 km modeling domain.

3.3 MODEL PERFORMANCE STATISTICS AND GOALS

To quantify model performance, several statistical measures were calculated and evaluated for all the IMPROVE, STN, CASTNet, SEARCH, FRM, NADP and AQS monitors within the VISTAS/ASIP region or VISTAS/ASIP 12 km domain, individually for each monitoring network and individually for each VISTAS/ASIP state. The statistical measures selected were based on the recommendations outlined in section 18.4 of the USEPA's Guidance On The Use Of Models And Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze (EPA, 2007a).

In 2004, VISTAS established model performance goals and criteria for components of fine particle mass based on previous model performance for ozone and fine particles (e.g., Morris et al., 2004a,b,c). EPA modeling guidance for fine particulate matter at the time noted that PM models might not be able to achieve the same level of performance as ozone models. The VISTAS and ASIP model performance evaluation considered several statistical performance measures and displays. VISTAS/ASIP reviewed numerous model performance evaluation metrics to evaluate their descriptive capabilities for summarizing the salient features of the model performance evaluation. Although numerous model performance statistics measures are routinely calculated, VISTAS/ASIP have found that the fractional bias and fractional gross error provide the best descriptive power over a wide range of concentrations. The fractional bias and error are expressed as a percentage and are normalized by the average of the predicted and gross observed values. Consequently, they are bounded statistics, with the fractional bias bounded by

-200% to +200% and the fractional gross error bounded by 0 to 200%. Table 3-2 summarized the formulas for the fractional bias and gross error statistics. The VISTAS/ASIP model performance goals and criteria are given in Table 3-3. Note that for ozone model performance the traditional (EPA, 1991) ≤ ±15% and ≤ 35% performance goals for mean normalized bias (MNB) and mean normalized gross error (MNGE) using hourly predicted and observed ozone pairs with the observed ozone value greater than 60 ppb are used. The MNB and MNGE statistics are similar to the fractional statistics given in Table 3-2, only the normalized statistics are divided by just the observed value rather than the average of the predicted and observed values.

Table 3-2. Definitions of the fractional bias and fractional error statistical model performance metrics.

Statistical Measure	Shorthand Notation	Mathematical Expression	Notes
Mean Fractional Gross Error (Fractional Error)	MFE	$\frac{2}{N}\sum_{i=1}^{N}\left\lvert\frac{P_i - O_i}{P_i + O_i}\right\rvert$	Reported as %
Mean Fractionalized Bias (Fractional Bias)	MFB	$\frac{2}{N}\sum_{i=1}^{N}\left(\frac{P_i - O_i}{P_i + O_i}\right)$	Reported as %

Table 3-3. VISTAS/ASIP model performance goals and criteria for components of fine particle mass.

Fractional Bias	Fractional Error	Comment
≤±15%	≤35%	Goal for PM model performance based on ozone model performance, considered excellent performance
≤±30%	≤50%	Goal for PM model performance, considered good performance
≤±60%	≤75%	Criteria for PM model performance, considered average performance. Exceeding this level of performance indicates fundamental concerns with the modeling system.

3.4 VISTAS REGIONAL PM MODEL PERFORMANCE EVALUATION

Details on the regional model performance evaluation for PM across the VISTAS/ASIP region km grid are provided in Chapter 3 and Appendix B of the VISTAS Technical Support Document (TSD; Morris et al., 2009). Below we summarizes the key findings of the of the VISTAS regional model performance evaluations of $PM_{2.5}$ component species across the VISTAS region using monthly fractional bias and gross error performance statistics. More details, including scatter plots, quantile-quantile plots, Bugle Plots, etc. can be found in the VISTAS TSD referenced above.

3.4.1 Sulfate (SO4) Model Performance

Figure 3-2 compares the monthly CMAQ SO4 concentration fractional bias and error across the VISTAS/ASIP 12 km grid region for the IMPROVE, STN, CASTNet, SEARCH Daily and SEARCH Hourly monitoring networks. The underprediction bias in SO4 concentrations is clearly evident across most of the year and monitoring networks with the best (i.e., closest to zero) SO4 bias occurring in October. However, this underprediction bias is not severe usually within ±20% and almost always within ±25% usually achieving the PM model performance goals for bias/error (i.e., within ±30%/50%, see Table 3-3). The exception to this is the comparison with the SEARCH Hourly network that exhibits a positive overprediction SO4 bias for several months.

The SO4 monthly fractional error values are usually under 40% and, with one exception, always under 50% thereby achieving the PM performance goal (Figure 3-2). The exception is comparison with the SEARCH Hourly network with error values ranging from 50% to 70%.

The summer SO4 underprediction bias is partly due to overstated convective precipitation in the MM5 simulations (Olerud, 2003c,d). This is somewhat confirmed by the SO4 wet deposition model performance evaluation that exhibits near zero bias during the winter when precipitation is dominated by synoptic weather events, but has a positive overprediction bias during the summer when convective precipitation is greatest (Morris et al., 2009).

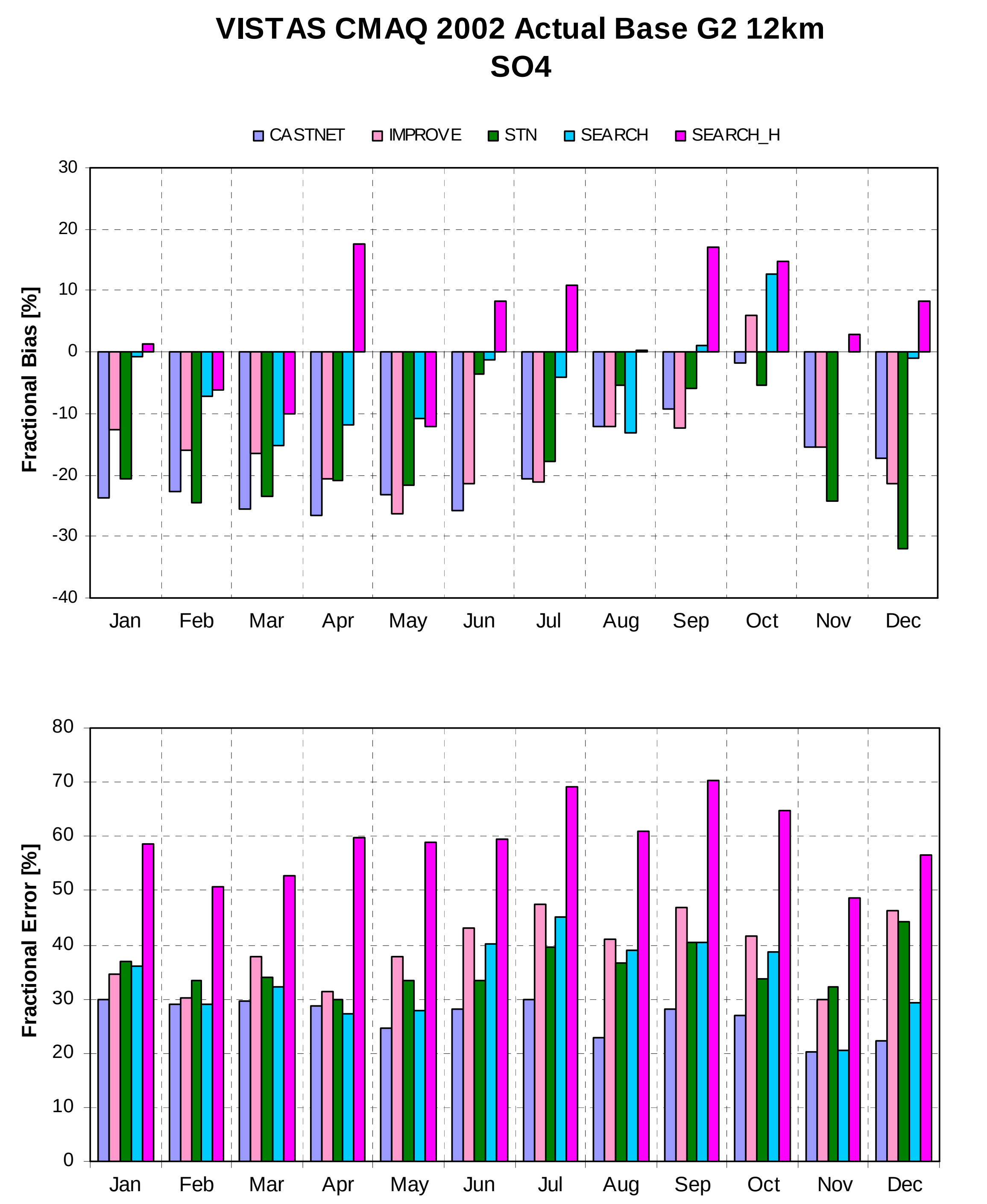


Figure 3-2. Monthly SO4 fractional bias (top) and fractional error (bottom) statistical measures for CASTNet, IMPROVE, STN and SEARCH (daily and hourly) monitoring sites in the ASIP 12 km grid.

3.4.2 Nitrate (NO3) Modeling Performance

The monthly fractional bias time series plot for NO3 clearly shows a seasonal dependence of this performance measure with a severe summer underprediction bias of -100% to -150% and bias values generally within ±50% in the winter (Figure 3-3). The time series of fractional error values also exhibits a seasonal dependence with an 80% error in the winter peaking to a 160% error in the summer with a bell-like distribution. The large summer underprediction bias occurs when NO3 concentrations are extremely low (< 1.0 μg/m^3) and, in fact, when the average observed NO3 concentration exceeds 1 μg/m^3 the model mostly achieves the model performance goal and almost always achieves the model performance criteria for bias as indicated by the Bugle Plots in the VISTAS TSD (Morris et al., 2009). The model performance goal and criteria are achieved less often for NO3 fractional error, however the goal is always achieved across the CASTNet and usually achieved across the IMPROVE monitoring networks.

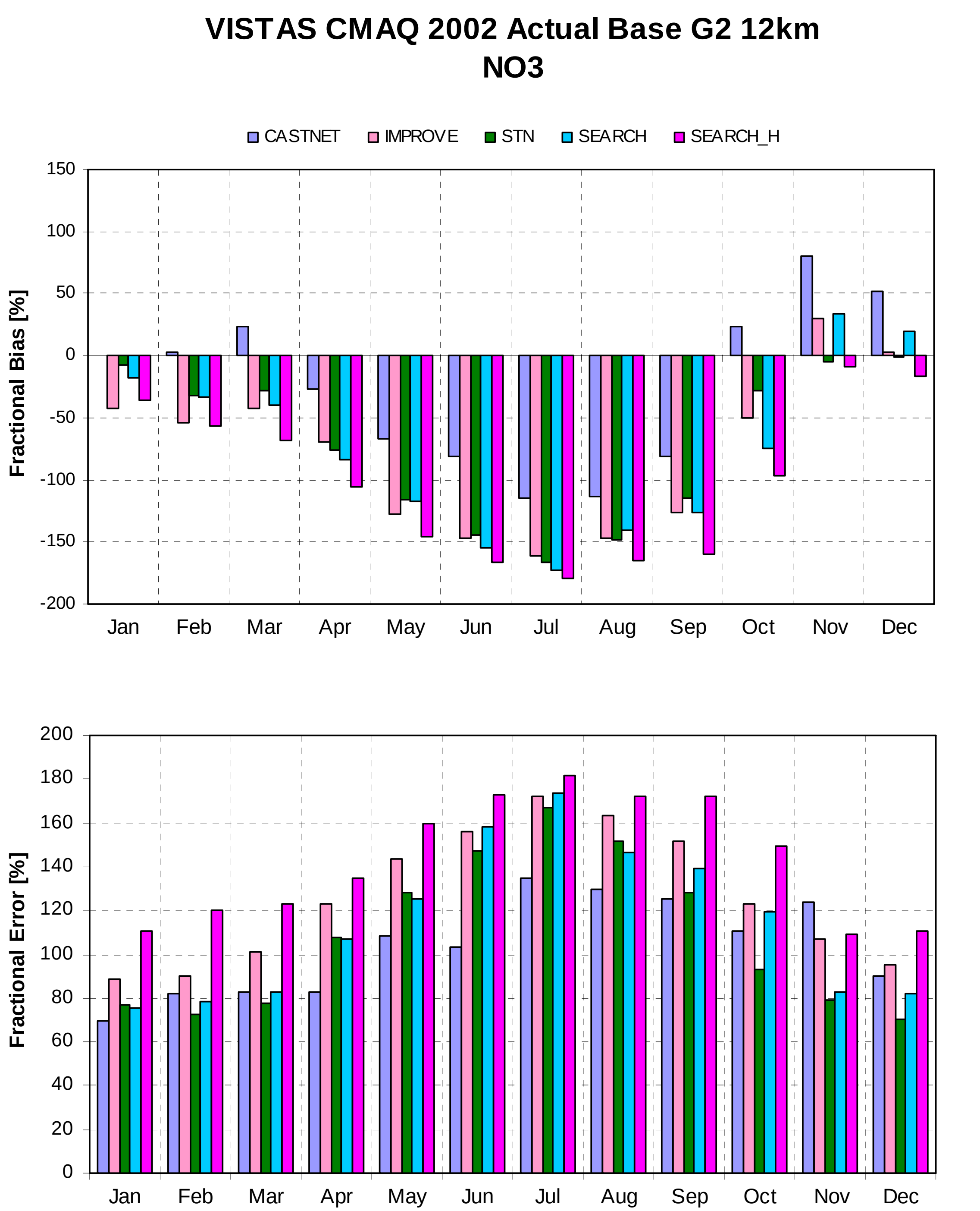


Figure 3-3. Monthly NO3 fractional bias (top) and fractional error (bottom) statistical measures for CASTNet, IMPROVE, STN and SEARCH daily and hourly monitoring sites in the ASIP region.

3.4.3 Organic Carbon Mass (OCM) Performance

The monthly fractional bias and error plots for the 12 km CMAQ base case simulation OCM performance are given in Figure 3-4. Fairly good OCM model performance is seen across the IMPROVE monitors with bias usually within ±15% and errors between 40% and 50%. However, at the urban STN sites the model exhibits a large OCM underprediction bias of -60% to -90%. Part of the underprediction bias at the STN sites may be due to measurement uncertainties and artifacts and part may also be due to the model over diluting the urban OCM emissions through the coarse 12 km grid. There are also evidence that current emission inventories neglect condensable (semi-volatile) organic emissions from gasoline and diesel combustion (e.g., mobile sources) that form OCM. The underprediction of urban OCM is a common problem in PM modeling and likely also points to uncertainties in the OCM and SOA precursor emission inventories.

One source of uncertainty in the OCM measurements is the fact that OCM is actually derived from OC measurements. The amount of additional elements (e.g., oxygen) attached to the OC to form OCM varies with the age and level of photochemical processing of the organic particles with OCM/OC ratios typically ranging from 1.2 to 2.2 with lower ratios for fresh and higher ratios for aged processed OCM. For the OCM model performance evaluation we used a 1.4 OCM/OC ratio that is consistent with the original IMPROVE equation and based on measurements from Los Angeles. The new IMPROVE equation uses a higher 1.8 OCM/OC ratio reflecting the fact that OCM that reaches the mostly rural Class I areas will be aged and subject to photochemical processing. There really is no one right OCM/OC factor to use in all cases. However, in interpreting the model performance it is important to know which OCM/OC ratio was used and recognize that selection of another ratio could make a 30% or so difference in the OCM measurements.

The STN OC measurements are also not blank corrected, which is believed to result in an approximate 0.5 $\mu g/m^3$ positive artifact in the STN OC observations (which would be 0.5-0.9 $\mu g/m^3$ positive artifact in OCM depending on which OCM/OC factor is used). The subtraction of 0.5-0.9 $\mu g/m^3$ from the measured OCM value would greatly improve the CMAQ OCM model performance across the STN network and bring the CMAQ OCM bias closer to zero.

In the preliminary evaluation of the CMAQ model using early VISTAS Phase I and II databases, the OCM performance was a great cause of concern due to a large summer OCM underprediction bias and the importance of OCM to the visibility extinction and PM budgets (Morris et al.., 2004b,c). This resulted in VISTAS conducting a focused research study on the reasons for the summer OCM underprediction, the identification of processes missing in the CMAQ model and the development of the SOAmods enhancement to CMAQ (see Section 1.3.3.3.1) that greatly improved the CMAQ OCM model performance (Morris et al., 2006a). The CMAQ Version 4.51 with the SOAmods enhancements was used in the ASIP modeling as well.

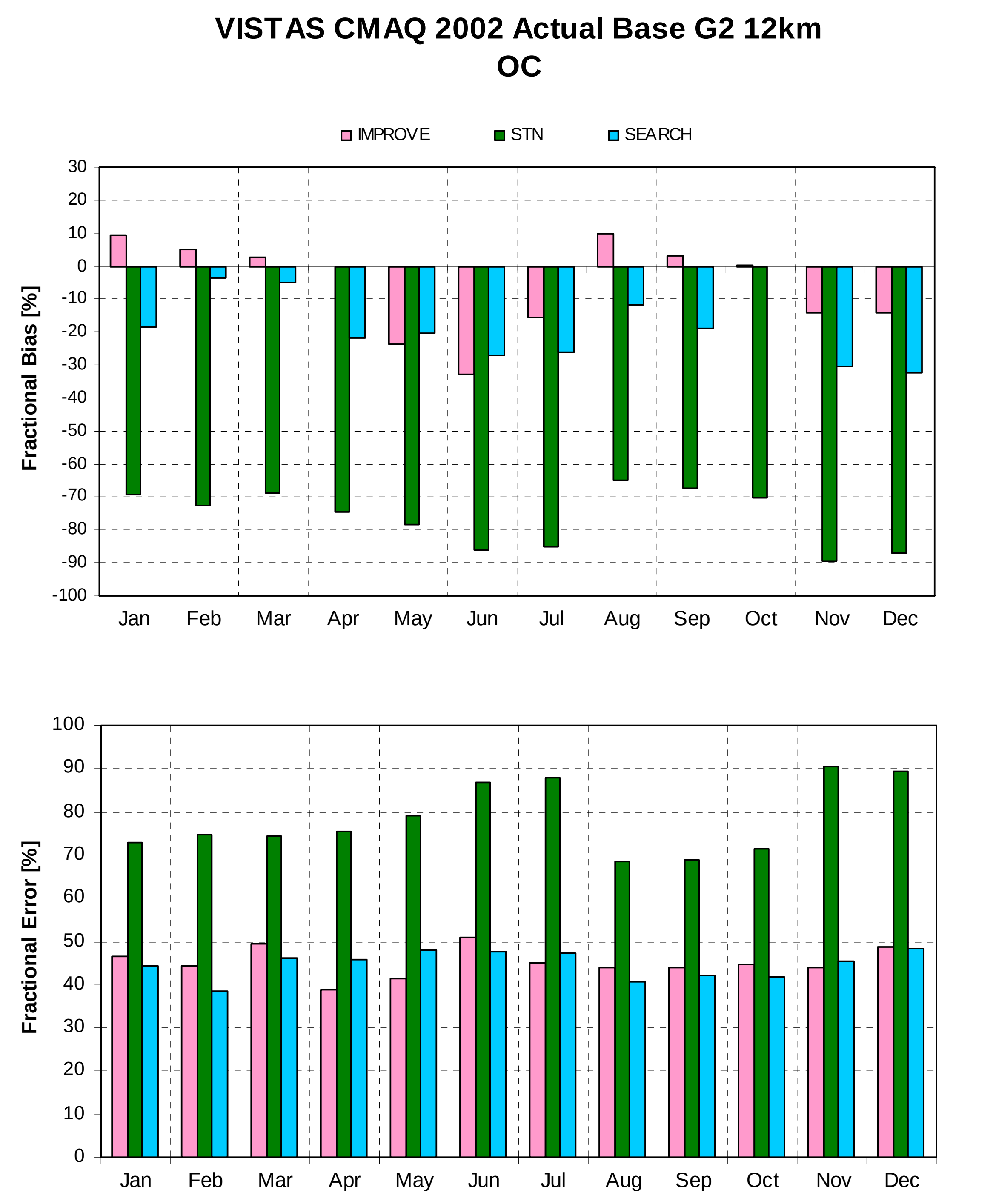


Figure 3-4. Monthly OCM fractional bias (top) and fractional gross error (bottom) statistical measures for IMPROVE, STN and SEARCH monitoring sites in the ASIP region.

3.4.4 Elemental Carbon (EC) Performance

The monthly fractional bias and error performance statistics for EC across the ASIP 12 km domain are shown in Figure 3-5. Bias and error are lower in the first and last quarters of the year. During the summer and adjacent months, EC performance across the IMPROVE network exhibits a large underprediction bias (-40% to -80%) that peaks in June. The EC performance across the SEARCH network is somewhat similar to IMPROVE only the underprediction bias in the summer is not as great. Model performance compared to the STN network has fairly low EC fractional bias during quarters 1, 3 and 4 (achieving the most stringent < ±15% ozone goal), but has larger underprediction bias during quarter 2 (-20% to -40%). The comparison to the STN network very low EC bias during most of the year suggests that the anthropogenic EC emissions inventory may be adequately characterized in urban areas.

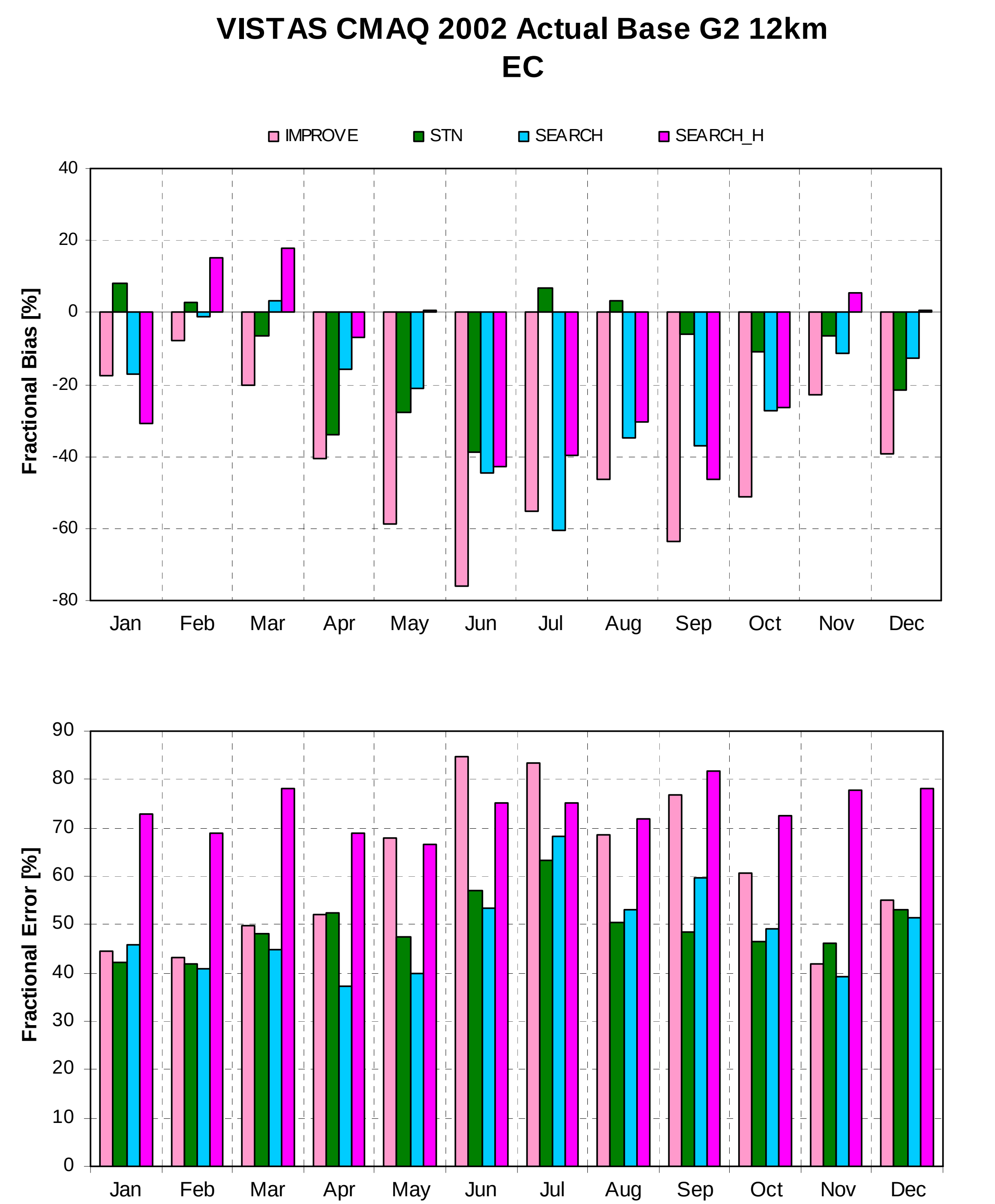


Figure 3-5. Monthly EC fractional bias (top) and fractional gross error (bottom) statistical measures for IMPROVE, STN and SEARCH daily and hourly monitoring sites in the ASIP region.

3.4.5 Other $PM_{2.5}$ or Soil Performance

The seasonal dependence of the Soil model performance across the IMPROVE and STN monitors in the VISTAS region is clearly evident in the monthly fractional bias time series plot in Figure 3-6 that show a large (> 100%) overprediction bias in the winter and near zero (IMPROVE) or much lower (SEARCH) bias in the summer. The modeled Soil values tend to always be between 0 and 2 $\mu g/m^3$ year round, however the observed values are much lower in the winter (0 to 0.5 $\mu g/m^3$) and comparable to the modeled values in the summer. These results suggest that the poorer winter Soil model performance is likely due to incorrect emission temporal adjustment factors. For example, the effect of wetted surfaces that suppresses fugitive dust emissions may not be properly characterized in the seasonal adjustments to the emissions inventory.

The Soil model performance is confounded by the incommensurability between the modeled and measured Soil species. The IMPROVE observed Soil is built up of measured elements. The modeled "Soil", on the other hand, is fine particulate matter emissions that have not been explicitly identified and speciated as SO4, NO3, EC or OC in the PM speciation profiles used in the SMOKE emissions modeling. The emissions PM speciation profiles may have unidentified PM that is lumped in the other PM category that are not the same as the IMPROVE Soil. The measured Soil will typically be associated with fugitive dust emissions, so the separate tracking of fugitive dust may be one approach to separate the true Soil component from the other $PM_{2.5}$ component. VISTAS investigated this issue with an inert (no chemistry) CMAQ sensitivity run that separately tracked just fugitive dust emissions and found improved Soil model performance with lower bias when just other $PM_{2.5}$ concentrations due to fugitive dust emission sources were mapped to the Soil species.

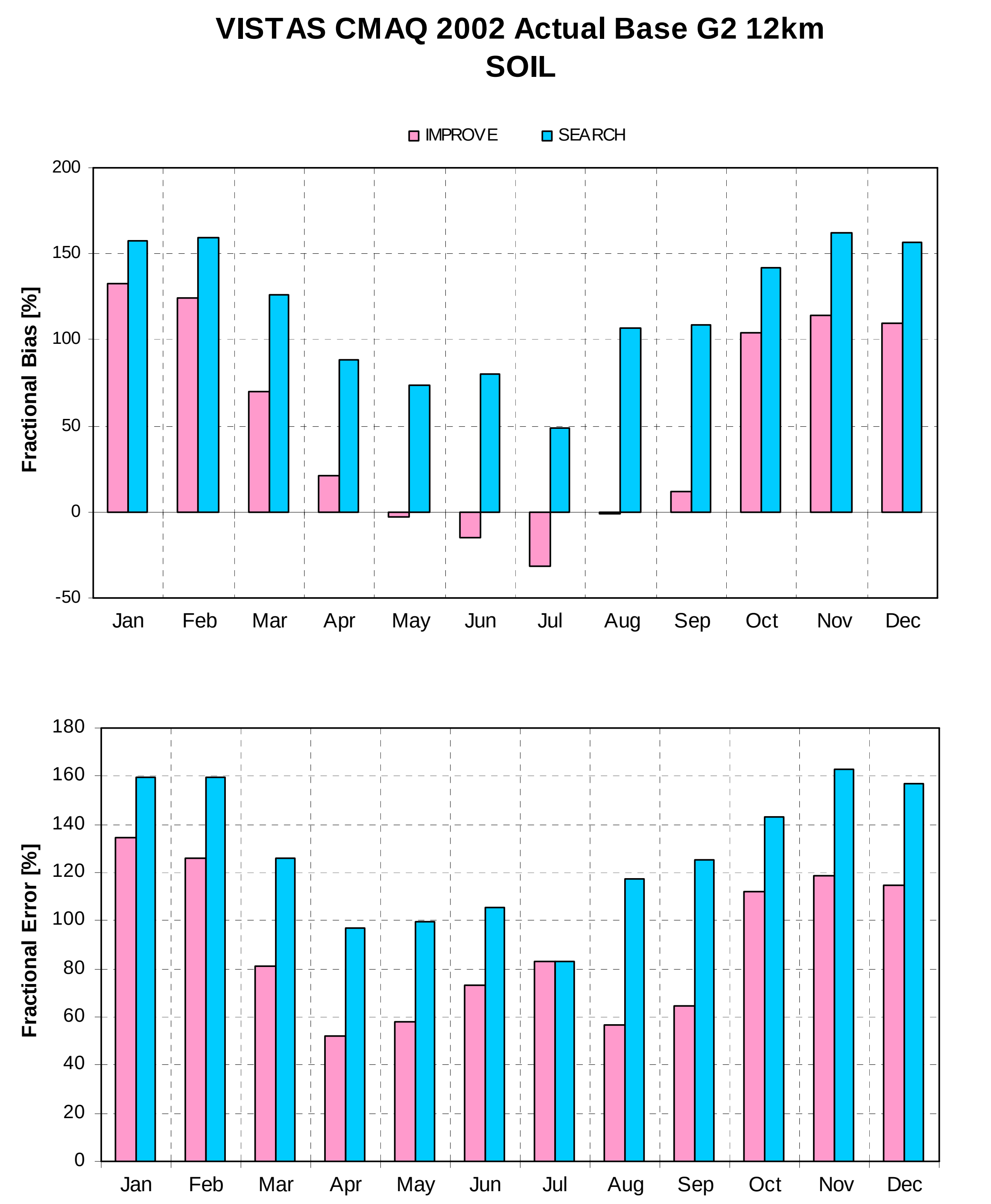


Figure 3-6. Monthly Soil fractional bias (top) and fractional gross error (bottom) statistical measures for IMPROVE and SEARCH Daily monitoring sites in the ASIP region.

3.4.6 Total Fine Particulate ($PM_{2.5}$) Mass Performance

Figure 3-7 displays the monthly time series of fractional bias and error for $PM_{2.5}$ mass concentrations for the IMPROVE, STN, SEARCH Daily, SEARCH Hourly and FRM networks in the VISTAS/ASIP region. The model generally is exhibiting good performance for total $PM_{2.5}$ mass concentrations. For the first three and last three months of the year the model performs well for $PM_{2.5}$ with low fractional bias (<±20%) and error (<40%) except for the SEARCH Hourly network. During April through July, the underprediction bias becomes larger and is in the -20% to -50% range and the errors are also larger. This is driven in part by the SO4 underprediction bias discussed previously as SO4 is a major component of $PM_{2.5}$ in the summer and the southeastern U.S. It is also driven by the OCM summer under prediction bias.

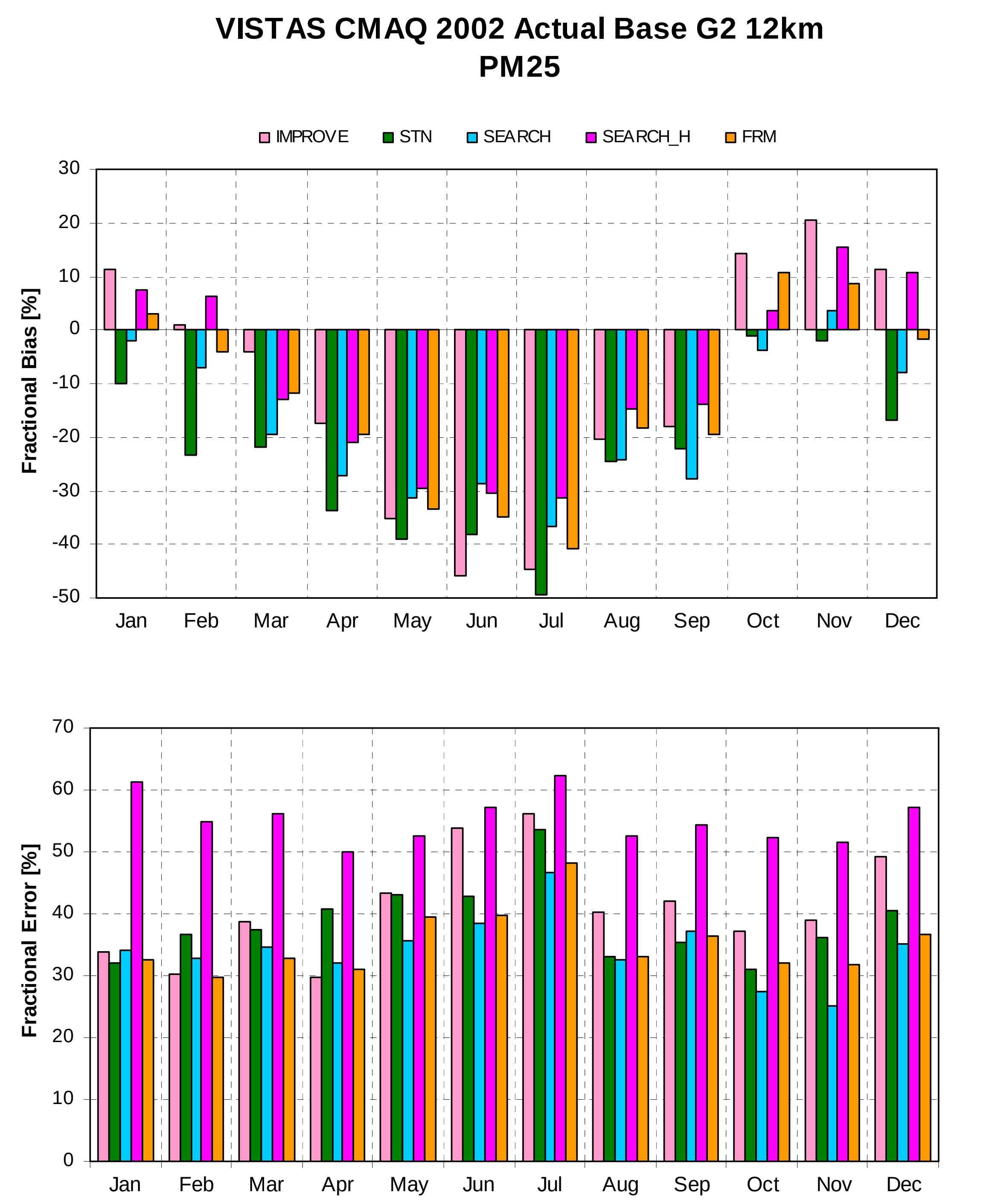


Figure 3-7. Monthly total $PM_{2.5}$ mass fractional bias (top) and fractional gross error (bottom) statistical measures in the ASIP region.

3.5 $PM_{2.5}$ MODEL PERFORMANCE BY STATE

In this section we evaluate the CMAQ base case for $PM_{2.5}$ at the mainly urban STN and FRM monitoring sites. Appendix B presents a detailed model performance evaluation by $PM_{2.5}$ species component and for total $PM_{2.5}$ mass by each state in the ASIP/VISTAS region. An example of the types of displays of model performance from Appendix B are given below for Alabama and SO4 performance; Soccer Plots of fractional bias and error for $PM_{2.5}$ mass are also presented for all states. For the remainder of the state-by-state scatter plots, time series plots and Bugle Plots of $PM_{2.5}$ mass and components model performance the reader is referred to Appendix B.

3.5.1 Alabama

Figure 3-8 is a repeat of Figure B-2a in Appendix B that contains a scatter plot and model performance statistics for SO4 at STN sites located in Alabama and the four quarters of 2002. Similar scatter plots and performance statistics for the other $PM_{2.5}$ component species and total $PM_{2.5}$ mass are shown in Figures B-3b through B-3g in Appendix B. Performance for SO4 is quite good with the points on the scatter plots clustered tightly around the 1:1 line of perfect agreement (Figures 3-8 and B-2a). The SO4 fractional bias and error performance metrics mostly achieve the stringent <±15% and < 35%, respectively, performance goals for ozone (Table 3-2). Performance for NO3 shown in Figure B-2b exhibits an underprediction tendency with fractional bias values of approximately -20% in Q1, -140% in Q2, -160% in Q3 and -30% in Q4. The large summer NO3 underprediction bias occurs when both the model and measured NO3 values are extremely low with the modeled values near zero and the STN NO3 observed values are < 1 $\mu g/m^3$. Note that under these summer conditions, the NO3 will almost completely volatize off the FRM filter so the FRM would measure insignificant $PM_{2.5}$ mass due to NO3. Thus, these large summer NO3 underpredictions are not a concern as NO3 is not an important component of $PM_{2.5}$ mass in the summer. Performance for NH4 is also fairly good achieving the <±30%/50% fractional bias/error goal for PM species (Figure B-2c), which is not surprising given its strong link to SO4.

With the exception of a few outliers, performance for organic carbon mass (OCM or OC) is underestimated by -40% to -70% (Figure B-2d). The reasons for the OCM underprediction bias includes the fact that the STN OC measurements are not blank corrected and have high uncertainties (see SANDWICH discussion in Chapter 4) and there are also large uncertainties in the OC emissions and the form of OC emissions as particles or semi-volatile organic gases. EC model performance at STN sites in Alabama is also fairly good mostly achieving the PM model performance goal, albeit with an underestimation tendency in Q2, Q3, and Q4 (Figure B-2f).

The CMAQ performance for $PM_{2.5}$ mass at ~20 FRM monitoring sites in Alabama is shown in Figure B-2g. Performance for $PM_{2.5}$ mass is generally good achieving the most stringent ozone performance goal in Q1 and Q4 and the PM goal year round.

Time series of predicted (CMAQ 12 km results) and observed 24-hour $PM_{2.5}$ components and model performance statistics at the key North Birmingham STN and SEARCH sites are shown in Figures B-3 and B-4, with the SO4 performance time series at these co-located sites reproduced as Figure 3-9 below. As discussed in Chapter 4, this is the site with the highest projected 2009 $PM_{2.5}$ Design Value in the ASIP region (i.e., North Birmingham). SO4 performance is quite good with annual fractional bias and errors of 6% and 29% achieving the most stringent ozone performance goal at the STN site and fractional bias and error of 18% and 34% that almost achieves the most stringent ozone performance goal at the SEARCH site. NO3 has a large underprediction bias at the North Birmingham site that is driven by near zero modeled NO3 concentrations in the summer when the observed values are < 1 ug/m^3 (Figures B-3a and B-4a, bottom). However, the NO3 performance in the winter when observed values are above 1 ug/m^3 is much better. The EC and OCM performance at the North Birmingham STN site is characterized by an underprediction with fractional bias of approximately -30% and -50%, respectively (Figures B-3b and B-4b). This underprediction is due in part to uncertainties in the carbon measurements as well as the contributions of nearby industrial sources whose impacts are diluted across the 12 km CMAQ grid. Performance for NH4 and $PM_{2.5}$ mass at the North Birmingham STN and SEARCH sites are also quite good with fractional bias/error values of, respectively, -5%/33% and 11%/29% at the STN site that achieves the more stringent ozone performance goal and values of, respectively, -24%/42% and 17%/31% that achieves the PM performance goal at the SEARCH site. The good performance of NH4 and $PM_{2.5}$ mass is not surprising given that they are closely related to SO4 that exhibits good model performance.

Figure 3-10 reproduces Figure B-5 from Appendix B and displays a Soccer Plot of monthly fractional bias versus gross error for $PM_{2.5}$ mass performance across ~20 FRM sites in Alabama and compares them with the three levels of bias/error performance goals in Table 3-3. Total $PM_{2.5}$ mass model performance across the FRM sites in Alabama is best in the winter months when the most stringent ozone < ±15%/35% bias/error goal is achieved. In the summer months, the model tends to underestimate the FRM observed $PM_{2.5}$ mass by -15% to -25%, but still achieves the <±30%/50% PM model performance goal.

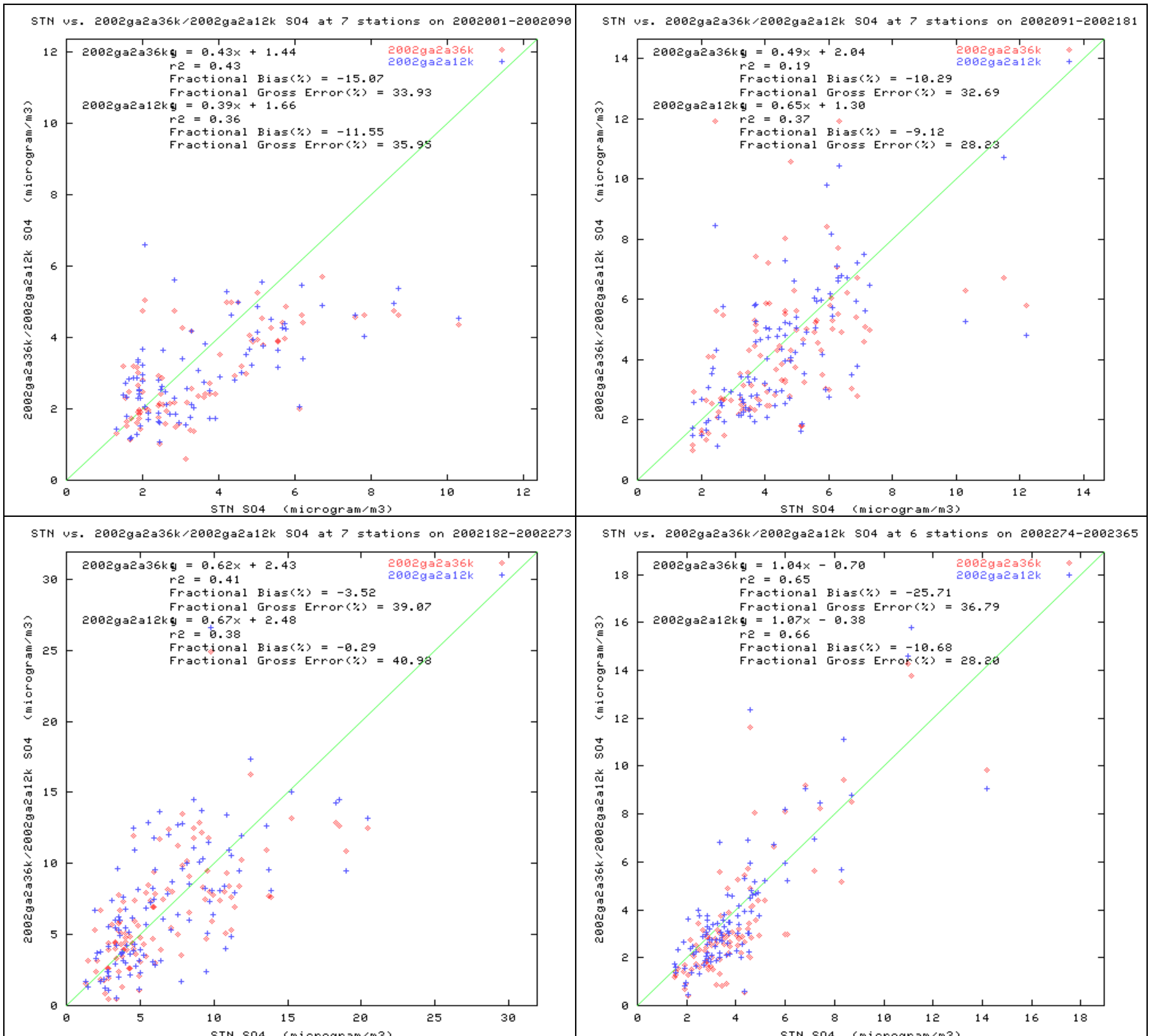
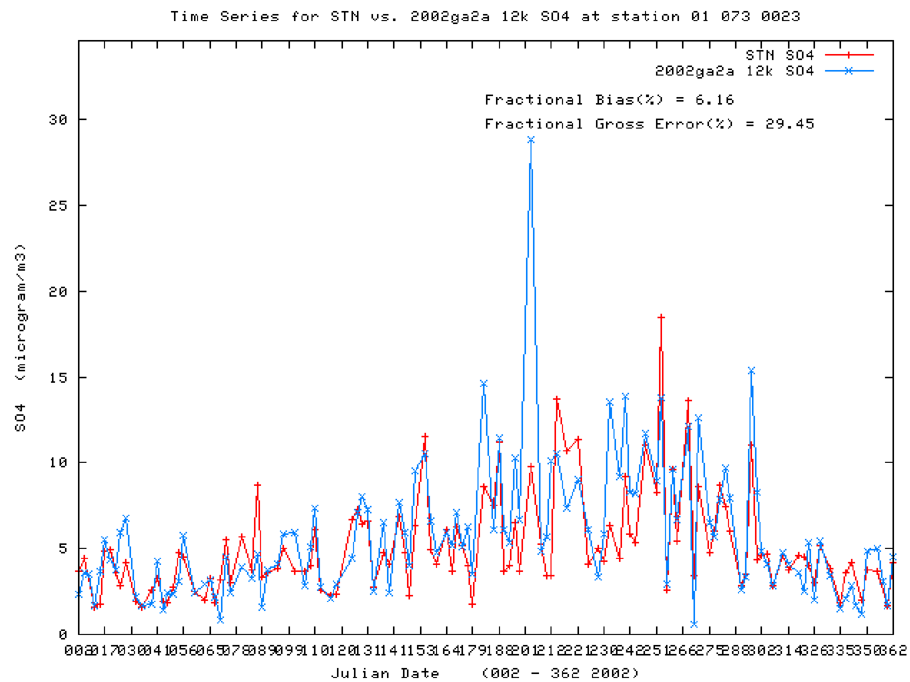


Figure 3-8. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation (duplicate of Figure B-2a in Appendix B)



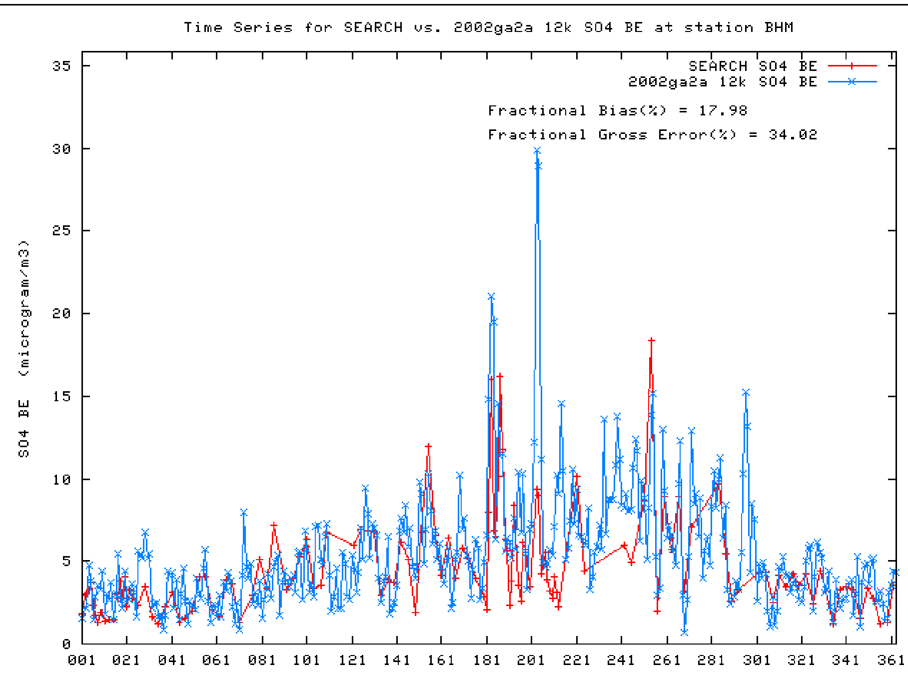


Figure 3-9. Time series of predicted and observed 24-hour sulfate (SO4) concentrations during 2002 at the STN Jefferson County, Alabama Site No. 01-073-0023 (top) and SEARCH BHM (bottom) co-located North Birmingham sites for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

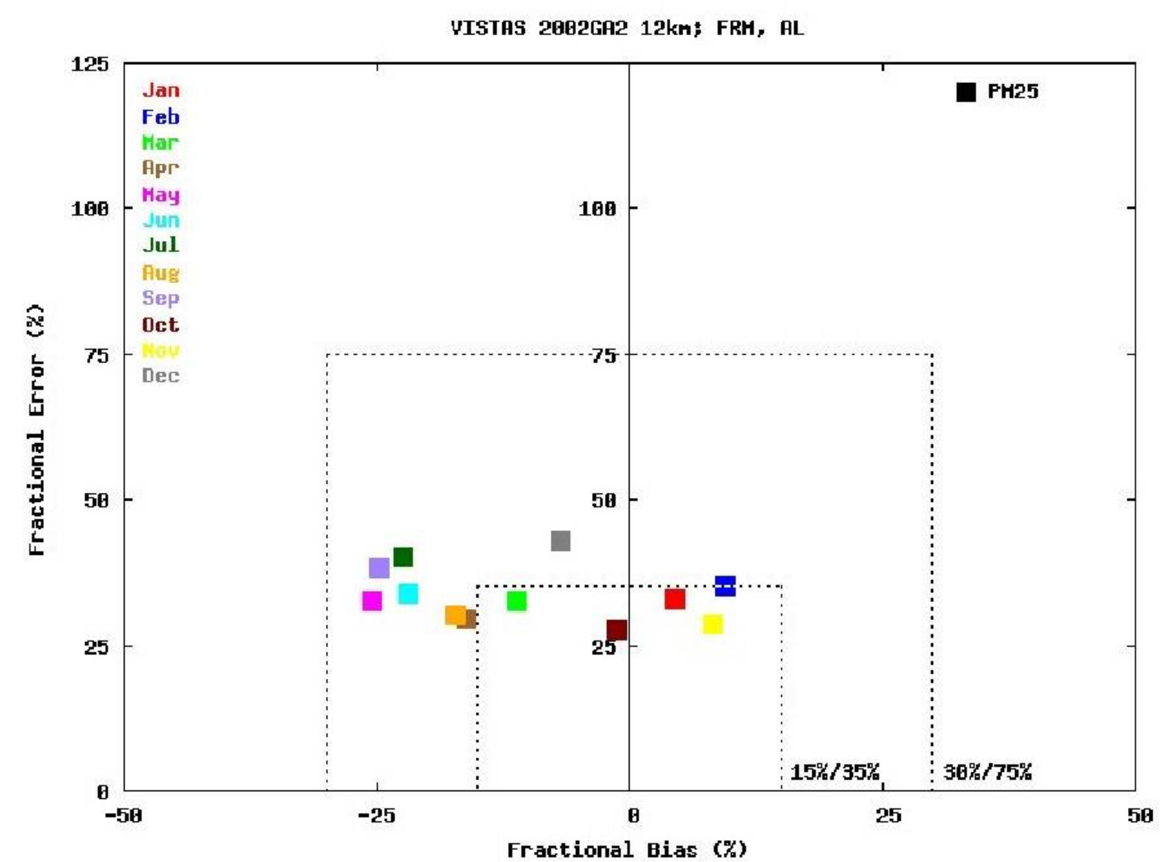


Figure 3-10. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Alabama for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.2 Florida

Figure B-7 summarizes the CMAQ $PM_{2.5}$ species model performance across the ~4 STN sites in Florida and Q1, Q2, Q3 and Q4 2002. SO4 is underestimated at the Florida STN sites (Figure B-7a) with fractional bias values that are closer to zero (i.e., better) in the winter than summer (e.g., -6% in Q4 versus -23% in Q3 for the 12 km CMAQ results). The SO4 bias is also closer to zero using the 12 km than 36 km CMAQ modeling results (e.g., in Q4 bias is -6% using 12 km and -11% using 36 km modeling results). Even with this underestimation bias, SO4 performance at the Florida STN CMAQ sites is fairly good. NO3 performance, on the other hand, exhibits a large underprediction bias with fractional bias values that range from -70% in Q4 to -170% in Q3 (Figure B-7b). NH4 performance at the Florida STN sites is fairly good always achieving the <±30%/50% PM performance goal and sometimes even achieving the more stringent <±15%/35% ozone performance goal (Figure B-7c). It is interesting that in Q1 and Q4 when both SO4 and NO3 exhibit an underprediction bias, NH4 exhibits a slight overprediction bias. Given the linked relationship between these species this is somewhat surprising and may be due to artifacts in the measurements, or the modeled SO4 being more fully neutralized by NH4 than in the measurements. The OCM and EC are characterized by underprediction tendency with the OCM fractional bias ranging from -75% to -110% and the CMAQ 36 km and 12 km producing nearly identical performance metrics (Figure B-7d). The EC performance is better with fractional bias values ranging from -22% to -53% and the 12 km modeling results producing significantly better EC model performance metrics than the 36 km modeling results (Figure B-7e).

The $PM_{2.5}$ mass scatter plots and performance statistics in Florida are summarized across ~3 STN sites and 28 FRM sites in Figures B-7f and B-7g, respectively. The Soccer Plot of monthly $PM_{2.5}$ bias and error performance for FRM sites in Florida is shown in Figure B-9, which is repeated as Figure 3-11 below. For the winter months of Nov, Dec, Jan and Feb, the $PM_{2.5}$ performance statistics are quite good with bias/error values meeting the <±15%/35% ozone performance goal. The spring and fall months either achieve the <±30%/50% or <±50%/125% performance goal and criteria. The May-Jul summer months are at or exceed the -50% bias performance criteria levels (note that in the Soccer Plots if the symbol would be plotted outside of the range of the plot then it is plotted on the axis, such as the May and July -50% values in Figures 3-11 and B-9). Thus, the $PM_{2.5}$ performance in Florida is significantly worse than the other ASIP states and is a cause for concern. Fortunately, Florida is one of the ASIP states without any violating $PM_{2.5}$ monitors (See Chapter 4).

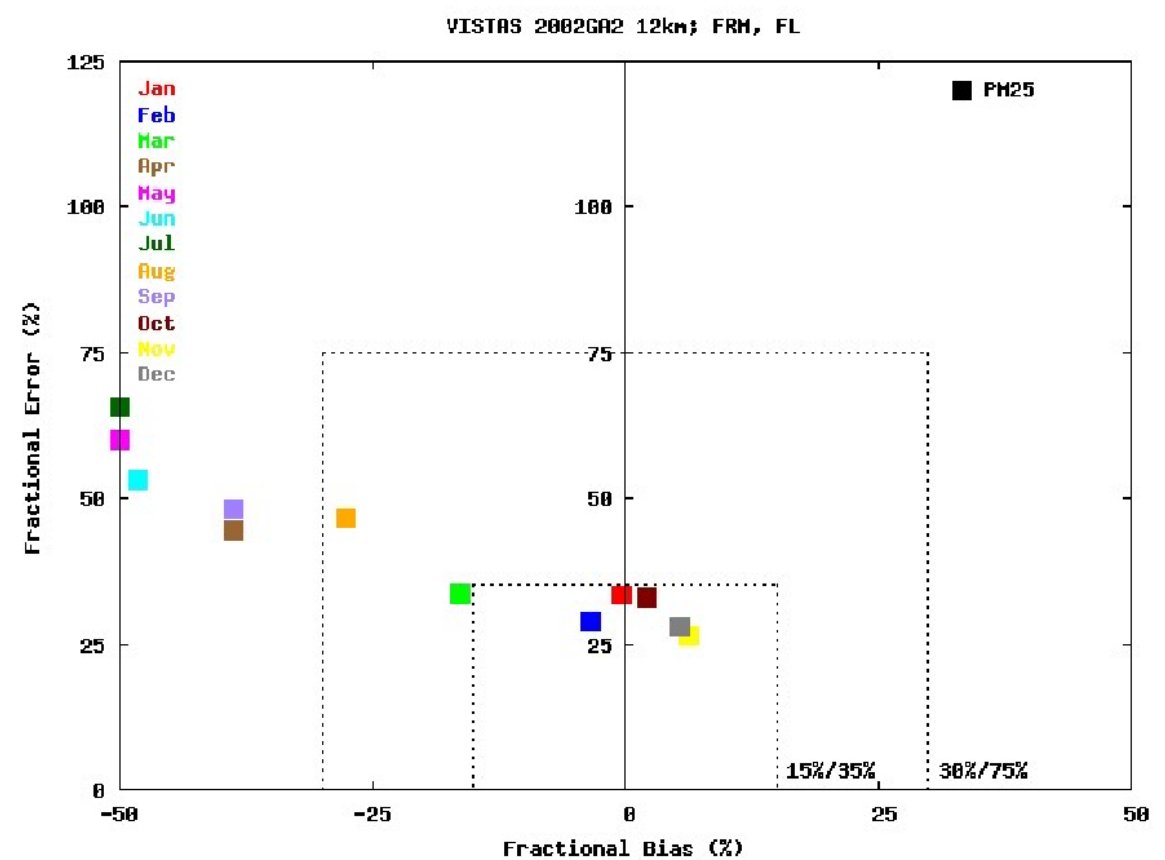


Figure 3-11. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Florida for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.3 Georgia

There appears to be valid data capture issues in the 2002 STN database for Georgia due to the start up of some of the STN sites in 2002 so data are not available in the early months. The CMAQ SO4 performance in Georgia is generally pretty good with bias/error frequently achieving the <±15%/35% ozone performance goal and always achieving the PM goal (Figure B-11a). The STN sites also have the summer nitrate underprediction performance issue as seen in the other states (Figure B-11b). The NH4 model performance falls between the SO4 and NO3 performance and achieves the <±30%/50% PM performance goal for all four quarters (Figure B-11c). The carbon performance in Georgia appears to be slightly better than the other states, although still with a general underestimation tendency of -40% to -67% (Figure B-11d). EC performance is variable with generally low bias in Q3 and Q4 an overestimation bias in Q1 and underestimation bias in Q2 (Figure B-11e).

The performance of total $PM_{2.5}$ mass across the STN (Figure B-11f) and FRM (Figure B-11g) monitoring sites in Georgia is generally fairly good. Q3 exhibits an underprediction tendency with fractional bias values of approximately -25% (STN) and -18% (FRM) that is likely caused by the underestimation of SO4 and especially OCM. But in general the $PM_{2.5}$ performance statistics mostly achieve the more stringent ozone performance goal.

An example time series of predicted and observed PM concentrations and annual statistics for two sites in the Atlanta Georgia (a DeKalb County STN and the SEARCH Jefferson Street sites) are shown in Figures B-12 and B-13. The model tracks the observed SO4 concentrations at these sites extremely well producing low fractional bias (-5% and +9%) and gross error (27% and 30%). NO3 performance exhibits the underprediction tendency seen in the other states, but is not as severe with a fractional bias of -16% and ~80% error. The CMAQ 12 km results reproduces the OCM concentrations at the DeKalb County site surprisingly well with low bias (-14%) and error (31%), with a slight degradation at the SEARCH JST site (-35% bias and 46% error). EC is overestimated (bias of 28%) at the DeKalb site but has zero error at the SEARCH site. Finally, the performance for $PM_{2.5}$ mass at the two Atlanta sites is extremely good with very low bias (2% and -3%) and error (25% and 24%).

Figure 3-12 below is reproduced from Figure B-14 in Appendix B and displays a Soccer Plot of monthly fractional bias and error across the 26 FRM sites in Georgia. All months achieve the PM performance goal and 8 of the 12 months even achieve the more stringent ozone performance goal. The months that the $PM_{2.5}$ mass performance doesn't achieve the ozone performance goal are due to an overestimation bias in January and underestimation bias in the summer months of May-July with the latter primarily caused by an underestimation of SO4 and OCM.

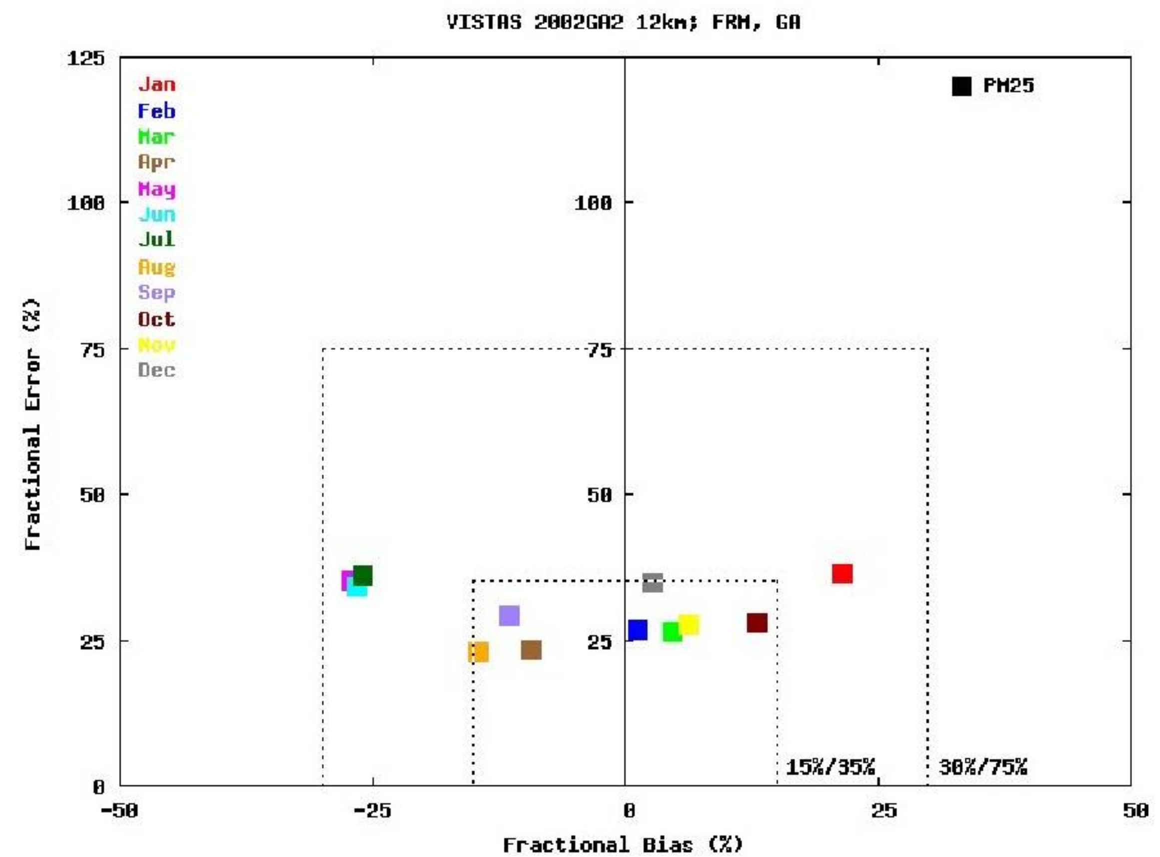


Figure 3-12. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Georgia for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.4 Kentucky

The quarterly scatter plots and performance statistics for 24-hour average PM species and sites in Kentucky are shown in Figure B-16 in Appendix B. The performance for SO4 in Q1 is mixed, with a group of points clustered around the 1:1 line and another further to the right that has been determined to be variations of SO4 performance in Kentucky on different STN sampling days in Q1. Good SO4 performance is seen in Q2 and Q3, whereas Q1 and Q4 exhibit an SO4 underestimation bias. As seen in the other states, NO3 performance in Kentucky is characterized by underprediction bias that is largest in the Q3 with fractional bias of -5% in Q1, -100% in Q2 -120% in Q3 and 8% in Q4. Like SO4, NH4 performance is fairly good albeit with an underprediction bias in Q2 and Q3 (Figure B-16c). As seen for the other states, OCM is underpredicted in Kentucky with the bias ranging from -80% in Q1 to -90% in Q3 (Figure B-16d). The OCM errors are the opposite sign but the same magnitude as the bias suggesting that the OCM underprediction bias is almost systematic. The CMAQ 36 km and 12 km modeling results exhibits different EC performance in Kentucky. The CMAQ 12 km results have better bias that is much closer to zero than the 36 km results (Figure B-16e). This is likely due to the 36 km grid cells over dispersing the urban EC emissions. Both the CMAQ 36 km and 12 km results exhibit a lot of variability producing a lot of scatter and high error metrics.

The performance of total $PM_{2.5}$ mass concentrations in Kentucky is evaluated across 10 STN (Figure B-16f) and 23 FRM sites (Figure B-16g). Given the underprediction of most of the PM component species it is not surprising that total $PM_{2.5}$ mass is underpredicted across the STN sites by -19%, -33%, -20% and 0% for Q1, Q2, Q3 and Q4, respectively. Across the FRM sites in Kentucky, however, the CMAQ model for $PM_{2.5}$ mass bias is much closer to zero with values of -3%, -23%, -22% and 12% for the same four quarters. The FRM $PM_{2.5}$ mass performance always achieves the PM performance goal and sometimes even achieves the ozone model performance goal.

An example PM model performance for STN sites in Lexington (Fayette County) and Kenton County (Cincinnati NAA) are shown in Figures B-17 and B-18. The model performance at these two sites is similar. At the Lexington site the model reproduces the temporal variations in SO4 quite well (Figure B-17a, top) resulting in low bias (-10%) and error (33%). Although the model shows some skill in reproducing the observed higher NO3 values in the winter, especially in the first part of the year, the near zero modeled NO3 during the summer results in a fractional bias value of -62% with 87% error, so does not achieve the PM performance goal (Figure B-17a, bottom). OCM is underpredicted with fractional bias values of -52% and an error of 58% just at the PM performance goal (Figure B-17b, top). EC exhibits much better performance at the Lexington, Kentucky site with a bias near zero (-4%) and error of 36% so almost achieves the ozone performance goal. The fractional bias for NH4 and $PM_{2.5}$ at Lexington are both approximately -10% with NH4 having an error of 36% and $PM_{2.5}$ an error of 28% thereby achieving the ozone performance goal.

Figure 3-13 below reproduces Figure B-19 from Appendix B that summarizes the Kentucky $PM_{2.5}$ mass model performance using a Soccer Plot of monthly bias and error. With the exception of July, whose fractional bias falls slightly below -30%, $PM_{2.5}$ performance in the other 11 months achieves the PM bias/error performance goal of <-30%/75%. In fact 5 months, which occur mainly in the winter, even achieve the more stringent ozone model performance goal.

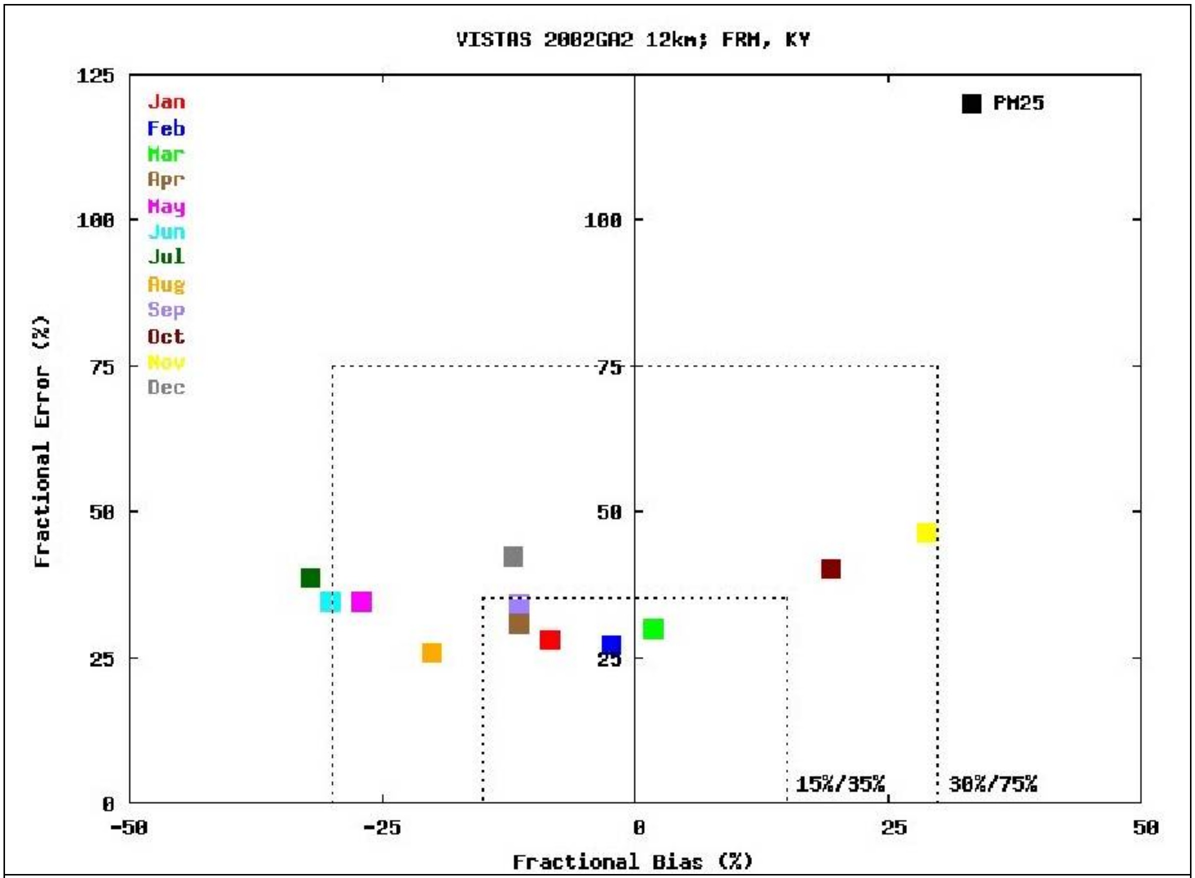


Figure 3-13. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Kentucky for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.5 Mississippi

Performance of PM species across sites in Mississippi is shown in Figure B-21. The CMAQ performance in Mississippi is generally worse than the other ASIP states (with the exception of Florida). SO4 is underpredicted with fractional bias values ranging from -20% to -40% with the worse SO4 performance seen in Q1 and Q4. NO3 performance metrics are extremely poor with fractional bias values of -60% in Q1, -110% in Q2, -150% in Q4 and -30% in Q4. OCM is underpredicted at sites in Mississippi with fractional bias values of -70% to -80%. Performance for EC is better, albeit still with an underprediction bias and, as seen for other states, the CMAQ 12 km modeling results produces much better lower EC bias than the 36 km modeling results (Figure B-21e). $PM_{2.5}$ performance in Mississippi across the STN and FRM networks are shown in Figures B-21f and B-21g, respectively. Across the STN network, $PM_{2.5}$ is underestimated by approximately -40% in Q1 rising to -50% in Q3. Across the FRM network, the $PM_{2.5}$ underprediction bias is lower, at -20% in Q1 and -30% in Q2 and rising to approximately -30% in Q3. In Q4 the model is better able to replicate the observed $PM_{2.5}$ mass with CMAQ 12 km bias and error values across the FRM network of -2% and -33%, respectively, achieving the ozone model performance goals.

The Soccer Plot (Figures 3-14 and B-23) for $PM_{2.5}$ mass performance confirm that $PM_{2.5}$ performance in Mississippi is worse than seen for the other ASIP states, except Florida. Only two months achieve the ozone model performance goal and only 8 months achieve the PM model performance goal. The model underprediction tendency during March through July 2002 produces fractional bias for $PM_{2.5}$ that ranges from -50% to -100% thereby not achieving the PM model performance goal. However, unlike Florida, the Mississippi monthly bias/error for $PM_{2.5}$ always achieves the <-50%/75% PM performance criteria.

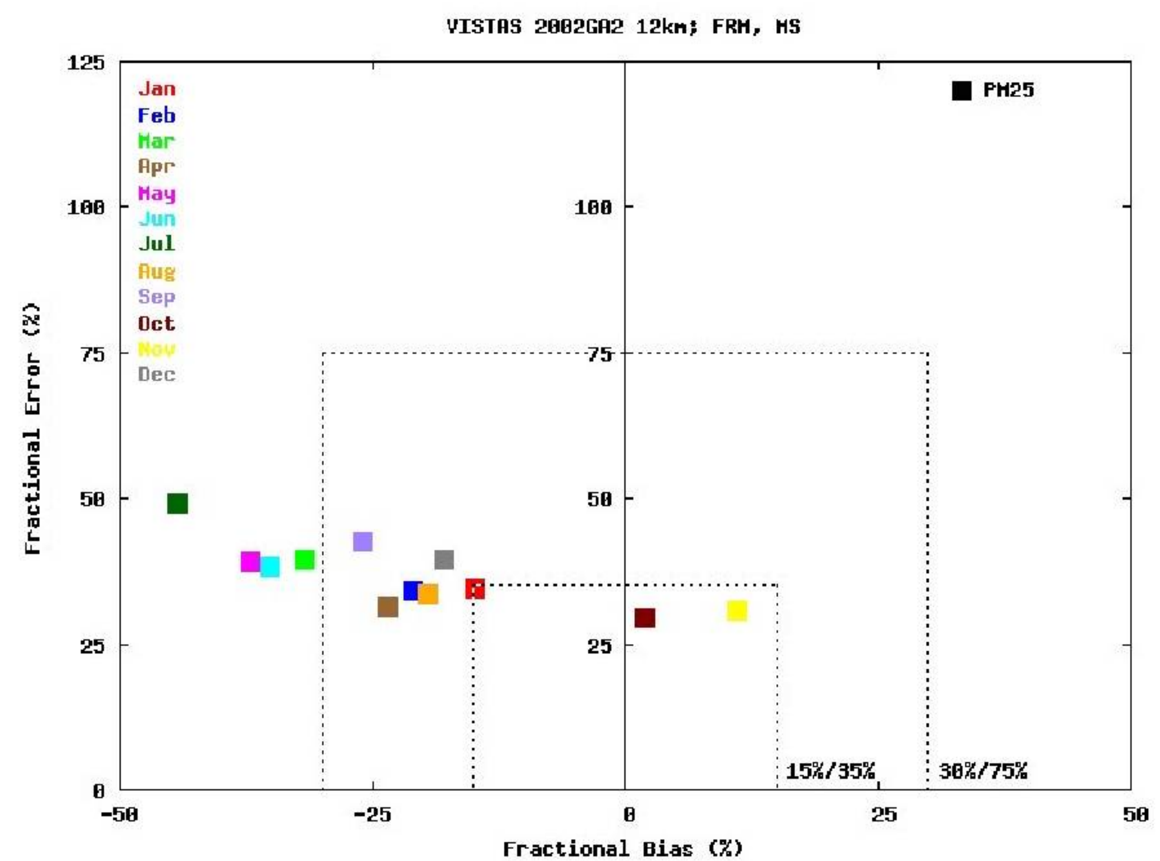


Figure 3-14. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Mississippi for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.6 North Carolina

SO4 performance across 9 STN monitoring sites in North Carolina and four quarters from 2002 is shown in Figure B-25a. SO4 performance achieves the PM performance goal with fractional bias results varying from -13% to -30%. Although NO3 is still greatly underestimated in North Carolina during the summer (Q3 bias of -90% to -120%), during Q1 and Q4 NO3 exhibits an overestimation bias with values of 11% to 30%, respectively (Figure B-25b). This is likely due to overstated ammonia emissions during the winter and adjacent periods which is somewhat verified by the overstated ammonium during Q1 and Q4 that have fractional bias values of approximately +30% (Figure B-25c). OCM is characterized by an underprediction bias ranging from -70% to -90%. EC, on the other hand, achieves the PM performance goal in Q1 and Q4 but has lots of scatter in the other two months exceeding the PM performance goal for bias in Q2 and for error in Q4. $PM_{2.5}$ mass performance across the 9 STN and 36 FRM sites in North Carolina exhibits monthly variations (Figures B-25f and B-25g). FRM $PM_{2.5}$ is overpredicted in January (15% to 18%) and October (25% to 30%), but underpredicted in April (-9% to -16%) and July (-37% to -39%). The STN $PM_{2.5}$ performance is similar except because the STN measurements tend to be higher so the underprediction bias is greater and the overprediction bias is less.

The Soccer Plot summary of FRM total $PM_{2.5}$ mass monthly model performance in North Carolina is shown in Figure 3-15 (reproduced from Figure B-28 in Appendix B). With the exception of the large summer underprediction bias in June and July, the other 10 months $PM_{2.5}$ performance achieves the <±30%/50% PM performance goal with four of the months even achieving the more stringent ozone performance with four additional months right at the ozone goal.

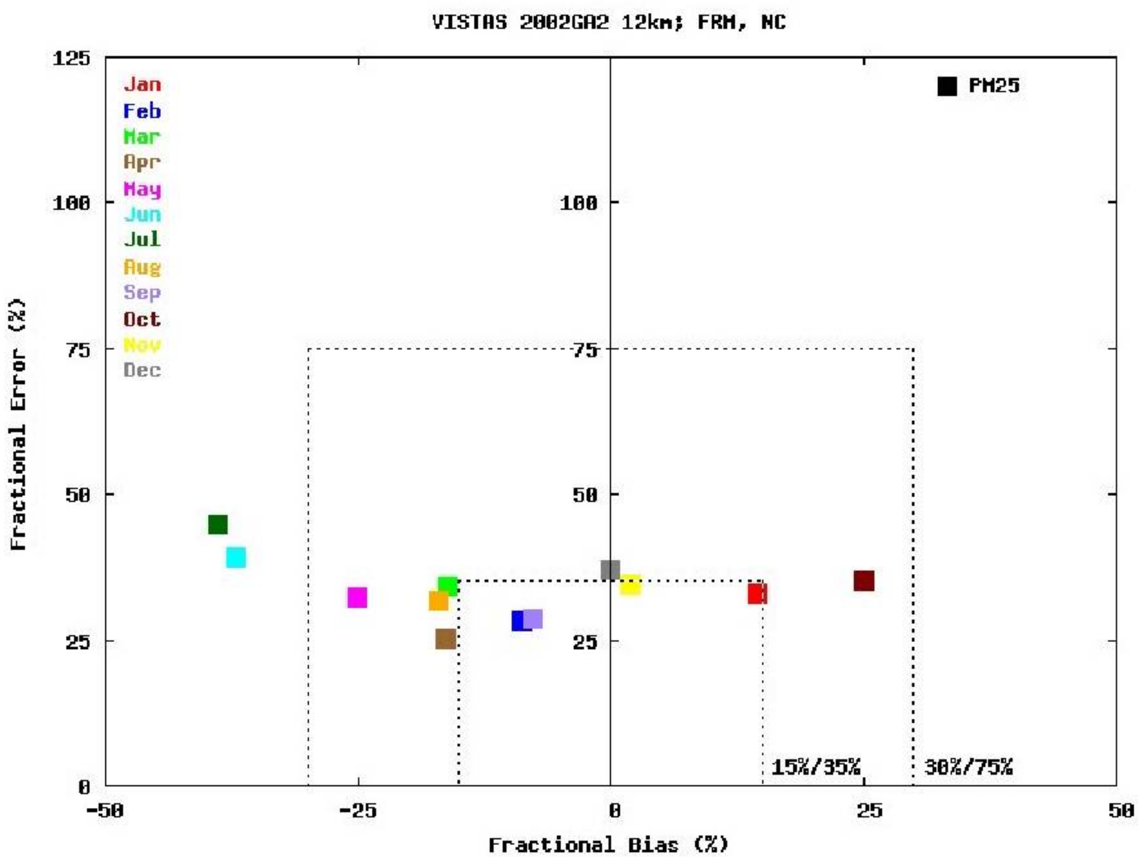


Figure 3-15. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in North Carolina for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.7 South Carolina

The CMAQ performance for SO4 across the 4 STN sites in South Carolina has an underprediction bias but is reasonably good, always achieving the PM performance goal and sometimes even achieving the ozone performance goal (Figure B-30a). NO3 performance is poor with an underprediction bias generally from -20% to -170% that is worst in the summer (Q3) when NO3 is lowest and not an important component of the $PM_{2.5}$ (Figure B-30b). NH4 performance is variable frequently achieving the PM performance goal with the worst performance in the summer characterized by a large underprediction tendency. OCM is underestimated with bias of approximately -80%. EC performance also has an underestimation tendency, although not is bad as seen for OCM. The CMAQ 12 km results also exhibits much better EC performance than the CMAQ 36 km modeling results with the 12 km EC model performance always achieving the PM performance goal and sometimes even achieving the ozone performance goal, whereas the CMAQ 36 km EC results never achieves the PM performance goal for the four quarters with an underprediction bias that is approximately twice the 12 km results (Figure B-30e). $PM_{2.5}$ model performance across STN and FRM networks in South Carolina are shown in Figures B-30f and B-30g, respectively. $PM_{2.5}$ mass is usually underpredicted across both networks, with the fractional bias across the STN network worse and approximately 20 percentage points larger underprediction than the FRM network. In fact, the bias/error for $PM_{2.5}$ across the FRM network always achieves the ≤±30%/50% PM performance goal and even achieves the <±15%/35% bias/error ozone model performance goal for Q1 and Q4.

The summary fractional bias and gross error Soccer Plot for total $PM_{2.5}$ mass across the FRM network in South Carolina is shown in Figures 3-16 and B-32. During the fall and winter months of August, September, November, December, January and February, the monthly bias and error statistics for $PM_{2.5}$ achieve the very stringent ozone model performance goal. The three additional months of March, April and October achieve the PM performance goal. Whereas during the summer months of May, June and July FRM $PM_{2.5}$ performance fails to achieve the PM performance goal (but does achieve the PM performance criteria) due to large underprediction bias that is caused by the underprediction of each of the PM component species.

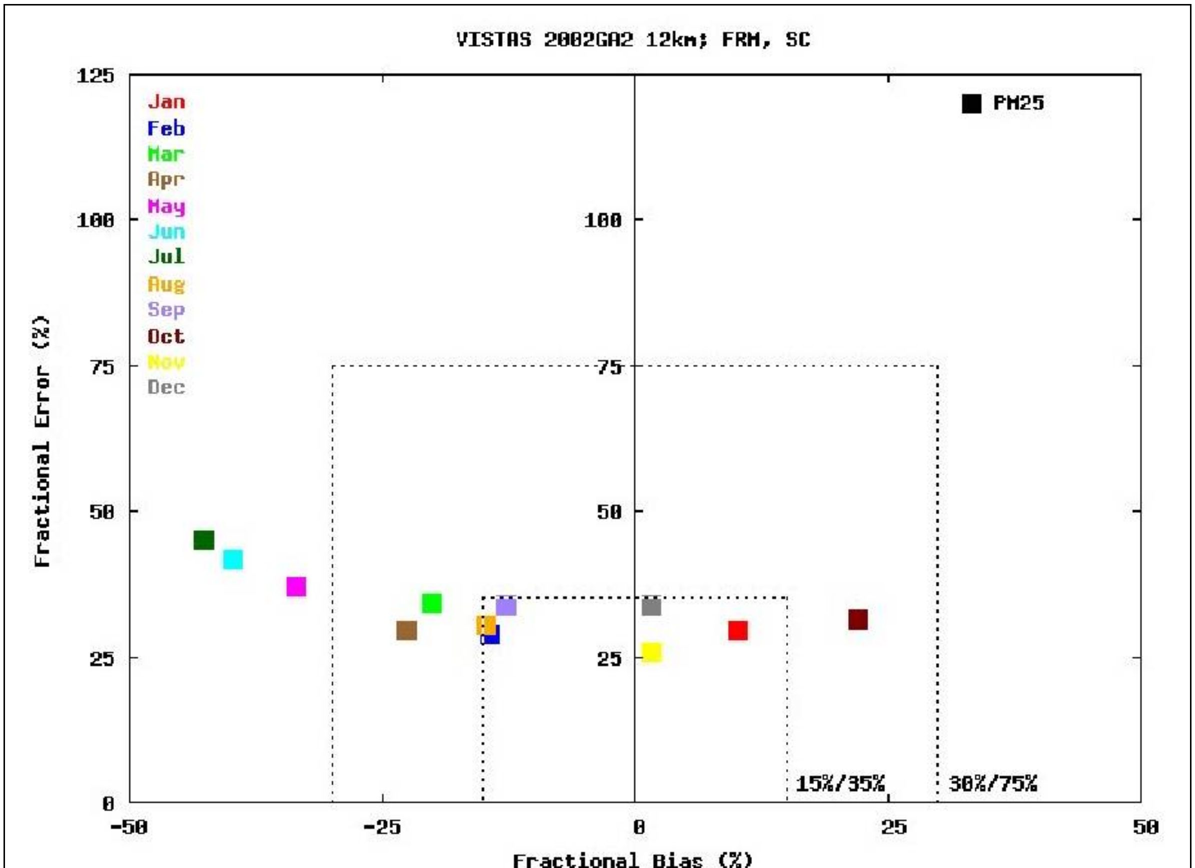


Figure 3-16. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in South Carolina for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.8 Tennessee

The CMAQ does a good job predicting the observed SO4 concentrations in Tennessee with bias and error values that either achieve the most stringent ozone performance goal or are right at the edge of the ozone goal (Figure B-34a). The CMAQ 12 km results are slightly better than the 36 km predictions and, unlike the other states where the summer had the largest underprediction bias, in Tennessee the SO4 performance in Q3 is quite good with the 12 km results producing a 8% bias and 36% error. The model exhibits little skill in its NO3 predictions (Figure B-34b) with the usual large underprediction bias in the summer (e.g., -150% in Q3). Although the bias is low in Q1 and Q4 (<±10%), the error is large (60% to 80%). NH4 performance is generally reasonably good with low bias throughout the year.

As seen in the other states, OCM exhibits a large underprediction bias that generally ranges from -60% in Q1 to -80% in Q4 (Figure B-34d). EC performance is quite good for the 12 km CMAQ results, with the 36 km CMAQ results having a larger underprediction bias (Figure B-34f). Tennessee $PM_{2.5}$ mass performance across the STN and FRM networks are shown in Figures B-34f and B-34g. Across the STN network performance for $PM_{2.5}$ achieves the ozone goal in Q1, but exhibits an underprediction bias in Q2 and Q3 but does achieve the PM performance goal. Across the FRM network, the model performs better for $PM_{2.5}$ achieving the ozone performance goal in Q1 and Q4, but with an underprediction bias in Q2 (-17% and -22%) and Q3 (-18% and -29%).

The monthly fractional bias and error Soccer Plot for FRM $PM_{2.5}$ performance in Tennessee shown in Figure 3-17 and indicates that all months of the year achieve the PM model performance goal and that 5 of the months even achieve or are right at the ozone model performance goal. The months that do not achieve the ozone performance goal are due to a summer underprediction bias for May-July and a fall/winter overprediction bias for October and November and a too high error for December.

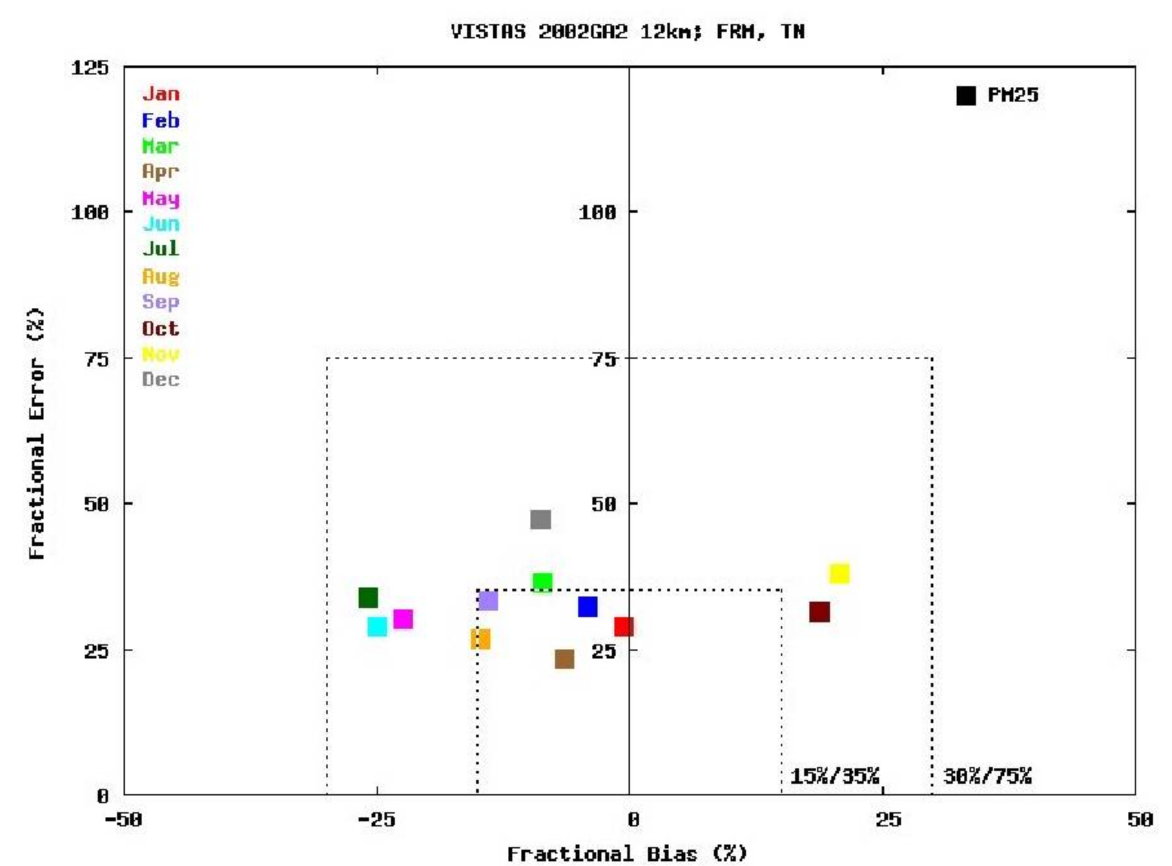


Figure 3-17. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Tennessee for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.9 Virginia

SO4 performance is fairly good in Virginia with low bias and error in Q2 and Q3 that achieves the <±15%/35% ozone bias/error performance goal (Figure B-39a). Although Q1 and Q4 exhibit a -15% to -20% underprediction bias for SO4, it still achieves the PM performance goal. As seen for the other states, NO3 performance is poor and characterized by an underprediction bias that is greatest in the summer (-150%) when CMAQ estimates near zero NO3 predictions. NH4 performance achieves the ozone performance goal in Q1 and Q2 and PM performance goal in Q4 but the -34% to -42% bias in Q4 exceeds the PM performance goal (Figure B-39c).

OCM performance is characterized by an underprediction bias of from -65% to -90% with error of opposite sign and similar magnitude (Figure B-39d). The fractional bias for EC is about 20-30 percentage points higher using CMAQ with a 12 km grid than 36 km grid resulting in the 12 km results always achieving the PM performance goal but the 36 km results underprediction bias in Q2 and Q4 is approximately -40% so does not achieve the PM performance goal.

Figure 3-18 below summarize the $PM_{2.5}$ model performance across 19 FRM sites in Virginia using a Soccer Plot. Monthly fractional bias and gross error for $PM_{2.5}$ mass in Virginia achieves the PM performance goal for every month in 2002, with nine of the months also achieving or almost achieving the more stringent ozone performance goal. As seen in the other states, the three summer months of May, June and July have an underprediction bias that does not meet the ozone performance goal, but still meets the PM performance goal. As noted for other states, the summer SO4 underprediction bias is believed to be due in part to overstated convective precipitation from the MM5 meteorological model that is somewhat verified by an overprediction in wet deposited sulfate in the summer across the NADP network.

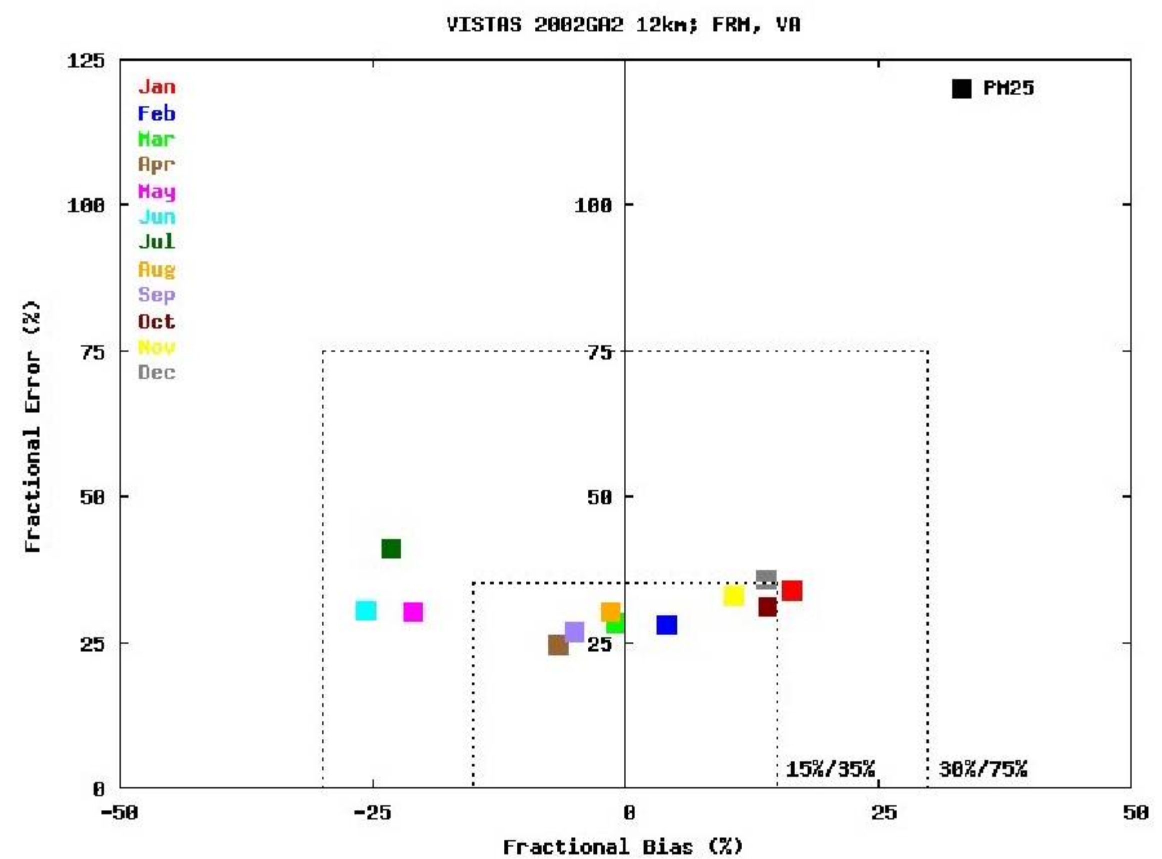


Figure 3-18. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Virginia for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.5.10 West Virginia

There were no speciated $PM_{2.5}$ STN monitoring sites within West Virginia during the 2002 modeling year, so the $PM_{2.5}$ model evaluation is limited to the 16 FRM $PM_{2.5}$ mass monitoring sites. In Q1, Q2 and Q3, CMAQ underestimates $PM_{2.5}$ mass across the FRM sites in West Virginia by approximately -23%, -37% and -27%, respectively, and achieves the PM performance goal (Figure B-44). In Q4 the model has near zero bias and 32% error so achieves the ozone model performance goal. The Soccer Plot in Figures 3-19 below summarizes the FRM $PM_{2.5}$ mass performance in West Virginia in each month. Nine of the months achieve the PM performance goal, with the winter months even achieving or nearly achieving the ozone model performance goal. As seen for the other states, the underprediction bias during the May-July summer months results in the bias falling outside of the PM performance goal, but within the PM performance criteria.

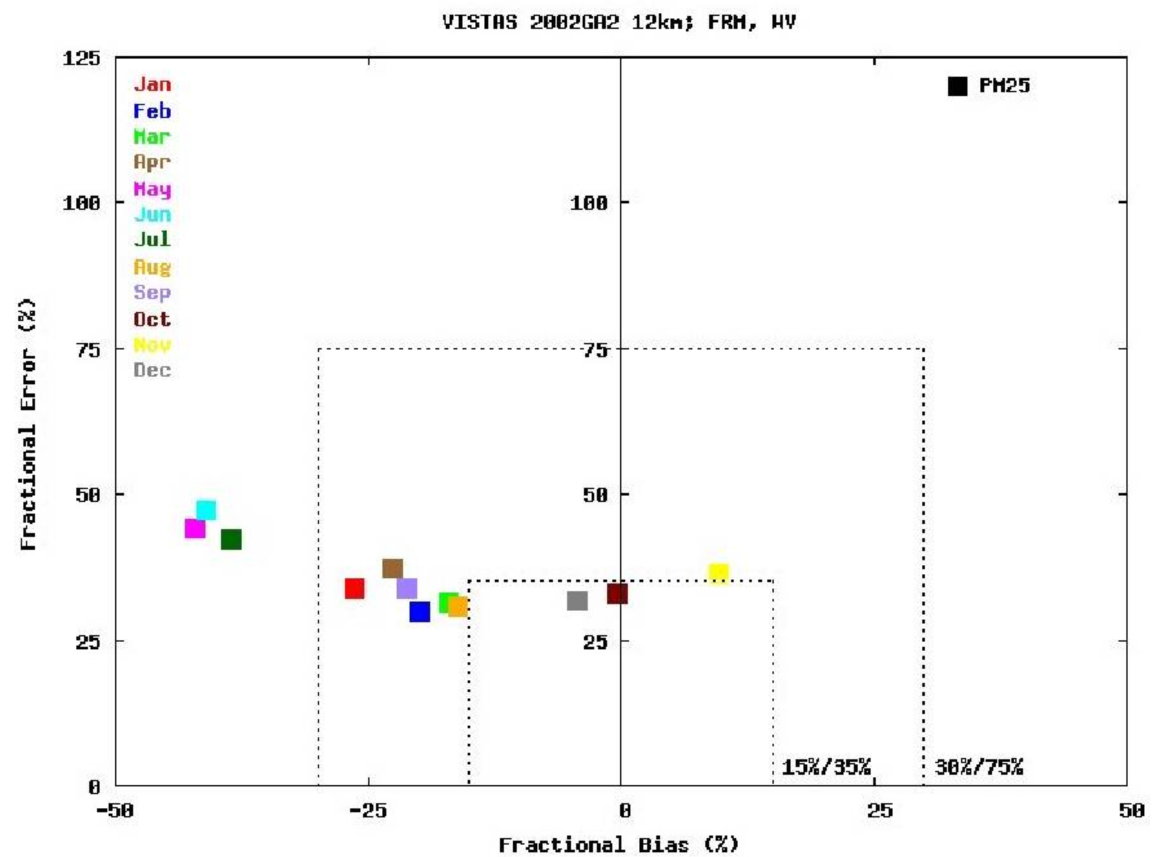


Figure 3-19. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in West Virginia for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

3.6 SPATIAL AND SEASONAL ANALYSIS OF PM MODEL PERFORMANCE

This section summarizes the results in Appendix C that contains a general qualitative overview of the CMAQ 2002 Base G2 Actual base case model performance across the ASIP 12 km domain, with emphasis on temporal (seasonal) and spatial patterns within the domain. The evaluation is carried out for each of the major $PM_{2.5}$ components separately (sulfate, nitrate, ammonium, organic carbon material, elemental carbon, soil $PM_{2.5}$, sea-salt $PM_{2.5}$), as well as for total $PM_{2.5}$ mass. The performance evaluation summarized in this section and presented in Appendix C present spatial maps of modeled quarterly average $PM_{2.5}$ concentrations with overlaid quarterly average observations. For each $PM_{2.5}$ species, two sets of figures are provided, one comparing model predictions to observations at the STN sites, the other to observations at the IMPROVE network sites (soil and sea-salt are available at the IMPROVE network only). Modeled spatial maps with overlaid observations for total $PM_{2.5}$ mass are compared for the FRM network, in addition to the STN and IMPROVE networks. Four figures are provided for each set corresponding to the average concentrations during the four quarters of the year (Q1: Jan-Mar; Q2: Apr-Jun; Q3: Jul-Sep; Q4: Oct-Dec). In Appendix C all of the spatial maps comparisons are presented, with the figures for the STN $PM_{2.5}$ species components and the FRM $PM_{2.5}$ mass also provided below.

This evaluation allows for a general understanding of model performance and key issues. A more detailed and quantitative performance evaluation for monitoring sites within each ASIP states is provided in Appendix B and summarized in Section 3.5 above.

The observed quarterly average $PM_{2.5}$ mass and $PM_{2.5}$ species concentrations were obtained by averaging all 24-hour measurements at a site that occurred during each three month quarter. The modeled quarterly average spatial maps were obtained by averaging the daily average concentrations for each day in the three month quarter and each grid cell. No attempt was made in the averaging to match the modeled daily average concentrations with the 1:3 day sampling frequency typically used by the monitoring networks. In fact, obtaining modeled quarterly average concentrations trying to match the measurement days is problematic since not all sites collect valid samples on every 1:3 day sampling day. For some STN sites this resulted in a bias in the Q1 quarterly average predicted and observed comparisons since many of the STN sites started up in 2002 and are missing data for the first part of 2002, thus they only have samples near the end of Q1. In the case of species like SO4 that has a strong seasonal variation, basing observed Q1 averages on samples in March and modeled values averaged across January-February-March introduces a seemingly underprediction bias that is artificial and an artifact of the network sampling periods. We know this is occurring at some STN sites, for example see discussion for Georgia in Section 3.5.3.

3.6.1 Sulfate (SO4)

Modeled sulfate concentrations show a very strong seasonal pattern (Figure 3-20 below and Figures C-1a and C-1b in Appendix B), with peak concentrations occurring during summer months (Quarters 2 and 3) when photochemistry is highest. A spatial pattern is also evident, with higher concentrations in the northeast, Ohio River valley, and southeast, compared to the upper Midwest and Florida, caused mainly by the higher and denser SO_2 emissions in those regions compared to the latter two. In Florida, the impacts of individual major sources of SO_2 are evident (such as in the Tampa and Jacksonville areas), as their emissions remain relatively unmixed with emissions from other regions, being surrounded by ocean. However, in most of the domain, a "regional" sulfate field is observed as a result of mixing of emissions from various regions, especially for the long averaging time presented here (three months).

Overall, the model seems to accurately simulate sulfate levels over the domain and captures both the temporal and spatial patterns exhibited in the observations, both from the STN (Figures C-1a and 3-20) and IMPROVE (Figure C-1b) networks. The exception is Quarter 1 for the STN network, in which the observed concentrations seem higher than the modeled ones, and there is not much agreement in the spatial pattern between the two. This is partly due to an artifact in the way the observations are presented here. Since some of the STN sites were not in operation during the first few months of 2002, observed Quarter 1 averages might in fact be driven by observations during the latter (and warmer) part of Quarter 1 (e.g., March samples), and therefore are biased high relative to the modeled Q1 SO4 concentrations.

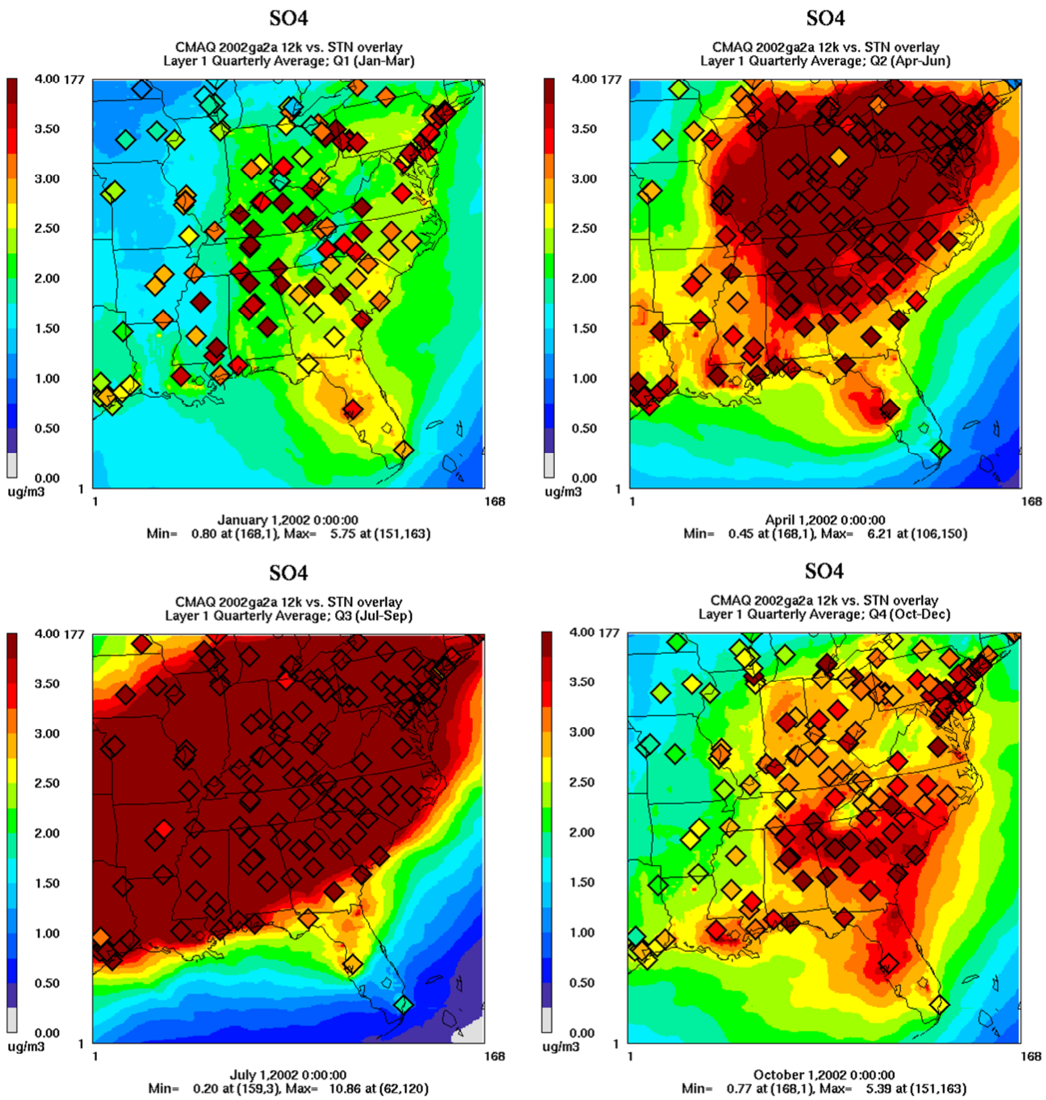


Figure 3-20. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) sulfate (SO4) concentrations over the VISTAS 12 km domain (for IMPROVE comparisons see Appendix C).

3.6.2 Nitrate (NO3)

Nitrate is in many ways the “mirror” image of sulfate, with peak concentrations occurring during wintertime, when the cooler temperatures are favorable for particulate nitrate formation, and due to lower SO4 as more ammonia is available to bond with nitrate, rather than sulfate (Figure 3-21 and Figures C-2a and C-2b in Appendix C). Also for this reason, peak particulate nitrate concentrations occur in areas of the domain where ammonia emissions are highest, such as the Midwest.

While overall the model does capture the seasonal and spatial variability in particulate nitrate concentrations (Figures C-2a,b), it does seem to overestimate concentrations during wintertime, especially over urban centers, such as in part of the Northeast and over Atlanta and Birmingham. Winter overestimations are also evident over much of North Carolina. While it is impossible to infer from these data alone on the cause for these overpredictions, they are related to either one or a combination of the model nitrate partitioning between gaseous and particulate phase, and the availability of gaseous ammonia, as reflected by the emissions inventory. The latter can be the common denominator between the overpredictions over the urban centers and over North Carolina as ammonia emissions in these areas, though originating from different sources (mobile sources in the urban centers; agricultural ammonia emissions in North-Carolina), might be overestimated making more ammonia available for particulate formation compared to the observations. Also note that the artifact of the start up of the STN network for some of the sites during the Q1 as discussed for SO4 above also affects NO3 performance. The NO3 observations at the STN sites that started during Q1 will have Q! averaged values biased toward the warmer portion of Q1 which will favor lower NO3 concentrations due to the thermodynamic properties of the partitioning of total nitrate to particulate NO3 and gaseous HNO3. This artifact of the sampling frequency of the observations would results in a seemingly underprediction bias in NO3 during Q1.

In the summer the model estimates near zero (< 0.25 $\mu g/m^3$) particulate nitrate concentrations, whereas the observed values are typically in the 0.25-0.75 $\mu g/m^3$ range. So both the modeled and observed summer NO3 values suggest that it is not an important component of the total $PM_{2.5}$ mass concentrations in the southeastern U.S. during the summer.

Fairly similar trends are observed when comparing the model to either the STN (Figures 3-21 and C-2a) or the IMPROVE (Figure C-2b) networks, however a more detailed analysis is provided based on the STN given its larger size and density.

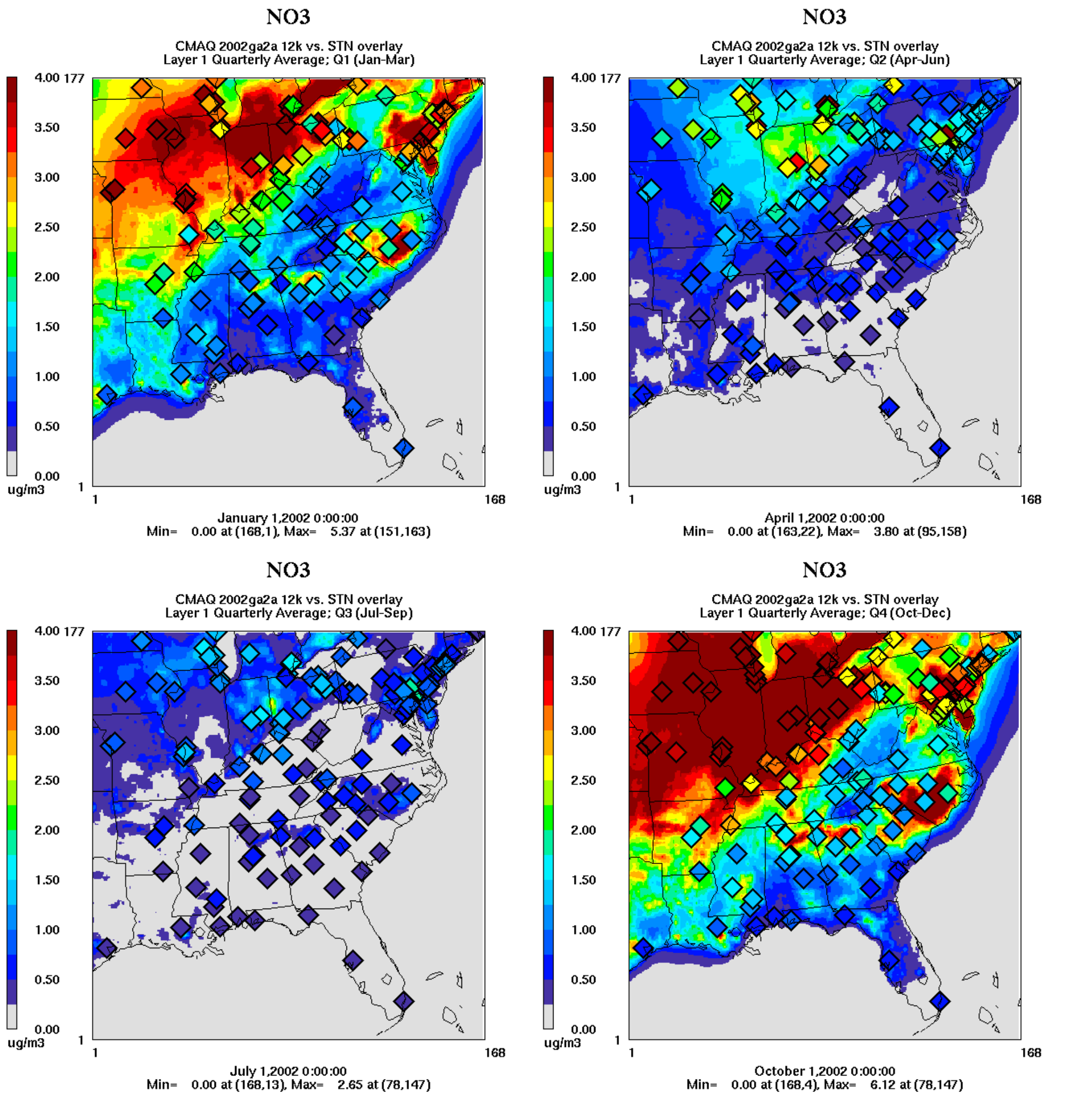


Figure 3-21. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) nitrate (NO3) concentrations over the VISTAS 12 km domain (IMPROVE comparisons are provided in Appendix C).

3.6.3 Ammonium (NH4)

Ammonium concentrations depend, to a large degree, on the availability of sulfate and nitrate. Therefore, ammonium levels do not exhibit as strong seasonal pattern, due to the seasonal tradeoff between sulfate and nitrate to which it bonds (Figures 3-22 and C-3).

Model performance when compared to the STN data (Figures 3-22 and C-3a), seems to be better during summertime (Quarters 2 and 3) when the ammonium is mainly associated with sulfate. During wintertime (Quarters 1 and 4), most of the issues observed with nitrate overpredictions are also evident in the ammonium plots, especially over North-Carolina and the urban centers of the Southeast.

Ammonium is not directly measured by IMPROVE, rather it is derived by assuming it completely neutralizes the measured sulfate and nitrate. Although assuming that nitrate is completely neutralized by ammonium is, most of the time, a valid assumption, the same may not be true for sulfate, especially in the summer months. Hence the observed ammonium comparison in the IMPROVE case (Figure C-3b) is likely overstated during the summer months and the seemingly underpredicted observed ammonium concentrations across the Appalachian Mountain IMPROVE monitoring sites in Quarter 3 in Figure C-3b are in part due to using derived observed ammonium.

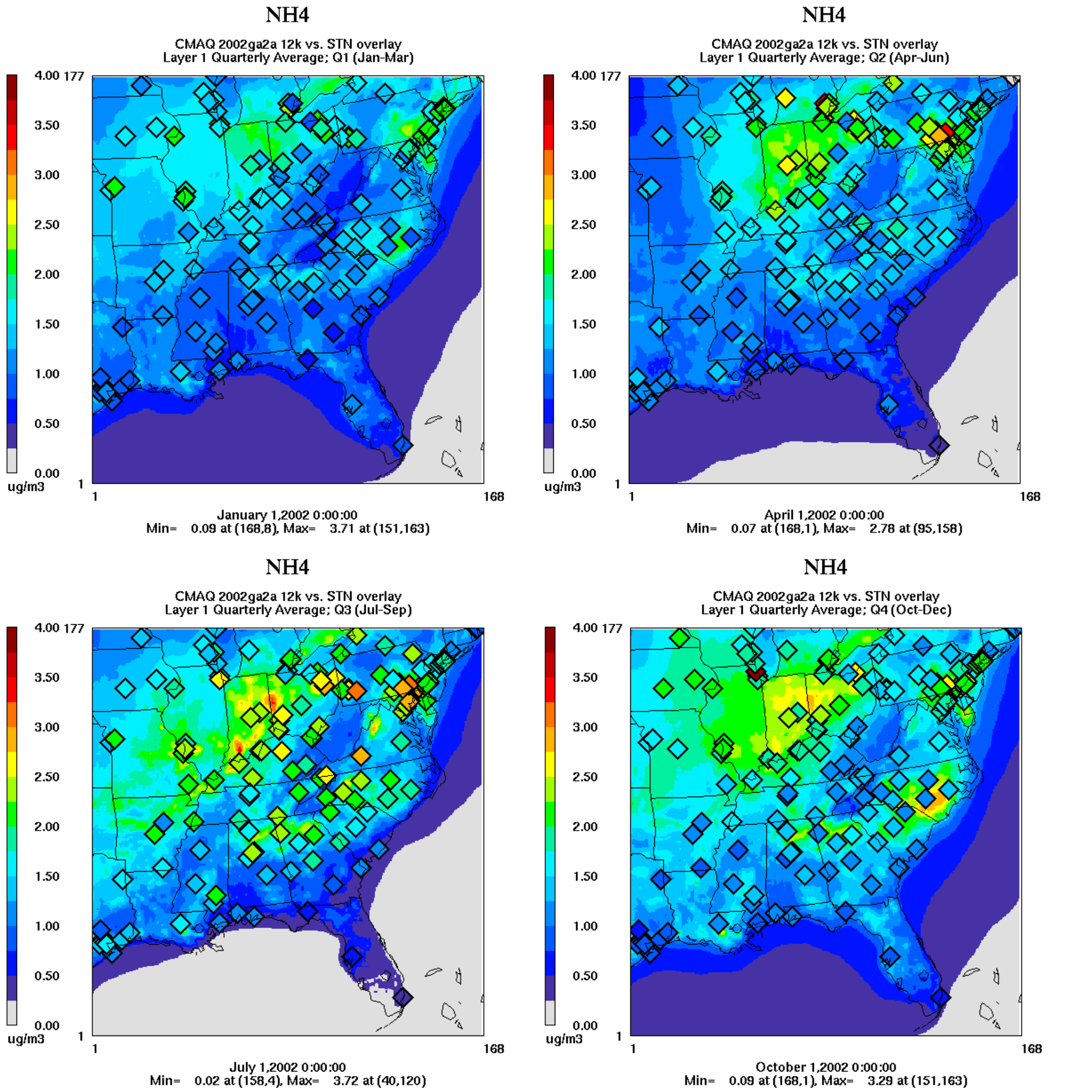


Figure 3-22. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) ammonium (NH4) concentrations over the VISTAS 12 km domain (IMPROVE comparisons provided in Appendix C).

3.6.4 Organic Carbon Material (OCM)

Evaluating model performance for OCM is complicated due to its dual primary/secondary nature and anthropogenic/biogenic sources. As a result, the evaluation is dependant on a combination of very different emissions and formation processes. In addition, there is a fair amount of uncertainty associated with OC measurements with the major limitation being the inability to directly measure OCM. Instead, only OC is measured and OCM is estimated (and compared to model results) by multiplying OC by an OCM/OC ratio factor. OCM/OC ratio factors typically range from 1.2 to 2.2 depending on whether the OCM is fresh or aged. For this model performance evaluation analysis, an OCM/OC factor of 1.4 has been used to convert the observed OC to OCM. Another complicating factor is that different analysis methods are used in the STN (NIOSH) and IMPROVE networks that introduce additional measurement artifacts and uncertainties.

The seasonal pattern of OCM concentrations would depend on the relative contributions from secondary OCM (peak concentrations during summertime) and primary OCM. The seasonal pattern of primary OCM would depend on the seasonality of activity and emissions from sources such as biomass burning and transportation. Given a flat activity/emissions profile, primary OCM is would typically be higher in wintertime, due to reduced atmospheric mixing.

Comparing the modeled quarterly OCM predictions to STN observations (Figures 3-23 and C-4a), both exhibit a fairly flat seasonal pattern. Overall, the modeled OCM concentrations are lower compared to the observations. The model seems to exhibit a much stronger spatial pattern, with peak concentrations occurring in the Southeastern U.S. This is likely associated with biomass burning in the winter months, and biogenic secondary OCM formation in the summer months. The increased modeled concentrations of secondary OCM are evident in Quarter 3, especially over the Northeast. When comparing simulated concentrations to IMPROVE observations (Figure C-4b), better agreement is observed. Given that most IMPROVE sites are located in rural areas, this may be an indication that the OCM underprediction at urban sites (STN, Figures 3-23 and C-4a) may possibly be due to local spatial gradients and the comparison of 12 km grid-cell volume average concentrations to point measurements at urban sites. It is also partly due to measurement artifacts where the STN OC observations are not “blank corrected” so are biased high.

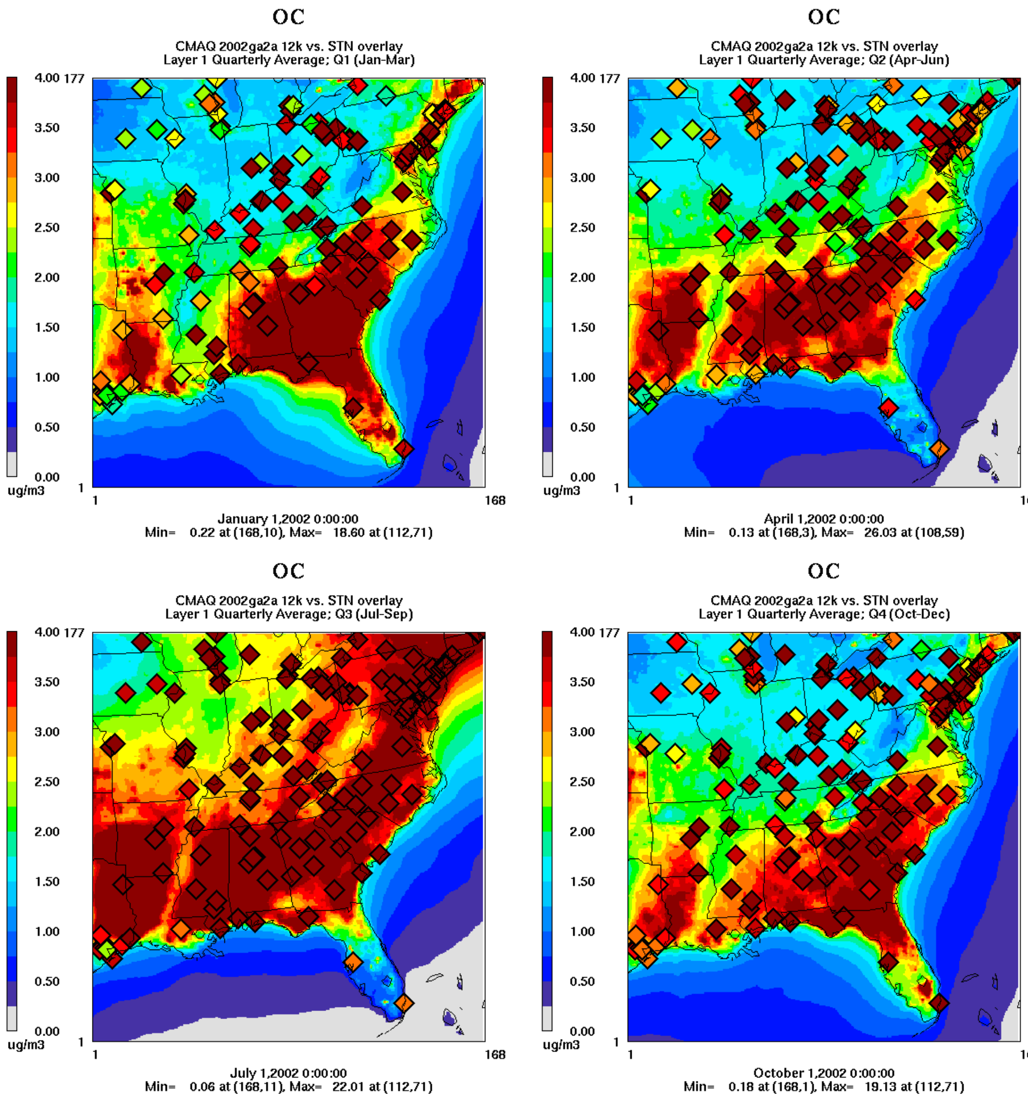


Figure 3-23. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) organic carbon material (OCM) concentrations over the VISTAS 12 km domain (IMPROVE comparisons provided in Appendix C).

3.6.5 Elemental Carbon (EC)

Evaluating model performance for EC, the model tends to underpredict concentrations when compared to the STN network (Figures 3-24 and C-5a), while better agreement is observed with the IMPROVE network (Figure C-5b). This follows the same conclusion as for OCM, and may be reflecting the differences between grid-cell volume average concentrations and point measurements. These differences are expected to be more pronounced at urban sites (STN) compared to rural ones (IMPROVE), as at urban locations there are likely stronger local spatial gradients in EC concentrations. The STN and IMPROVE networks also use different methods for measuring EC that may also be contributing to the differences in EC model performance using the two networks. In Section 3.5 and Appendix B we noted that the CMAQ 12 km modeling results exhibited superior model performance to the CMAQ 36 km modeling results across the urban STN network with bias closer to zero with the 12 km grid versus a large underprediction bias with the 36 km grid. Thus, the dilution of the urban EC emissions across coarse grid cell is surely contributing to the EC underprediction tendency at the STN monitoring network.

Both the modeled values and observations (at both networks) exhibit higher concentrations in wintertime (Quarters 1 and 4), that is likely due to reduced atmospheric mixing compared to summertime. However, the seasonal pattern is much stronger in the model results compared to the observations.

Another interesting finding has to do with relatively high modeled EC concentrations in the western part of the Georgia-Florida border, especially in Quarter 1. This is due to modeled emissions from biomass burning activities. However, nearby measurements at both the STN and IMPROVE networks do not exhibit the same trend.

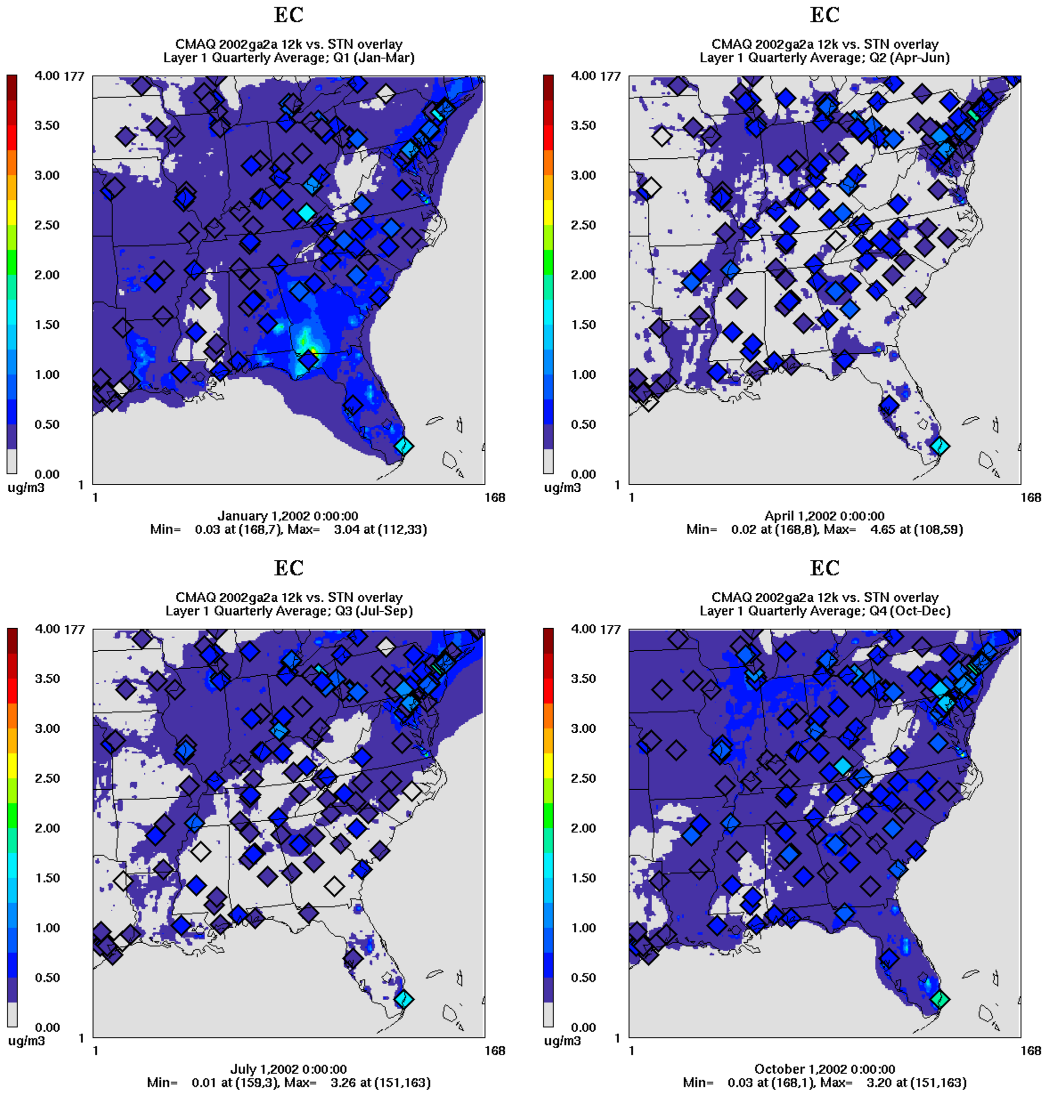


Figure 3-24. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) elemental carbon (EC) concentrations over the VISTAS 12 km domain (IMPROVE comparisons provided in Appendix C).

3.6.6 Soil $PM_{2.5}$ (SOIL)

Soil $PM_{2.5}$ was evaluated just at the IMPROVE monitoring sites (Figures 3-25 and C-6). In general, soil $PM_{2.5}$ is overpredicted compared to the observations. This is a common issue in grid-based models, where resuspended fugitive dust is assumed to be mixed uniformly in the first layer of the model, whereas in practice most of it is removed locally by impaction onto surfaces such as cars, buildings and vegetation. Higher concentrations are especially evident in urban centers, due to the way the model calculates the emission and dispersion of resuspended road dust. However, this is not very evident in this comparison, since most IMPROVE sites are located at rural areas. The ASIP/VISTAS modeling did apply fugitive dust transport factors (FDTF) to fugitive dust emission source categories to account for dust that is deposited locally and not transported.

Another issue associated with the Soil evaluation is the mismatch between how Soil is defined in the measurement versus modeled values. The measured Soil values are derived by building it up from the elements, whereas the modeled values are obtained from the emission speciation profiles that are assigned all $PM_{2.5}$ to the other $PM_{2.5}$ species that is not explicitly speciated as SO4, NO3, EC or OCM.

Also evident in the figures are the higher modeled concentrations in the western portion of the ASIP/VISTAS 12 km domain. This could be originating from various reasons, such as possibly higher emissions in that region, transport into the domain from the west, or differences in methodologies used to calculate soil emissions between the various Regional Planning Organizations (RPOs). The latter is likely the case, since a sharp spatial gradient is observed between the Midwest RPO states (and west of Mississippi, in the portions of the CENRAP states) and the MANE-VU (northeast) and VISTAS (southeast) states (see Figure 1-1 for definition of the RPO states).

Regardless of actual model performance, in the context of State Implementation Plan (SIP) development and future attainment tests, modeled levels of soil components are of relatively little importance, since they are normalized according to observations, and little to no controls are being applied (so the Relative Reduction Factor would be equal or close to unity).

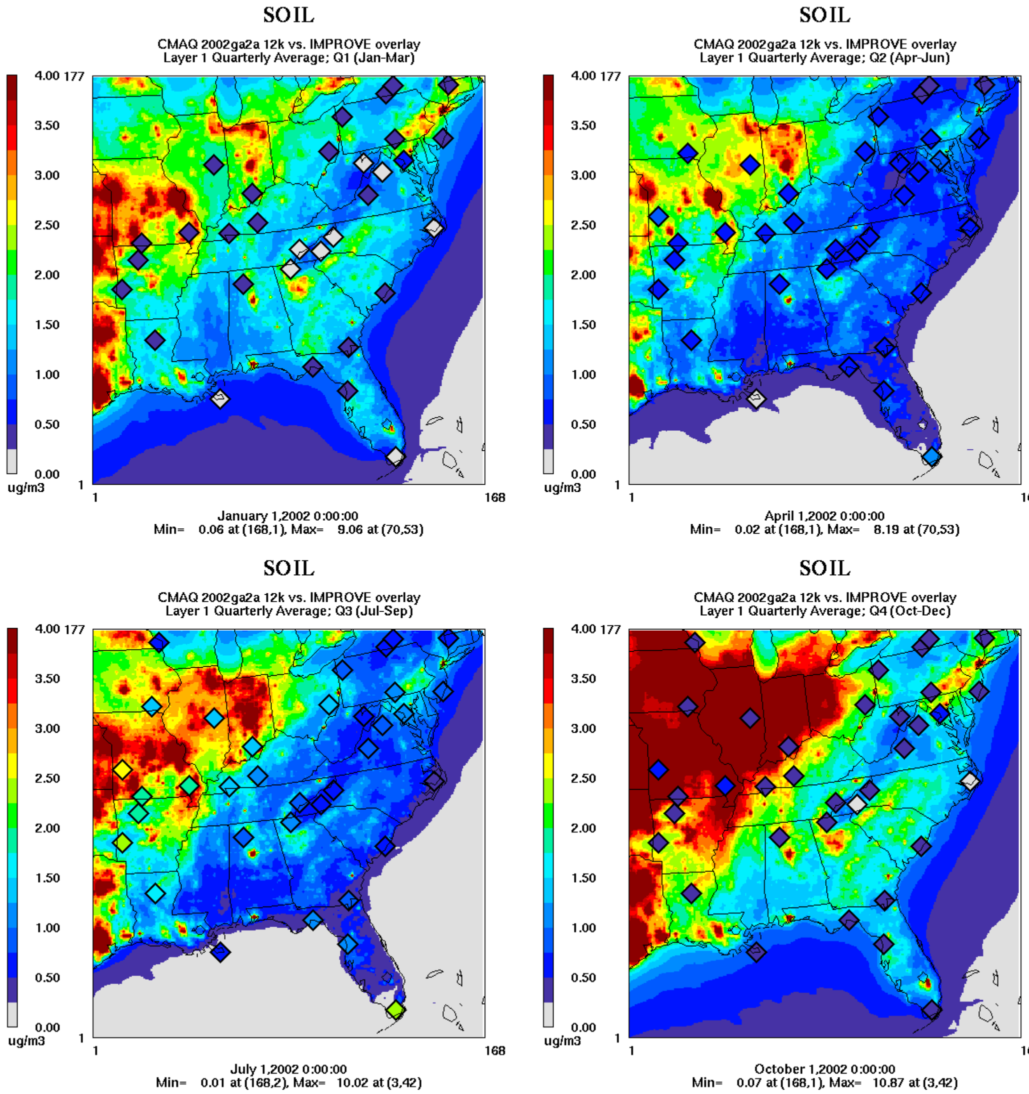


Figure 3-25. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) soil $PM_{2.5}$ (SOIL) concentrations over the VISTAS 12 km domain.

3.6.7 Sea Salt $PM_{2.5}$ (Sea Salt)

Sea Salt $PM_{2.5}$ is measured/calculated at some of the IMPROVE sites only (see Figure C-7 in Appendix C). As expected, higher concentrations are measured at sites along the coastline. This spatial pattern is captured by the model as well; however, concentrations along the coastline are underpredicted compared to the measurements.

The model-estimated Sea Salt $PM_{2.5}$ is not used in the future year $PM_{2.5}$ projections (see Chapter 4; EPA, 2007a), thus the model performance in this case is of relatively little importance. In the future year $PM_{2.5}$ projections, the measured Sea Salt is one of the components of the current year $PM_{2.5}$ and it is assumed to remain constant from the current to future years.

3.6.8 Total $PM_{2.5}$ Mass ($PM_{2.5}$)

A comparison of the quarterly modeled spatial distribution of total $PM_{2.5}$ mass concentrations with observations from the FRM, STN and IMPROVE network are provided in Figure C-8, with the results for the FRM network repeated in Figure 3-26 below. The conclusions on the model performance for total $PM_{2.5}$ mass vary by which network is examined. For Q1 there are elevated $PM_{2.5}$ concentrations in the major urban areas (e.g., Chicago-Gary, St. Louis, Atlanta, Northeast Corridor, etc.) due to concentrated urban emissions. There are also elevated $PM_{2.5}$ mass concentrations for Q1 in the western part of the Georgia-Florida border that is due to biomass burning. The mainly rural IMPROVE monitors fail to capture many of these elevated areas, but does confirm the relative clean conditions in the Appalachian Mountains (Figure C-8c, top left). The IMPROVE St. Marks measured $PM_{2.5}$ levels appears to refute the elevated $PM_{2.5}$ in Q1 along the western Florida-Georgia border. However, the STN (Figure C-8b) and FRM (Figures 3-26 and C-8a) spatial plots confirm that elevated $PM_{2.5}$ levels existed in this area; the lack of elevated $PM_{2.5}$ at St. Marks is likely due to its coastal location and the sea breeze.

During Q2 the model predicts elevated total $PM_{2.5}$ mass levels from St. Louis across the Midwest into Ohio with highest values centered on Indianapolis, in southeastern Pennsylvania and up the Northeast Corridor and in the Birmingham and Atlanta urban areas in the southeast. The IMPROVE monitors suggest that the model is capturing the rural aspect of the spatial distribution of the total $PM_{2.5}$ mass patterns, albeit with an underprediction bias (Figure C-8c, top right). However, the FRM (Figures 3-26 and C-8a) and STN (Figure C-8b) plots indicates that the model is underestimating the spatial extent of the elevated total $PM_{2.5}$ mass levels.

The highest seasonal $PM_{2.5}$ levels occur in the Q3 summer period when increased photochemistry produces the highest SO4 concentrations. The observations indicate that the entire interior portion of the ASIP/VISTAS 12 km grid domain is covered by elevated $PM_{2.5}$ levels, which is reproduced reasonably well by the model. However, the model is estimating slightly lower values and relatively cleaner areas over the Appalachian Mountains that are not supported by the observations. In addition, the observed $PM_{2.5}$ concentration gradient from high to low occurs further south than predicted by the model. However, in general the model is doing a good job in reproducing the spatial distribution of $PM_{2.5}$ in Q3.

In Q4 the model estimates elevated $PM_{2.5}$ levels across the upper Midwest (MO-IL-OH) and southwest (Northern AL and GA, SC and NC) that is split by the Appalachian Mountains and elevated levels in the Northeast Corridor. The IMPROVE network plots confirm the relative cleaner area in the Appalachian Mountains (Figure C-8c) and the STN network plot confirms the three areas of high $PM_{2.5}$ (Figure C-8b). The FRM network spatial map (Figure 3-26 and C-8a) confirms the three areas of elevated $PM_{2.5}$ concentrations, but suggests the southeast area is not as high as the others and that the $PM_{2.5}$ distribution should be spottier.

In conclusion, the model appears to do a good job in reproducing the spatial and temporal variations in $PM_{2.5}$ concentrations across the ASIP/VISTAS 12 km grid albeit with an underprediction bias. The spatial distribution of the modeled $PM_{2.5}$ concentrations is smoother and less spotty than the observed distributions, which is due in part to the coarse 12 km grid spacing used in the modeling.

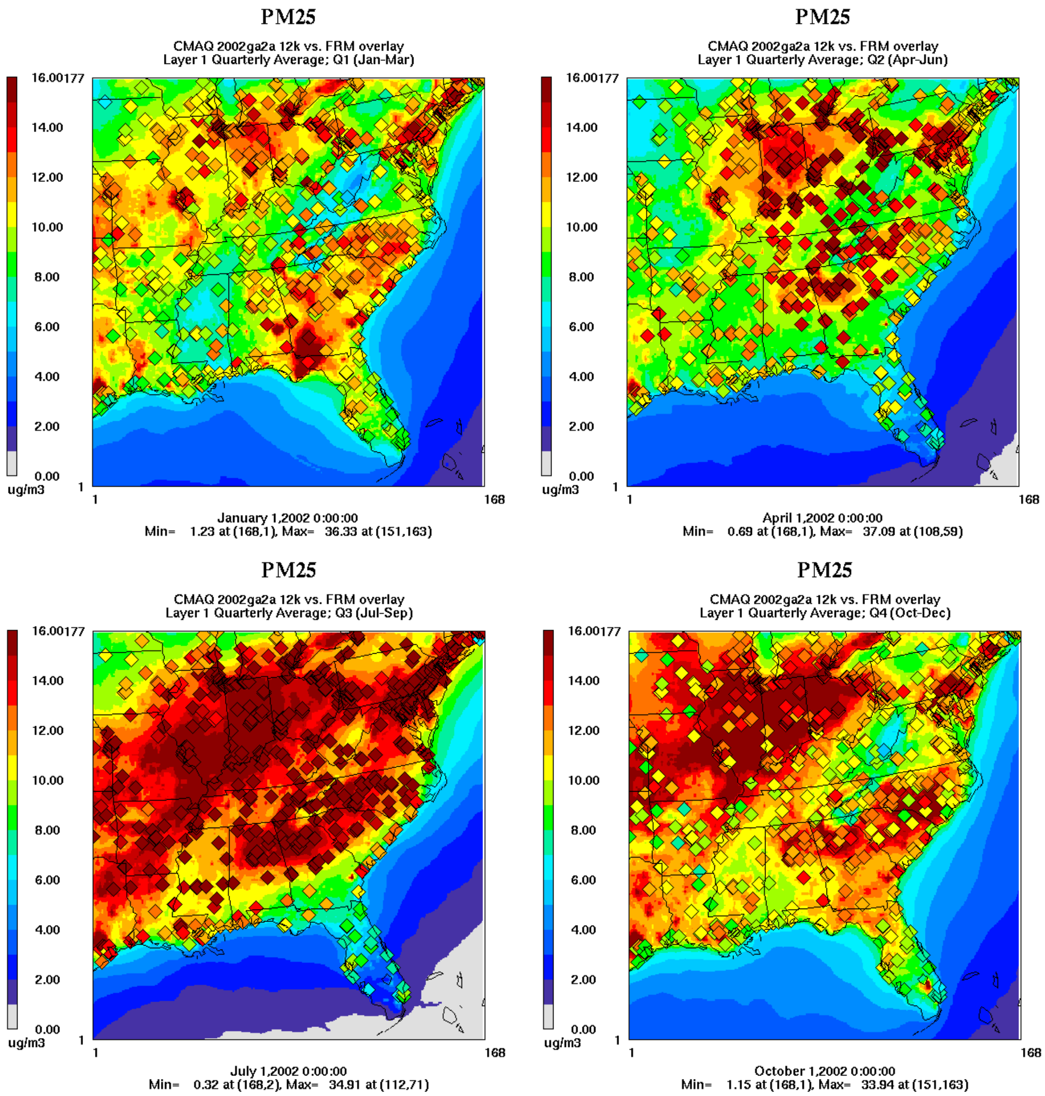


Figure 3-26. 2002 Quarterly averages of CMAQ simulated and FRM observed (diamonds) total $PM_{2.5}$ mass concentrations over the VISTAS 12 km domain.

3.7 OZONE MODEL PERFORMANCE

Ozone model performance for the 2002 Base G2 Actual base case CMAQ 12 km simulation was performed separately for each of the 8 ASIP states, as well as combined across all ASIP states. The ozone model evaluation was conducted for both hourly and 8-hour ozone concentrations and included scatter plots and time series plots of predicted and observed ozone, NOx, NOy and CO concentrations and ozone/NOx and ozone/NOy ratios. Spatial maps of daily maximum hourly and 8-hour predicted ozone concentrations with superimposed observations were also generated for each day of the 2002 calendar year. The graphics and statistical performance measures were calculated separately for each month from 2002. The complete ozone model performance for the 2002 Base G2 CMAQ base case simulation can be found on the project website:

- http://pah.cert.ucr.edu/vistas/vistas2/evaluation_results/2002ga2a.mpe/2002ga2a/

The original ozone model performance goals of ≤±15% and ≤35% were developed for the, respectively, Mean Normalized Bias (MNB) and Mean Normalized Gross Error (MNGE) performance metrics for all predicted and observed hourly ozone concentration pairs for which the observed value is greater than a 60 ppb cut off concentration (EPA, 1991). We have extended this performance goal to PM and the fractional bias and error statistical metrics (see Table 3-3). Below we present some of the key ozone model performance results for hourly ozone and across all 8 VISTAS states and the 5 key months in the ozone season (May through September). Results for 8-hour ozone are similar. Results of the ozone model performance for each individual ASIP state and for 8-hour ozone concentrations are provided on the Project Website listed above.

Table 3-4 lists a summary of the 1-hourly ozone model performance statistics across the 8 VISTAS states using a 60 ppb observed hourly ozone concentrations cutoff threshold. The bias and error performance metrics are compared against EPA's ≤±15% and ≤35% performance goals (EPA, 1991), respectively. Although these performance goals were developed for the MNB and MNGE performance statistics, we also compare them to the Mean Fractional Bias (MFB) and Error (MFE) statistics and Normalized Mean Bias (NMB) and Error (NME) statistical performance measures. The CMAQ 2002 Base G2 model achieves EPA's ozone model performance goals across the ASIP states during May, June, and July. During August and September, the MNB of -15.8% and -16.2% falls barely outside of EPA's performance goal, although the MNGE is well within EPA's performance goal. When looking at the other bias performance metrics, the bias NMB and MFB performance statistics also fail to achieve the ≤±15% performance goal during August and September but are close (≤±17% and ≤±20%, respectively) and the error statistics always achieves the ≤35% performance goal by a wide margin.

Figure 3-27 displays scatter plots of the predicted and observed daily maximum hourly ozone concentrations across sites in the ASIP states for May through August 2002. The data points tend to be centered on the 1:1 line of perfect agreement, although with an underestimation tendency. This underestimation tendency is confirmed with the plots of hourly Normalized Mean Bias (MNB) and Normalizes Mean Gross Error (MNGE) for May through September given in Figure 3-28 (these plots do not use the 60 ppb observed ozone cutoff as used in Table 3-4). During the day, the hourly MNB achieves EPA's performance goal on most days. The MNGE achieves the EPA performance goal almost always during most of the summer of 2002.

Figure 3-29 displays a time series of the predicted and observed hourly ozone concentrations averaged across all monitoring sites in the ASIP region. On average, the modeled hourly ozone concentrations match the observed average during most days during the ozone season, although there is a tendency to underestimate the observed nighttime low ozone concentrations that is likely partly due to the coarse grid (12 km) spacing used that fails to accurately account for the local titration of ozone by fresh NO emissions..

Table 3-4. Summary hourly ozone model performance statistical performance measures across the 8 VISTAS states for the 2002 Base G2 CMAQ 12 km base case.

Month	MNB (%)	MNGE (%)	AOBS (ppb)	APRD (ppb)	RATIO	MB (ppb)	NMB (%)	MFB (%)	ME (ppb)	NME (%)	MFE (%)
Goal	*≤±15%*	*≤35%*					*≤±15%*	*≤±15%*	*≤35%*	*≤35%*	
May	-8.9	13.6	69.1	62.5	0.91	-6.5	-9.5	-11.0	9.6	13.9	15.4
Jun	-12.7	15.8	73.5	63.8	0.87	-9.7	-13.2	-14.9	11.8	16.1	17.8
Jul	-12.2	16.7	73.7	64.2	0.88	-9.5	-12.9	-14.6	12.6	17.1	18.8
Aug	-15.8	18.5	75.4	63.0	0.84	-12.4	-16.5	-18.7	14.3	18.9	21.2
Sep	-16.2	18.5	74.7	62.2	0.84	-12.5	-16.7	-19.3	14.1	18.9	21.4

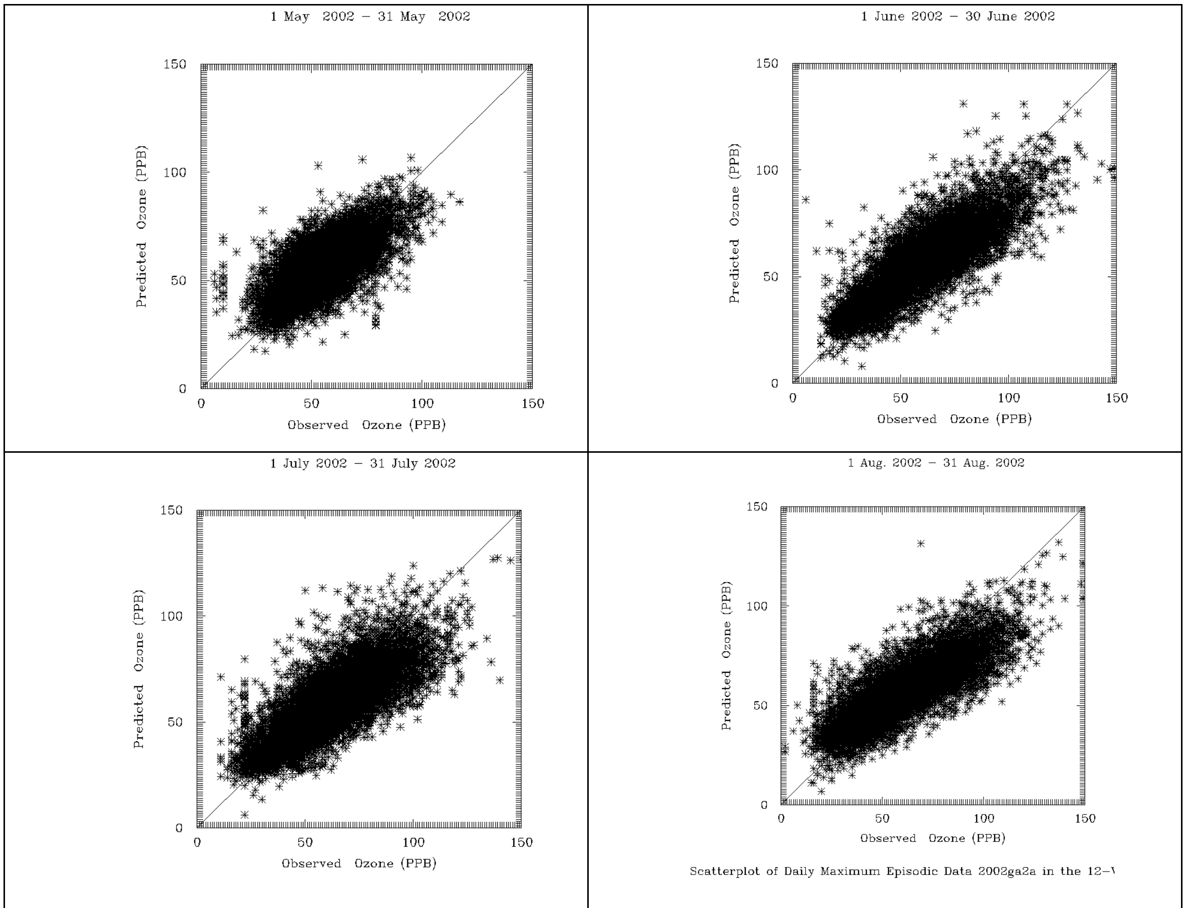


Figure 3-27. Scatter plot of predicted and observed daily maximum 1-hour ozone concentrations at sites in the ASIP states during May (top left), June (top right), Jul (bottom left) and August (bottom right).

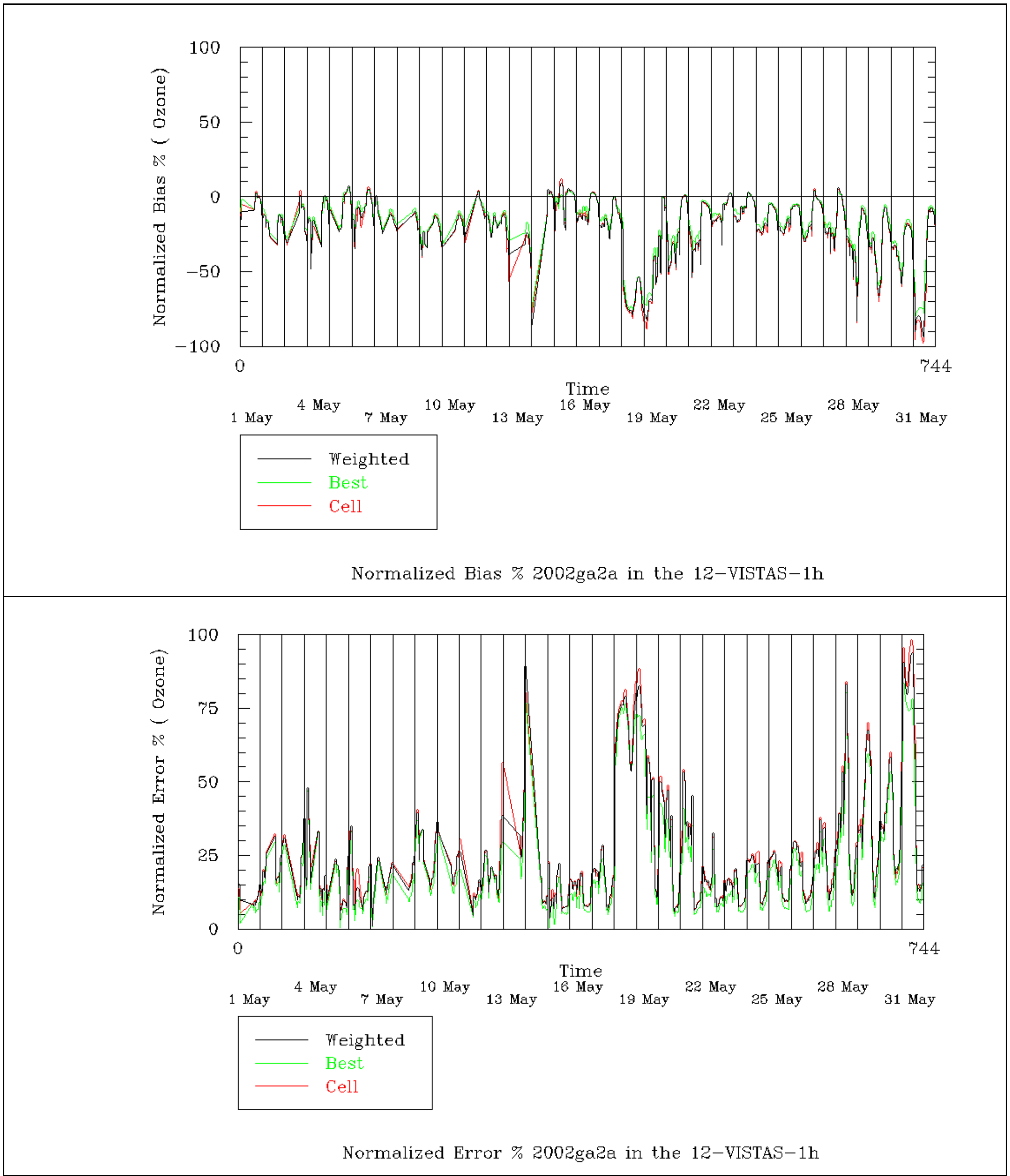
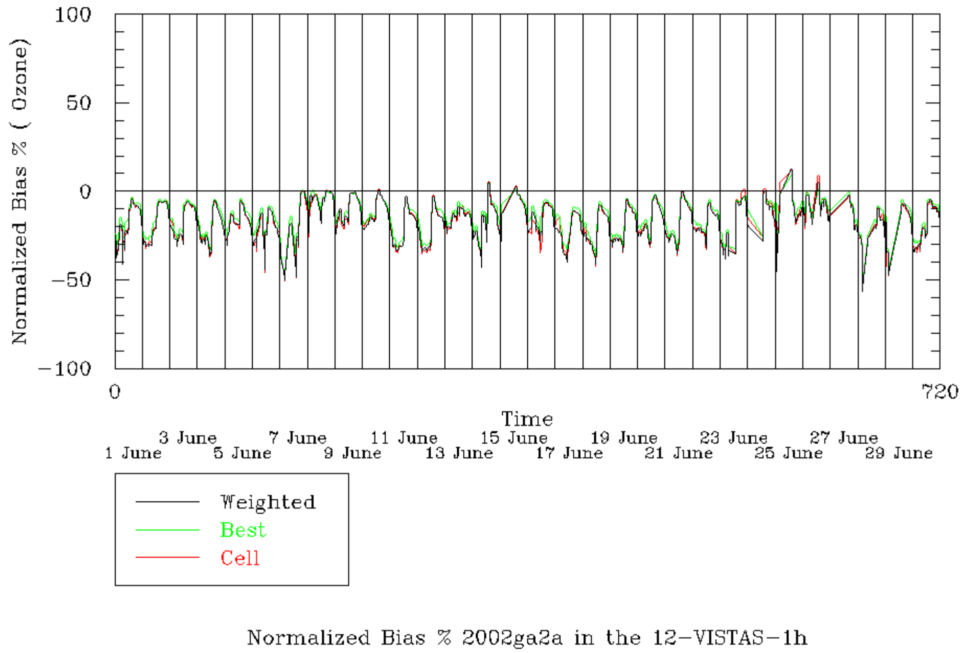


Figure 3-28a. Hourly Mean Normalized Bias (MNB) and Mean Normalized Gross Error (MNGE) for May 2002.



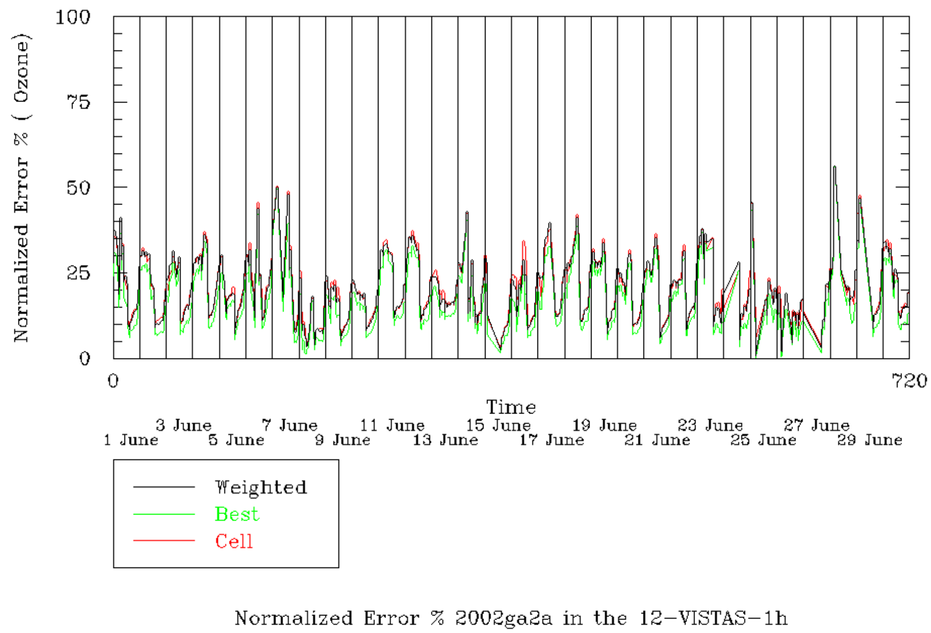
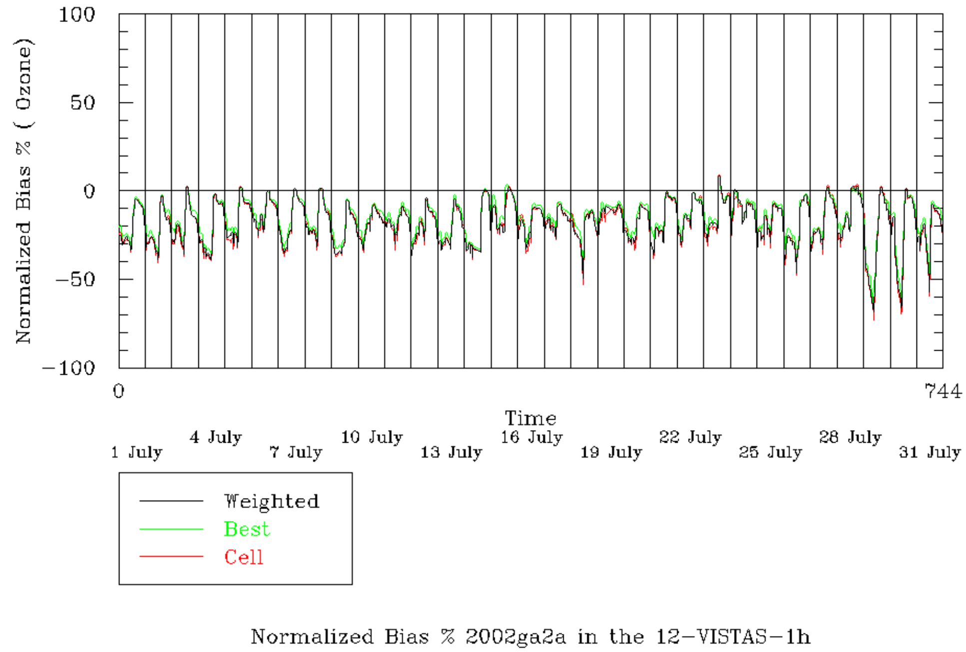


Figure 3-28b. Hourly Mean Normalized Bias (MNB) and Mean Normalized Gross Error (MNGE) for June 2002.



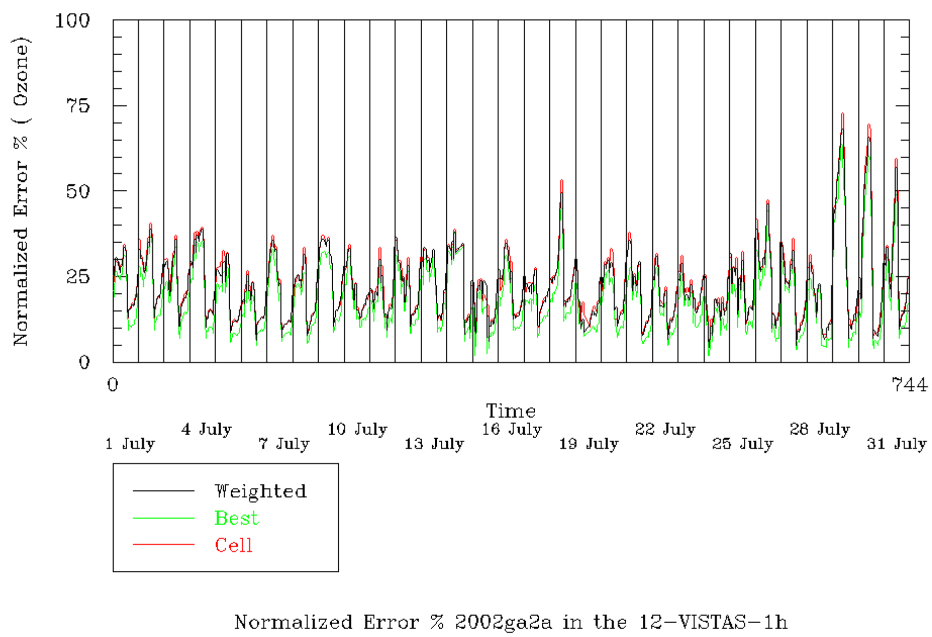
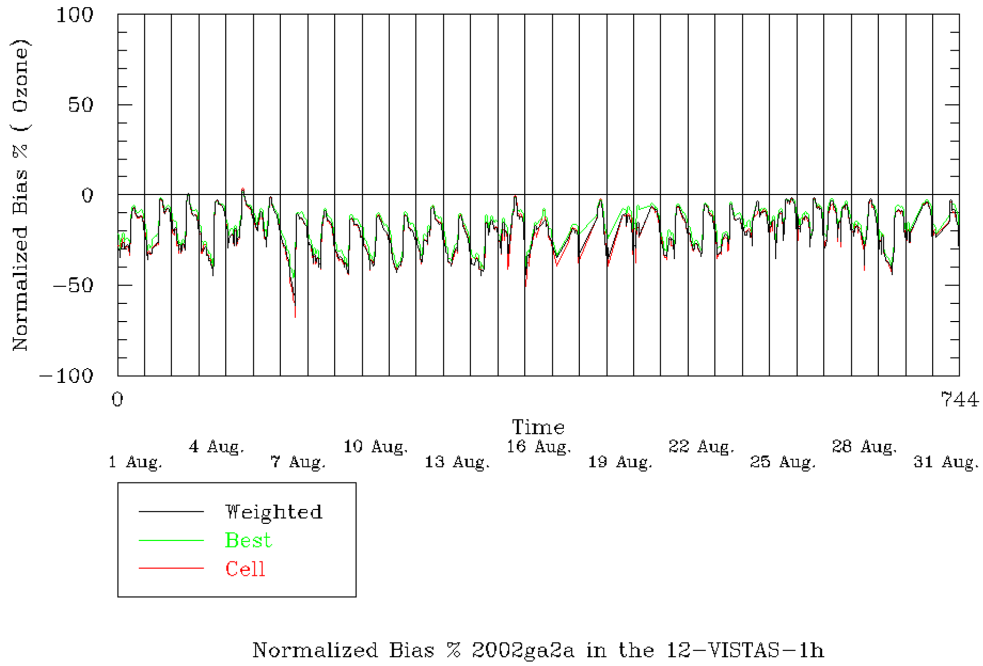


Figure 3-28c. Hourly Mean Normalized Bias (MNB) and Mean Normalized Gross Error (MNGE) for July 2002.



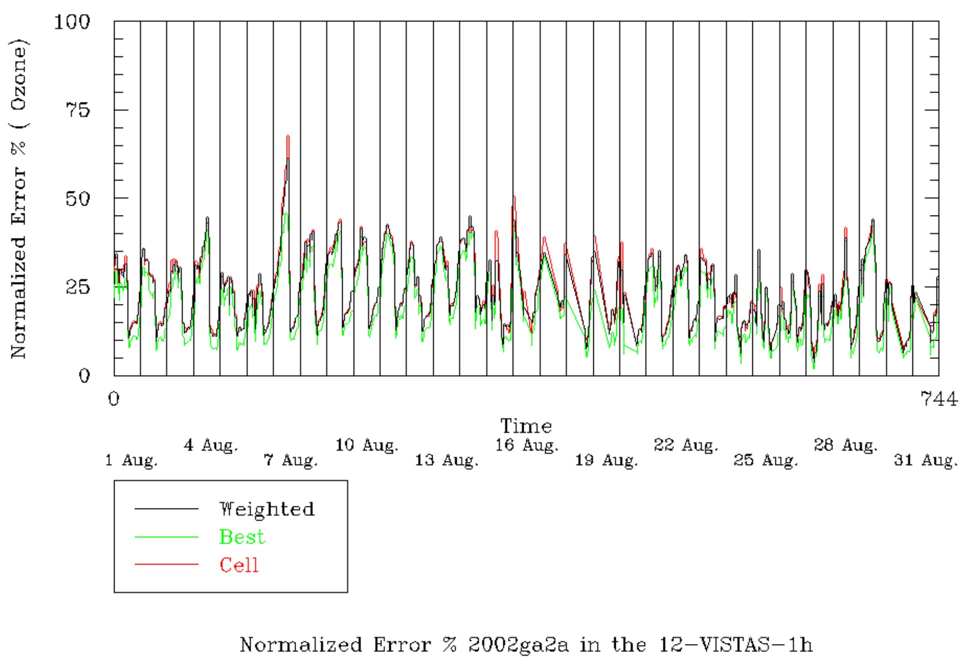
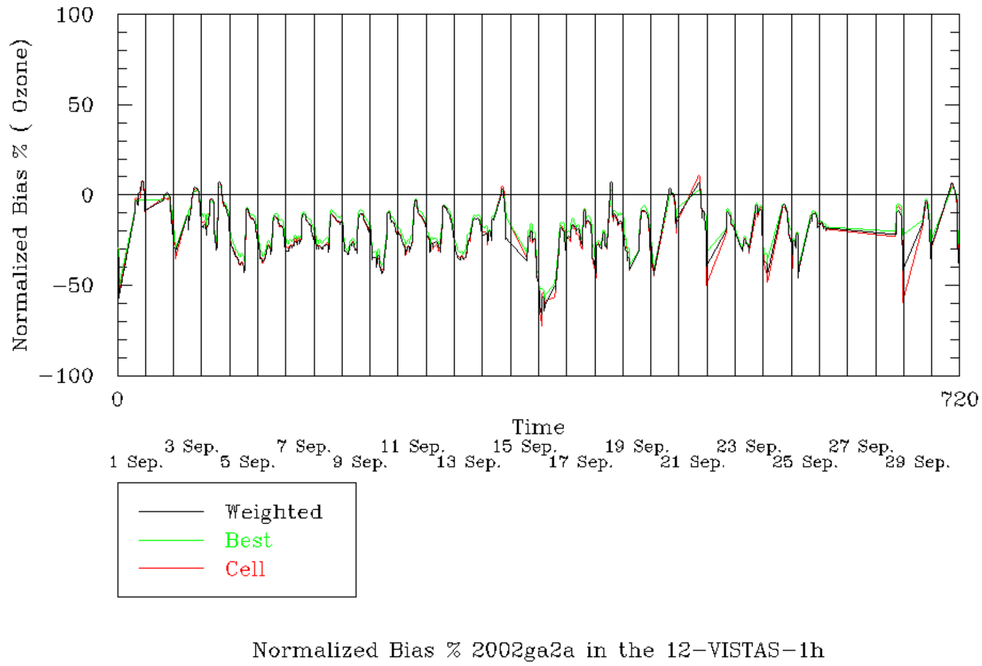


Figure 3-28d. Hourly Mean Normalized Bias (MNB) and Mean Normalized Gross Error (MNGE) for August 2002.



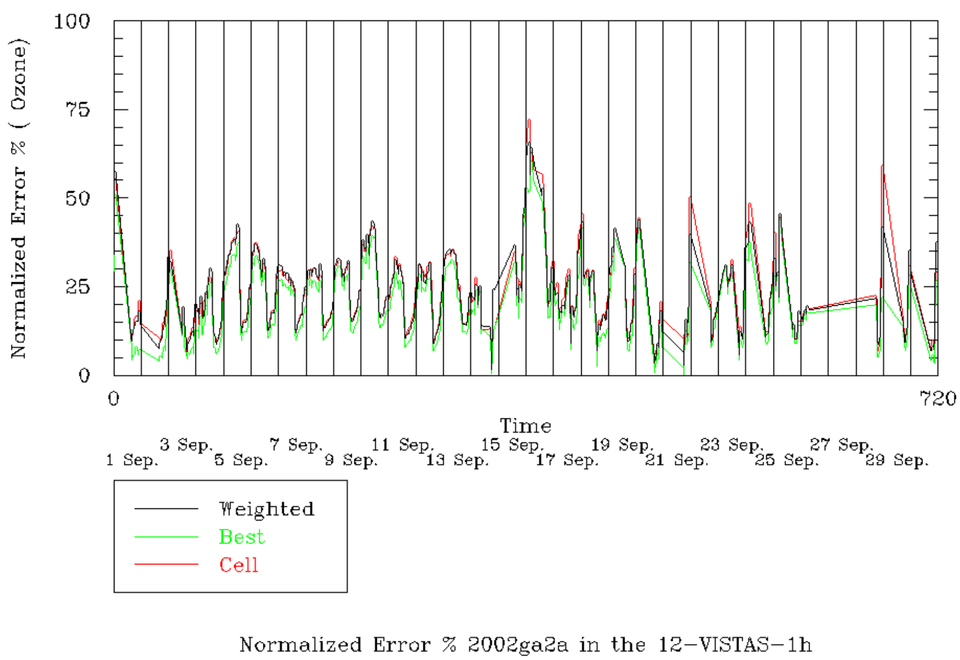
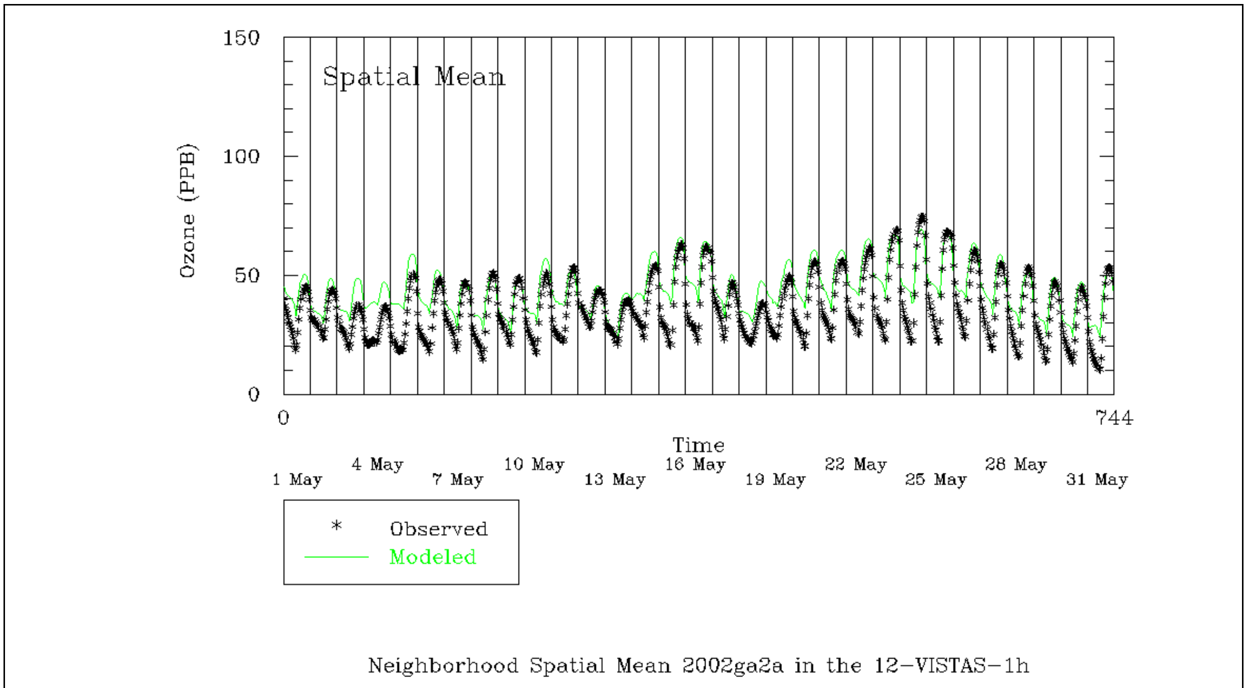


Figure 3-28e. Hourly Mean Normalized Bias (MNB) and Mean Normalized Gross Error (MNGE) for September 2002.



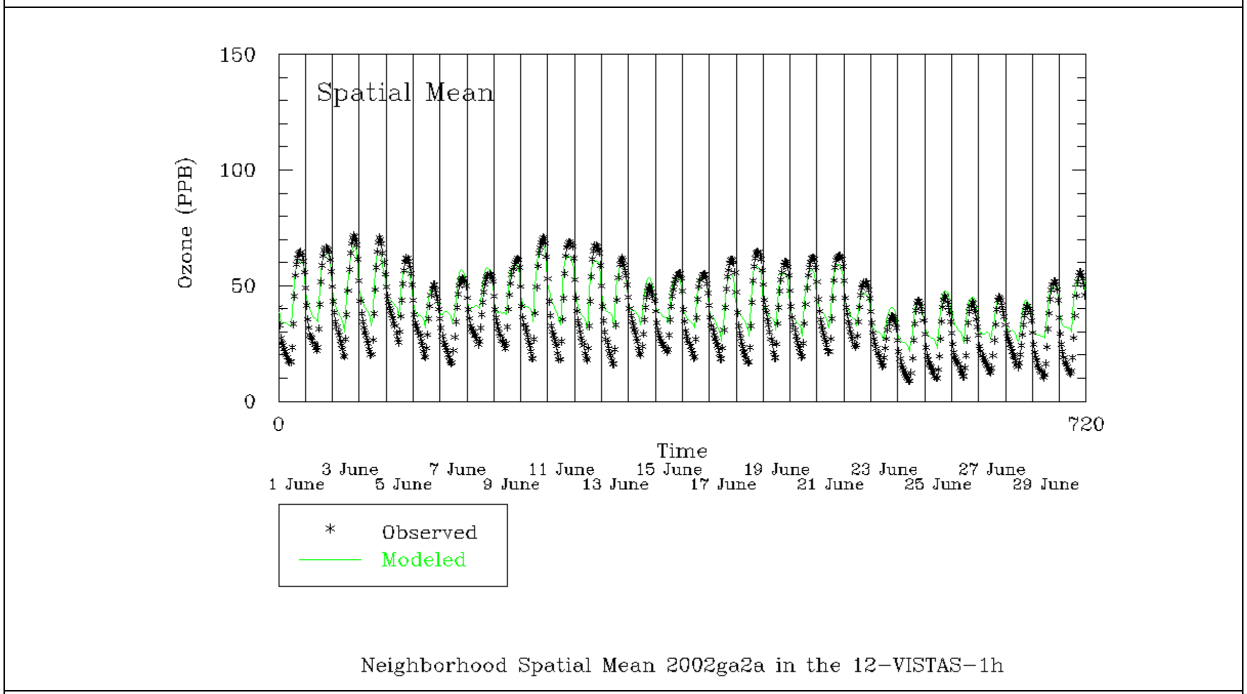
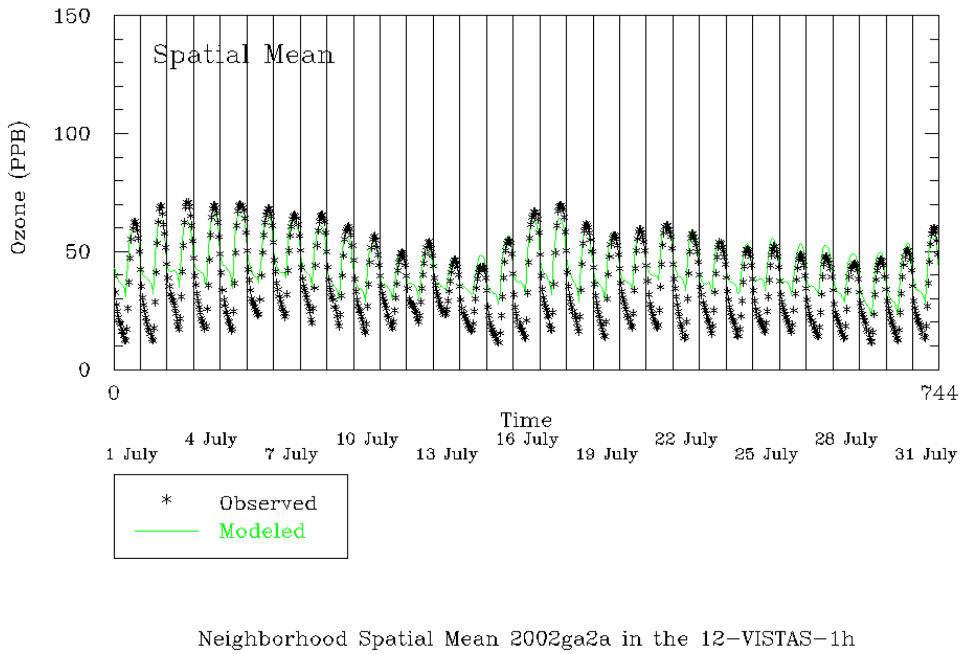


Figure 3-29a. Comparison of predicted and observed hourly ozone concentrations averaged across monitoring sites in the ASIP states during May (top) and June (bottom).



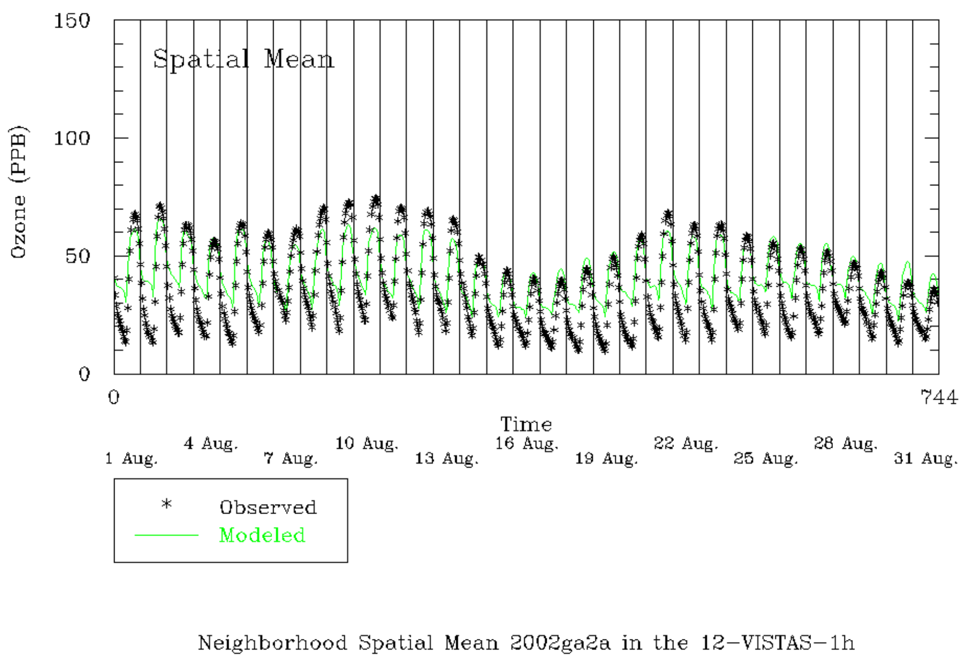


Figure 3-29b. Comparison of predicted and observed hourly ozone concentrations averaged across monitoring sites in the ASIP states during July (top) and August (bottom).

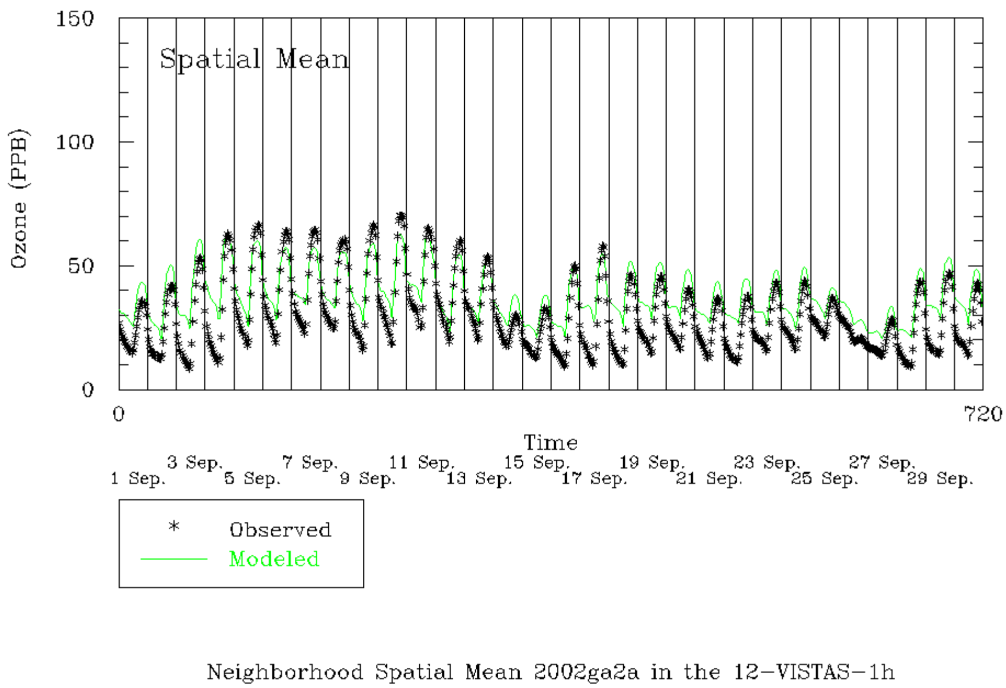


Figure 3-29c. Comparison of predicted and observed hourly ozone concentrations averaged across monitoring sites in the ASIP states during September.

3.8 CONCLUSIONS OF MODEL PERFORMANCE EVALUATION

The quarterly average CMAQ $PM_{2.5}$ component species results near the FRM monitors are used in the Speciated Model Attainment Test (SMAT) to project the current year $PM_{2.5}$ Design Values to the 2009 future year for comparison with the $PM_{2.5}$ NAAQS. SMAT uses the relative changes CMAQ 2002 and 2009/2012 modeling results to scale each of the $PM_{2.5}$ components of the current year $PM_{2.5}$ Design Values. These model derived scaling factors are referred to as Relative Response Factors (RRFs). In Chapter 4 of this TSD, we present the results of the SMAT $PM_{2.5}$ Design Value projections for FRM monitoring sites in and near the ASIP states. These results indicate that most of the reductions in the $PM_{2.5}$ Design Values between 2002 and 2009/2012 are primarily due to reductions in sulfate concentrations. Thus, performance of the model for sulfate is of most importance in the model performance evaluation.

Below we discuss the implications of the major findings in the ASIP model performance evaluation in the context of the modeling results are used to project future year $PM_{2.5}$ attainment through SMAT. The model evaluation of the $PM_{2.5}$ component species was performed by comparing the model predictions against the observed $PM_{2.5}$ components as measured in the IMPROVE and STN networks. The procedures used to speciate the FRM $PM_{2.5}$ mass measurements is different than the IMROVE and STN $PM_{2.5}$ speciation as it accounts for the measurement artifacts in the different networks (see Chapter 4).

- Nitrate (NO3) Underprediction Tendency: NO3 is routinely underpredicted during the summer and adjacent months throughout the ASIP region. This underprediction is due to modeled NOx concentrations near zero, when observed values are low, but above zero (typically < 1 μg/m^3). However, NO3 is almost always a very minor to insignificant contributor to total $PM_{2.5}$ mass at FRM monitors in the ASIP region (see stacked bar charts in Chapter 4). In fact, the maximum NO3 contribution to a 2009 projected $PM_{2.5}$ Design Value is 1.0 μg/m^{3}with a median value of 0.2 μg/m^3. Thus, the NO3 performance issues are not a big concern in the $PM_{2.5}$ projections.

- Organic Carbon Mass (OCM) Underpredictions: The OCM underprediction bias is a cause for concern since it is a major component of the $PM_{2.5}$ mass at ASIP FRM monitoring sites with maximum contributions to the 2009 $PM_{2.5}$ Design Values of ~8 μg/m^3, minimum values of ~3 μg/m^3 and a median value of ~4 μg/m^3. The reasons for the underestimation of OCM are unclear, but the fact that the underpredictions are higher in the urban than rural areas suggest that there may be missing anthropogenic emission sources, or possibly the urban OCM emissions are over diluted across the 12 km grid resolution used in the ASIP modeling, or both. The changes in projected OCM concentrations between the current and projected $PM_{2.5}$ Design Values are mostly less than 5% (i.e., $0.95 < RRF_{OCM} < 1.05$). Thus, the changes in OCM between the current and future year are having a minor influence on the projected $PM_{2.5}$ Design Values.

- Elemental Carbon (EC) Performance Issues: The EC underprediction bias at the urban sites is partly due to over dilution of the urban EC emissions due to the coarse (12 km) grid used. For the most part, the CMAQ model performed well for EC and the underprediction would not affect the relative changes in the model response to anthropogenic EC emissions changes. Therefore, any EC performance issues are not a cause for concern, although the model performance for EC was generally good.

- Sulfate (SO4) Underprediction Bias: Although SO4 is performing well, it does have an underprediction bias that is largest in the summer months. But this underprediction is not severe and the model appears to be capturing the temporal and spatial variations in the observed sulfate well and is responding to the SO2 emission reductions between 2002 and 2009/2012 in a manner as expected. Thus the model performance indicates that the modeled relative changes in SO4 concentrations are likely a valid response.

- Soil Performance Issues: The CMAQ performance for the Soil species is quite poor. This Soil component of the 2009 projected $PM_{2.5}$ Design Value ranges from 0.4 to 1.8 μg/m^3. The RRFs for Soil indicate that it is mostly increasing, with summer (Q3) Soil RRFs typically ranging from 1.0 to 1.3.

SO4 reductions dominate the changes in $PM_{2.5}$ Design Values between 2002 and 2009. SO4 performance is quite good in the CMAQ 2002 Base G2 Actual base case simulation almost always achieving the PM performance goal and frequently also achieving the more stringent ozone performance goal. These factors provide confidence in the future-year $PM_{2.5}$ Design Value projections using the CMAQ Base G modeling results.

The ozone model performance almost always achieves EPA's ozone model performance goals (EPA, 1991), albeit with an underestimation tendency. The ozone performance is comparable to that seen in many SIPs and it was judged sufficiently good, that the modeling system can produce reliable future year ozone projections.

4.0 $PM_{2.5}$ AND 8-HOUR OZONE PROJECTIONS

This section presents the future-year $PM_{2.5}$ and 8-hour ozone Design Value projections for, respectively, $PM_{2.5}$ Federal Reference Method (FRM) and ozone compliance monitoring sites within and near the ASIP region and their comparison with the annual $PM_{2.5}$ and 8-hour ozone National Ambient Air Quality Standards (NAAQs). Future-year annual $PM_{2.5}$ and 8-hour ozone Design Value projections are made for the 2009, 2012 and 2018 years. These projections are based on the ASIP 2002 Typical Base G2 and 2009 and 2012 Base G4 and VISTAS 2018 Base G4 CMAQ 12 km modeling results. The 2009, 2012 and 2018 Base G4 modeling results are also referred to as the Best and Final emission scenarios. The results the unmonitored area analysis is also presented in this section. All of the $PM_{2.5}$ and 8-hour ozone projections presented in this chapter are made using EPA's Modeled Attainment Test Software (MATS; http://www.epa.gov/scram001/modelingapps_mats.htm).

4.1 GUIDANCE FOR $PM_{2.5}$ PROJECTIONS

EPA has published final modeling guidance that includes recommendations on how modeling results should be used to project future-year $PM_{2.5}$ and 8-hour ozone levels:

> "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze" (EPA, 2007a)[1].

EPA recommends that the modeling results be used in a relative fashion to scale the observed current-year $PM_{2.5}$ Design Value (DVC) to project a future-year $PM_{2.5}$ Design Value (DVF). The model derived scaling factors are called Relative Response Factors (RRFs) and are defined as the ratio of the future-year to current-year modeling results. The future-year $PM_{2.5}$ Design Values (DVF) are obtained from the current-year $PM_{2.5}$ Design Values (DVC) by applying the RRF to the DVC:

$$DVF = DVC \times RRF$$

Separate RRFs are applied for each major component of $PM_{2.5}$ using a procedure called the Speciated Modeled Attainment Test (SMAT). The RRFs are PM species-specific and monitoring site-specific and are derived using modeling results "near" each monitor. The SMAT procedure applies the PM species-specific RRFs to the six major components that make up the $PM_{2.5}$ DVC to obtain future-year $PM_{2.5}$ species estimates that are summed to obtain the DVF that is compared with the $PM_{2.5}$ NAAQS. The six major components of $PM_{2.5}$ that are projected from the current to future-year are:

- Sulfate (SO4);
- Nitrate (NO3);
- Ammonium (NH4);
- Elemental Carbon (EC);
- Organic Carbon Mass (OCM); and
- Other $PM_{2.5}$ or Fine Crustal Matter (also called Soil).

[1] http://www.epa.gov/scram001/guidance/guide/final-03-pm-rh-guidance.pdf

Also included in the current-year and future-year $PM_{2.5}$ concentrations are particle bound water (PBW), which is associated with the hygroscopic species (SO4 and NO3), sea salt and a blank correction measurement artifact that is assumed to be 0.5 $\mu g/m^3$. Both sea salt and the blank correction remain constant from the current-year to future-year. The PBW is calculated using site-specific meteorological parameters and the hygroscopic components of the $PM_{2.5}$, which is assumed to be SO4 and NO3.

The current $PM_{2.5}$ State Implementation Plans (SIPs) are addressing the 1997 $PM_{2.5}$ NAAQS that have thresholds of 15.0 $\mu g/m^3$ annual and 65 $\mu g/m^3$ 24-hour $PM_{2.5}$ concentrations. Currently, all FRM monitors in ASIP states attain the 65 $\mu g/m^3$ 24-hour $PM_{2.5}$ NAAQS so projections are only made for the annual $PM_{2.5}$ NAAQS. Note that in 2006 EPA revised the 24-hour $PM_{2.5}$ NAAQS with a new threshold of 35 $\mu g/m^3$. The new 35 $\mu g/m^3$ 24-hour $PM_{2.5}$ NAAQS will be addressed in future $PM_{2.5}$ SIP actions.

$PM_{2.5}$ attainment is based on $PM_{2.5}$ mass measurements collected at FRM monitoring sites. In order to apply the $PM_{2.5}$ species-specific RRFs, the FRM $PM_{2.5}$ mass measurements must be speciated into the components of $PM_{2.5}$. There are two routine $PM_{2.5}$ speciation networks being operated in the U.S.: (1) the Speciated Trends Network (STN)[2]; and (2) the Interagency Monitoring of Protected Visual Environments (IMPROVE) networks. Thus, the $PM_{2.5}$ speciation from these two networks need to be mapped to the FRM $PM_{2.5}$ mass measurements in order to apply the RRFs to project future-year $PM_{2.5}$ Design Values. This results in two main components for using modeling results to project future-year $PM_{2.5}$ Design Values:

> Speciation of Measured FRM $PM_{2.5}$ Mass using the SANDWICH Method: The FRM $PM_{2.5}$ mass and STN/IMPROVE $PM_{2.5}$ speciation measurements have positive and negative artifacts that need to be accounted for when mapping observed $PM_{2.5}$ speciation data to the FRM mass measurements. As $PM_{2.5}$ attainment is based solely on the FRM $PM_{2.5}$ mass measurements, then the STN/IMPROVE $PM_{2.5}$ speciation measurements must be adjusted to mimic the FRM $PM_{2.5}$ mass measurements. EPA has developed the **S**ulfate **A**djusted **N**itrate, **D**erived **W**ater **I**nferred **C**arbon **H**ybrid material balance approach (SANDWICH) for estimating $PM_{2.5}$ mass composition produced by the FRM $PM_{2.5}$ mass measurements to account for measurements artifacts (Frank, 2006a,b).

> Projection of Current-Year $PM_{2.5}$ Components to Future-Year using SMAT: The procedures for using the relative changes in modeled concentrations to project current observed $PM_{2.5}$ Design Values to the future is termed the Speciated Modeled Attainment Test (SMAT) (EPA, 2007a; Timin, 2007).

EPA has codified the SMAT recommended procedures (EPA, 2007a) for projecting future-year 8-hour ozone and $PM_{2.5}$ Design Values and regional haze in a software tool known as the Modeled Attainment Test Software (MATS; http://www.epa.gov/scram001/modelingapps_mats.htm). The latest version of MATS at this writing (Version 1.5.1 dated June 6, 2008) includes procedures for projecting 8-hour ozone, annual $PM_{2.5}$ and regional haze, but not 24-hour $PM_{2.5}$. Previous versions of MATS before January 2008 did not have a capability for making annual $PM_{2.5}$ projections. Thus, ASIP had to develop their own $PM_{2.5}$ projection software that was used to make the ASIP $PM_{2.5}$ Design Value

[2] The STN network is now referred to as the Chemical Speciation Network (CSN).

projections in previous versions of the ASIP $PM_{2.5}$ TSD. In this version of the TSD, we have switched to using the MATS $PM_{2.5}$ projection procedures in this Chapter. The $PM_{2.5}$ projections using the ASIP projection approach are used to corroborate the MATS $PM_{2.5}$ projections and are presented as additional analysis in Chapter 5.

The MATS $PM_{2.5}$ projection procedures used SANDWICH STN and IMPROVE speciated $PM_{2.5}$ data that have been imported in the MATS tool. The speciated $PM_{2.5}$ measurements are then interpolated to the FRM monitoring sites where they are used to speciate FRM $PM_{2.5}$ mass measurements. As stated in EPA modeling guidance (EPA, 2007a), the starting point for the future-year $PM_{2.5}$ Design Value projections (i.e., the current year Design Value, DVC) is the average of the three years of Design Values straddling the 2002 modeling year. Thus, this results in an average of the $PM_{2.5}$ Design Values from 2000-2002, 2001-2003 and 2002-2004. This has the effect of weighting the annual average PM concentrations by factors of 1, 2, 3, 2 and 1 for the years 2000-2004, respectively.

In the SMAT procedure, the RRFs are applied separately to the quarterly average components of the current year $PM_{2.5}$ Design Value (DVC). When developing the quarterly PM species components of the monitor DVCs from the FRM $PM_{2.5}$ mass and SANDWICH $PM_{2.5}$ speciation, the 24-hour average concentrations from each sample day are averaged across each quarter with quarters defined in 3-month increments (e.g., Quarter 1 is January-February-March). The FRM, STN and IMPROVE typically use a 1:3 day sampling frequency, which results in approximately 30 days per quarter used in the averaging for one year assuming complete data capture. For the quarterly averaged modeled RRFs, the quarterly averages are obtained by averaging across every modeled day in each quarter of 2002. Thus, Quarters 1 through 4 are based on modeled averages across 90, 91, 91 and 91 days, respectively. Note that the full day of December 31, 2002 is not simulated by the model because the MM5 meteorological data stops at midnight GMT so the conversion to local standard time loses the end of the day. Also note that no attempt was made to develop modeled quarterly average RRFs using the same 1:3 day FRM/STN/IMPROVE monitoring site sampling frequency. Although the FRM/STN 1:3 sampling frequency protocol specifies the same days, in practice samples at some sites may be skipped. Also if a sampling day is missed there may be a make up day outside of the standard 1:3 day protocol, in addition samples at some sites may be declared invalid so will be missing. And finally some sites use a 1:6 day sampling frequency.

4.2 PROCEDURES FOR SANDWICH SPECIATION OF STN/IMPROVE $PM_{2.5}$ COMPONENTS

The SANDWICH procedure is designed to map the STN/IMPROVE $PM_{2.5}$ speciation measurements to the FRM $PM_{2.5}$ mass measurements accounting for the artifacts and sampling protocols of both of the sampling devices. $PM_{2.5}$ attainment is based solely on the FRM $PM_{2.5}$ mass measurements, which were developed by design to emulate the $PM_{2.5}$ mass measurements from the epidemiological studies that formed the basis for the $PM_{2.5}$ NAAQS (CFR, 1997). The FRM mass sampling procedures include a specific sampling protocol that involves sampling PM at a 2.5 μm cut point and filter temperature control, rapid sample retrieval and cold filter shipping. The $PM_{2.5}$ mass is determined by gravimetrically weighing the pre- and post-sampling Teflon filters that have been equilibrated for a minimum of 24 hours at standardized conditions of 25-30 degrees C temperature and 30-40% relative humidity (RH). This results in the FRM $PM_{2.5}$ mass measurements not capturing all particles and reflects loss of volatile species including ammonium nitrate [NH_4NO_3] and semi-volatile organic compounds (SVOC), which are negative artifacts in the FRM sampling. The FRM measurements also include particle bound water (PBW) associated with hygroscopic species, which is a positive artifact.

The SANDWICH uses a mass balance approach to adjust the STN and IMPROVE speciated $PM_{2.5}$ measurements to characterize the FRM $PM_{2.5}$ mass. In addition to addressing the artifacts of the FRM sampling procedures, it also addresses the artifacts and sampling protocol of the STN filter measurements accounting for blank correction and inaccuracies in the STN organic carbon measurements. In particular the SANDWICH approach uses the STN measured sulfate, adjusted nitrate, derived PBW and inferred organic carbon. The SANDWICH assumes that the FRM $PM_{2.5}$ mass consists of the following components:

FRM $PM_{2.5}$ Mass = [SO4] + [EC] + [$NO3_{FRM}$] + [$NH4_{FRM}$] + [OCM_{mb}] + [water] + [crustal material] + [sea salt] + [blank correction]

where,

[SO4] is the measured sulfate ion, which for ASIP is taken as the SO4 fraction of the STN $PM_{2.5}$ from the STN site associated with the FRM monitor;

[EC] is the measured elemental carbon from the associated STN monitor;

[$NO3_{FRM}$] is the NO3 ion retained on the FRM filter after a portion as been volatilized in the FRM measurement process;

[$NH4_{FRM}$] is the NH4 cation retained on the FRM filter after partial volatilization;

[OCM_{mb}] is the organic carbon material that is obtained as the difference between the FRM $PM_{2.5}$ mass measurements and the remainder of the $PM_{2.5}$ components;

[water] is particle bound water to the hygroscopic PM components;

[crustal material] is soil and other inorganic fine particulate matter;

[sea salt] is the measured sea salt that is assumed to remain constant between the current- and future-years; and

[blank correction] is the passively collected PM material in the STN measurement process that is assumed to be 0.5 µg/m^3 and is assumed to remain constant from the current- to future-year.

4.2.1 Retained Particulate Nitrate [$NO3_{FRM}$]

The first step in the SANDWICH procedure for identifying mass components was to estimate the retained nitrate mass on the FRM filters. The FRM does not capture all of the semi-volatile components of the ambient air, such as ammonium nitrate. The retained amount of nitrate ion, however, can be reasonably estimated by a simple thermodynamic model that uses 24-hour ambient nitrate speciation concentrations (as measured by a standard speciation sampler using a nylon filter preceded by a HNO3 denuder) together with hourly ambient temperature and humidity. Atmospheric nitrates are higher during the cooler months. Retention on the FRM is also higher during the cooler months and essentially all the nitrates are lost during the summer. The retention does not appear to depend on ambient NH3 or HNO3. More NO3 is retained at low temperatures and high humidity which varies by sampling location and time of year.

Because nitrate retention varies by site and season, the Aerosol Inorganic Model (AIM) ammonium nitrate equilibrium model is used to predict the amount of nitrates retained on the FRM Teflon filter under the FRM sampling conditions (35% RH and 21 C). As used by Hering and Cass (Hering and Cass, 1999; Zhang and McMurry, 1992) the amount of volatilized nitrate (delta NO3) is defined by:

$$\text{delta NO3 } (\mu g/m^3) = 745.7/T_R * 1/24 * \sum_{i=1}^{24} (\mathbf{K}_i^{1/2})$$

where, T_R is the reference temperature for the sampled air volume in degrees Kelvin and $\mathbf{K_i}$ is the dissociation constant for ammonium nitrate evaluated at the ambient temperature for hour i. This volatilization prediction characterizes depletion of some or all of the nitric acid and ammonia vapors ahead of the filter and specifies a 3-5 degree Kelvin increase in the filtration temperature above ambient.

This model is used to adjust 24-hour STN nitrate ion (NO3-) concentrations [$NO3_{STN}$] to estimate FRM NO3 [$NO3_{FRM}$] as follows:

$$NO3_{FRM} = NO3_{STN} - \text{delta NO3 } (\mu g/m^3)$$

For each hour of the day, the equilibrium dissociation constant for ammonium nitrate, K_i, was calculated from hourly ambient temperature and hourly ambient relative humidity based on formulas developed by Mozurkewich (1993) and as applied by Chang and co-workers (2000).

When RH is less than deliquescence point of ammonium nitrate (61%), then:

$$\ln(K) = 118.87 - (24084/T) - 6.025 \ln(T)$$, where K is in nanobars and T is in Kelvins

When RH is higher than 61%, K is replaced by

$$K' = [P_1 - P_2(1-a) + P_3(1-a)^2]\,(1-a)^{1.75} * K$$

where ln(P1), ln(P2) and ln(P3) are specified as:

$$\ln(P_1) = -135.94 + 8763/T + 19.12\ln(T)$$
$$\ln(P_2) = -122.65 + 9969/T + 16.22\ln(T)$$
$$\ln(P_3) = -182.61 + 13875/T + 24.46\ln(T)$$

The above equation for K' assumes crystallization of ammonium nitrate when RH is less than 61%. Thus, predicted NO3 loss may be underestimated for situations where solids do not form on the filter. For supersaturated solutions and with lower RH, the estimated dissociation for the solution will be larger than K for the solid. However, there is little (or no) data that can be used to give a reliable result for how much larger.

Based on the equations above, Figure 4-1 illustrates the potential nitrate loss as a function of temperature and relative humidity. Temperature is presented as degrees F for more convenient interpretation. It shows that at 50 deg F and RH of 80%, approximately 1.6 $\mu g/m^3$ nitrate would be lost. At RH less < 61% an additional 0.4 ug/m3 could be lost. In both cases, the loss cannot exceed the amount of ambient NO3, as depicted by the STN NO3.

When these predictions are compared with measured FRM nitrates at six eastern US monitoring locations, the annual average prediction errors are less than -0.3 to +0.1 $\mu g/m^3$ (Frank, 2006a).

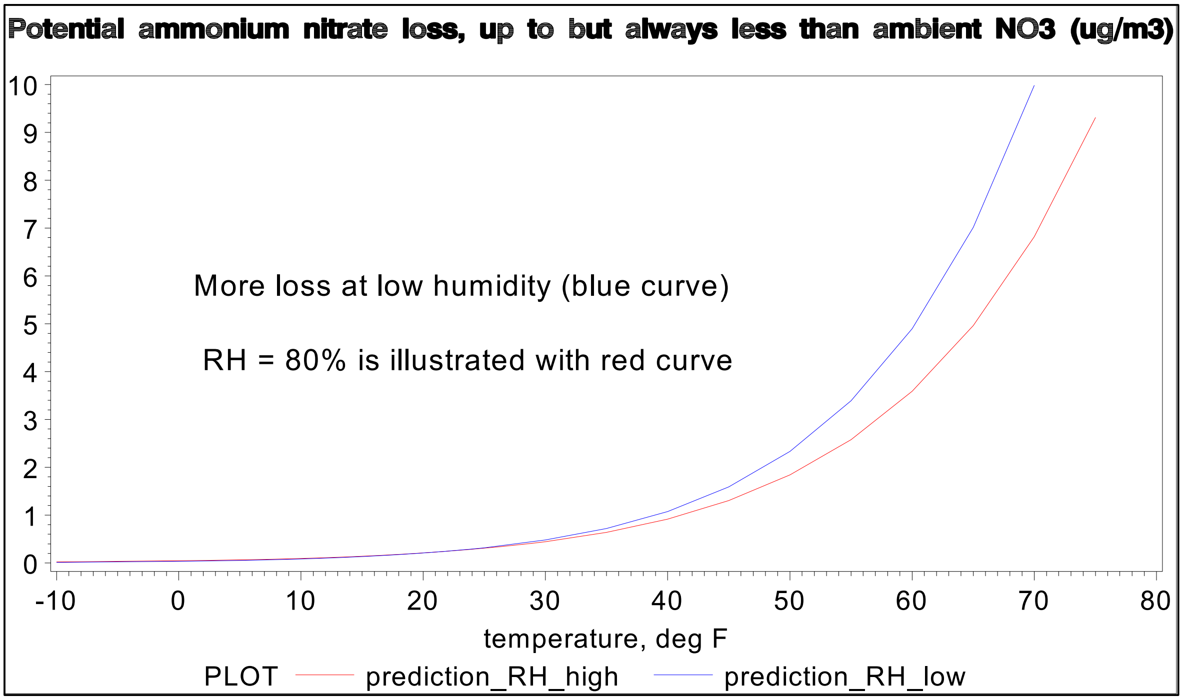


Figure 4-1. Potential NO3 loss (delta NO3) as a function of temperature and relative humidity.

4.2.2. Estimated Ammonium Associated with Sulfate and Retained Nitrates and Sulfates

To determine the mass associated with nitrates, the SANDWICH approach assumes that all retained nitrate is in the form of ammonium nitrate, which is likely an accurate assumption over most of the ASIP southeastern U.S. region. Although in coastal areas, nitrate may also be neutralized by sodium. However, sodium nitrate concentrations would mainly be in the coarse PM mode so would not be collected on the FRM or STN $PM_{2.5}$ samplers. Assuming that all of the particulate nitrate is in the form of ammonium nitrate, the ammonium associated with nitrates can be derived directly from the FRM retained $NO3_{FRM}$ as:

$$NH4_{NO3} = 0.29 * NO3_{FRM}$$

Similarly, the dry $PM_{2.5}$ mass associated with ammonium nitrate is:

$$[\text{Retained dry FRM Ammonium Nitrates}] = 1.29 * NO3_{FRM}$$

4.2.3 Ammoniated Sulfate Mass

The mass associated with sulfates is first estimated as its dry mass. All estimated sulfates are assumed to be associated with ammonium, but the form of the sulfate compound and the amount of ammonium must be estimated. The form of the ammoniated sulfate compound(s) and the amount of associated ammonium, however, is somewhat uncertain.

Sulfates may not be fully neutralized in all geographic areas or seasons of the year. During winter-time conditions, when nitrates are prevalent in the ambient aerosol, sulfates tend to be fully neutralized and exist as ammonium sulfate [$(NH_4)_2SO_4$]. During the summer, when sulfates are higher and nitrates are lower and ammonia is less available for reaction with H_2SO_4, the resulting aerosol can be acidic and the form of sulfates can include ammonium bisulfate [NH_4SO_4] or even H_2SO_4.

The amount of ammonium associated with the sulfate ion can be estimated as:

$$NH4_{(SO4)} = NH4_{FRM} - 0.29 * NO3_{FRM},$$

where, 0.29 is the molar ratio of NH4 to NO3 and
$NH4_{FRM}$ and $NO3_{FRM}$ reflect the amounts retained on the FRM filter.

The amount of $NH4_{(SO4)}$ is not allowed to exceed the fully neutralized amount of 0.375 multiplied by the estimated sulfate ion concentration.

Because of uncertainties in NH4 speciation measurements and the fact that the IMPROVE monitoring network does not measure NH4, NH4 is calculated by deriving the degree of sulfate neutralization (DON) from the estimated $NH4_{(SO4)}$ as:

$$DON = NH4_{(SO4)} / SO4$$

The DON is assumed to remain constant from the current-year to future-year. Values of DON, sulfate and estimated FRM nitrate (adjusted nitrate) are used to estimate the adjusted ammonium at each FRM site as follows:

$$NH4_{FRM} = DON * SO4 + 0.29*NO3_{FRM}$$

where, DON, SO4 and $NO3_{FRM}$ are the quarterly average values at each FRM site.

Thus, in the standard SANDWICH SMAT application $NH4_{FRM}$ is not a direct measured value, but is derived from the DON, SO4, and $NO3_{FRM}$ values. In the default EPA $PM_{2.5}$ Design Value projection approach, interpolated DON values are used to estimate ammonium, this is due to uncertainties in the ammonium measurements and the lack of NH4 measurements at IMPROVE sites.

4.2.4 Particle Bound Water

Because ammoniated sulfate and ammonium nitrate are hygroscopic, the retained sulfate and nitrate mass will include water[3]. Particle bound water (PBW) is estimated using the Aerosol Inorganic Model (AIM) (Clegg, Brimblecombe and Wexler, 1998). PBW was derived from quarterly average FRM concentrations of sulfate, ammonium, nitrate as describe above. Estimated hydronium ion, H+, needed to achieve ionic balance was derived from the latter values. The model enables the distribution of water and ions to be calculated between liquid, solid and vapor phases for specific temperature and relative humidity conditions. Typical filter equilibration conditions of 35% RH and 22 deg C (295 deg K) temperature are used.

Application of AIM at the specified FRM filter equilibration conditions show that PBW is much more dependent on sulfate concentration compared to nitrate and that the relationship varies somewhat by season to differentiate the relative amounts of sulfate and nitrate aerosol. There is proportionally less estimated PBW water for wintertime aerosol which has higher NH4 and NO3 and lower SO4.

For computational convenience, a polynomial regression equation was fit to the calculated water mass from AIM under the FRM equilibration conditions and the three input values that fed into AIM (sulfate, nitrate and ammonium). The polynomial equation was used in all SMAT analyses to estimate water. Due to the non-linear nature of the water calculation, the measurements were divided into 2 regimes; all measurements (site-days) where DON > 0.225 and all measurements where DON ≤ 0.225. A separate equation was developed to represent each regime.

The equations are as follows:

$$S = SO4 / (SO4 + NO3_{FRM} + NH4_{FRM})$$
$$N = NO3_{FRM} / (SO4 + NO3_{FRM} + NH4_{FRM})$$
$$A = NH4_{FRM} / (SO4 + NO3_{FRM} + NH4_{FRM})$$

If DON ≤ 0.225 then:

PBW = 595.56
- 1440.58*S
- 1126.49*N
+ 283.91*(S**1.5)
- 13.38*(N**1.5)
- 1486.71*(A**1.5)
+ 764.23*(S**2)
+ 1502.00*(N*S)
+ 451.87*(N**2)
- 185.18*(S**2.5)
- 375.98*(S**1.5)*N
- 16.90*(S**3)
- 65.81*(N**1.5)*S

[3] Note that some organic carbon (OC) species are also likely hygroscopic but due to uncertainties the PBW associated with hygroscopic OC species it is not accounted for in SANDWICH.

+ 96.83*(N**2.5)
+ 83.04*(N**1.5)*(S**1.5)
- 4.42*(N**3)
+ 1720.82*(A**1.5)*S
+ 1220.38*(A**1.5)*N
- 311.50*(A**1.5)*(S**1.5)
+ 148.77*(A**1.5)*(N**1.5)
+ 1151.65*(A**3)) * (SO4 + $NO3_{FRM}$ + $NH4_{FRM}$)

If DON > 0.225 then:

PBW = 202049.0
- 391494.6*S
- 390912.1*N
+ 442.4*(S**1.5)
- 155.3*(N**1.5)
- 293406.8*(A**1.5)
+ 189277.5*(S**2)
+ 377992.6*N*S
+ 188636.8*(N**2)
- 447.1*(S**2.5)
- 507.2*(S**1.5)*N
- 12.8*(S**3)
+ 146.2*(N**1.5)*S
+ 217.2*(N**2.5)
+ 30.0*(N**1.5)*(S**1.5)
- 18.6*(N**3)
+ 216267.0*(A**1.5)*S
+ 215419.9*(A**1.5)*N
- 621.8*(A**1.5)*(S**1.5)
+ 239.1*(A**1.5)*(N**1.5)
+ 95413.1*(A**3)) * (SO4 + $NO3_{FRM}$ + $NH4_{FRM}$)

4.2.5 Passively Collected $PM_{2.5}$ Components (Blank Correction)

Another quantifiable component of $PM_{2.5}$ mass include passively collected mass, represented by the field blank concentration that is typically 0.3-0.5 μg/m^3 (EPA, 2002). This appears to constitute a contamination of the filter resulting from handling or contact with the FRM cassette. This value is deemed to be an important constituent of $PM_{2.5}$ mass (it is assumed to not be dependent on pollutant emissions). A nominal blank mass value of 0.5 μg/m^3 is assumed in mass construction computations. This value is assumed to remain constant from the current-year to future-year.

4.2.6 Calculation of Carbonaceous Mass

Carbonaceous mass is estimated from blank corrected $PM_{2.5}$ speciation data, where organic carbonaceous mass (OCM) is first estimated by multiplying the organic carbon (OC) concentrations by 1.4 (OCM = 1.4 x OC) to account for the oxygen, hydrogen and other elements associated with ambient carbon particles. Note that the 1.4 OCM/OC ratio was based on limited organic compound speciation data in Los Angeles (Watson, 2002). More recent analysis by Turpin and Lim (2001) have found OCM/OC ratios that vary from 1.6±0.2 for urban areas to 2.4±0.2 for rural areas. However, since the SANDWICH derivation of the initial OCM is just used as a "floor' for the OCM calculation, the lower OCM/OC ratio of 1.4 is used. To that amount is added the elemental carbon (EC) concentration. An alternative approach to estimate carbon contribution to $PM_{2.5}$ mass is used for SMAT because of: (1) many uncertainties in estimating carbonaceous mass from carbon measurements (Turpin and Lim, 2001; Chow et al., 2004); (2) differences in carbon measurement protocol between urban and rural monitoring locations; (3) a relatively "bumpy" surface of urban carbon concentrations as derived from these urban and rural organic carbon measurements; and (4) lack of carbon measurements at all FRM locations. The SANDWICH approach estimates carbon by mass balance comparing precisely measured FRM $PM_{2.5}$ mass (EPA, 2003) with the sum of its non-carbon components. The latter are sulfates, ammonium, nitrates, estimated particle bound water, sea salt, estimated crustal material plus 0.5 $\mu g/m^3$ passively collected mass blank correction as discussed earlier.

This approach estimates retained carbonaceous FRM mass and explicitly accounts for the following important and difficult to estimate carbon mass properties: (1) regional and urban-rural differences in the mix of carbonaceous aerosols (i.e. the amount of oxygen, hydrogen, etc that is associated with the organic carbon); (2) retained water associated with hygroscopic carbon compounds (Saxena and Hildemann, 1996; Yua, et. al., 2004); (3) volatile carbonaceous material measured by speciation samplers, but not retained in FRM mass; and (4) uncertainties associated with blank corrections of measured organic and elemental carbon.

Total Carbonaceous Mass by mass balance (TCM_{mb}) is defined as:

$$TCM_{mb} = FRM\ PM_{2.5} - \{[SO4] + [NO3_{FRM}] + [NH4_{FRM}] + [water] + [crustal\ material] + [sea\ salt] + [0.5]\}$$

In this expression, all of the above quarterly average components represent the mass retained on FRM Teflon filters.

The mass associated with organic compounds is defined as:

$$OCM_{mb} = TCM_{mb} - [EC]$$

where, EC is STN measured elemental carbon.

This approach completely accounts for FRM mass and OCM_{mb} is often greater than the amount that would be derived directly from speciation measurements. Because of uncertainties in speciation measurements and their estimates from interpolated surfaces, a lower limit (floor) for OCM_{mb} was set so that the OCM_{mb} was not unreasonably low. The floor was set so that OCM_{mb} could not be more than 30% lower than measured OCM. For the ASIP projections, the STN measured OCM was used to calculate the floor assuming a 1.4 OCM/OC ratio. The lower limit is equal to interpolated (measured) OC * 1.4 * 0.7. If the OCM_{mb} concentration was less than the lower limit, it was set equal to the lower limit.

4.2.7 Sea Salt

Sea salt is estimated from the measured chloride ion using the following equation:

$$[\text{sea salt}] = 1.8 \times [Cl^-]$$

4.2.8. Summary of $PM_{2.5}$ Composition Calculations

As presented in the beginning of this section, the application of the SANDWICH speciated STN/IMPROVE data to the FRM $PM_{2.5}$ mass produces the following composition of PM species as they relate to the measured FRM values for each quarter of 2002. Quarterly average FRM mass is equal to the sum of the seven species plus blank mass.

$$PM2.5_{FRM} = \{ [OCM_{mb}] + [EC] + [SO4] + [NO3_{FRM}] + [NH4_{FRM}] + [water] + [\text{crustal material}] + [\text{sea salt}] + [0.5] \}$$

The SANDWICH species data is generated in the following order:

1. Adjusted nitrate is calculated using hourly meteorology and 24-hour average nitrate measurements.

2. Quarterly averages are calculated for adjusted nitrate, sulfate, elemental carbon, degree of sulfate neutralization (DON), crustal mass , and measured OCM.

3. Quarterly average ammonium is calculated from the adjusted nitrate, sulfate, and DON values.

4. Calculated ammonium, sulfate, and nitrate values are input into the water equation to derive particle bound water concentrations.

5. Carbon mass by difference (OMC_{mb}) is calculated from the $PM_{2.5}$ mass, adjusted nitrate, ammonium, sulfate, water, elemental carbon, crustal, sea salt and blank mass values.

6. The sum of the 7 species plus blank mass is equal to the FRM mass.

4.3 DEFINING CURRENT-YEAR $PM_{2.5}$ DESIGN VALUES (DVC)

The $PM_{2.5}$ component species fractions are applied to current-year $PM_{2.5}$ Design Values (DVC) that are then projected to the future using the model derived RRFs. EPA's $PM_{2.5}$ modeling guidance recommends using the average of the 3 years of $PM_{2.5}$ Design Value periods that straddle the emissions year. The average of the 3 design values is not a straight five year average. It is, in effect, a weighted average of the annual averages. The base year inventory and modeling year for the ASIP modeling is 2002. Therefore, the design value period is from 2000-2004. In the average of 2000-2002, 2001-2003, and 2002-2004 $PM_{2.5}$ Design Values for the DVC, the annual average $PM_{2.5}$ concentrations for 2002 is "weighted" 3 times, 2001 and 2003 are weighted twice, and 2000 and 2004 are weighted once. EPA notes that this has the desired effect of weighting the projected $PM_{2.5}$ values towards the middle year of the five year period, which is the emissions and meteorology year for the ASIP modeling (i.e., 2002).

There are several steps in the derivation of the average $PM_{2.5}$ design values for projections to the future. Quarterly average values are needed for each FRM site. The following steps were used to derive the quarterly average FRM values.

1. The analysis began with quarterly average FRM data for all quarters from 2000-2004.

2. A quarterly average 3 year design value was calculated for each design value period in which a site had at least one of three quarters complete data (2000-2002, 2001-2003, and 2002-2004). This results in four quarterly averages for up to three design value periods for each FRM site.

3. The (up to) 3 quarterly design value periods were averaged together to get a single quarterly average design value for each site.

4.4 SPECIATED MODEL ATTAINMENT TEST (SMAT)

The EPA default procedure for projecting future-year $PM_{2.5}$ Design Values using the Speciated Model Attainment Test (SMAT) is as follows:

1. Derive current quarterly mean concentrations for each of the major components of $PM_{2.5}$. This is done by multiplying the monitored quarterly mean concentration of Federal Reference Method (FRM) (EPA, 1997) derived $PM_{2.5}$ mass by the monitored fractional composition of $PM_{2.5}$ species (at speciation monitor sites) for each quarter. In the case of the ASIP projections using MATS, the PM composition at each FRM site is defined from the SANDWICH PM speciation at STN and IMPROVE sites that are interpolated to the location of the FRM sites.

2. Use the ASIP current year 2002 Typical Base G2 Base Case and future-year 2009, 2012 and 2018 Base G4 Base Case CMAQ modeling results to estimate current and future quarterly average concentrations for each of the components of $PM_{2.5}$ near the FRM monitor. Take the ratio of future to current predictions for each component. The result is a component-specific quarterly average relative response factor (RRF).

3. For each quarter, multiply the current quarterly mean component concentration from Step 1 times the component-specific RRF obtained in Step 2. This leads to an estimated future quarterly mean concentration for each $PM_{2.5}$ component.

4. Derive the future-year ammonium concentrations assuming the future-year nitrate is completely neutralized and that the DON stays constant from the current-year to future-year. Derive PBW concentrations from the future-year $PM_{2.5}$ components (SO4 and NO3) and atmospheric conditions for the FRM monitor. Assume that sea salt and the blank correction stay constant from the current-year to future-year.

5. Average the four quarterly mean future concentrations to get an estimated future annual mean concentration for each $PM_{2.5}$ component. Sum the annual mean concentrations of the $PM_{2.5}$ components to obtain an estimated future annual concentration for $PM_{2.5}$.

The FRM data is used for nonattainment designations. Therefore it is important that the SMAT procedures described above use the FRM data as the base value for projecting future $PM_{2.5}$ concentrations. As can be seen from the list of steps, the modeled attainment test is dependent on the availability of species component mass representative of the FRM sites.

4.5 ESTIMATING FUTURE YEAR $PM_{2.5}$ DESIGN VALUES

Future-year concentrations of $PM_{2.5}$ component species are estimated by assuming that the quarterly average component concentration will change in the same proportion as the model predicted change. Model predicted changes in species concentrations (from a current-year to a future-year) are used to calculate RRFs. RRFs are calculated for each grid cell and species as the ratio of the quarterly average future-years (2009, 2012 and 2018) model predictions to the current-year (2002) base case model predictions "near" the FRM monitor. The RRF for each $PM_{2.5}$ species is then multiplied by the estimated base year ambient $PM_{2.5}$ species mass for the site to estimate future species concentrations.

4.5.1 Projecting $PM_{2.5}$ Component Species

In the SMAT methodology, RRFs are calculated for five of the $PM_{2.5}$ component species: sulfate (SO4), nitrate ($NO3_{FRM}$), organic carbon mass (OCM_{mb}), elemental carbon (EC), and crustal mass (Soil). Note that future-year values for the other four $PM_{2.5}$ component species are either derived from the projections of these five $PM_{2.5}$ component species (i.e., NH4 and PBW) or held constant (i.e., blank correction and Sea Salt). The future year concentrations of the five $PM_{2.5}$ components are calculated for each site and each quarter. The future-year ammonium concentrations are calculated from the future-year sulfate, nitrate, and (current-year) DON values. Assuming that the DON is unchanged from the current year, the ammonium is calculated using the following formula:

$$NH4_{future} = DON * SO4_{future} + 0.29*NO3_{future},$$

The $NH4_{future}$, $SO4_{future,}$ and $NO3_{future}$ concentrations are then run through the water equation to predict a future-year particle bound water (PRB) concentration. The future-year $PM_{2.5}$ species concentrations at each FRM site are then summed over the seven species plus blank mass to estimate the future quarterly average $PM_{2.5}$ concentration. The four quarterly values are then averaged to obtain the estimated future annual average $PM_{2.5}$ for each FRM site.

4.6 DEFINING RRFS BASED ON MODELING RESULTS "NEAR" THE MONITOR

When defining the model derived RRFs, EPA recommends using current-year and future-year modeling results "near" the monitor. By "near" EPA recommends using spatially averaged modeling results for a grid resolution NX by NY array of grid cells centered on the FRM monitor. In the ASIP modeling grid resolutions of 36 km and 12 km are being used for which

EPA recommends that NX=NY=1 and NX=NY=3, respectively. Thus, for the ASIP 2009 $PM_{2.5}$ Design Value projections, RRFs were based on the modeling results within the grid cell containing the FRM monitoring when using the CMAQ 36 km modeling results, and in the 9 grid cells centered on the FRM monitor for the CMAQ 12 km modeling results.

4.7 $PM_{2.5}$ DESIGN VALUE PROJECTIONS USING BASE G4 MODELING RESULTS

The 2000-2004 current-year $PM_{2.5}$ Design Values at FRM sites within and near the ASIP region were projected to 2009, 2012 and 2018 using the SMAT/SANDWICH procedures described above that were implemented in MATS tool and the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results. The ASIP future-year Base G4 $PM_{2.5}$ Design Value projections are discussed next by state.

Attainment of the annual $PM_{2.5}$ NAAQS is achieved when the projected $PM_{2.5}$ Design Value (DVF) is less than 15.0 $\mu g/m^3$ rounded (i.e., DVF < l5.05$\mu g/m^3$). However, EPA requires a supplemental weight of evidence analysis if a DVF lies between 14.5 and 15.5 $\mu g/m^3$.

Across all sites within and near the ASIP region there is a consistent reduction in the projected $PM_{2.5}$ concentrations in the future years. These reductions are primarily due to reductions in SO4. Only small changes are seen in the other components of $PM_{2.5}$.

4.7.1 Alabama

Figure 4-2 and Table 4-1 display the current-year (DVC) and projected future-year $PM_{2.5}$ Design Values (DVFs) using the 2002 Base G2 Typical and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results for FRM sites in Alabama. The stacked bar charts of current-year (based on average of three year Design Values from 2002-2002, 2001-2003 and 2002-2004) and future-year $PM_{2.5}$ Design Values includes the contributions of each of the $PM_{2.5}$ component of the Design Values. The largest two PM components by far for sites in Alabama are sulfate (SO4) and organic carbon mass (OCM). Next most important PM components to annual $PM_{2.5}$ concentrations in Alabama are crustal material, ammonium (NH4), particle bound water (PBW) followed closely by elemental carbon (EC). Nitrate (NO3) and sea salt are an extremely small to insignificant component of the annual average $PM_{2.5}$ Design Values in Alabama.

In addition to the current-year and projected future-year $PM_{2.5}$ Design Values using the CMAQ 12 km modeling results, Table 4-1 also lists the differences between the future-year and current-year Design Values. With the exception with sites in the Birmingham area, the $PM_{2.5}$ Design Values in Alabama are projected to go down as we go further out in time (2002, 2009, 2012 and 2018). These reductions are primarily due to reductions in SO4 due to the regional reductions in SO2 emissions.

For the Birmingham sites (Jefferson and Shelby Counties), there is a large contribution from local sources. This issue is being addressed in the Birmingham Air Pollution Study (BAPS) that is performing urban-scale 4 km CMAQ modeling along with local source impact modeling using the AERMOD plume model. The 2002 Base G2 emissions were based on the original estimates of PM emissions from the Birmingham local sources. These emissions were grown to the future years for the 2009 and 2018 Base G4 emission inventories. In the mean time, BAPS has updated the 2002 emissions for the Birmingham local sources that substantially reduced their PM emission estimates. These lower 2002 emissions estimates were then grown to 2012 for the 2012 Base G4 modeling. This resulted in more reductions in PM concentrations in Birmingham between the 2002 Base G2 and 2012 Base G4 CMAQ simulations then there should be. As the SMAT $PM_{2.5}$ projection procedure uses the relative changes in the modeling results between the current and future years, the ASIP 2012 $PM_{2.5}$ projections for sites in Birmingham overstate the level of $PM_{2.5}$ improvements due to the inconsistencies in the local source PM emissions between the 2002 Base G2 and 2012 Base G4 emission scenarios. The BAPS is performing 2012 $PM_{2.5}$ projections for Birmingham using consistent 2002 and 2012 local source emissions and should be used instead of the ASIP 2012 projections.

There are two $PM_{2.5}$ monitors in Alabama that the CMAQ 12 km 2009 Base G4 modeling project to exceed the annual $PM_{2.5}$ NAAQS in 2009:

- North Birmingham in Birmingham, Alabama (01-073-0023) with 2009 Base G4 projected $PM_{2.5}$ Design Values of 17.0 $\mu g/m^3$; and

- Wylam in Birmingham, Alabama (01-073-2003) with 2009 projected $PM_{2.5}$ Design Values of 15.8 $\mu g/m^3$.

In the past, these two sites were Community Monitoring Zone (CMZ) monitoring sites whose values were averaged for comparisons with the NAAQS. However, their CMZ status is no longer recognized by EPA. The ASIP CMAQ Base G4 2009 modeling results project that all other FRM monitors in Alabama will attain the annual $PM_{2.5}$ NAAQS in 2009.

Both of these Birmingham sites, along with all other sites in Alabama, are projected to attain the annual $PM_{2.5}$ NAAQS in 2012. Note that the North Birmingham site is projected to exceed the $PM_{2.5}$ NAAQS in 2018, however as noted above that is due to an assumption of too high growth in emissions from local sources.

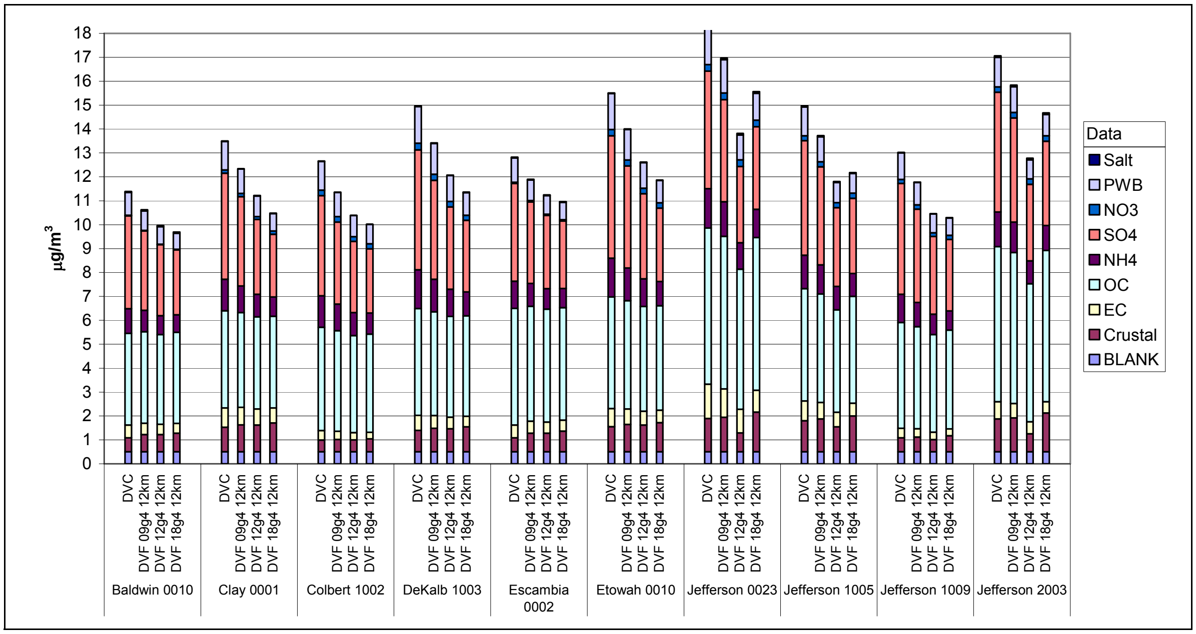


Figure 4-2a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Alabama using the CMAQ 12 km Base G4 modeling results.

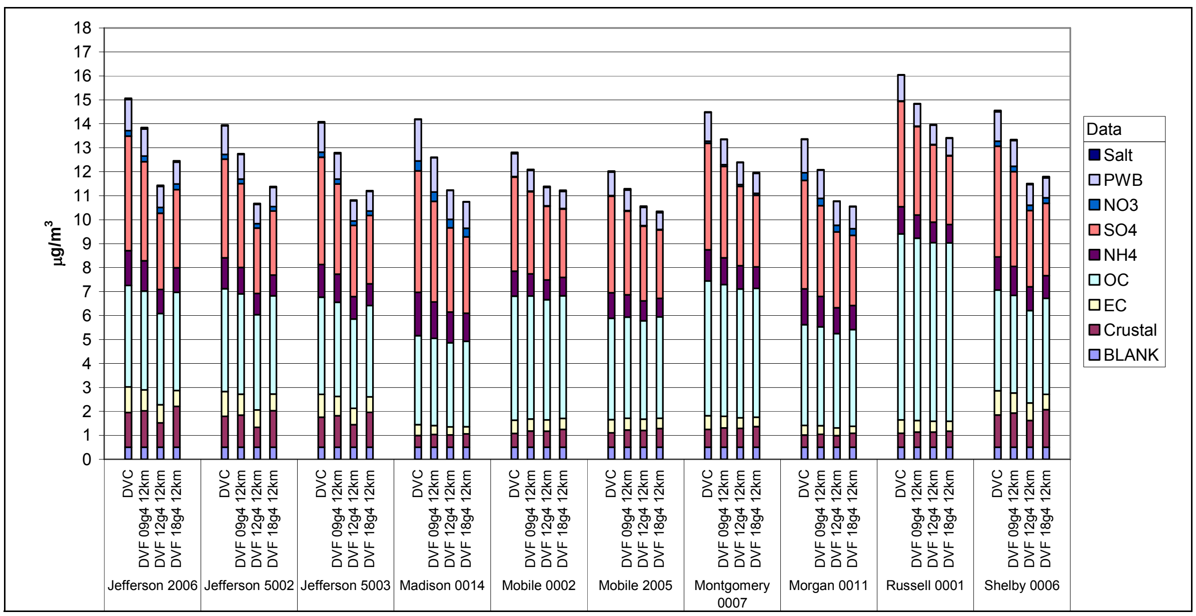


Figure 4-2b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Alabama using the CMAQ 12 km Base G4 modeling results.

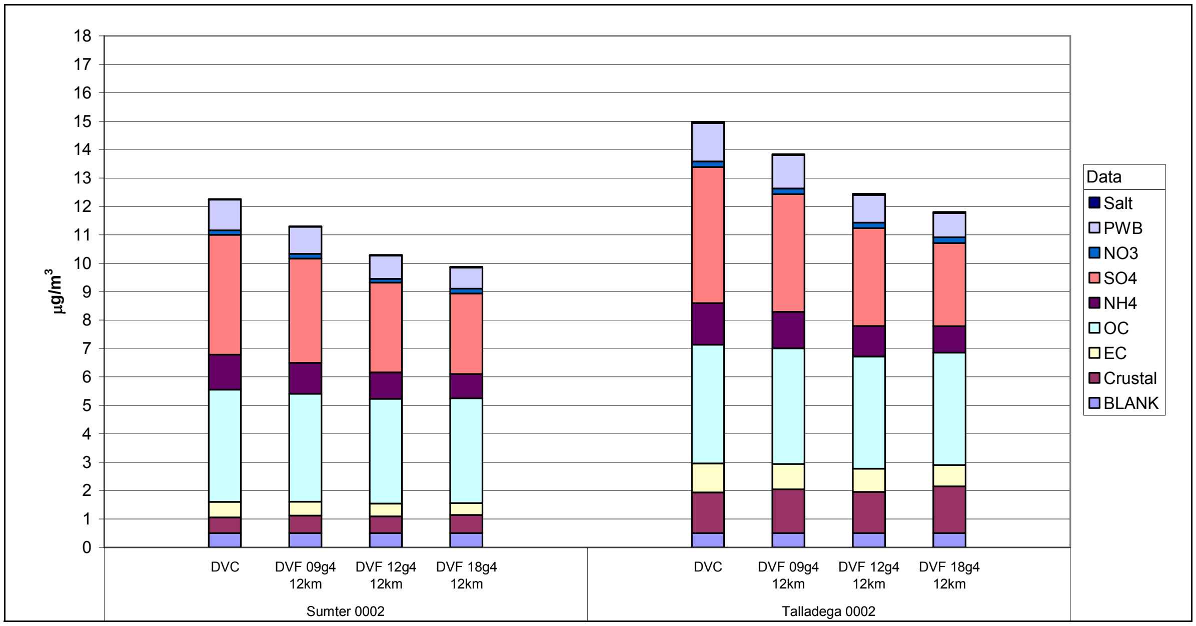


Figure 4-2c. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Alabama using the CMAQ 12 km Base G4 modeling results.

Table 4-1. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values ($\mu g/m^3$) in Alabama using the 2002 Typical Base G2 and 2009 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
01-003-0010	**AL**	Baldwin	11.4	10.6	10.0	9.7	-0.8	-1.4	-1.7
01-027-0001	**AL**	Clay	13.5	12.3	11.2	10.5	-1.2	-2.3	-3.0
01-033-1002	**AL**	Colbert	12.7	11.4	10.4	10.0	-1.3	-2.3	-2.6
01-049-1003	**AL**	DeKalb	15.0	13.4	12.1	11.4	-1.5	-2.9	-3.6
01-053-0002	**AL**	Escambia	12.8	11.9	11.2	11.0	-0.9	-1.6	-1.9
01-055-0010	**AL**	Etowah	15.5	14.0	12.6	11.9	-1.5	-2.9	-3.6
01-073-0023	**AL**	Jefferson	**18.4**	**17.0**	13.8*	**15.6**	-1.4	-4.6	-2.8
01-073-1005	**AL**	Jefferson	15.0	13.7	11.8*	12.2	-1.3	-3.2	-2.8
01-073-1009	**AL**	Jefferson	13.0	11.8	10.5*	10.3	-1.2	-2.6	-2.7
01-073-2003	**AL**	Jefferson	**17.1**	**15.8**	12.8*	14.7	-1.2	-4.3	-2.4
01-073-2006	**AL**	Jefferson	**15.1**	13.8	11.4*	12.5	-1.2	-3.6	-2.6
01-073-5002	**AL**	Jefferson	14.0	12.8	10.7*	11.4	-1.2	-3.3	-2.6
01-073-5003	**AL**	Jefferson	14.1	12.8	10.8*	11.2	-1.3	-3.3	-2.9
01-089-0014	**AL**	Madison	14.2	12.6	11.2	10.8	-1.6	-3.0	-3.5
01-097-0002	**AL**	Mobile	12.8	12.1	11.4	11.2	-0.7	-1.4	-1.6
01-097-2005	**AL**	Mobile	12.0	11.3	10.6	10.3	-0.8	-1.5	-1.7
01-101-0007	**AL**	Montgomery	14.5	13.4	12.4	12.0	-1.1	-2.1	-2.6
01-103-0011	**AL**	Morgan	13.4	12.1	10.8	10.6	-1.3	-2.6	-2.8
01-113-0001	**AL**	Russell	**16.0**	14.8	14.0	13.4	-1.2	-2.1	-2.6
01-117-0006	**AL**	Shelby	14.6	13.3	11.5*	11.8	-1.2	-3.1	-2.8
01-119-0002	**AL**	Sumter	12.3	11.3	10.3	9.9	-1.0	-2.0	-2.4
01-121-0002	**AL**	Talladega	15.0	13.8	12.4	11.8	-1.1	-2.5	-3.2

* 2012 emissions for local sources in Birmingham were updated with lower values from BAPS for the 2012 emissions scenario, with the original higher emissions estimates used in the 2002, 2009 and 2018 inventories. Thus, the 2012 $PM_{2.5}$ projections in Jefferson and Shelby Counties will overstate the amount of $PM_{2.5}$ reduction between 2002 and 2012.

4.7.2 District of Columbia

Figure 4-3 and Table 4-2 display the current-year and future-year $PM_{2.5}$ Design Values at FRM monitoring sites in the District of Columbia (DC) that is adjacent to the ASIP region. Two of the three sites current-year Design Values exceed the NAAQS. However, by 2009 all three monitoring sites are estimated to be well below the annual $PM_{2.5}$ NAAQS. The PM levels are projected to continue to decrease in 2012 and 2018. The reduction in PM concentrations at the Washington DC sites is due primarily to reductions in SO4 and the NH4 and PBW that is associated with the SO4.

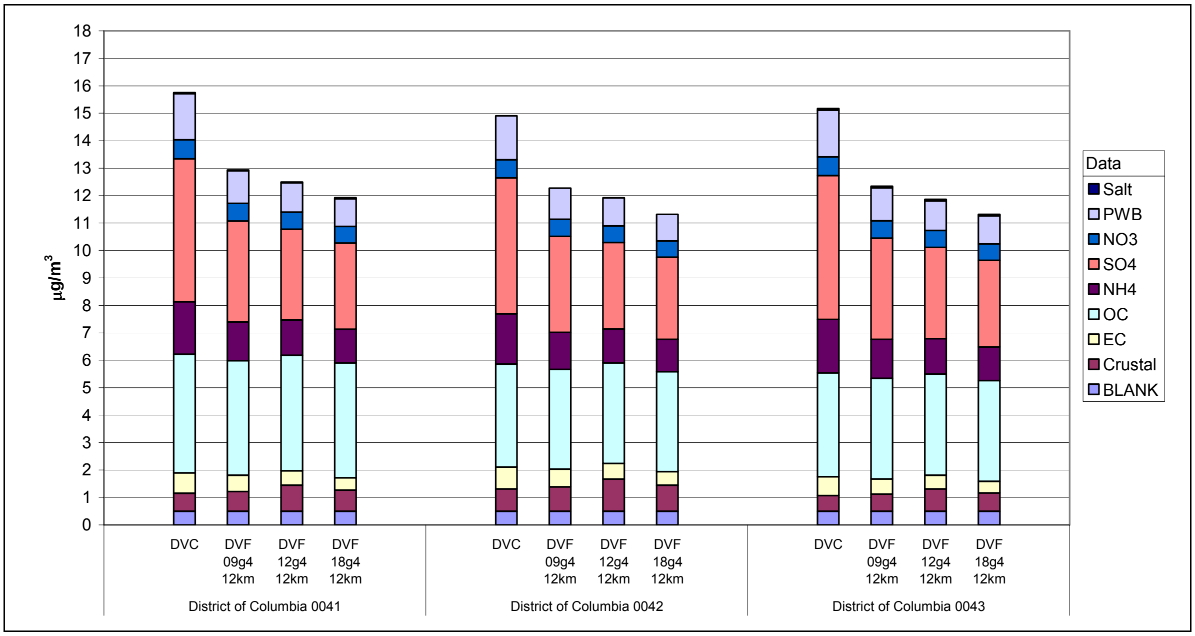


Figure 4-3. Current (2000-2004) $PM_{2.5}$ Design Values centered on 2002 and Projected 2009 $PM_{2.5}$ Design Values (DVF) in the District of Columbia using the CMAQ 36/12 km 2009 Base G4 modeling results.

Table 4-2. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in the District of Columbia using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
11-001-0041	**DC**	District of Columbia	**15.8**	12.9	12.5	11.9	-2.8	-3.3	-3.8
11-001-0042	**DC**	District of Columbia	14.9	12.3	11.9	11.3	-2.6	-3.0	-3.6
11-001-0043	**DC**	District of Columbia	**15.2**	12.3	11.9	11.3	-2.8	-3.3	-3.9

4.7.3 Florida

There are 28 FRM monitoring sites in the state of Florida (Figure 4-4 and Table 4-3). The maximum current-year $PM_{2.5}$ Design Value is only 12.7 µg/m^3, which is projected to be reduced to 11.8 µg/m^3 by 2009. The future year $PM_{2.5}$ Design Values are projected to be further reduced for the farther out future years (2012 and 2018). These reductions are primarily due to reductions in sulfate. Thus, none of the Florida FRM sites are currently or projected in the future to exceed the annual $PM_{2.5}$ NAAQS.

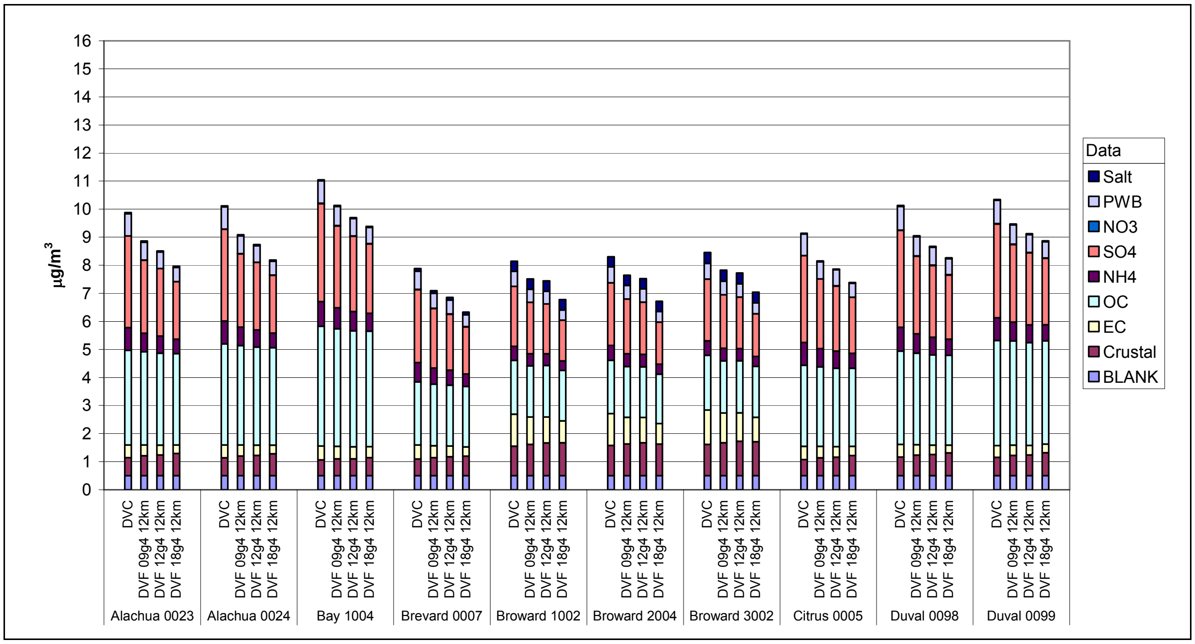


Figure 4-4a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Florida using the CMAQ 12 km Base G4 modeling results.

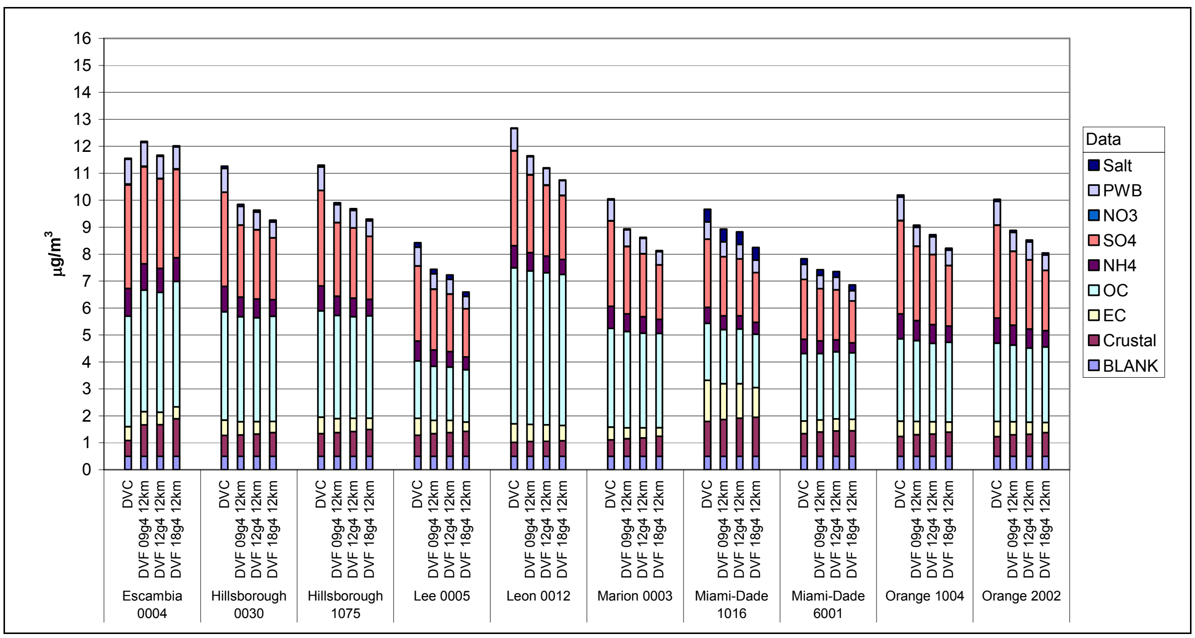


Figure 4-4b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Florida using the CMAQ 12 km Base G4 modeling results.

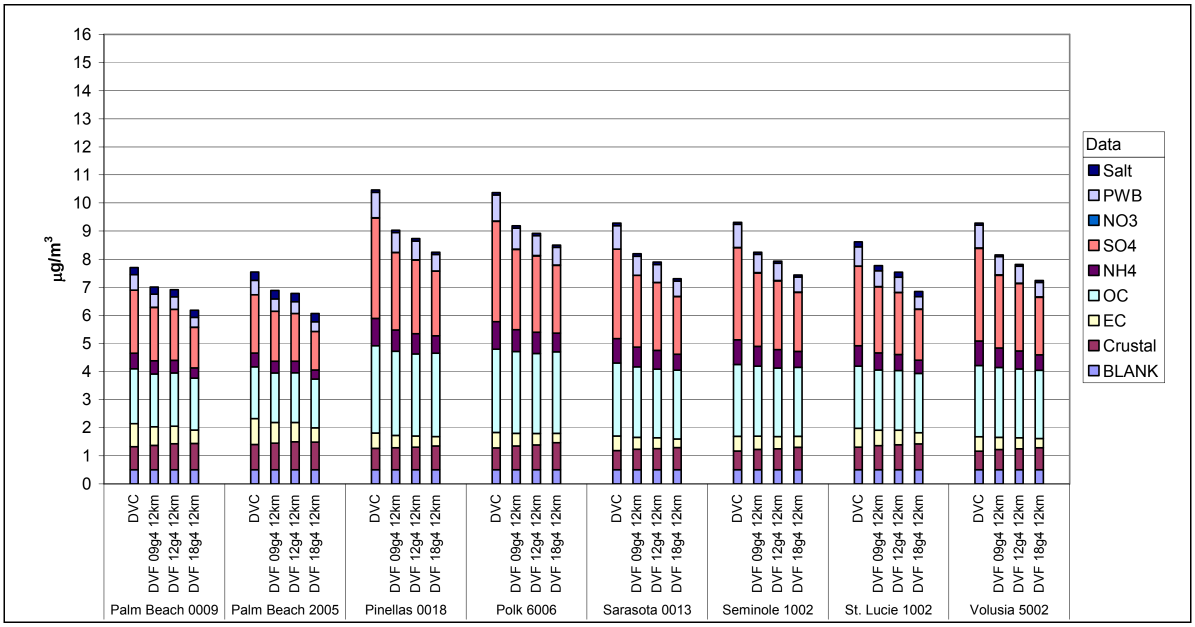


Figure 4-4c. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Florida using the CMAQ 12 km Base G4 modeling results.

Table 4-3. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Florida using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
12-001-0023	FL	Alachua	9.9	8.9	8.5	8.0	-1.0	-1.4	-1.9
12-001-0024	FL	Alachua	10.1	9.1	8.7	8.2	-1.0	-1.4	-1.9
12-005-1004	FL	Bay	11.0	10.1	9.7	9.4	-0.9	-1.3	-1.7
12-009-0007	FL	Brevard	7.9	7.1	6.9	6.3	-0.8	-1.0	-1.6
12-011-1002	FL	Broward	8.1	7.5	7.4	6.8	-0.6	-0.7	-1.4
12-011-2004	FL	Broward	8.3	7.6	7.5	6.7	-0.7	-0.8	-1.6
12-011-3002	FL	Broward	8.5	7.8	7.7	7.0	-0.6	-0.7	-1.4
12-017-0005	FL	Citrus	9.1	8.1	7.9	7.4	-1.0	-1.3	-1.8
12-031-0098	FL	Duval	10.1	9.1	8.7	8.3	-1.1	-1.5	-1.9
12-031-0099	FL	Duval	10.3	9.5	9.1	8.9	-0.9	-1.2	-1.5
12-033-0004	FL	Escambia	11.6	12.2	11.7	12.0	0.6	0.1	0.4
12-057-0030	FL	Hillsborough	11.3	9.8	9.6	9.3	-1.4	-1.6	-2.0
12-057-1075	FL	Hillsborough	11.3	9.9	9.7	9.3	-1.4	-1.6	-2.0
12-071-0005	FL	Lee	8.4	7.4	7.2	6.6	-1.0	-1.2	-1.8
12-073-0012	FL	Leon	12.7	11.6	11.2	10.8	-1.0	-1.5	-1.9
12-083-0003	FL	Marion	10.0	8.9	8.6	8.1	-1.1	-1.4	-1.9
12-086-1016	FL	Miami-Dade	9.7	8.9	8.8	8.2	-0.7	-0.8	-1.4
12-086-6001	FL	Miami-Dade	7.8	7.4	7.4	6.9	-0.4	-0.5	-1.0
12-095-1004	FL	Orange	10.2	9.1	8.7	8.2	-1.1	-1.5	-2.0
12-095-2002	FL	Orange	10.0	8.9	8.5	8.0	-1.2	-1.5	-2.0
12-099-0009	FL	Palm Beach	7.7	7.0	6.9	6.2	-0.7	-0.8	-1.5
12-099-2005	FL	Palm Beach	7.5	6.9	6.8	6.1	-0.7	-0.8	-1.5
12-103-0018	FL	Pinellas	10.5	9.0	8.7	8.2	-1.4	-1.7	-2.2
12-105-6006	FL	Polk	10.4	9.2	8.9	8.5	-1.2	-1.4	-1.9
12-111-1002	FL	St. Lucie	8.6	7.8	7.5	6.8	-0.9	-1.1	-1.8
12-115-0013	FL	Sarasota	9.3	8.2	7.9	7.3	-1.1	-1.4	-2.0
12-117-1002	FL	Seminole	9.3	8.2	7.9	7.4	-1.1	-1.4	-1.9
12-127-5002	FL	Volusia	9.3	8.2	7.8	7.2	-1.1	-1.5	-2.0

4.7.4 Georgia

Of the 26 FRM monitoring sites in the state of Georgia, 15 of them have current-year $PM_{2.5}$ Design Values (DVCs) that exceed the annual $PM_{2.5}$ NAAQS. The highest of these is in Fulton County (Atlanta; 13-121-0039) that has a DVC of 18.3 $\mu g/m^3$ (Figure 4-5; Table 4-4). The ASIP 2009 modeling projects that of the 15 Georgia monitoring sites that currently exceed the NAAQS, just the Fulton County 13-121-0039 and Clayton County 13-063-0091 FRM sites would still be violating the annual $PM_{2.5}$ NAAQS in 2009, with the values of, respectively, 16.6 $\mu g/m^3$ and 15.1 $\mu g/m^3$. There are three Georgia FRM sites with projected 2009 $PM_{2.5}$ Design Value within the 14.5-15.5 $\mu g/m^3$ WOE range (including the Clayton County site mentioned previously) that requires additional weight of evidence (WOE) analysis, in addition to the Fulton County site whose 2009 $PM_{2.5}$ Design Value projections is above the WOE range (16.6 $\mu g/m^3$).

In 2012, only the Atlanta Fulton County monitor is estimated to continue to violate the annual $PM_{2.5}$ NAAQS with a 2012 DVF projection of 15.3 $\mu g/m^3$. All of the other Georgia monitoring sites 2012 $PM_{2.5}$ Design Values are projected to not only be below the NAAQS, but also below the WOE zone of additional analysis.

All of the Georgia FRM monitoring sites are projected to achieve the annual $PM_{2.5}$ NAAQS by 2018. The Atlanta Fulton County site is still the highest (14.9 $\mu g/m^3$) and is the only site whose 2018 Design Value projection lies within the WOE range.

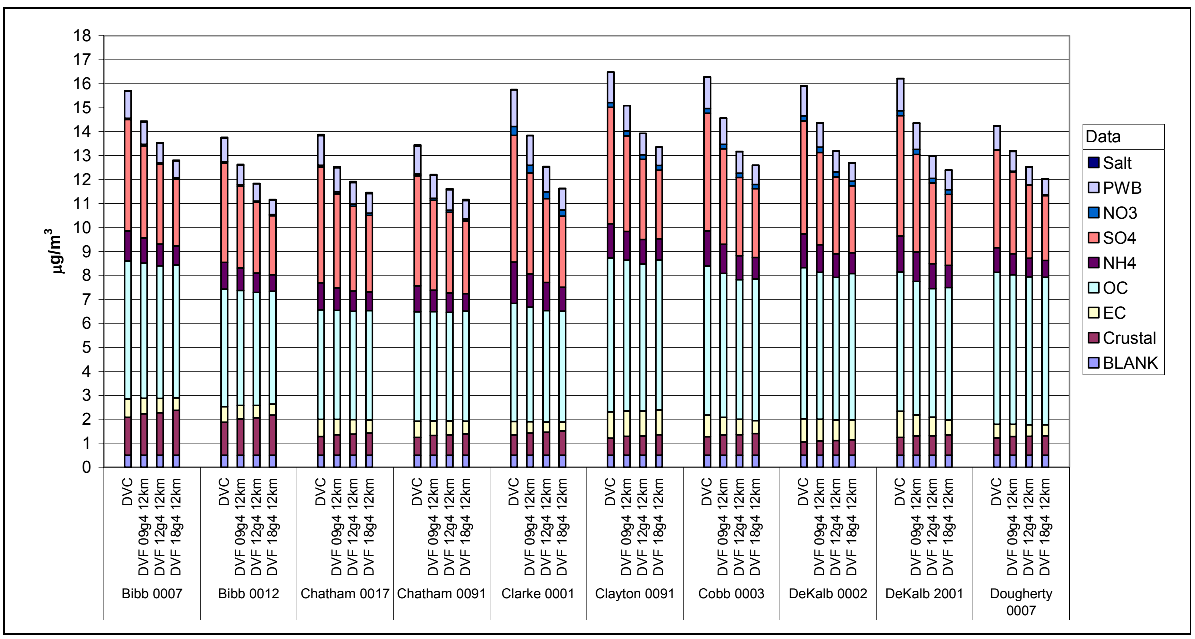


Figure 4-5a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Georgia using the CMAQ 36/12 km Base G4 modeling results.

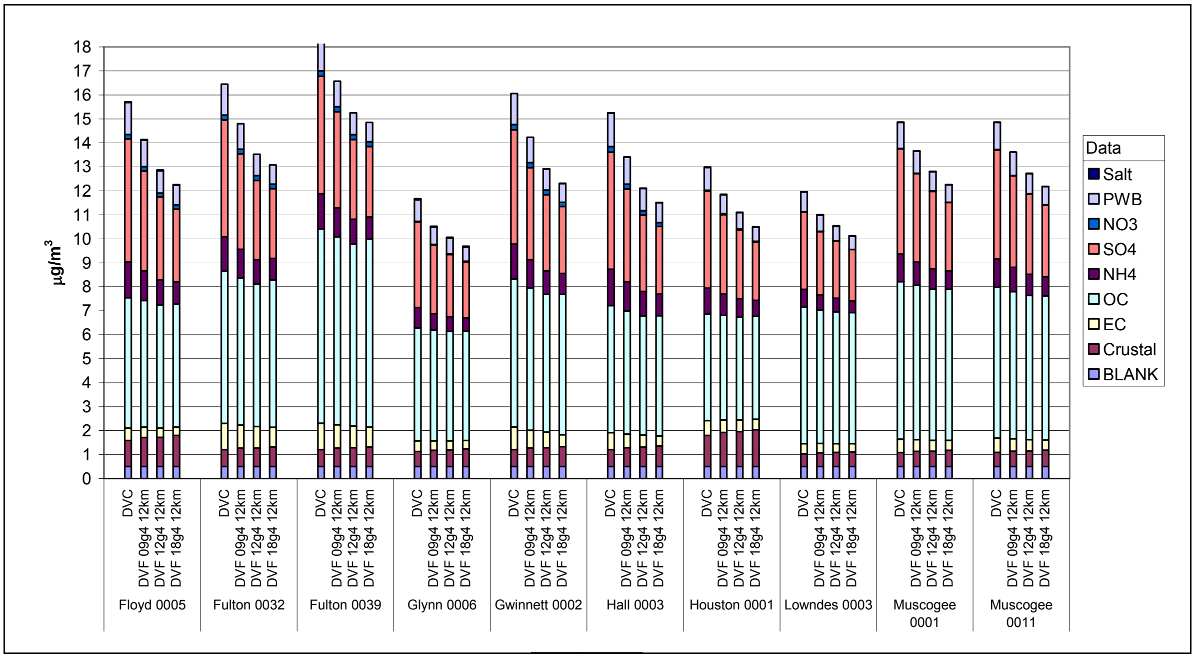


Figure 4-5b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Georgia using the CMAQ 36/12 km Base G4 modeling results.

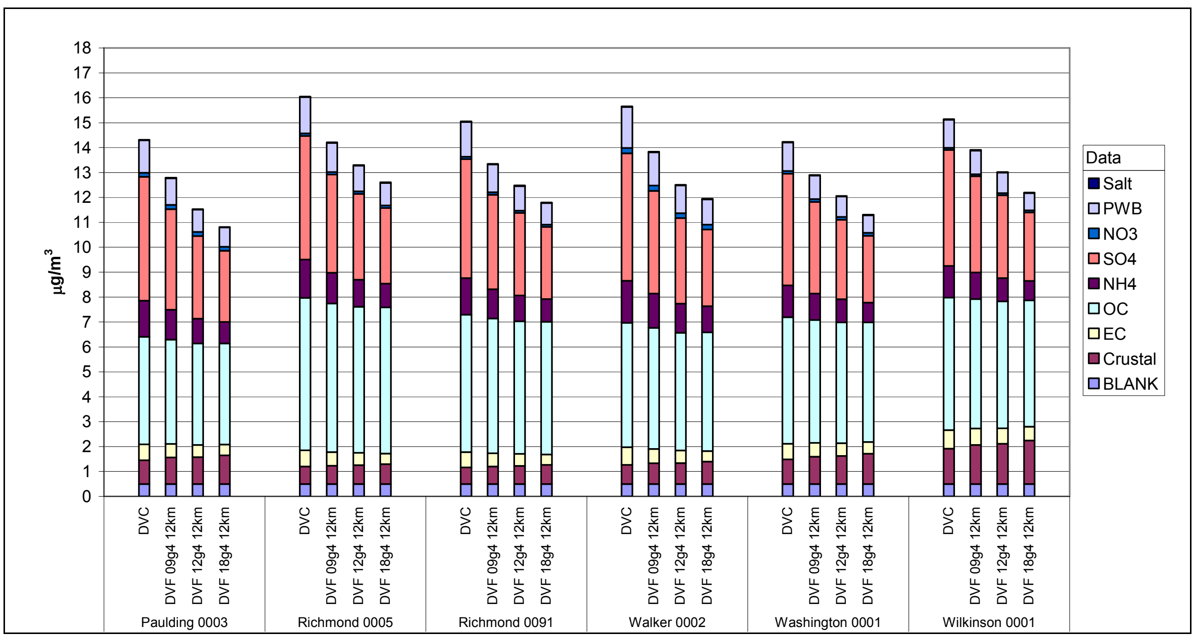


Figure 4-5c. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Georgia using the CMAQ 36/12 km Base G4 modeling results.

Table 4-4. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Georgia using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
13-021-0007	**GA**	Bibb	**15.7**	14.4	13.5	12.8	-1.3	-2.2	-2.9
13-021-0012	**GA**	Bibb	13.8	12.6	11.8	11.2	-1.1	-1.9	-2.6
13-051-0017	**GA**	Chatham	13.9	12.5	11.9	11.5	-1.3	-2.0	-2.4
13-051-0091	**GA**	Chatham	13.4	12.2	11.6	11.2	-1.2	-1.8	-2.3
13-059-0001	**GA**	Clarke	**15.8**	13.8	12.5	11.6	-1.9	-3.2	-4.1
13-063-0091	**GA**	Clayton	**16.5**	**15.1**	13.9	13.4	-1.4	-2.6	-3.1
13-067-0003	**GA**	Cobb	**16.3**	14.6	13.2	12.6	-1.7	-3.1	-3.7
13-089-0002	**GA**	DeKalb	**15.9**	14.4	13.2	12.7	-1.5	-2.7	-3.2
13-089-2001	**GA**	DeKalb	**16.2**	14.4	13.0	12.4	-1.9	-3.3	-3.8
13-095-0007	**GA**	Dougherty	14.2	13.2	12.5	12.0	-1.1	-1.7	-2.2
13-115-0005	**GA**	Floyd	**15.7**	14.1	12.9	12.3	-1.6	-2.9	-3.5
13-121-0032	**GA**	Fulton	**16.5**	14.8	13.5	13.1	-1.7	-2.9	-3.4
13-121-0039	**GA**	Fulton	**18.3**	**16.6**	**15.3**	14.9	-1.7	-3.0	-3.4
13-127-0006	**GA**	Glynn	11.7	10.5	10.1	9.7	-1.1	-1.6	-2.0
13-135-0002	**GA**	Gwinnett	**16.1**	14.2	12.9	12.3	-1.8	-3.2	-3.8
13-139-0003	**GA**	Hall	**15.2**	13.4	12.1	11.5	-1.8	-3.1	-3.7
13-153-0001	**GA**	Houston	13.0	11.9	11.1	10.5	-1.1	-1.9	-2.5
13-185-0003	**GA**	Lowndes	12.0	11.0	10.5	10.1	-1.0	-1.4	-1.9
13-215-0001	**GA**	Muscogee	14.9	13.7	12.8	12.3	-1.2	-2.1	-2.6
13-215-0011	**GA**	Muscogee	14.9	13.6	12.7	12.2	-1.3	-2.1	-2.7
13-223-0003	**GA**	Paulding	14.3	12.8	11.5	10.8	-1.5	-2.8	-3.5
13-245-0005	**GA**	Richmond	**16.0**	14.2	13.3	12.6	-1.8	-2.7	-3.4
13-245-0091	**GA**	Richmond	**15.1**	13.4	12.5	11.8	-1.7	-2.6	-3.3
13-295-0002	**GA**	Walker	**15.7**	13.8	12.5	11.9	-1.8	-3.1	-3.7
13-303-0001	**GA**	Washington	14.2	12.9	12.1	11.3	-1.3	-2.2	-2.9
13-319-0001	**GA**	Wilkinson	**15.2**	13.9	13.0	12.2	-1.3	-2.1	-3.0

4.7.5 Kentucky

Of the 23 FRM monitoring sites in the state of Kentucky, 5 have current-year $PM_{2.5}$ Design Values (DVCs) that exceed the annual $PM_{2.5}$ NAAQS (Figure 4-6 and Table 4-5). The highest of these is in Jefferson County (Louisville) that has a DVC of 16.6 $\mu g/m^3$ (site 21-111-0044). This site has a projected 2009 DVF of 14.5 $\mu g/m^3$ using 12 km CMAQ results, which is below the NAAQS but within the WOE range (Table 4-5). All other FRM monitoring sites in Kentucky are projected to be below the annual average $PM_{2.5}$ NAAQS in 2009.

In 2012, the $PM_{2.5}$ Design Values in Jefferson County are projected to increase, whereas they are projected to decrease at the other FRM sites in Kentucky. This increase is large enough so that one site (21-111-0044) is projected to violate the $PM_{2.5}$ NAAQS in 2012 (15.3 $\mu g/m^3$). As noted in Chapter 2, the 2012 emissions for the non-VISTAS states were developed using an alternative approach to those developed for the 2002, 2009 and 2018 emission scenarios, whereby some of them were interpolated rather than grown and controlled inventories. The main objective of the 2012 inventories were to address the benefits of additional VISTAS EGU controls for the Alabama and Georgia $PM_{2.5}$ SIP activities and, due to time constraints, some simplifications in the 2012 inventories were made for the non-VISTAS states. Consequently, care should be taken in the interpretation of 2012 $PM_{2.5}$ projections in border areas of the VISTAS states, such as Louisville, Kentucky, as those projections will not be as accurate as those for 2009 and 2018. The 2012 $PM_{2.5}$ increases in Jefferson County, Kentucky are due to increases in OCM, not SO4.

By 2018 all sites in Kentucky are projected to achieve the annual $PM_{2.5}$ NAAQS and be below the WOE zone.

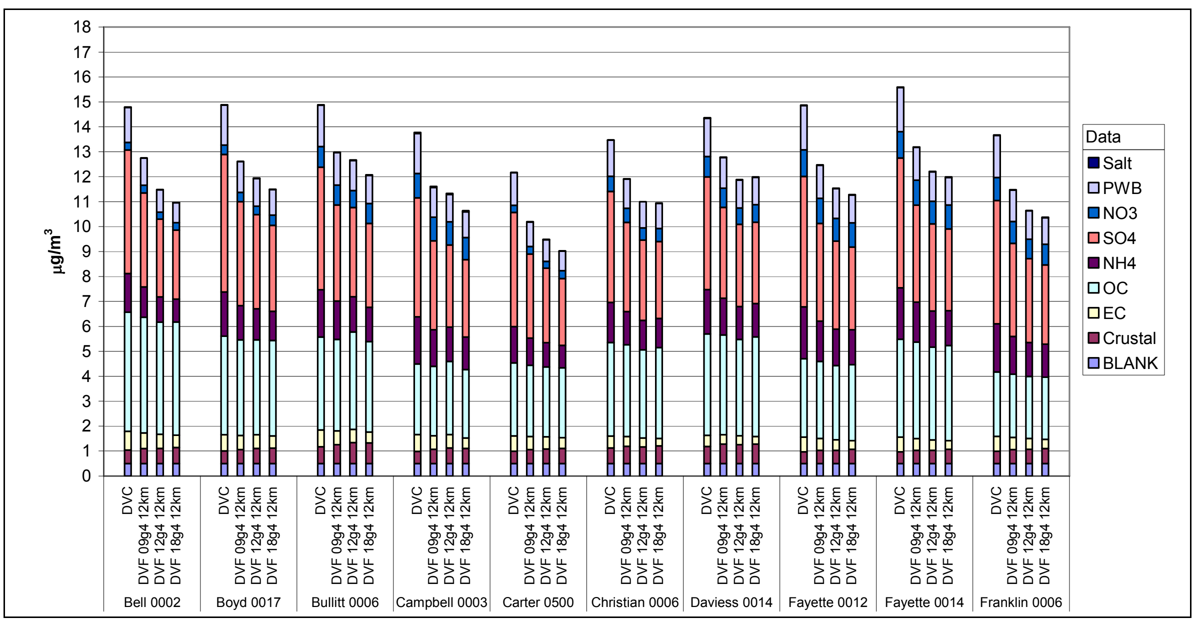


Figure 4-6a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Kentucky using the CMAQ 36/12 km Base G4 modeling results.

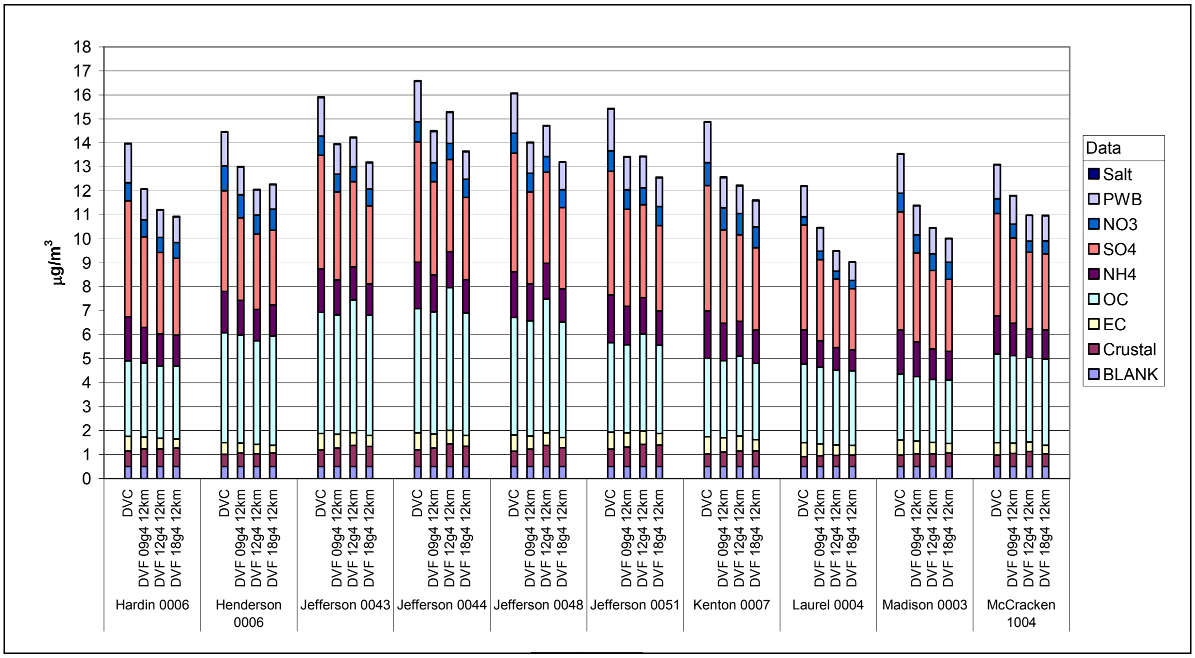


Figure 4-6b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Kentucky using the CMAQ 36/12 km Base G4 modeling results.

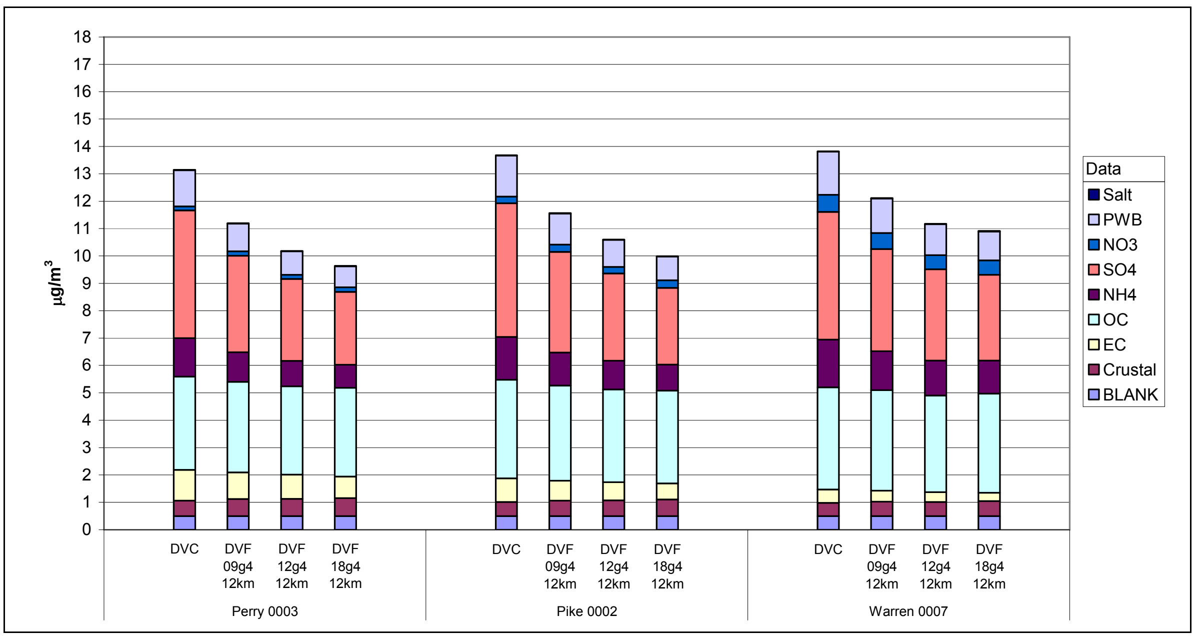


Figure 4-6c. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Kentucky using the CMAQ 36/12 km Base G4 modeling results.

Table 4-5. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Kentucky using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
21-013-0002	**KY**	Bell	14.8	12.8	11.5	11.0	-2.0	-3.3	-3.8
21-019-0017	**KY**	Boyd	14.9	12.6	11.9	11.5	-2.3	-2.9	-3.4
21-029-0006	**KY**	Bullitt	14.9	13.0	12.7	12.1	-1.9	-2.2	-2.8
21-037-0003	**KY**	Campbell	13.8	11.6	11.3	10.6	-2.2	-2.4	-3.1
21-043-0500	**KY**	Carter	12.2	10.2	9.5	9.0	-2.0	-2.7	-3.2
21-047-0006	**KY**	Christian	13.5	11.9	11.0	10.9	-1.6	-2.5	-2.5
21-059-0014	**KY**	Daviess	14.4	12.8	11.9	12.0	-1.6	-2.5	-2.4
21-067-0012	**KY**	Fayette	14.9	12.5	11.5	11.3	-2.4	-3.3	-3.6
21-067-0014	**KY**	Fayette	**15.6**	13.2	12.2	12.0	-2.4	-3.4	-3.6
21-073-0006	**KY**	Franklin	13.7	11.5	10.6	10.4	-2.2	-3.0	-3.3
21-093-0006	**KY**	Hardin	14.0	12.1	11.2	10.9	-1.9	-2.8	-3.0
21-101-0006	**KY**	Henderson	14.5	13.0	12.1	12.3	-1.5	-2.4	-2.2
21-111-0043	**KY**	Jefferson	**15.9**	14.0	14.2	13.2	-2.0	-1.7	-2.7
21-111-0044	**KY**	Jefferson	**16.6**	14.5	**15.3**	13.7	-2.1	-1.3	-2.9
21-111-0048	**KY**	Jefferson	**16.1**	14.0	14.7	13.2	-2.0	-1.3	-2.9
21-111-0051	**KY**	Jefferson	**15.4**	13.4	13.4	12.6	-2.0	-2.0	-2.9
21-117-0007	**KY**	Kenton	14.9	12.6	12.2	11.6	-2.3	-2.7	-3.3
21-125-0004	**KY**	Laurel	12.2	10.5	9.5	9.0	-1.7	-2.7	-3.2
21-145-1004	**KY**	McCracken	13.1	11.8	11.0	11.0	-1.3	-2.1	-2.1
21-151-0003	**KY**	Madison	13.5	11.4	10.5	10.0	-2.1	-3.1	-3.5
21-193-0003	**KY**	Perry	13.2	11.2	10.2	9.6	-2.0	-3.0	-3.5
21-195-0002	**KY**	Pike	13.7	11.6	10.6	10.0	-2.1	-3.1	-3.7
21-227-0007	**KY**	Warren	13.8	12.1	11.2	10.9	-1.7	-2.6	-2.9

4.7.6 Mississippi

The maximum current-year $PM_{2.5}$ Design Value in Mississippi is 14.5 $\mu g/m^3$ in Jones County which is projected to be reduced to 13.6 $\mu g/m^3$ in 2009. All FRM monitoring sites in Mississippi currently and are projected to attain the annual $PM_{2.5}$ NAAQS in 2009, 2012 and 2018 (Figure 4-7 and Table 4-6).

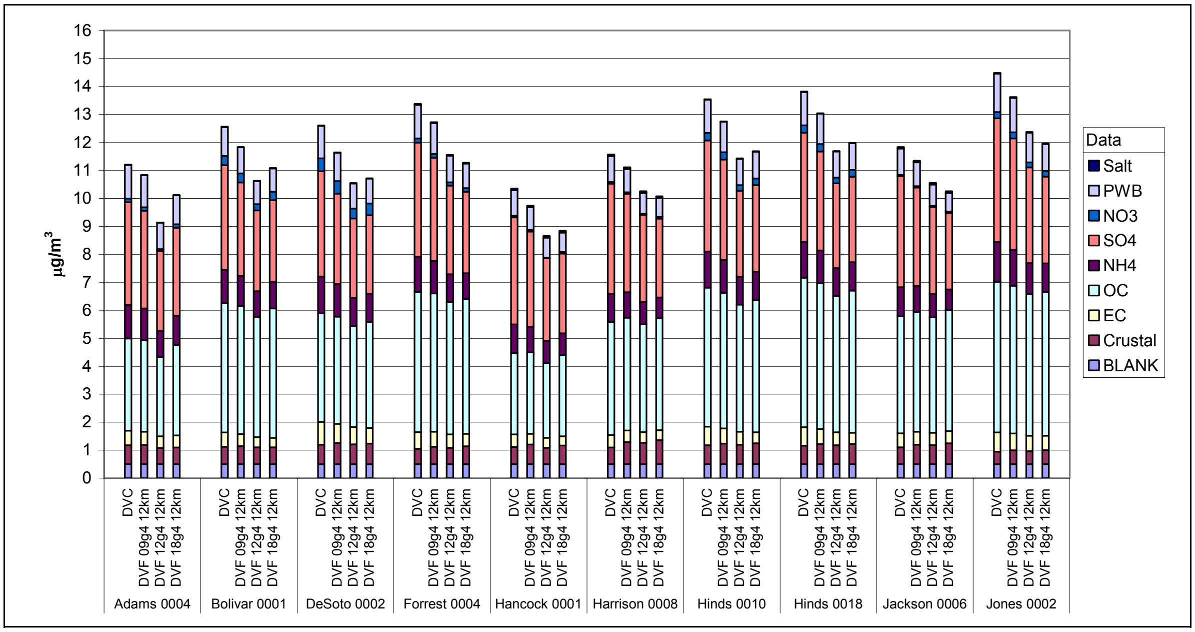


Figure 4-7a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Mississippi using the CMAQ 12 km Base G4 modeling results.

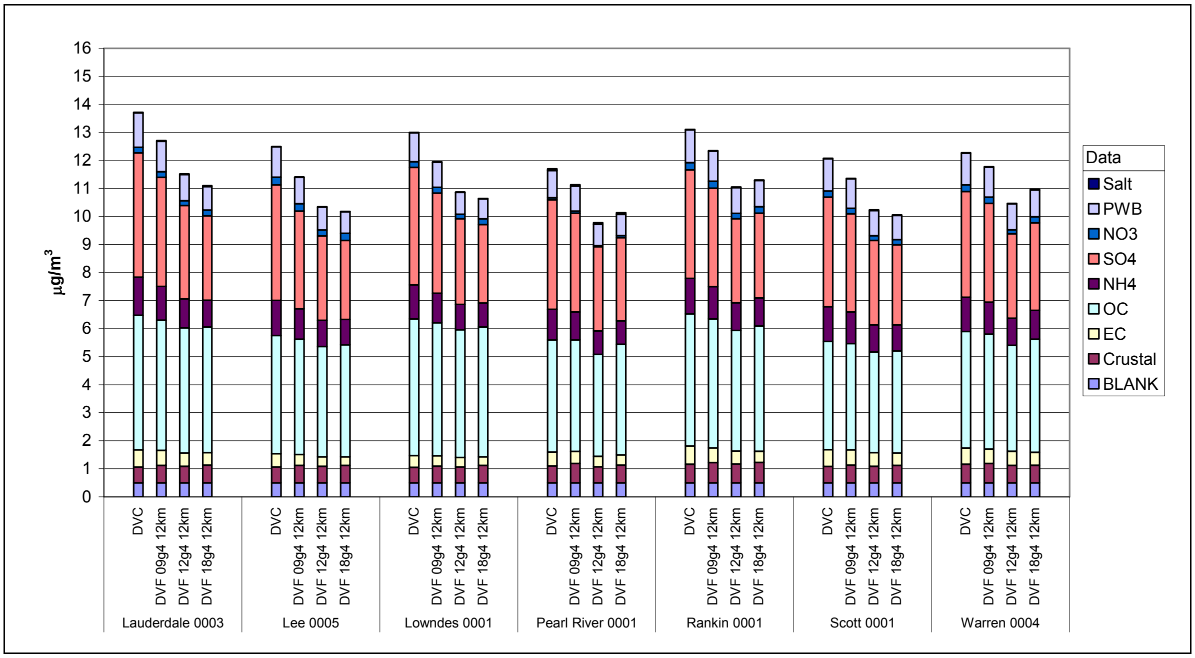


Figure 4-7b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Mississippi using the CMAQ 12 km Base G4 modeling results.

Table 4-6. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Mississippi using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
28-001-0004	**MS**	Adams	11.2	10.8	9.1	10.1	-0.4	-2.1	-1.1
28-011-0001	**MS**	Bolivar	12.6	11.8	10.6	11.1	-0.7	-1.9	-1.5
28-033-0002	**MS**	DeSoto	12.6	11.6	10.5	10.7	-1.0	-2.1	-1.9
28-035-0004	**MS**	Forrest	13.4	12.7	11.6	11.3	-0.6	-1.8	-2.1
28-045-0001	**MS**	Hancock	10.3	9.7	8.7	8.8	-0.6	-1.7	-1.5
28-047-0008	**MS**	Harrison	11.6	11.1	10.3	10.1	-0.5	-1.3	-1.5
28-049-0010	**MS**	Hinds	13.5	12.8	11.4	11.7	-0.8	-2.1	-1.9
28-049-0018	**MS**	Hinds	13.8	13.0	11.7	12.0	-0.8	-2.1	-1.8
28-059-0006	**MS**	Jackson	11.8	11.3	10.6	10.3	-0.5	-1.3	-1.6
28-067-0002	**MS**	Jones	14.5	13.6	12.4	12.0	-0.9	-2.1	-2.5
28-075-0003	**MS**	Lauderdale	13.7	12.7	11.5	11.1	-1.0	-2.2	-2.6
28-081-0005	**MS**	Lee	12.5	11.4	10.3	10.2	-1.1	-2.1	-2.3
28-087-0001	**MS**	Lowndes	13.0	11.9	10.9	10.6	-1.1	-2.1	-2.4
28-109-0001	**MS**	Pearl River	11.7	11.1	9.8	10.1	-0.6	-1.9	-1.6
28-121-0001	**MS**	Rankin	13.1	12.3	11.1	11.3	-0.8	-2.1	-1.8
28-123-0001	**MS**	Scott	12.1	11.4	10.2	10.1	-0.7	-1.8	-2.0
28-149-0004	**MS**	Warren	12.3	11.8	10.5	11.0	-0.5	-1.8	-1.3

4.7.7 North Carolina

Of the 34 FRM monitoring sites in North Carolina, 3 have DVCs that currently exceed the annual $PM_{2.5}$ NAAQS that are in Mecklenburg and Catawba Counties (Charlotte NAA) and Davidson County (Winston-Salem-Greensboro NAA). The highest DVC is 15.9 μg/m^3 that occurs in Davidson County and is reduced to 13.1 μg/m^3 in 2009. All North Carolina FRM monitoring sites are projected to attain the annual $PM_{2.5}$ NAAQS in 2009 and are also projected to be below the range of WOE. The $PM_{2.5}$ Design Values are projected to be even lower in 2012 and 2018 (Figure 4-8 and Table 4-7).

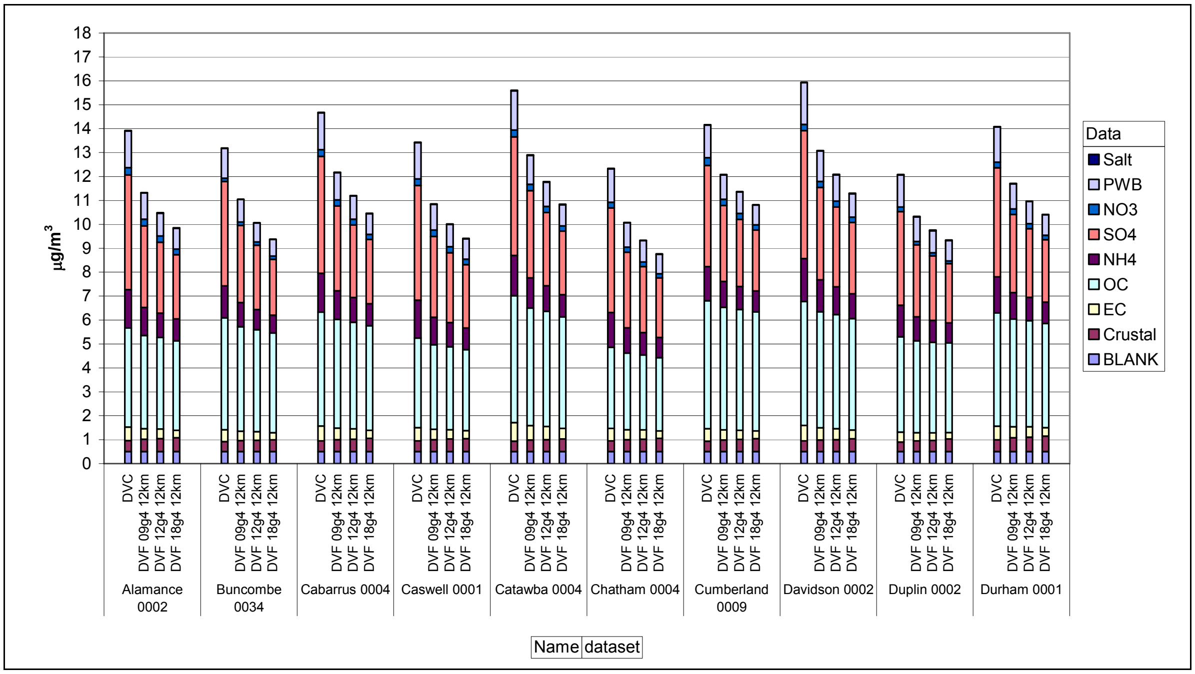


Figure 4-8a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in North Carolina using the CMAQ 36/12 km Base G4 modeling results.

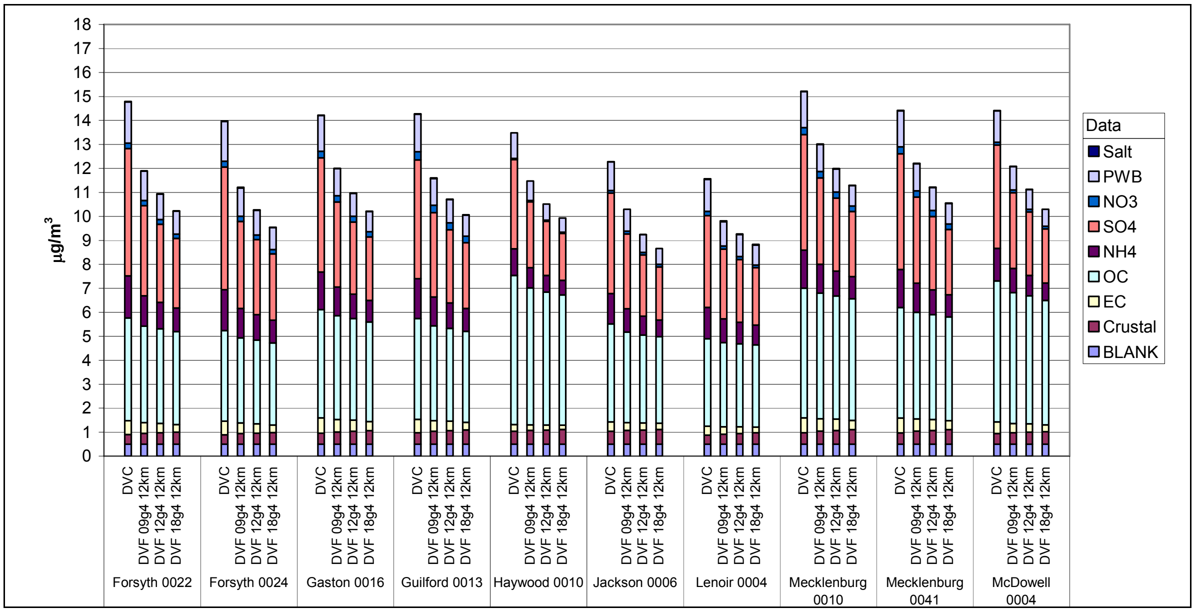


Figure 4-8b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in North Carolina using the CMAQ 36/12 km Base G4 modeling results.

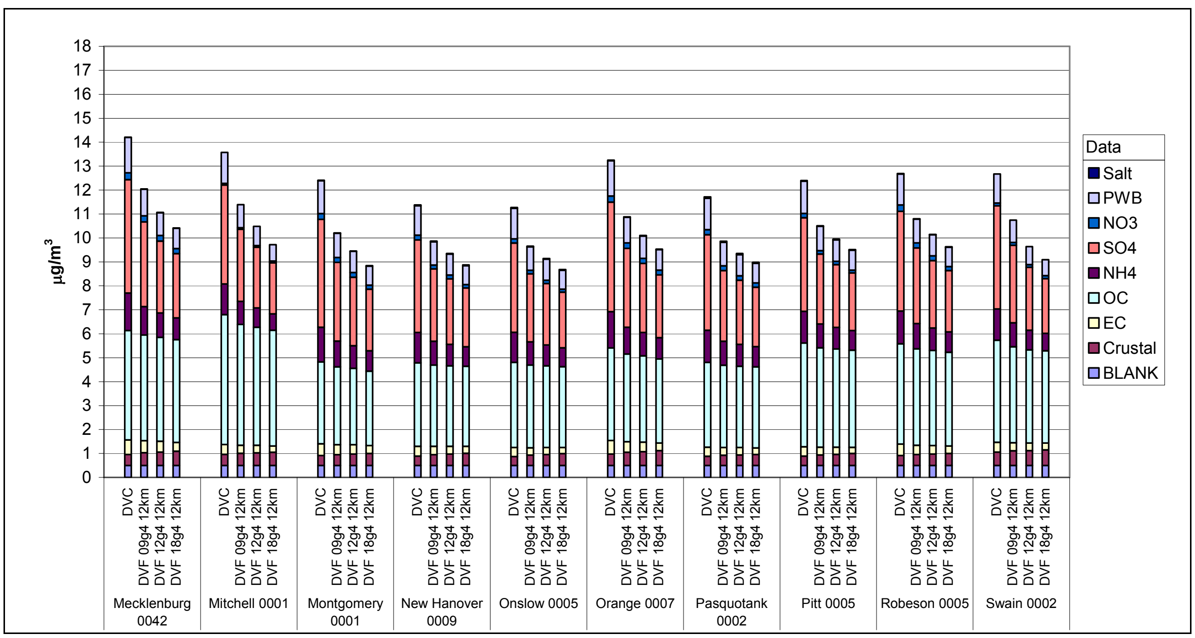


Figure 4-8c. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in North Carolina using the CMAQ 36/12 km Base G4 modeling results.

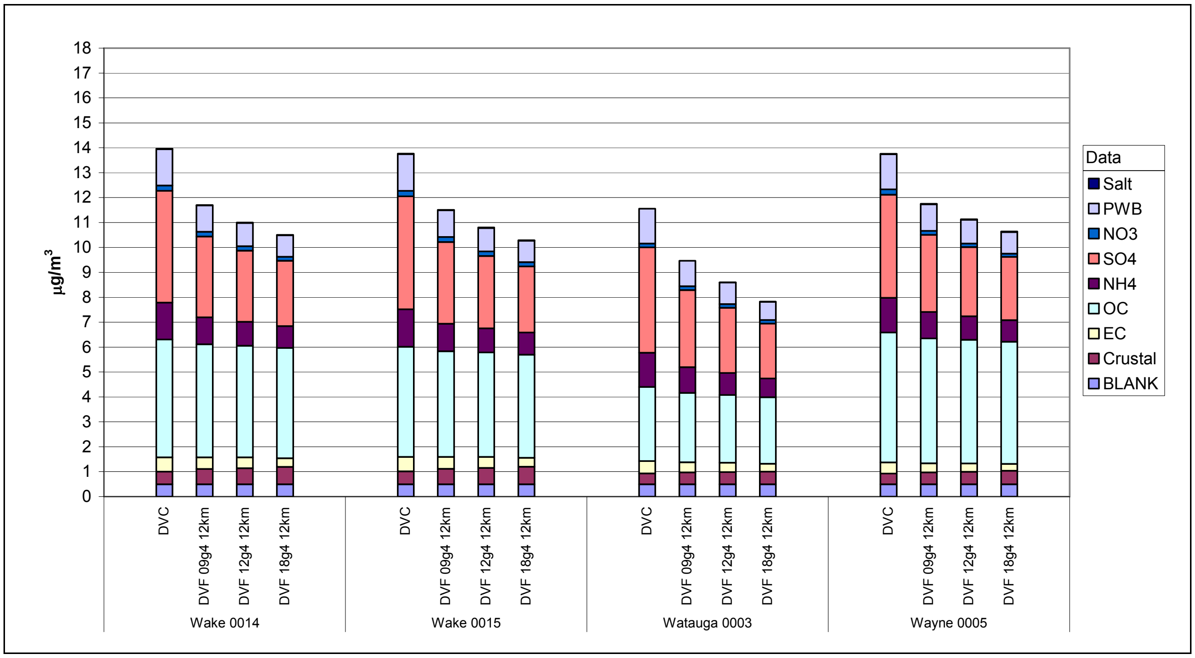


Figure 4-8d. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in North Carolina using the CMAQ 36/12 km Base G4 modeling results.

Table 4-7. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (μg/m^3) in North Carolina using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
37-001-0002	NC	Alamance	13.9	11.3	10.5	9.9	-2.6	-3.5	-4.1
37-021-0034	NC	Buncombe	13.2	11.1	10.1	9.4	-2.1	-3.1	-3.8
37-025-0004	NC	Cabarrus	14.7	12.2	11.2	10.5	-2.5	-3.5	-4.2
37-033-0001	NC	Caswell	13.4	10.9	10.0	9.4	-2.6	-3.4	-4.0
37-035-0004	NC	Catawba	**15.6**	12.9	11.8	10.8	-2.7	-3.8	-4.8
37-037-0004	NC	Chatham	12.3	10.1	9.3	8.8	-2.3	-3.0	-3.6
37-051-0009	NC	Cumberland	14.2	12.1	11.4	10.8	-2.1	-2.8	-3.4
37-057-0002	NC	Davidson	**15.9**	13.1	12.1	11.3	-2.9	-3.9	-4.6
37-061-0002	NC	Duplin	12.1	10.3	9.8	9.3	-1.8	-2.3	-2.8
37-063-0001	NC	Durham	14.1	11.7	11.0	10.4	-2.4	-3.1	-3.7
37-067-0022	NC	Forsyth	14.8	11.9	10.9	10.2	-2.9	-3.9	-4.6
37-067-0024	NC	Forsyth	14.0	11.2	10.3	9.5	-2.8	-3.7	-4.4
37-071-0016	NC	Gaston	14.2	12.0	11.0	10.2	-2.2	-3.3	-4.0
37-081-0013	NC	Guilford	14.3	11.6	10.7	10.1	-2.7	-3.6	-4.2
37-087-0010	NC	Haywood	13.5	11.5	10.5	9.9	-2.0	-3.0	-3.6
37-099-0006	NC	Jackson	12.3	10.3	9.2	8.7	-2.0	-3.0	-3.6
37-107-0004	NC	Lenoir	11.6	9.8	9.3	8.8	-1.8	-2.3	-2.7
37-111-0004	NC	McDowell	14.4	12.1	11.1	10.3	-2.3	-3.3	-4.1
37-119-0010	NC	Mecklenburg	**15.2**	13.0	12.0	11.3	-2.2	-3.2	-3.9
37-119-0041	NC	Mecklenburg	14.4	12.2	11.2	10.6	-2.2	-3.2	-3.9
37-119-0042	NC	Mecklenburg	14.2	12.0	11.1	10.4	-2.2	-3.1	-3.8
37-121-0001	NC	Mitchell	13.6	11.4	10.5	9.7	-2.2	-3.1	-3.9
37-123-0001	NC	Montgomery	12.4	10.2	9.5	8.8	-2.2	-3.0	-3.6
37-129-0009	NC	New Hanover	11.4	9.9	9.4	8.9	-1.5	-2.0	-2.5
37-133-0005	NC	Onslow	11.3	9.7	9.1	8.7	-1.6	-2.1	-2.6
37-135-0007	NC	Orange	13.2	10.9	10.1	9.5	-2.4	-3.1	-3.7
37-139-0002	NC	Pasquotank	11.7	9.9	9.3	9.0	-1.9	-2.4	-2.7
37-147-0005	NC	Pitt	12.4	10.5	9.9	9.5	-1.9	-2.5	-2.9
37-155-0005	NC	Robeson	12.7	10.8	10.1	9.6	-1.9	-2.6	-3.1
37-173-0002	NC	Swain	12.7	10.7	9.6	9.1	-1.9	-3.0	-3.6
37-183-0014	NC	Wake	14.0	11.7	11.0	10.5	-2.3	-3.0	-3.5
37-183-0015	NC	Wake	13.8	11.5	10.8	10.3	-2.3	-3.0	-3.5
37-189-0003	NC	Watauga	11.6	9.5	8.6	7.8	-2.1	-3.0	-3.7
37-191-0005	NC	Wayne	13.8	11.7	11.1	10.6	-2.0	-2.6	-3.1

4.7.8 South Carolina

There is one monitoring site in Greenville County, South Carolina (city of Greenville) whose DVC currently exceeds the annual $PM_{2.5}$ NAAQS at 15.8 μg/m^3 (Figure 4-9 and Table 4-8). It is estimated to be reduced to 13.6 μg/m^3 in 2009. Thus, all South Carolina FRM monitoring sites are projected to attain the annual $PM_{2.5}$ NAAQS in 2009, with further reductions projected to occur in 2012 and 2018.

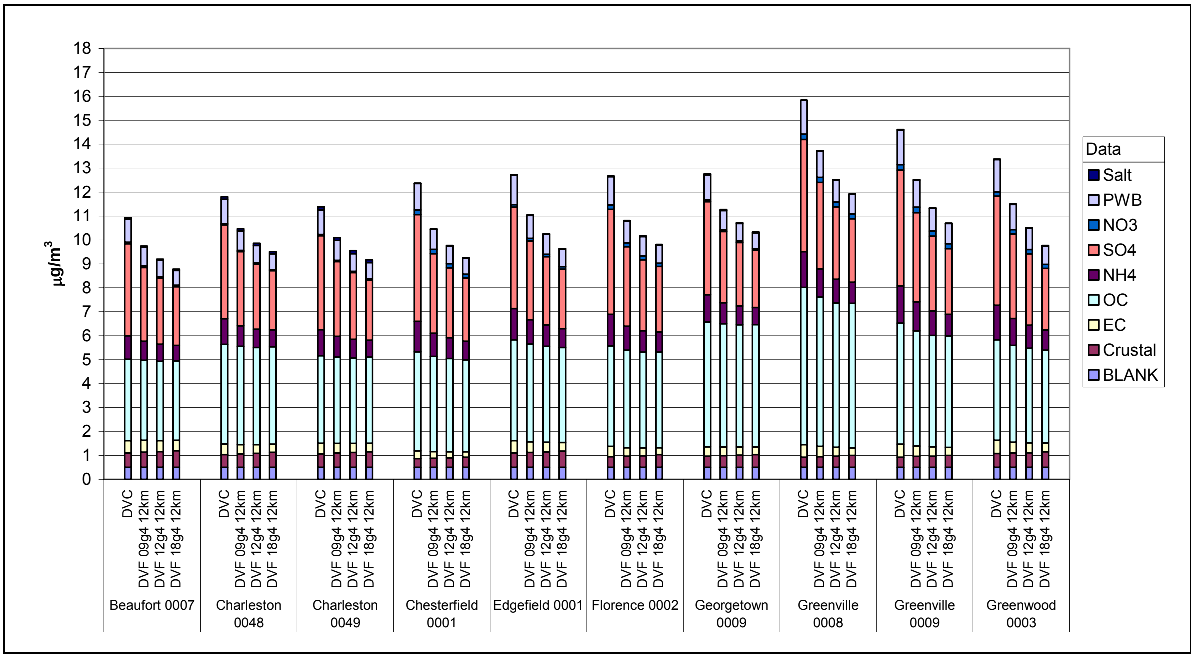


Figure 4-9a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in South Carolina using the CMAQ 12 km Base G4 modeling results.

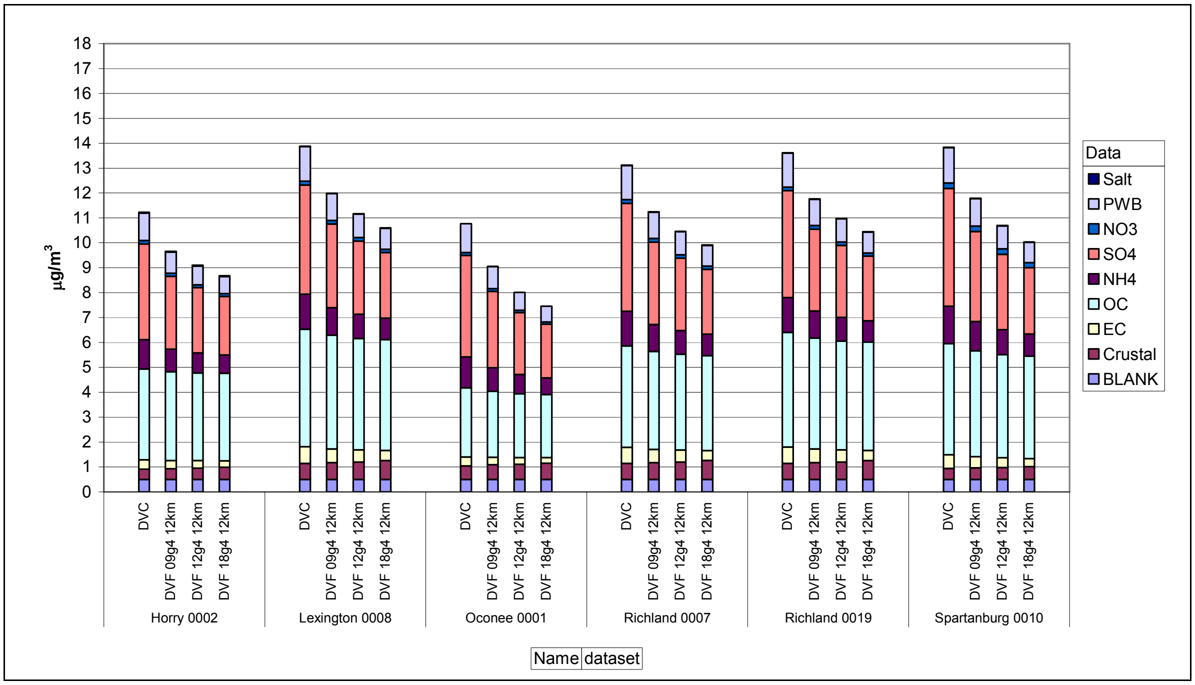


Figure 4-9b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in South Carolina using the CMAQ 12 km Base G4 modeling results.

Table 4-8. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in South Carolina using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
45-013-0007	**SC**	Beaufort	10.9	9.7	9.2	8.8	-1.2	-1.7	-2.1
45-019-0048	**SC**	Charleston	11.8	10.5	9.9	9.5	-1.3	-2.0	-2.3
45-019-0049	**SC**	Charleston	11.4	10.1	9.6	9.2	-1.3	-1.8	-2.2
45-025-0001	**SC**	Chesterfield	12.4	10.5	9.8	9.3	-1.9	-2.6	-3.1
45-037-0001	**SC**	Edgefield	12.7	11.0	10.3	9.6	-1.7	-2.5	-3.1
45-041-0002	**SC**	Florence	12.7	10.8	10.2	9.8	-1.9	-2.5	-2.9
45-043-0009	**SC**	Georgetown	12.8	11.3	10.7	10.3	-1.5	-2.0	-2.4
45-045-0008	**SC**	Greenville	**15.8**	13.7	12.5	11.9	-2.1	-3.3	-3.9
45-045-0009	**SC**	Greenville	14.6	12.5	11.3	10.7	-2.1	-3.3	-3.9
45-047-0003	**SC**	Greenwood	13.4	11.5	10.5	9.8	-1.9	-2.9	-3.6
45-051-0002	**SC**	Horry	11.2	9.7	9.1	8.7	-1.6	-2.1	-2.6
45-063-0008	**SC**	Lexington	13.9	12.0	11.2	10.6	-1.9	-2.7	-3.3
45-073-0001	**SC**	Oconee	10.8	9.0	8.0	7.5	-1.7	-2.8	-3.3
45-079-0007	**SC**	Richland	13.1	11.2	10.5	9.9	-1.9	-2.7	-3.2
45-079-0019	**SC**	Richland	13.6	11.8	11.0	10.4	-1.9	-2.6	-3.2
45-083-0010	**SC**	Spartanburg	13.8	11.8	10.7	10.0	-2.0	-3.1	-3.8

4.7.8 Tennessee

Five monitoring sites in Tennessee have DVCs that exceed the annual $PM_{2.5}$ NAAQS, with three of them at 16.0 µg/m^3 or greater that occur in the Knoxville (Knox County) and Chattanooga (Hamilton County) NAAs (Figure 4-10 and Table 4-9). However, all of the 2009 $PM_{2.5}$ Design Values in Tennessee are projected to be below the annual $PM_{2.5}$ NAAQS with a maximum projected DVF of 14.4 µg/m^3 that occurs in both the in Knoxville and Chattanooga areas and are below the WOE range. For most sites there are further reductions in the $PM_{2.5}$ Design Values in 2012 and 2018. The exception to this are Dyer and Shelby counties where the $PM_{2.5}$ projections are flat or even go up between 2012 and 2018, These counties are on the western edge of Tennessee and are highly influenced by emissions from the CENRAP states and in particular Arkansas that is not included in the CAIR PM controls. As discussed for the Kentucky projections in Section 4.2.5, the purpose of the ASIP 2012 modeling was primarily to support the Georgia and Alabama SIPs. Thus, a simpler emissions projection approach was used for the non-VISTAS states 2012 projections than used for 2009 and 2018 so that the ASIP 2012 $PM_{2.5}$ projections at sites along the border of the ASIP region (e.g., Dyer and Shelby Counties, Tennessee) are more uncertain.

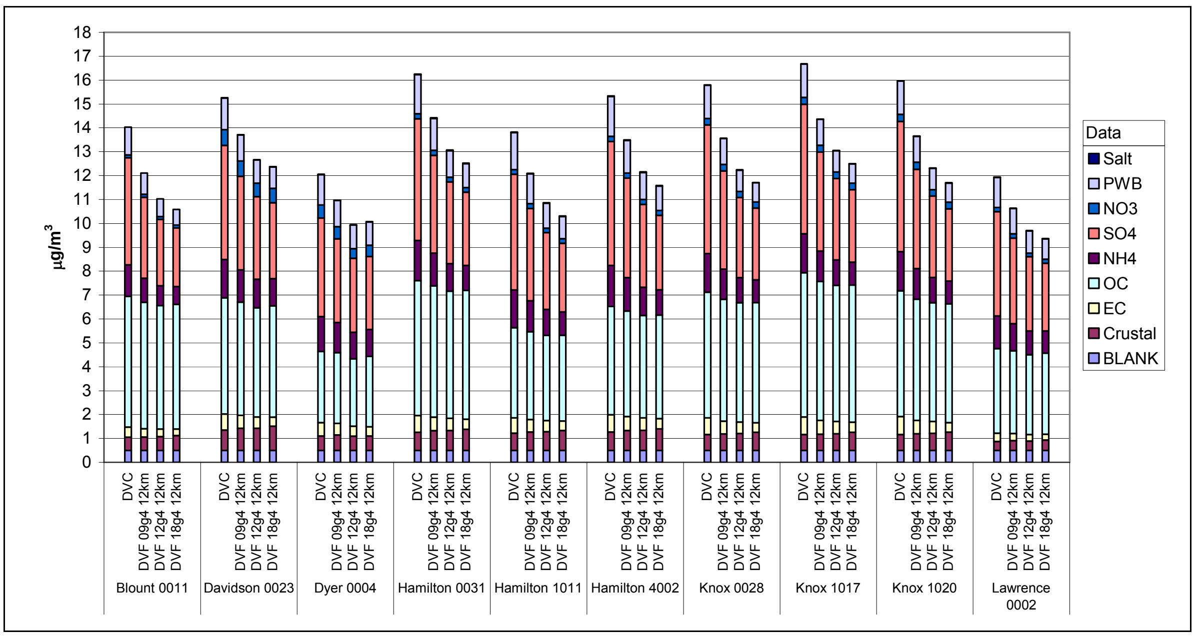


Figure 4-10a. Current (2000-2004) $PM_{2.5}$ Design Values centered on 2002 and Projected 2009 $PM_{2.5}$ Design Values (DVF) in Tennessee using the 2009 CMAQ 36/12 km Base G4 modeling results.

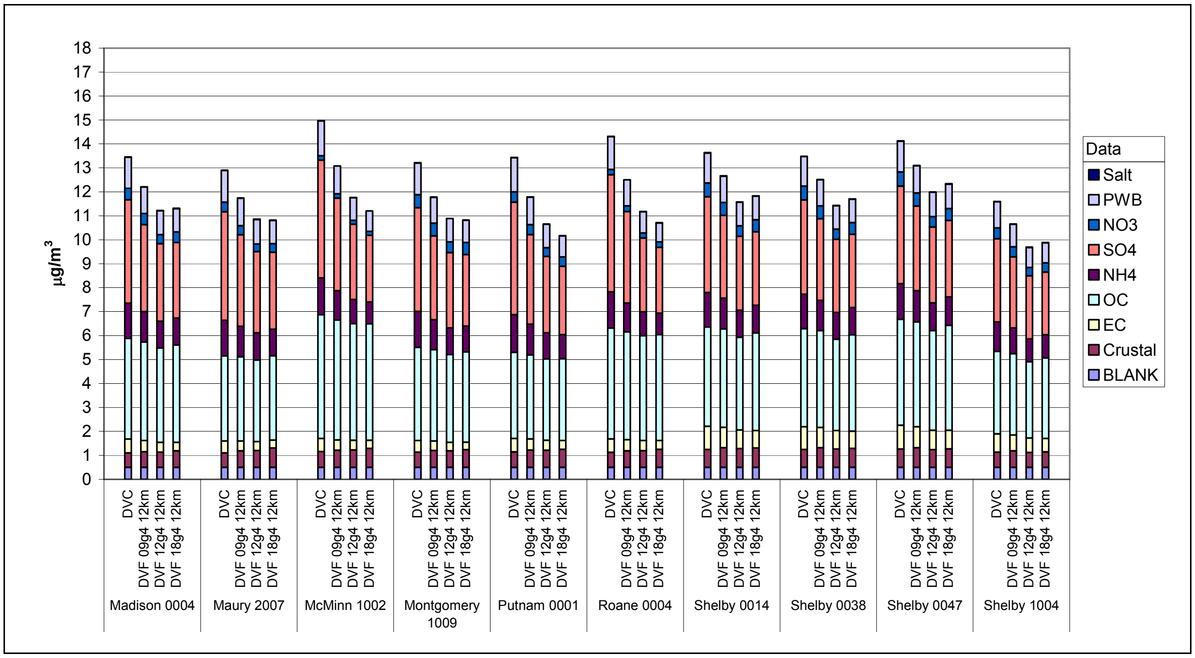


Figure 4-10b. Current (2000-2004) $PM_{2.5}$ Design Values centered on 2002 and Projected 2009 $PM_{2.5}$ Design Values (DVF) in Tennessee using the 2009 CMAQ 36/12 km Base G4 modeling results.

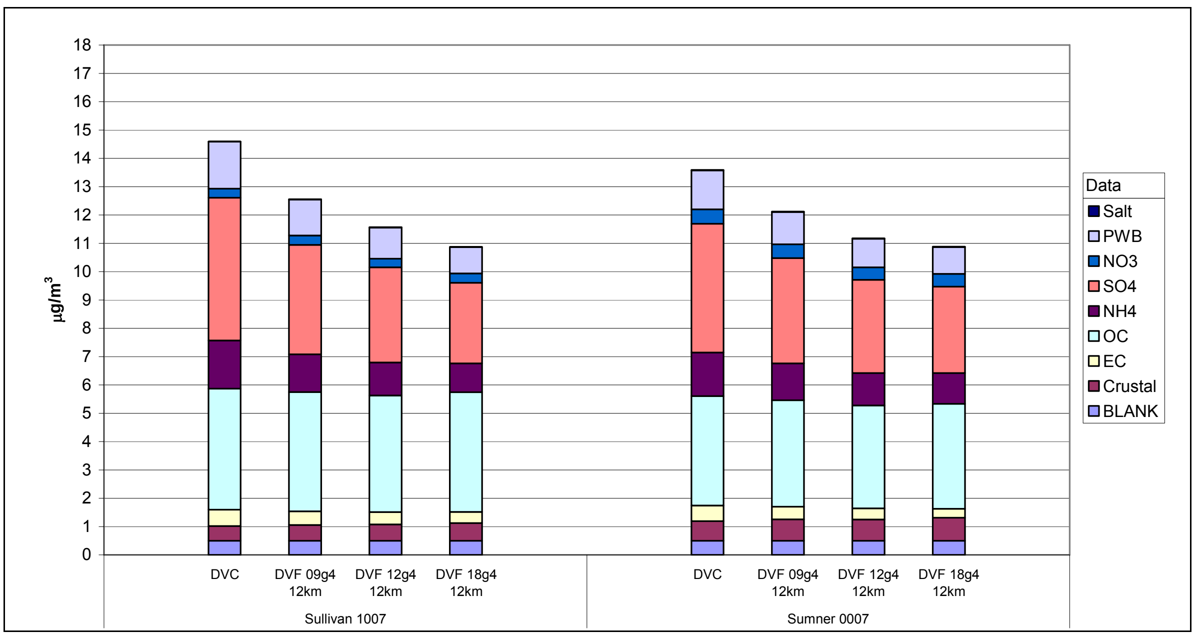


Figure 4-10c. Current (2000-2004) $PM_{2.5}$ Design Values centered on 2002 and Projected 2009 $PM_{2.5}$ Design Values (DVF) in Tennessee using the 2009 CMAQ 36/12 km Base G4 modeling results.

Table 4-9. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Tennessee using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
47-009-0011	**TN**	Blount	14.0	12.1	11.0	10.6	-1.9	-3.0	-3.4
47-037-0023	**TN**	Davidson	15.3	13.7	12.7	12.4	-1.5	-2.6	-2.9
47-045-0004	**TN**	Dyer	12.1	11.0	9.9	10.1	-1.1	-2.1	-2.0
47-065-0031	**TN**	Hamilton	**16.3**	14.4	13.1	12.5	-1.8	-3.2	-3.7
47-065-1011	**TN**	Hamilton	13.8	12.1	10.9	10.3	-1.7	-3.0	-3.5
47-065-4002	**TN**	Hamilton	**15.3**	13.5	12.2	11.6	-1.9	-3.2	-3.8
47-093-0028	**TN**	Knox	**15.8**	13.6	12.2	11.7	-2.2	-3.6	-4.1
47-093-1017	**TN**	Knox	**16.7**	14.4	13.1	12.5	-2.3	-3.6	-4.2
47-093-1020	**TN**	Knox	**16.0**	13.7	12.3	11.7	-2.3	-3.7	-4.3
47-099-0002	**TN**	Lawrence	11.9	10.6	9.7	9.4	-1.3	-2.2	-2.6
47-107-1002	**TN**	McMinn	15.0	13.1	11.8	11.2	-1.9	-3.2	-3.8
47-113-0004	**TN**	Madison	13.5	12.2	11.2	11.3	-1.2	-2.2	-2.2
47-119-2007	**TN**	Maury	12.9	11.7	10.9	10.8	-1.2	-2.0	-2.1
47-125-1009	**TN**	Montgomery	13.2	11.8	10.9	10.8	-1.4	-2.3	-2.4
47-141-0001	**TN**	Putnam	13.4	11.8	10.6	10.2	-1.7	-2.8	-3.3
47-145-0004	**TN**	Roane	14.3	12.5	11.2	10.7	-1.8	-3.1	-3.6
47-157-0014	**TN**	Shelby	13.6	12.7	11.6	11.8	-1.0	-2.1	-1.8
47-157-0038	**TN**	Shelby	13.5	12.5	11.4	11.7	-1.0	-2.0	-1.8
47-157-0047	**TN**	Shelby	14.1	13.1	12.0	12.3	-1.0	-2.1	-1.8
47-157-1004	**TN**	Shelby	11.6	10.7	9.7	9.9	-0.9	-1.9	-1.7
47-163-1007	**TN**	Sullivan	14.6	12.6	11.6	10.9	-2.0	-3.0	-3.7
47-165-0007	**TN**	Sumner	13.6	12.1	11.2	10.9	-1.5	-2.4	-2.7

4.7.9 Virginia

For Virginia, all of the current-year and future-year $PM_{2.5}$ Design Values are below the annual $PM_{2.5}$ NAAQS (Figure 4-12 and Table 4-11). There are large reductions in the projected $PM_{2.5}$ Design Values between 2002 and 2009, with further reductions in the further out years.

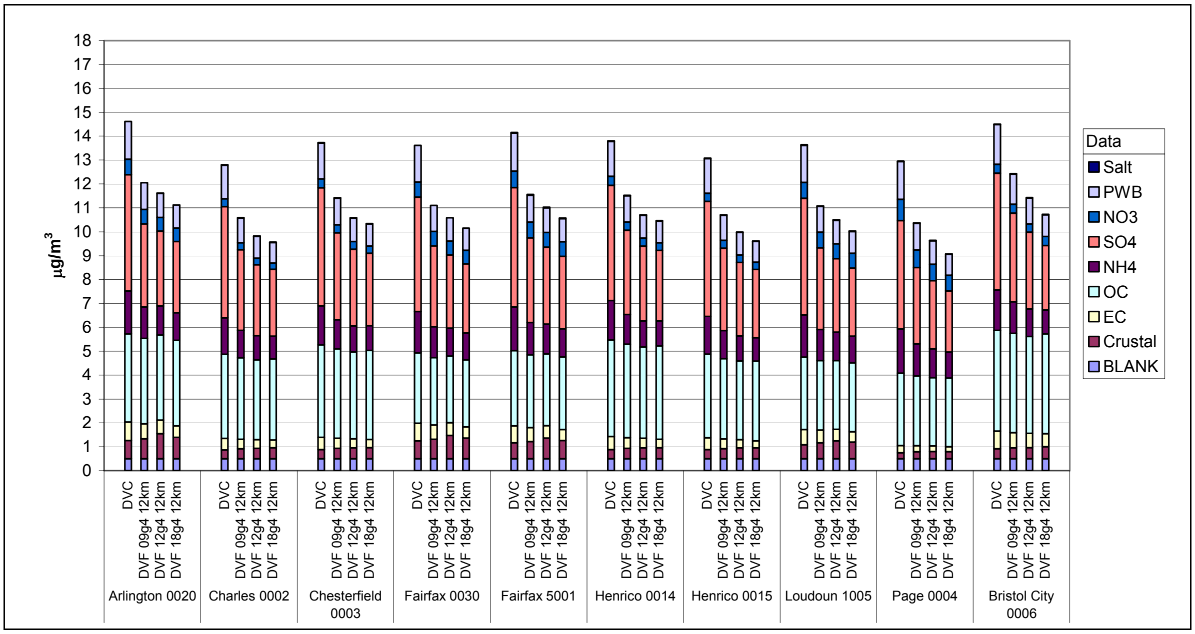


Figure 4-12a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Virginia using the CMAQ 36/12 km Base G4 modeling results.

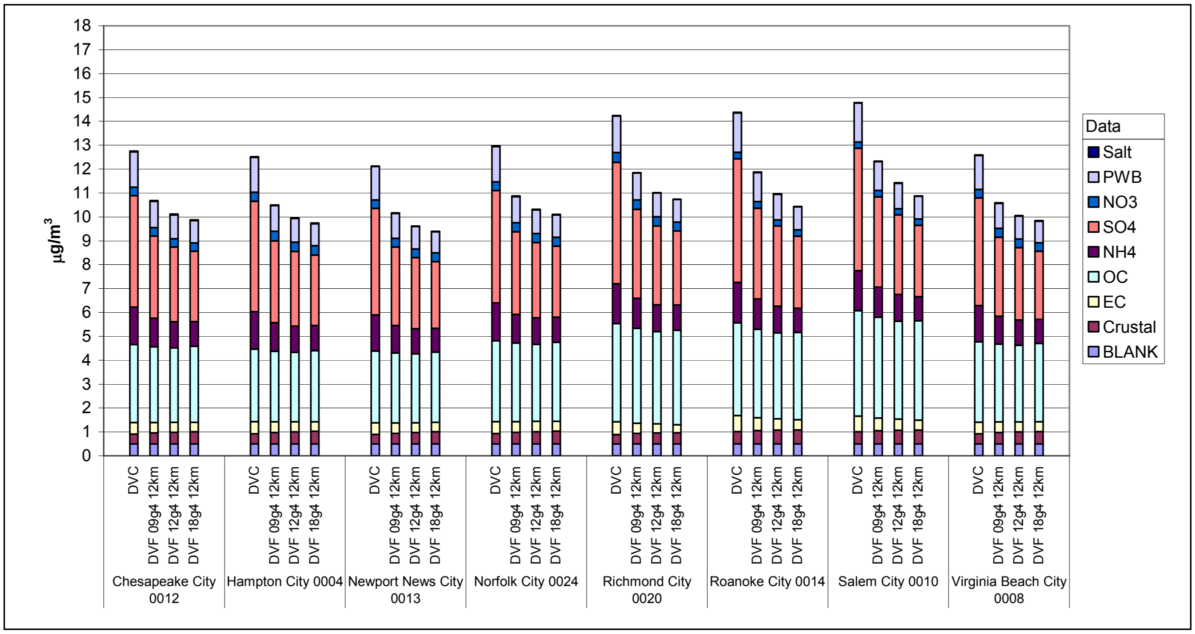


Figure 4-12b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in Virginia using the CMAQ 36/12 km Base G4 modeling results.

Table 4-10. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (μg/m^3) in Virginia using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
51-013-0020	VA	Arlington	14.6	12.1	11.6	11.1	-2.6	-3.0	-3.5
51-036-0002	VA	Charles	12.8	10.6	9.8	9.6	-2.2	-3.0	-3.2
51-041-0003	VA	Chesterfield	13.7	11.4	10.6	10.3	-2.3	-3.2	-3.4
51-059-0030	VA	Fairfax	13.6	11.1	10.6	10.2	-2.5	-3.0	-3.5
51-059-5001	VA	Fairfax	14.2	11.6	11.0	10.6	-2.6	-3.1	-3.6
51-087-0014	VA	Henrico	13.8	11.5	10.7	10.5	-2.3	-3.1	-3.3
51-087-0015	VA	Henrico	13.1	10.7	10.0	9.6	-2.4	-3.1	-3.5
51-107-1005	VA	Loudoun	13.6	11.1	10.5	10.0	-2.6	-3.1	-3.6
51-139-0004	VA	Page	13.0	10.4	9.6	9.1	-2.6	-3.3	-3.9
51-520-0006	VA	Bristol City	14.5	12.4	11.4	10.7	-2.1	-3.1	-3.8
51-550-0012	VA	Chesapeake City	12.8	10.7	10.1	9.9	-2.1	-2.6	-2.9
51-650-0004	VA	Hampton City	12.5	10.5	10.0	9.7	-2.0	-2.6	-2.8
51-700-0013	VA	Newport News City	12.1	10.2	9.6	9.4	-2.0	-2.5	-2.7
51-710-0024	VA	Norfolk City	13.0	10.9	10.3	10.1	-2.1	-2.7	-2.9
51-760-0020	VA	Richmond City	14.2	11.9	11.0	10.7	-2.4	-3.2	-3.5
51-770-0014	VA	Roanoke City	14.4	11.9	11.0	10.4	-2.5	-3.4	-3.9
51-775-0010	VA	Salem City	14.8	12.3	11.4	10.9	-2.5	-3.4	-3.9
51-810-0008	VA	Virginia Beach City	12.6	10.6	10.1	9.8	-2.0	-2.5	-2.7

4.7.10 West Virginia

Eleven of the 16 FRM monitors in West Virginia have current-year $PM_{2.5}$ Design Values that exceed the annual $PM_{2.5}$ NAAQS. The ASIP modeling estimates that by 2009 all of the FRM monitors in West Virginia would achieve the annual $PM_{2.5}$ NAAQS. Although one of the Kanawha County monitors (14.7 µg/m^3) in the Charleston NAA is within the 14.5-15.5 µg/m^3 WOE range. Additional reductions are seen in the further out future-years.

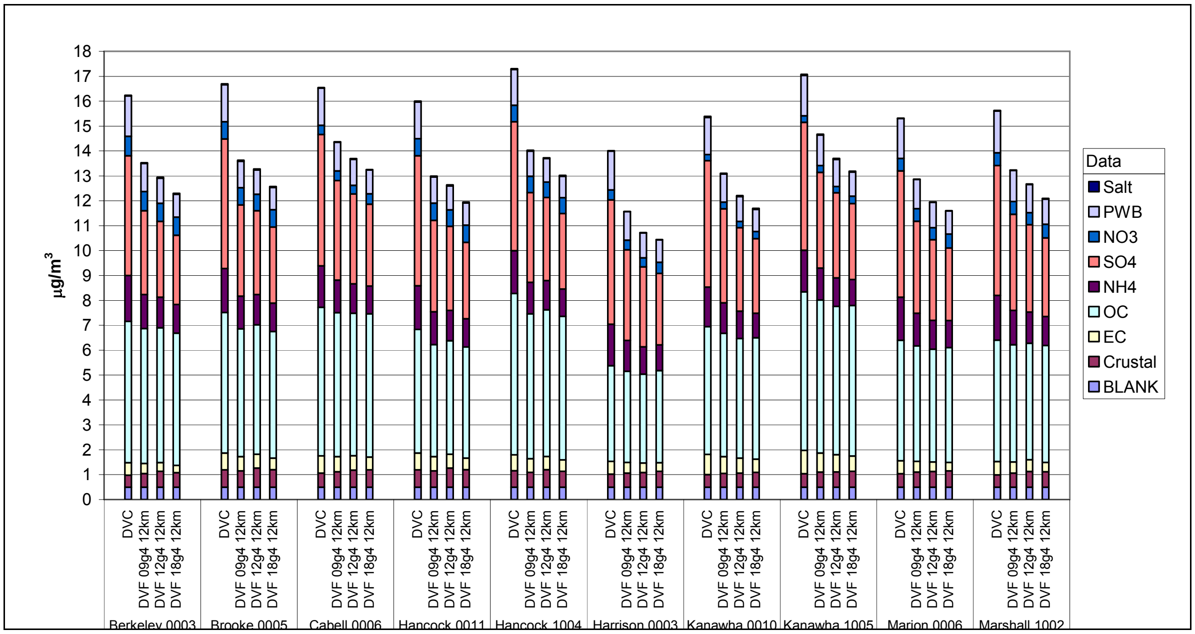


Figure 4-13a. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in West Virginia using the CMAQ 36/12 km Base G4 modeling results.

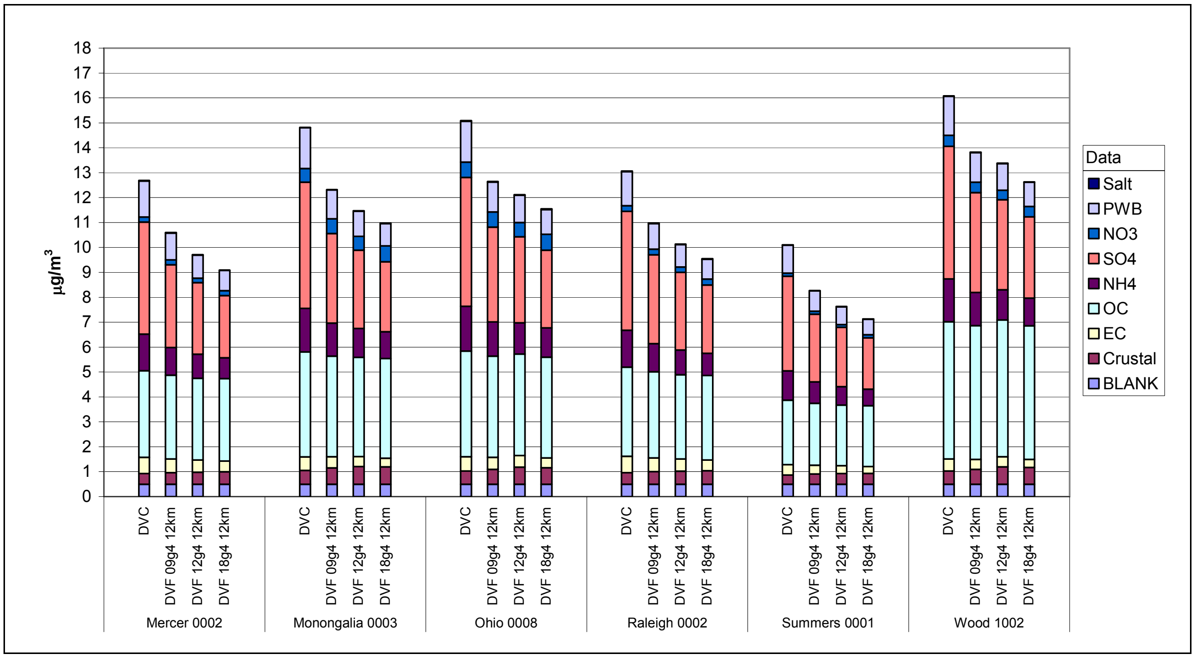


Figure 4-13b. Current (2000-2004) $PM_{2.5}$ Design Values (DVC) and Projected 2009, 2012 and 2018 $PM_{2.5}$ Design Values (DVF) in West Virginia using the CMAQ 36/12 km Base G4 modeling results.

Table 4-11. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values ($\mu g/m^3$) in West Virginia using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
54-003-0003	**WV**	Berkeley	**16.2**	13.5	12.9	12.3	-2.7	-3.3	-3.9
54-009-0005	**WV**	Brooke	**16.7**	13.6	13.3	12.6	-3.1	-3.4	-4.1
54-011-0006	**WV**	Cabell	**16.5**	14.4	13.7	13.3	-2.2	-2.9	-3.3
54-029-0011	**WV**	Hancock	**16.0**	13.0	12.6	11.9	-3.0	-3.4	-4.1
54-029-1004	**WV**	Hancock	**17.3**	14.0	13.7	13.0	-3.3	-3.6	-4.3
54-033-0003	**WV**	Harrison	14.0	11.6	10.7	10.4	-2.4	-3.3	-3.6
54-039-0010	**WV**	Kanawha	**15.4**	13.1	12.2	11.7	-2.3	-3.2	-3.7
54-039-1005	**WV**	Kanawha	**17.1**	14.7	13.7	13.2	-2.4	-3.4	-3.9
54-049-0006	**WV**	Marion	**15.3**	12.9	12.0	11.6	-2.5	-3.4	-3.7
54-051-1002	**WV**	Marshall	**15.6**	13.2	12.7	12.1	-2.4	-3.0	-3.5
54-055-0002	**WV**	Mercer	12.7	10.6	9.7	9.1	-2.1	-3.0	-3.6
54-061-0003	**WV**	Monongalia	14.8	12.3	11.5	11.0	-2.5	-3.3	-3.8
54-069-0008	**WV**	Ohio	**15.1**	12.6	12.1	11.5	-2.4	-3.0	-3.5
54-081-0002	**WV**	Raleigh	13.1	11.0	10.1	9.5	-2.1	-2.9	-3.5
54-089-0001	**WV**	Summers	10.1	8.3	7.6	7.1	-1.8	-2.5	-3.0
54-107-1002	**WV**	Wood	**16.1**	13.8	13.4	12.6	-2.3	-2.7	-3.4

4.7.11 Southern Indiana

Although Indiana is not an ASIP state, future-year $PM_{2.5}$ Design Value projections are presented for those FRM monitors in southern Indiana due to their close proximity to Kentucky (Table 4-12). Four of the six FRM monitors in southern Indiana have DVCs that exceed the annual $PM_{2.5}$ NAAQS. The ASIP modeling estimates that all southern Indiana FRM sites would achieve the annual $PM_{2.5}$ NAAQS by 2009, with additional reductions seen in the further out future-years (Table 4-12).

Table 4-12. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Southern Indiana using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
18-019-0006	IN	Clark	**16.3**	14.3	14.8	13.6	-2.0	-1.5	-2.8
18-043-1004	IN	Floyd	14.9	12.9	12.8	12.2	-2.0	-2.1	-2.7
18-147-0009	IN	Spencer	14.0	12.3	11.4	11.5	-1.7	-2.6	-2.5
18-163-0006	IN	Vanderburgh	**15.1**	13.5	12.5	12.9	-1.6	-2.6	-2.3
18-163-0012	IN	Vanderburgh	**15.1**	13.5	12.5	12.9	-1.6	-2.6	-2.2
18-163-0016	IN	Vanderburgh	**15.3**	13.7	12.7	13.0	-1.6	-2.6	-2.3

4.7.12 Maryland

Maryland is also not an ASIP state, but is adjacent to two ASIP states (Virginia and West Virginia) so would be influenced by their emissions. There are five FRM sites in Maryland that currently violate the annual $PM_{2.5}$ NAAQS (Table 4-13). All Maryland sites are projected to attain the NAAQS by 2009 with a maximum $PM_{2.5}$ Design Value of 13.8 µg/m^3.

Table 4-13. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Maryland using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
24-003-0014	**MD**	Anne Arundel	12.1	9.8	9.5	9.0	-2.3	-2.6	-3.1
24-003-0019	**MD**	Anne Arundel	12.9	10.6	10.3	9.8	-2.3	-2.6	-3.1
24-003-1003	**MD**	Anne Arundel	**15.4**	12.7	12.4	11.8	-2.7	-3.0	-3.6
24-003-2002	**MD**	Anne Arundel	14.1	11.6	11.3	10.7	-2.5	-2.8	-3.4
24-005-1007	**MD**	Baltimore	14.0	11.4	11.2	10.4	-2.5	-2.7	-3.5
24-005-3001	**MD**	Baltimore	15.0	12.4	12.1	11.4	-2.6	-2.9	-3.6
24-015-0003	**MD**	Cecil	13.4	10.9	10.6	9.9	-2.6	-2.8	-3.6
24-025-1001	**MD**	Harford	12.6	10.4	10.1	9.5	-2.3	-2.5	-3.2
24-031-3001	**MD**	Montgomery	12.8	10.4	10.1	9.5	-2.4	-2.7	-3.3
24-043-0009	**MD**	Washington	14.3	11.6	11.1	10.4	-2.7	-3.2	-3.9
24-510-0007	**MD**	Baltimore (City)	15.0	12.3	12.1	11.2	-2.7	-3.0	-3.8
24-510-0008	**MD**	Baltimore (City)	**15.3**	12.8	12.6	11.9	-2.6	-2.7	-3.4
24-510-0035	**MD**	Baltimore (City)	**16.0**	13.2	13.0	12.3	-2.8	-3.0	-3.8
24-510-0049	**MD**	Baltimore (City)	**15.4**	12.6	12.4	11.7	-2.8	-3.0	-3.7
24-033-0001	**MD**	Prince George's	**16.9**	13.8	13.4	12.7	-3.1	-3.5	-4.2

4.7.13 Southern Ohio

PM concentrations at FRM monitors in southern Ohio are adjacent to the Kentucky and/or West Virginia ASIP states. Of the 18 FRM monitors in southern Ohio, 16 have current DVCs that exceed the annual $PM_{2.5}$ NAAQS. Of these, only one remaining FRM site (39-061-0014) is projected to still exceed the annual $PM_{2.5}$ NAAQS in 2009 and that is in Hamilton County (Cincinnati) in the southwest corner of Ohio adjacent to Kentucky and Indiana. By 2012 there are two sites in Hamilton County estimates to exceed the annual NAAQS, however as noted in Chapter 2 and in the discussion on the Louisville Kentucky projections, care should be taken in the interpretation of the 2012 projections in and near the borders of the VISTAS region due to the simplifications in developing the 2012 emissions for the non-VISTAS states to meet the objectives of the 2012 modeling. In any event, by 2018 and FRM sites in southern Ohio are projected to attain the annual $PM_{2.5}$ NAAQS.

Table 4-14. Current-year (DVC) and projected future-year (DVF) $PM_{2.5}$ Design Values (µg/m^3) in Southern Ohio using the 2002 Typical Base G2 and 2009, 2012 and 2018 Base G4 CMAQ 12 km modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
39-009-0003	**OH**	Athens	12.3	10.2	9.7	9.1	-2.1	-2.6	-3.2
39-017-0003	**OH**	Butler	**16.1**	14.0	13.9	13.3	-2.1	-2.3	-2.8
39-017-0016	**OH**	Butler	**15.5**	13.2	12.9	12.3	-2.3	-2.6	-3.2
39-017-0017	**OH**	Butler	**15.3**	13.3	13.1	12.5	-2.1	-2.3	-2.8
39-017-1004	**OH**	Butler	14.1	12.1	11.9	11.4	-2.0	-2.3	-2.7
39-061-0014	**OH**	Hamilton	**17.8**	**15.5**	**15.5**	14.3	-2.3	-2.2	-3.4
39-061-0040	**OH**	Hamilton	**15.6**	13.4	13.4	12.4	-2.1	-2.2	-3.2
39-061-0041	**OH**	Hamilton	**15.8**	13.5	13.3	12.5	-2.3	-2.5	-3.3
39-061-0042	**OH**	Hamilton	**16.8**	14.3	14.0	13.3	-2.4	-2.8	-3.5
39-061-0043	**OH**	Hamilton	**15.5**	13.3	13.1	12.3	-2.3	-2.4	-3.3
39-061-7001	**OH**	Hamilton	**16.3**	14.1	14.1	13.0	-2.2	-2.2	-3.2
39-061-8001	**OH**	Hamilton	**17.3**	15.0	**15.1**	14.0	-2.2	-2.1	-3.3
39-081-0016	**OH**	Jefferson	**18.1**	14.9	14.5	13.8	-3.2	-3.6	-4.3
39-081-1001	**OH**	Jefferson	**17.5**	14.3	13.9	13.2	-3.2	-3.6	-4.3
39-087-0010	**OH**	Lawrence	**15.7**	13.7	13.1	12.7	-2.0	-2.6	-3.0
39-113-0031	**OH**	Montgomery	**15.5**	13.4	12.9	12.5	-2.1	-2.6	-3.0
39-113-0032	**OH**	Montgomery	**15.5**	13.5	13.0	12.6	-2.0	-2.5	-2.9
39-145-0013	**OH**	Scioto	**17.1**	14.7	14.2	13.5	-2.4	-2.9	-3.6

4.8 SUMMARY OF HIGH 2009 $PM_{2.5}$ DESIGN VALUES

Table 4-15 summarizes the FRM monitoring sites within and adjacent to the ASIP region for which projected 2009 $PM_{2.5}$ Design Values are 14.5 µg/m^3 or higher using the ASIP CMAQ 12 km modeling results and EPA MATS projection approach. EPA guidance has a weight of evidence (WOE) zone where additional analysis is needed to support a modeled attainment demonstration when the projected $PM_{2.5}$ Design Values are close to the $PM_{2.5}$ NAAQS (EPA, 2007a). EPA recommends that a WOE analysis be conducted if the modeled future-year $PM_{2.5}$ Design Value is in the 14.5 to 15.5 µg/m^3 range. If the future-year projected $PM_{2.5}$ Design Value is 15.5 µg/m^3 or higher, EPA notes that no amount of additional analysis is likely to be convincing that attainment would be achieved.

There are three FRM monitors within or adjacent to the ASIP region whose 2009 projected $PM_{2.5}$ Design Values are above 15.5 µg/m^3:

- The North Birmingham monitor (17.0 µg/m^3) in the City of Birmingham in Jefferson County, Alabama;
- The Wylam monitor (15.8 µg/m^3) in the City of Birmingham in Jefferson County, Alabama; and
- An Atlanta, Georgia monitor in Fulton County (16.6 µg/m^3).

An additional two monitors are above the $PM_{2.5}$ NAAQS but within the WOE range (14.5-15.5 µg/m^3):

- A monitor in Clayton County, Georgia (15.1 µg/m^3) in the Atlanta area.
- And a monitor in Hamilton County, Ohio that is part of the Cincinnati NAA (15.5 µg/m^3).

An additional 7 FRM monitors have projected $PM_{2.5}$ Design Values that are below the NAAQS but within the WOE zone (Table 4-15). These monitors include ones in the Atlanta NAA, southern Indiana in the Louisville NAA, southern Ohio in the Cincinnati NAA, the greater Charleston-Huntington NAA and the Knoxville NAA.

The two monitors in Birmingham that are projected to violate the annual $PM_{2.5}$ NAAQS in 2009 are influenced by local sources, which are not captured well by the ASIP 12 km CMAQ modeling. Thus, the Alabama Department of Environmental Management (ADEM) and Jefferson County Department of Health (JCDH) are performing the Birmingham Air Pollution Study (BAPS). BAPS is using the ASIP 12 km CMAQ modeling results to provide boundary conditions (BCs) for 4 km urban CMAQ modeling and are also performing AERMOD near-source modeling to address $PM_{2.5}$ attainment issues (ENVIRON and Alpine, 2007).

The Georgia Environmental Protection Division (GEPD) of the Georgia Department of Natural Resources (GDNR) is also performing subregional CMAQ modeling using BCs from the ASIP 12 km CMAQ results.

Table 4-15. 2009 projected $PM_{2.5}$ Design Values within and adjacent to the ASIP region that are 14.5 µg/m^3 or higher using the 2009 CMAQ 12 km Base G4 modeling results.

AIRS ID	State	County	2002 Annual DVC	Annual DVF			Difference		
				2009	2012	2018	09-02	12-02	18-02
Sites with 2009 DVF above the 14.5-15.5 µg/m^3 WOE Zone									
01-073-0023	**AL**	Jefferson	**18.4**	**17.0**	13.8	**15.6**	-1.4	-4.6	-2.8
01-073-2003	**AL**	Jefferson	**17.1**	**15.8**	12.8	14.7	-1.2	-4.3	-2.4
13-121-0039	**GA**	Fulton	**18.3**	**16.6**	**15.3**	14.9	-1.7	-3.0	-3.4
Sites with 2009 DVF above the NAAQS but Within the WOE Zone									
13-063-0091	**GA**	Clayton	**16.5**	**15.1**	13.9	13.4	-1.4	-2.6	-3.1
39-061-0014	**OH**	Hamilton	**17.8**	**15.5**	**15.5**	14.3	-2.3	-2.2	-3.4
Sites with 2009 DVF below the NAAQS but Within the WOE Zone									
01-113-0001	**AL**	Russell	**16.0**	14.8	14.0	13.4	-1.2	-2.1	-2.6
13-067-0003	**GA**	Cobb	**16.3**	14.6	13.2	12.6	-1.7	-3.1	-3.7
21-111-0044	**KY**	Jefferson	**16.6**	14.5	15.3	13.7	-2.1	-1.3	-2.9
54-039-1005	**WV**	Kanawha	**17.1**	14.7	13.7	13.2	-2.4	-3.4	-3.9
39-061-8001	**OH**	Hamilton	**17.3**	15.0	**15.1**	14.0	-2.2	-2.1	-3.3
39-081-0016	**OH**	Jefferson	**18.1**	14.9	14.5	13.8	-3.2	-3.6	-4.3
39-145-0013	**OH**	Scioto	**17.1**	14.7	14.2	13.5	-2.4	-2.9	-3.6

4.9 $PM_{2.5}$ UNMONITORED AREA ANALYSIS

EPA's $PM_{2.5}$ projection procedure also includes an unmonitored area analysis (EPA, 2007a) that has been codified in MATS. The unmonitored area analysis uses the future-year annual $PM_{2.5}$ Design Value projection procedure applied to each grid cell in the modeling domain. In this procedure, the current-year annual $PM_{2.5}$ Design Values (DVC) are interpolated to each grid cell in the modeling domain. This interpolation scheme uses the modeled concentration gradients so that it is possible for the gridded DVCs to be higher than the DVCs at all the FRM monitors in locations where the model predicts higher $PM_{2.5}$ concentrations that are away from the monitoring sites. RRFs are then obtained for each grid cell in the modeling domain using essentially the same approach as used for the $PM_{2.5}$ projections at the FRM monitors described previously, only using the model predictions within each grid cell rather than near a grid cell as done for the projections at the monitor (i.e., average across 3 x 3 12 km grid cells).

Figure 4-14 displays the DVCs interpolated to the 12 km CMAQ domain using MATS and the CMAQ 12 km 2002 Base G2 modeling results. The spatial distribution of the gridded DVCs are displayed with the monitoring site locations in Figure 4-14a so you can see the locations of the monitors, and then without the monitoring site locations in Figure 4-14b so that they don't obscure any of the interpolated DVCs. There is the expected locations of the interpolated DVCs above the annual $PM_{2.5}$ NAAQS in several of the urban areas where DVCs at FRM monitors are above the NAAQS, such as Birmingham, Atlanta, Charlotte, Chattanooga, Knoxville, Cincinnati, Washington DC and along the Ohio River. But there are also unexpected areas of interpolated DVCs that exceed the NAAQS, including between Atlanta and Chattanooga and just west of Savannah, Georgia.

Figure 4-15 displays the MATS unmonitored area analysis projected 2009 $PM_{2.5}$ Design Values using the CMAQ 12 km modeling results for the 2009 Base G4 emissions scenario. As expected based on the monitored 2009 projections presented in Table 4-15 above, there are areas of projected 2009 $PM_{2.5}$ violations in the Birmingham and Atlanta area. But there are also other areas of continued violations in 2009: in Georgia just south of Chattanooga; just west of Savannah, Georgia; Pensacola, Florida; between Columbus and Montgomery Alabama; near Albany, Georgia; scattered areas along the Ohio River (e.g., Louisville); and other isolated areas.

The projected $PM_{2.5}$ Design Values unmonitored area analysis and the 2012 and 2018 future-years are shown in, respectively, Figures 4-16 and 4-17. By 2018, there appears to be only a few isolated areas of continued projected violations of the annual $PM_{2.5}$ NAAQS in the VISTAS states: Birmingham; in Georgia just south of Chattanooga; and just west of Savannah, Georgia.

EPA guidance stresses that the unmonitored area test has more uncertainties than the projections at the monitors and it should be treated separately from the monitor based attainment demonstration test (EPA, 2007a). EPA further notes that while it is expected that additional emission controls will likely be needed to eliminate predicted exceedances of the NAAQS in the monitor based attainment test, the same requirements may not be appropriate in unmonitored areas. In any event, EPA recommends that areas of predicted violations in the unmonitored area test be scrutinized and understood to determine whether they are likely to really exist in the ambient air, or whether they may be caused by an error or uncertainties in the modeling system. At a minimum, it may be appropriate to deploy additional $PM_{2.5}$ monitors to such areas.

In the case of the ASIP $PM_{2.5}$ modeling, the continued violations of the NAAQS in Birmingham and Atlanta areas are confirmed by the monitor-based attainment tests and each of the states involved are performing subregional analysis. The violations west of Savannah Georgia that continue in 2009, 2012 and 2018 appear to be due to wildfires that are assumed to stay constant between the current-year and future-years. The reasons for the other high PM areas (e.g., Pensacola, southeast Alabama, north Georgia and southwest Georgia) are unclear at this time.

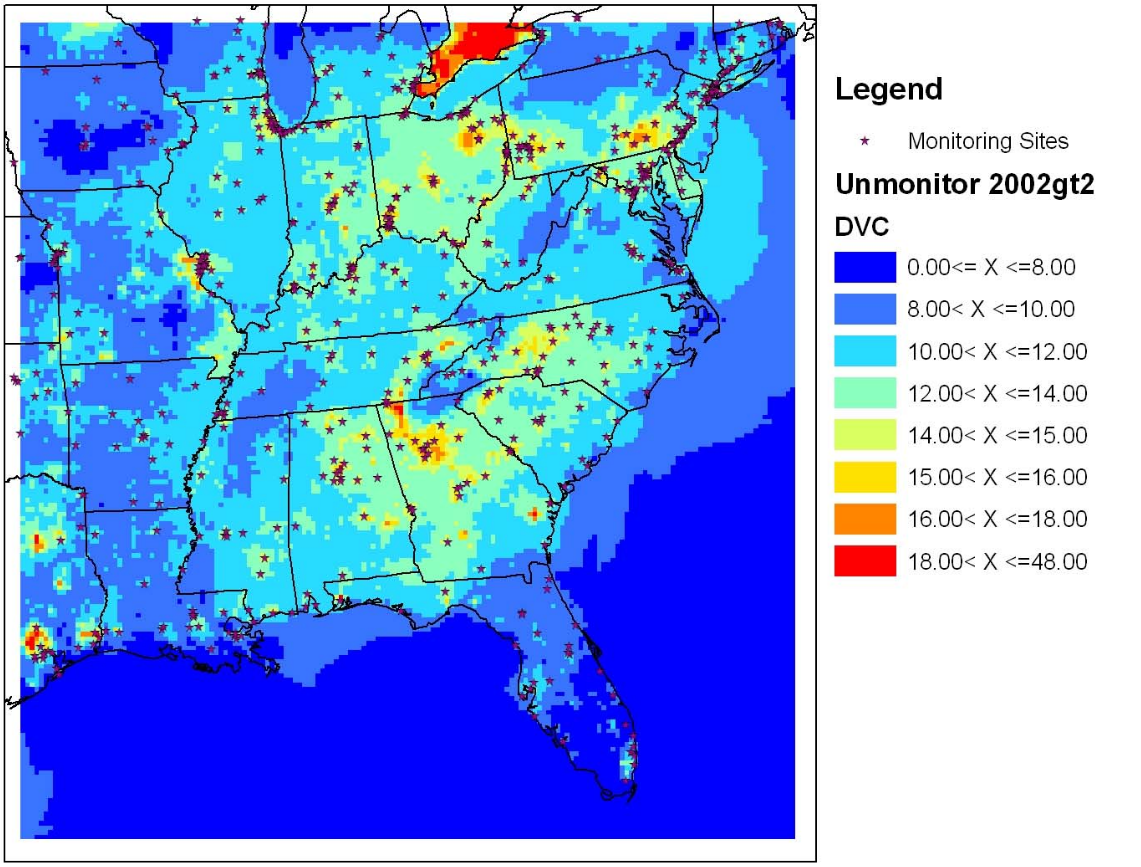


Figure 4-14a. Current-year $PM_{2.5}$ Design Values (DVC) with monitoring sites interpolated to 12 km domain by MATS unmonitored area analysis.

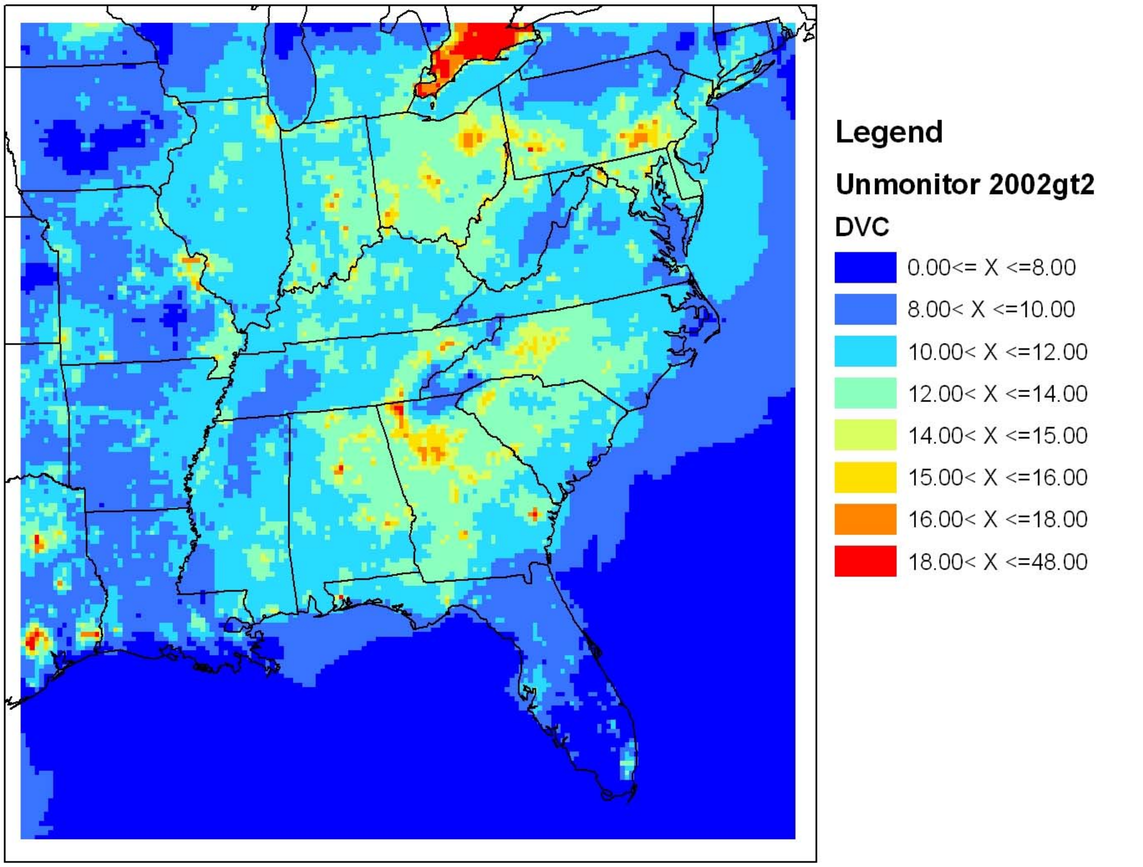


Figure 4-14b. Current-year $PM_{2.5}$ Design Values (DVC) without monitoring sites interpolated to 12 km domain by MATS unmonitored area analysis.

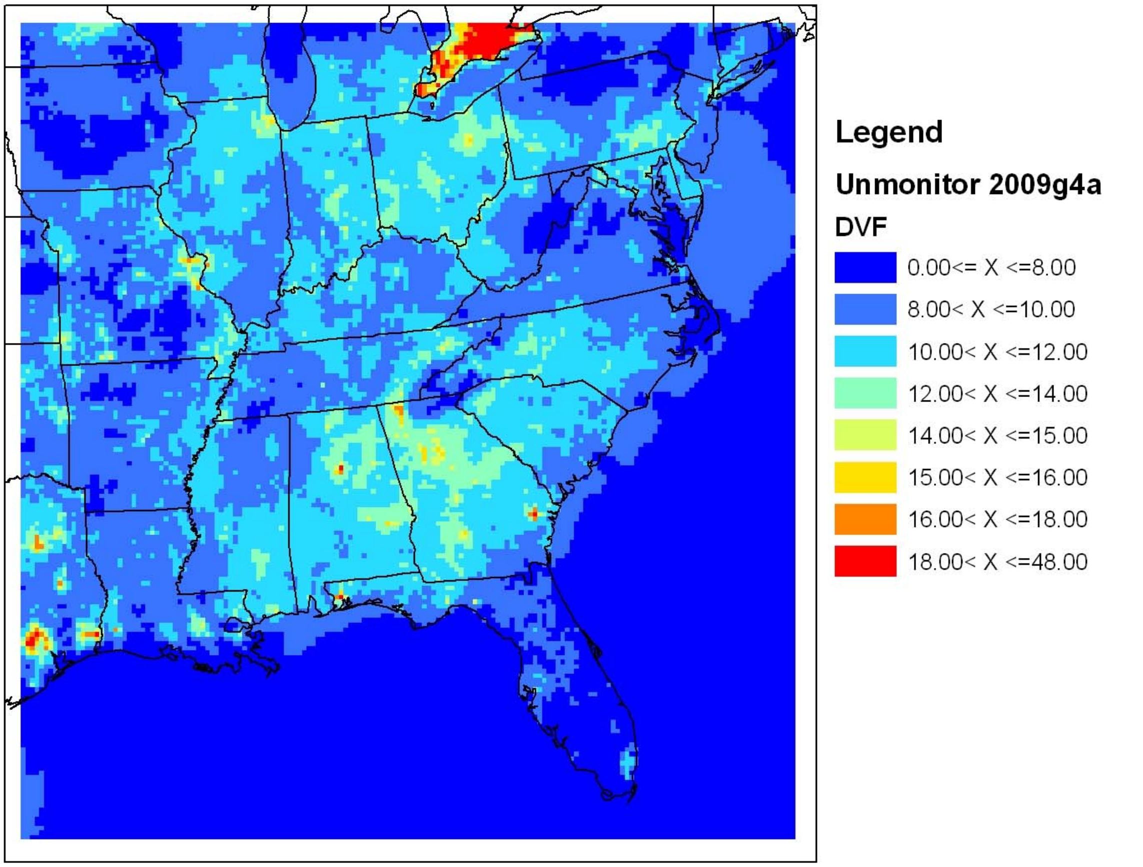


Figure 4-15. 2009 projected $PM_{2.5}$ Design Values (DVF) calculated by MATS unmonitored area analysis.

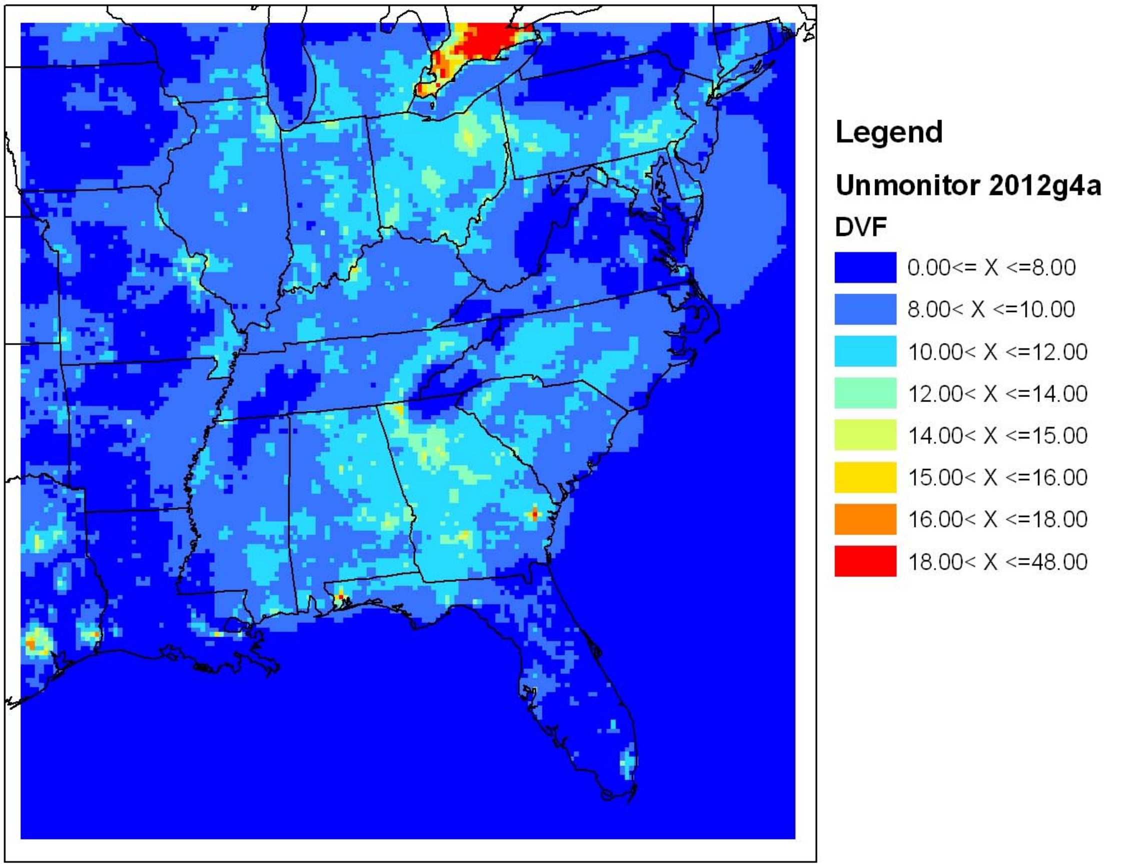


Figure 4-16. 2012 projected $PM_{2.5}$ Design Values (DVF) calculated by MATS unmonitored area analysis.

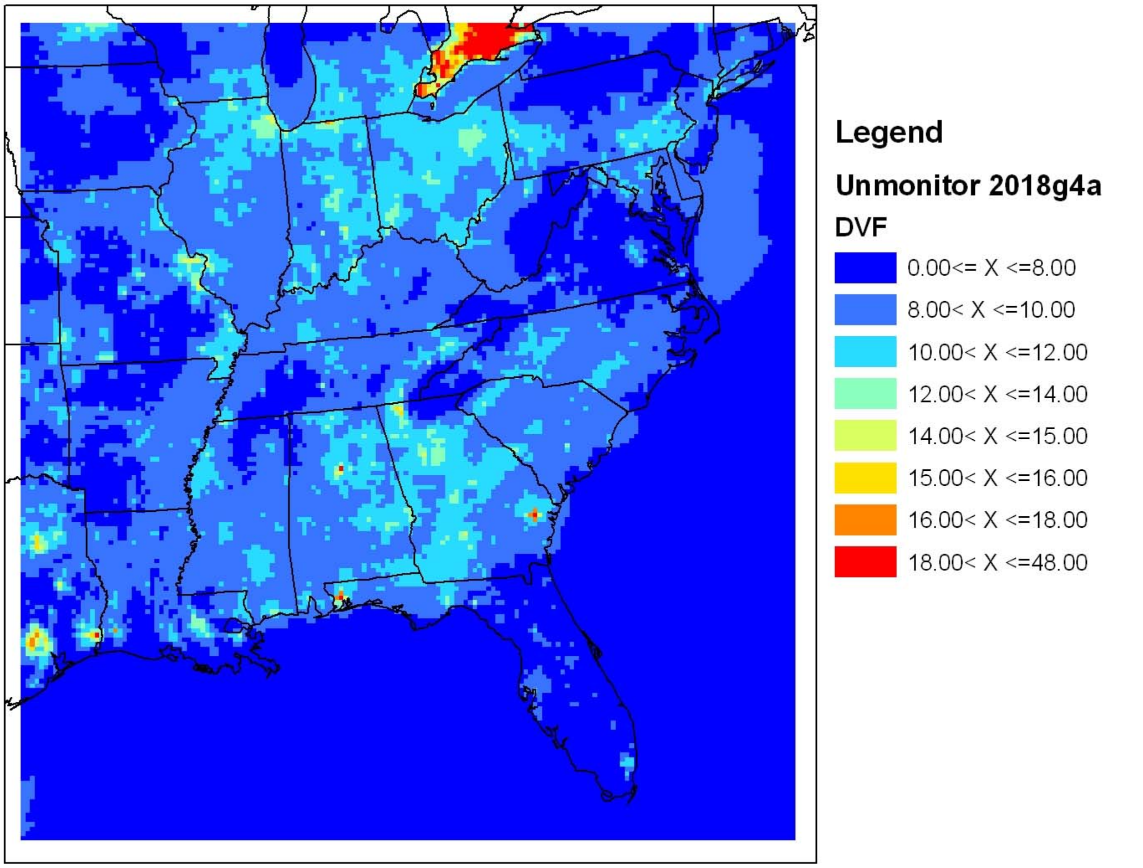


Figure 4-17. 2018 projected $PM_{2.5}$ Design Values (DVF) calculated by MATS unmonitored area analysis.

4.10 FUTURE YEAR 8-HOUR OZONE DESIGN VALUE PROJECTIONS

In this section we present the 2009, 2012 and 2018 8-hour ozone Design Value projections using the 2002 Base G2 and 2009, 2012 and 2018 Base G4 12 km CMAQ modeling results. The EPA Modeled Attainment Test Software (MATS) tool was used to make the future year 8-hour ozone Design Value projections.

4.10.1 Ozone Projection Procedures

The EPA modeling guidance for 8-hour ozone attainment demonstration modeling contain specific procedures that use current and future year modeling results in a relative fashion to scale current year observed 8-hour ozone Design Values to project future-year 8-hour ozone Design Values for comparisons with the NAAQS (EPA, 2007a). The EPA guidance projection procedures were used to estimate future year 8-hour ozone Design Values for all monitoring sites within the ASIP 12 km modeling domain. If the future-year projected 8-hour ozone Design Value for a monitor is less than or equal to 84 ppb, the modeled attainment test is passed. If the future-year Design Value is greater than or equal to 85 ppb, the modeled attainment test is not passed. If the future-year Design Value lies between 82 and 87 ppb, a weight of evidence (WOE) determination is required that provides corroborative information that attainment will be achieved in the future-year.

The EPA guidance procedure for projecting future-year 8-hour ozone Design Values has been codified in EPA's MATS tool. This procedure starts with a current-year observed 8-hour ozone Design Value (DVC) for each monitor. The modeling results are then used to scale the observed 8-hour ozone DVC to obtain a future-year 8-hour ozone Design Value projection (DVF). This is done through the calculation of model-estimated relative response factors (RRFs) that are the ratio of the model-estimated 8-hour ozone concentrations for the future-year to current-year emission scenarios. The RRF is monitor-specific and is used to scale the current year observed design value (DVC) to estimate the projected future-year 8-hour ozone design value (DVF):

$$DVF = DVC \times RRF$$

The RRF is defined as the ratio of the average of the maximum 8-hour ozone concentrations "near a monitor" for the future-year emissions scenario to the average for the current year base case emissions scenario. The EPA default definition of "near a monitor" is to select the maximum model-estimated daily maximum 8-hour ozone concentrations from an array of grid cells centered on the monitor. The size of the array of grid cells is grid cell size dependent and for the 12 km grid cell resolutions used in the ASIP modeling, EPA recommends use of an array of 3 x 3 grid cells (EPA, 2007a), which was used in the ASIP ozone projections.

EPA's 8-hour ozone modeling guidance includes the following language for selecting the current-year observed 8-hour ozone design values that are used in the modeled attainment demonstration test:

> *"For the modeled attainment tests we recommend using the average of the three design value periods which include the baseline inventory year…The average of the three design value periods best represents the baseline concentration, while taking into account the variability of meteorology and emissions (over a five year period)."* (EPA, 2007a, pg. 22).

For the ASIP modeling that used a 2002 baseline inventory and modeling year, that would mean the current year 8-hour ozone Design Value (DVC) is based on the average of three years of Design Values from 2000-2002, 2001-2003 and 2002-2004.

EPA recommends that at least of 10 modeling days be included in the calculation of the RRFs and future-year design values with an absolute 5 day minimum. The criterion for using an episode day in calculating the episode average Design Value for a monitor is that the model estimateds daily maximum 8-hour ozone near the monitor for the current year base case simulation exceeds a minimum Ozone Threshold value. EPA recommends use of an 85 ppb Ozone Threshold in the future-year 8-hour ozone Design Value calculations, but if insufficient number of modeling days are available to calculate the RRFs, then the Ozone Threshold can be reduced by 1 ppb until sufficient modeling days are obtained, or until a 70 ppb Ozone Threshold floor is obtained. When the 70 ppb Ozone Threshold floor is reached and there are less than 5 days available for calculating a RRF, then no RRF is calculated for that monitor.

In the final step of the 8-hour ozone modeled attainment test, the projected future-year 8-hour ozone Design Value is truncated to the nearest ppb and then compared with the NAAQS; if it is 84 ppb or lower at all monitors in the area then the modeled attainment test is passed. As noted above, even if the modeled attainment test is passed, if there are any projected 8-hour ozone Design Values above 82 ppb, then a weight of evidence (WOE) analysis is required that presents corroborative evidence that attainment would be achieved. Even if the modeled attainment test is not passed, if the projected future-year 8-hour ozone Design Values at all monitors are 87 ppb or lower, a WOE attainment demonstration may still be conducted.

4.10.2 4.10.2 Future Year 8-Hour Ozone Design Value Projections

Table 4-16 displays the projected future year 8-hour ozone Design Values at all monitoring sites within and adjacent to the ASIP region in which the current year DVC violates the 1997 0.08 ppm 8-hour ozone NAAQS. The modeling results estimate that there are six monitoring sites within and near the ASIP region that would continue to violate the 8-hour ozone NAAQS in 2009:

- Three sites in Maryland with projected 2009 DVFs of 85.8, 86.1 and 87.1 ppb.
- Two sites in Virginia with projected 2009 DVFs of 86.8 and 87.0 ppb.
- One site in Fulton County, Georgia (Atlanta) with a projected 2009 DVF of 85.6 ppb.

By 2012, all monitoring sites within and near the ASIP region are projected to achieve the 1997 0.08 ppm 8-hour ozone NAAQS. By 2018, the modeling estimates that not only is the 1997 0.08 ppm 8-hour ozone NAAQS is continued to be attained, but that the new 2008 0.075 ppm 8-hour ozone NAAQS is attained at all sites but three each in Maryland and Virginia. The 2008 0.075 ppm 8-hour ozone NAAQS will be addressed in future SIP actions.

Table 4-17, which is presented at the end of this Chapter, lists the current 8-hour ozone DVCs and future 8-hour ozone DVFs for 2009, 2012 and 2018 and all monitoring sites in the ASIP 12 km modeling domain calculated using the MATS tool, rather than just those sites with current DVC that violate the ozone NAAQS as given in Table 4-16. Note that for some monitoring sites, there are no future year 8-hour ozone DVFs. There are two potential reasons why there are no DVFs for a particular monitoring site in Table 4-17:

- There is insufficient ozone observations from 2000-2004 to calculate the DVC, in which case there will be no DVC for that site in Table 4-17; or
- Even using the Ozone Threshold floor of 70 ppb there are less than 5 modeling days for calculating the RRF for the particular site (in which case there will be a DVC but no DVFs in Table 4-17).

Table 4-16. Current (DVC) and future (DVF) year 8-hour ozone Design Values for all monitoring sites in the ASIP 12 km modeling domain whose current DVC exceeds the 0.08 ppm 8-hour ozone NAAQS.

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
01_117_0004	Alabama	Shelby	**88.0**	76.7	73.3	67.3
05_035_0005	Arkansas	Crittenden	**91.0**	81.4	78.1	72.7
10_001_0002	Delaware	Kent	**88.3**	80.3	76.3	73.8
10_003_1003	Delaware	New Castle	**92.0**	80.2	74.5	71.5
10_003_1007	Delaware	New Castle	**91.0**	77.4	70.8	68.0
10_003_1010	Delaware	New Castle	**92.7**	81.2	75.9	72.9
10_003_1013	Delaware	New Castle	**87.5**	76.3	70.9	68.0
10_005_1002	Delaware	Sussex	**90.0**	77.3	72.4	68.5
10_005_1003	Delaware	Sussex	**86.7**	79.9	76.4	73.2
11_001_0025	DC	DC	**88.7**	79.2	73.2	69.4
11_001_0041	DC	DC	**89.0**	80.7	75.1	71.2
11_001_0043	DC	DC	**92.7**	84.0	78.3	74.2
13_021_0012	Georgia	Bibb	**88.0**	76.5	71.5	66.1
13_067_0003	Georgia	Cobb	**91.0**	81.7	76.4	68.4
13_077_0002	Georgia	Coweta	**88.7**	79.1	74.0	64.8
13_089_0002	Georgia	DeKalb	**89.7**	81.8	76.9	69.9
13_089_3001	Georgia	DeKalb	**91.0**	82.9	77.7	70.2
13_097_0004	Georgia	Douglas	**91.0**	80.7	74.7	66.3
13_113_0001	Georgia	Fayette	**85.3**	76.5	71.7	65.0
13_121_0055	Georgia	Fulton	**94.3**	**85.6**	80.3	73.0
13_135_0002	Georgia	Gwinnett	**87.7**	79.1	74.3	66.7
13_151_0002	Georgia	Henry	**91.7**	81.0	75.2	66.6
13_213_0003	Georgia	Murray	**85.0**	74.1	69.8	63.2
13_223_0003	Georgia	Paulding	**88.0**	76.0	70.6	63.2
13_247_0001	Georgia	Rockdale	**91.0**	80.6	75.2	66.8
18_019_0003	Indiana	Clark	**90.0**	82.0	81.4	73.4
21_019_0017	Kentucky	Boyd	**88.3**	78.9	77.5	74.6
21_037_0003	Kentucky	Campbell	**90.7**	82.7	80.5	74.6
21_117_0007	Kentucky	Kenton	**85.0**	77.5	75.2	69.8
21_185_0004	Kentucky	Oldham	**85.3**	75.0	74.5	67.9
24_003_0014	Maryland	Anne Arundel	**98.3**	**86.1**	78.7	75.1
24_003_0019	Maryland	Anne Arundel	**97.0**	**85.8**	78.7	75.5
24_005_1007	Maryland	Baltimore	**88.7**	78.9	72.1	69.2
24_005_3001	Maryland	Baltimore	**91.3**	79.7	72.5	70.1
24_013_0001	Maryland	Carroll	**88.7**	76.9	69.7	66.2
24_015_0003	Maryland	Cecil	**97.7**	81.7	73.5	70.4
24_017_0010	Maryland	Charles	**93.0**	78.8	71.9	68.1
24_021_0037	Maryland	Frederick	**87.3**	75.3	69.7	66.5
24_025_1001	Maryland	Harford	**100.3**	**87.1**	79.4	76.8
24_025_9001	Maryland	Harford	**97.0**	83.4	75.7	72.9
24_029_0002	Maryland	Kent	**95.3**	81.7	74.6	71.1
24_031_3001	Maryland	Montgomery	**86.7**	76.4	70.0	66.4
24_033_0002	Maryland	Prnc George's	**94.0**	83.3	76.8	73.2
24_033_8003	Maryland	Prnc George's	**94.0**	82.6	75.6	71.8
24_043_0009	Maryland	Washington	**85.3**	74.3	69.1	65.7
37_003_0004	North Carolina	Alexander	**86.7**	76.3	72.9	67.7
37_033_0001	North Carolina	Caswell	**87.7**	73.6	69.9	64.0

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
37_051_0008	North Carolina	Cumberland	**85.3**	73.2	69.1	62.1
37_051_1003	North Carolina	Cumberland	**86.0**	74.3	69.8	62.3
37_059_0002	North Carolina	Davie	**91.3**	77.4	72.8	66.4
37_063_0013	North Carolina	Durham	**88.3**	76.6	72.1	65.3
37_065_0099	North Carolina	Edgecombe	**87.3**	75.6	71.1	64.9
37_067_0022	North Carolina	Forsyth	**91.3**	75.3	70.9	64.9
37_067_0028	North Carolina	Forsyth	**86.3**	71.1	67.2	61.8
37_067_1008	North Carolina	Forsyth	**88.3**	74.5	70.3	64.1
37_069_0001	North Carolina	Franklin	**89.7**	78.2	74.0	67.2
37_077_0001	North Carolina	Granville	**92.3**	79.4	75.1	68.4
37_081_0011	North Carolina	Guilford	**88.7**	75.8	71.5	64.6
37_099_0005	North Carolina	Jackson	**86.0**	76.1	73.3	68.8
37_109_0004	North Carolina	Lincoln	**90.7**	78.0	74.0	68.4
37_119_0041	North Carolina	Mecklenburg	**95.3**	84.1	80.3	73.0
37_119_1009	North Carolina	Mecklenburg	**97.3**	84.6	80.0	72.0
37_145_0003	North Carolina	Person	**89.3**	73.8	71.0	64.2
37_157_0099	North Carolina	Rockingham	**88.3**	71.3	66.8	61.1
37_159_0021	North Carolina	Rowan	**97.3**	83.4	78.6	71.6
37_159_0022	North Carolina	Rowan	**97.0**	83.9	79.1	71.5
37_179_0003	North Carolina	Union	**87.0**	76.3	72.4	65.2
37_183_0014	North Carolina	Wake	**90.7**	78.7	74.4	66.8
37_183_0015	North Carolina	Wake	**92.5**	80.3	75.9	68.1
37_183_0016	North Carolina	Wake	**87.0**	75.7	71.7	64.6
37_183_0017	North Carolina	Wake	**85.3**	74.5	70.5	63.5
39_017_0004	Ohio	Butler	**89.7**	81.3	79.1	72.8
39_017_1004	Ohio	Butler	**87.7**	78.9	76.4	70.3
39_025_0022	Ohio	Clermont	**89.3**	81.4	79.2	71.4
39_027_1002	Ohio	Clinton	**94.3**	82.5	80.1	71.6
39_057_0006	Ohio	Greene	**87.7**	76.9	74.5	67.7
39_061_0006	Ohio	Hamilton	**90.3**	81.8	79.4	73.0
39_061_0010	Ohio	Hamilton	**85.7**	77.9	75.7	70.3
39_061_0040	Ohio	Hamilton	**86.0**	79.1	77.0	71.1
39_165_0007	Ohio	Warren	**90.7**	81.2	78.7	71.8
39_167_0004	Ohio	Washington	**85.7**	70.1	66.2	61.9
45_007_0003	South Carolina	Anderson	**85.3**	76.8	73.2	67.6
45_079_1001	South Carolina	Richland	**89.3**	80.3	76.7	70.8
45_083_0009	South Carolina	Spartanburg	**87.0**	78.0	74.4	68.8
47_001_0101	Tennessee	Anderson	**87.0**	71.6	67.5	61.1
47_009_0101	Tennessee	Blount	**92.3**	77.3	73.1	66.0
47_065_1011	Tennessee	Hamilton	**88.3**	77.5	73.5	67.0
47_065_4003	Tennessee	Hamilton	**88.0**	77.6	73.3	66.3
47_089_0002	Tennessee	Jefferson	**91.0**	76.3	71.8	64.5
47_093_0021	Tennessee	Knox	**88.0**	74.0	69.3	62.0
47_093_1020	Tennessee	Knox	**92.0**	77.9	73.2	65.9
47_121_0104	Tennessee	Meigs	**89.0**	74.4	70.2	63.1
47_155_0101	Tennessee	Sevier	**91.3**	76.9	72.6	66.0
47_155_0102	Tennessee	Sevier	**92.3**	80.9	77.4	71.6
47_157_1004	Tennessee	Shelby	**87.7**	79.2	75.9	69.7
47_163_2002	Tennessee	Sullivan	**86.7**	78.7	76.3	71.5
47_163_2003	Tennessee	Sullivan	**86.3**	78.5	76.1	71.1

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
47_165_0007	Tennessee	Sumner	**85.7**	75.9	71.8	64.9
51_013_0020	Virginia	Arlington	**96.7**	**87.0**	81.2	77.0
51_036_0002	Virginia	Charles	**89.3**	79.4	76.0	71.5
51_059_0005	Virginia	Fairfax	**87.0**	75.9	70.7	65.3
51_059_0018	Virginia	Fairfax	**96.7**	**86.8**	81.0	77.0
51_059_0030	Virginia	Fairfax	**94.7**	84.4	79.2	75.2
51_059_1005	Virginia	Fairfax	**94.0**	83.8	78.6	74.7
51_059_5001	Virginia	Fairfax	**88.0**	78.1	73.2	68.8
51_085_0003	Virginia	Hanover	**92.0**	81.4	77.9	72.8
51_087_0014	Virginia	Henrico	**88.3**	77.9	74.3	69.6
51_107_1005	Virginia	Loudoun	**90.0**	78.3	73.7	68.7
51_153_0009	Virginia	Prince William	**85.0**	73.4	69.3	65.0
51_179_0001	Virginia	Stafford	**86.0**	75.2	69.1	64.7
51_510_0009	Virginia	Alexandria	**90.0**	80.8	75.4	71.6
51_650_0004	Virginia	Hampton City	**88.3**	81.5	78.7	75.6
51_800_0004	Virginia	Suffolk City	**87.0**	80.1	77.3	74.5
54_011_0006	West Virginia	Cabell	**85.7**	77.2	75.8	72.6
54_107_1002	West Virginia	Wood	**85.7**	69.6	68.1	63.0

4.10.3 8-Hour Ozone Unmonitored Area Analysis

EPA's 8-hour ozone projection procedure also includes an unmonitored area analysis that has been codified in MATS. The unmonitored area analysis uses the future-year 8-hour ozone Design Value projection procedure described above applied to each grid cell in the modeling domain. In this procedure, the current-year Design Values (DVC) are first interpolated to each grid cell in the modeling domain. This interpolation scheme uses the modeled concentration gradients in its interpolation procedures. RRFs are then obtained for each grid cell in the modeling domain using the procedures described above except using the actual modeled daily maximum 8-hour ozone concentrations in each grid cell (co-located) is used, rather than values near the grid cell. The same rules are used to assure there are sufficient days to calculate a robust and reliable RRF. Namely, pick the highest days above an ozone threshold value so that at least 10 modeling days are used in the RRFs by reducing the Ozone Threshold from 85 ppb until the 70 ppb floor is reached. If even with the 70 ppb Ozone Threshold floor there are 5 or more days, the RRF is still used. However, for grid cells in which there are less than 5 modeling days with daily maximum 8-hour ozone concentrations greater than 70 ppb no RRF is calculated and consequently no future year projected DVF is obtained for that grid cell.

Figure 4-18 displays the current year DVCs interpolated to the ASIP 12 km domain using MATS. There are several areas within and near the ASIP region that are current violating the 0.08 ppm (85 ppb) 8-hour ozone NAAQS: central North Carolina, eastern and western Tennessee, Atlanta and nearby regions in Georgia, Birmingham Alabama, along the Ohio River and in northern Virginia, District of Columbia, Maryland and Delaware.

The 2009 projected 8-hour ozone DVFs using the MATS unmonitored area analysis are shown in Figure 4-19. Within the ASIP region, continued violations of the 0.08 ppm 8-hour ozone NAAQS in 2009 are estimated mainly in the Atlanta and northern Virginia areas. There appears to be isolated grid cells of 8-hour ozone exceedances in Charlotte, Memphis and along the Ohio River in the Louisville and Cincinnati regions. By 2012 the unmonitored area analysis estimates that all grid cells in the ASIP region would attain the 0.08 ppm 8-hour ozone NAAQS (Figure 4-20). And attainment of the 0.08 ppm 8-hour ozone NAAQS in the ASIP region is projected to continue into 2018 (Figure 4-21). Note that the MATS unmonitored area analysis estimates that violations of the 0.08 ppm ozone NAAQS would occur in the future years over several water bodies near current high ozone areas, such as Lake Michigan, Chesapeake Bay and the Gulf of Mexico. These high residual ozone projections are due in part to the MATS use of modeled ozone gradients to interpolate the DVCs and the model's tendency to estimate higher ozone in the stable atmosphere over water bodies. Although higher ozone values have been estimated over water than nearby land locations (e.g., as in the Lake Michigan Ozone Study), the model may be overstating the extent of this ozone increase.

Note that areas with no shading in the unmonitored area DVF analysis in Figures 4-19 through 4-21 are grid cells where there were less than 5 days with ozone greater than 70 ppb so no ozone projection could be made.

EPA guidance stresses that the unmonitored area test has more uncertainties than the projections at the monitors and it should be treated separately from the monitor based attainment test (EPA, 2007a). EPA further notes that while it is expected that additional emission controls may be needed to eliminate predicted violations of the monitor based test, the same requirements may not be appropriate in unmonitored areas. In any event, EPA recommends that areas of predicted violations in the unmonitored area test be scrutinized and understood to determine whether they are likely to exist in the ambient air or whether they may be caused by an error or uncertainties in the modeling system. At a minimum, it may be appropriate to deploy additional ozone monitors to such areas. In this application the continued exceedances of the 0.08 ppm 8-hour ozone NAAQS over water bodies are believed to be due in part to modeling artifacts that produce too high ozone in these regions.

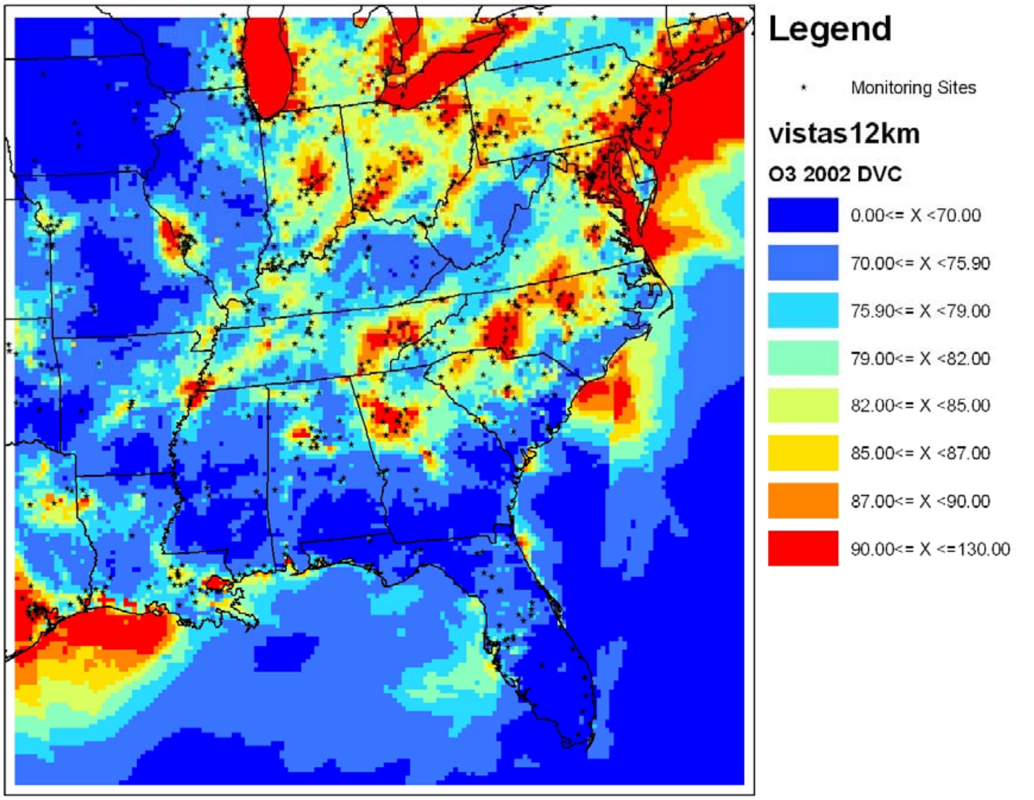


Figure 4-18. Current year interpolated 8-hour ozone Design Values (DVCs) using MATS.

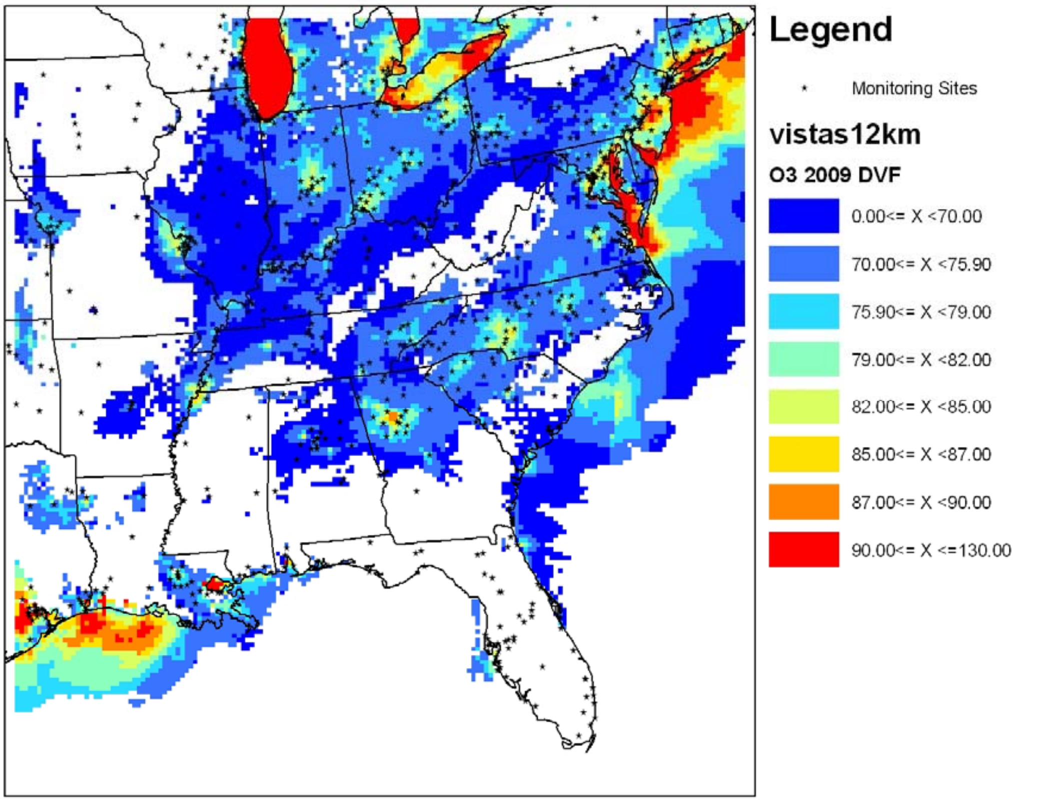


Figure 4-19. Projected 2009 8-hour ozone Design Values (DVFs) using MATS.

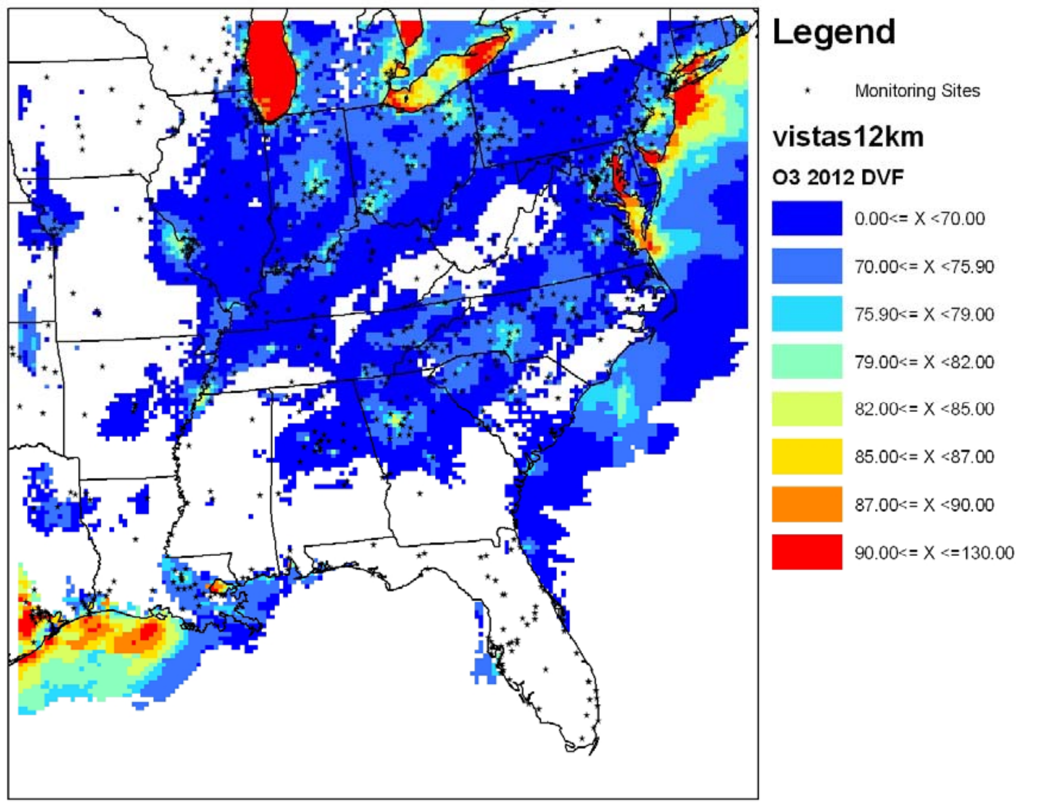


Figure 4-20. Projected 2012 8-hour ozone Design Values (DVFs) using MATS.

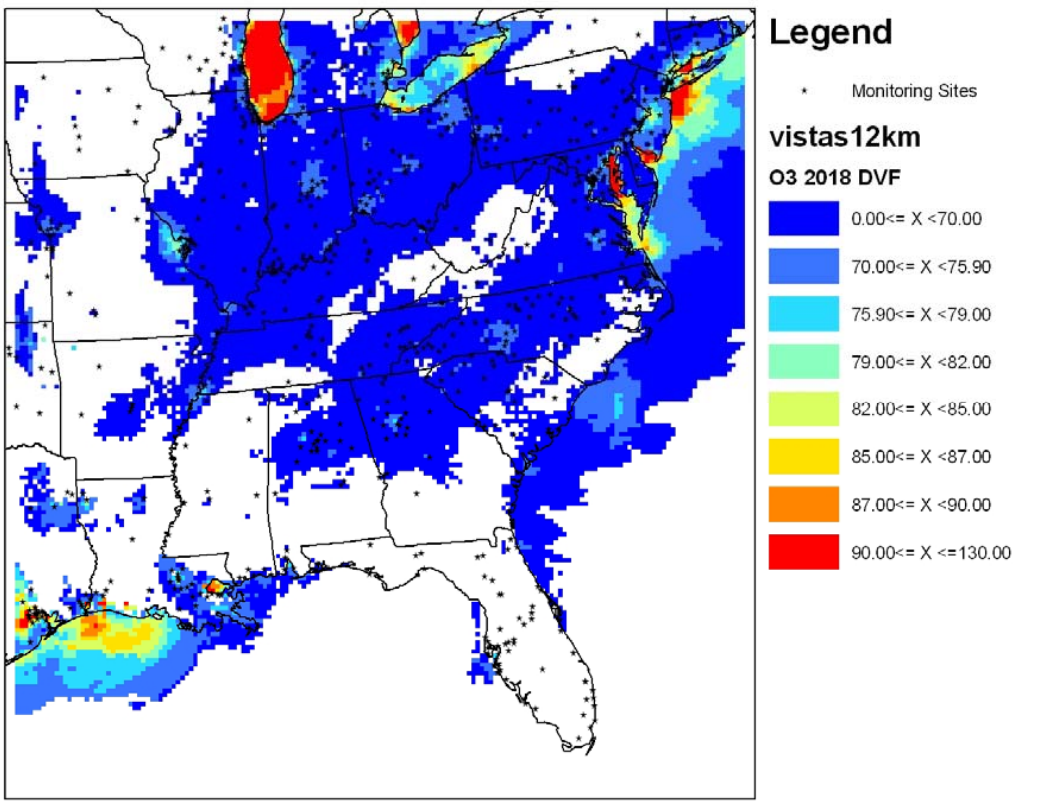


Figure 4-21. Projected 2018 8-hour ozone Design Values (DVFs) using MATS.

Table 4-17. Current (DVC) and future (DVF) year 8-hour ozone Design Values for all monitoring sites in the ASIP 12 km modeling domain.

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
01_003_0010	Alabama	Baldwin	78.0	72.7	69.0	66.2
01_027_0001	Alabama	Clay	79.3	70.8	67.0	60.6
01_033_1002	Alabama	Colbert				
01_051_0001	Alabama	Elmore	76.7	67.0	63.2	57.6
01_055_0011	Alabama	Etowah	75.0	66.4	63.5	57.9
01_073_0023	Alabama	Jefferson	77.0	67.3	64.5	59.2
01_073_1003	Alabama	Jefferson	79.0	68.4	65.6	60.1
01_073_1005	Alabama	Jefferson	80.0	69.2	65.9	60.0
01_073_1009	Alabama	Jefferson	81.3	67.2	63.9	59.3
01_073_1010	Alabama	Jefferson	72.5	63.3	60.9	55.6
01_073_2006	Alabama	Jefferson	83.7	73.4	70.5	64.7
01_073_5002	Alabama	Jefferson	78.7	68.8	66.0	61.3
01_073_5003	Alabama	Jefferson	79.7	65.0	61.9	57.9
01_073_6002	Alabama	Jefferson	78.7	69.4	67.0	61.6
01_079_0002	Alabama	Lawrence	76.3	65.0	62.1	57.9
01_089_0014	Alabama	Madison	79.7	68.7	64.9	59.0
01_097_0003	Alabama	Mobile	77.7	71.9	67.8	64.9
01_097_0028	Alabama	Mobile				
01_097_2005	Alabama	Mobile	79.0	73.1	69.2	65.8
01_101_1002	Alabama	Montgomery	75.0	65.9	62.3	57.3
01_103_0011	Alabama	Morgan	82.0	70.6	66.8	63.1
01_113_0002	Alabama	Russell				
01_117_0004	Alabama	Shelby	88.0	76.7	73.3	67.3
01_119_0002	Alabama	Sumter	71.7	61.1	58.3	54.1
01_121_0003	Alabama	Talladega				
01_125_0010	Alabama	Tuscaloosa	75.5	64.4	60.8	55.8
05_035_0005	Arkansas	Crittenden	91.0	81.4	78.1	72.7
05_097_0001	Arkansas	Montgomery	67.0			
05_101_0002	Arkansas	Newton	77.3			
05_119_0007	Arkansas	Pulaski	78.7	66.0	64.5	61.7
05_119_1002	Arkansas	Pulaski	81.7	68.6	66.9	64.4
05_119_1005	Arkansas	Pulaski				
09_001_0017	Connecticut	Fairfield	95.7	89.2	87.0	85.9
09_001_1123	Connecticut	Fairfield	95.7	87.5	82.6	78.9
09_001_3007	Connecticut	Fairfield	98.3	92.0	87.7	84.5
09_001_9003	Connecticut	Fairfield	94.0	87.8	84.2	81.8
09_003_1003	Connecticut	Hartford	88.0	78.2	72.0	68.1
09_005_0005	Connecticut	Litchfield	86.0	76.0	70.2	66.6
09_005_0006	Connecticut	Litchfield				
09_007_0007	Connecticut	Middlesex	95.7	85.8	80.0	76.5
09_009_0027	Connecticut	New Haven	93.3	86.8	82.6	79.6
09_009_1123	Connecticut	New Haven				
09_009_3002	Connecticut	New Haven	98.3	89.6	84.3	81.4
09_011_0008	Connecticut	New London	90.0	80.6	75.2	72.9
09_013_1001	Connecticut	Tolland	92.3	82.0	75.2	70.7
10_001_0002	Delaware	Kent	88.3	80.3	76.3	73.8
10_003_1003	Delaware	New Castle	92.0	80.2	74.5	71.5
10_003_1007	Delaware	New Castle	91.0	77.4	70.8	68.0

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
10_003_1010	Delaware	New Castle	92.7	81.2	75.9	72.9
10_003_1013	Delaware	New Castle	87.5	76.3	70.9	68.0
10_005_1002	Delaware	Sussex	90.0	77.3	72.4	68.5
10_005_1003	Delaware	Sussex	86.7	79.9	76.4	73.2
11_001_0025	DC	DC	88.7	79.2	73.2	69.4
11_001_0041	DC	DC	89.0	80.7	75.1	71.2
11_001_0043	DC	DC	92.7	84.0	78.3	74.2
12_001_0025	Florida	Alachua				
12_001_3011	Florida	Alachua	73.0			
12_003_0002	Florida	Baker	71.3			
12_005_0006	Florida	Bay	79.3			
12_009_0007	Florida	Brevard	72.7	66.7	63.3	56.9
12_009_4001	Florida	Brevard	71.0	65.3	62.5	56.3
12_011_0031	Florida	Broward	60.3			
12_011_2003	Florida	Broward	64.3			
12_011_8002	Florida	Broward	67.3			
12_021_0004	Florida	Collier	68.0			
12_023_0002	Florida	Columbia	70.5			
12_031_0077	Florida	Duval	69.0	59.3	56.5	52.9
12_031_0100	Florida	Duval	74.0	65.8	62.5	57.9
12_031_1003	Florida	Duval				
12_033_0004	Florida	Escambia	76.3	70.4	67.9	64.6
12_033_0018	Florida	Escambia	81.0	74.2	71.1	67.0
12_033_0024	Florida	Escambia	79.7	73.7	71.1	67.5
12_055_0003	Florida	Highlands	66.5			
12_057_0081	Florida	Hillsborough	76.7	75.5	73.1	69.3
12_057_0110	Florida	Hillsborough	73.0	71.5	69.9	66.7
12_057_1035	Florida	Hillsborough	72.3	71.8	70.4	68.6
12_057_1065	Florida	Hillsborough	78.0	79.5	78.0	75.9
12_057_3002	Florida	Hillsborough				
12_057_4004	Florida	Hillsborough	76.3	71.1	68.5	65.6
12_059_0004	Florida	Holmes	71.0			
12_069_0002	Florida	Lake	76.0			
12_071_2002	Florida	Lee	67.0			
12_071_3002	Florida	Lee	69.0			
12_073_0012	Florida	Leon	71.0			
12_073_0013	Florida	Leon	70.0			
12_081_3002	Florida	Manatee	76.3	74.0	71.5	67.9
12_081_4012	Florida	Manatee				
12_081_4013	Florida	Manatee	71.0	69.4	66.6	63.3
12_083_0003	Florida	Marion	74.0			
12_083_0004	Florida	Marion	73.5			
12_086_0021	Florida	Miami-Dade	66.0			
12_086_0027	Florida	Miami-Dade	67.0			
12_086_0029	Florida	Miami-Dade	66.7			
12_086_0030	Florida	Miami-Dade				
12_095_0008	Florida	Orange	76.0	68.8	65.4	60.3
12_095_2002	Florida	Orange	76.3			
12_097_2002	Florida	Osceola	71.0			
12_099_0007	Florida	Palm Beach				

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
12_099_0009	Florida	Palm Beach	66.5			
12_099_2004	Florida	Palm Beach	68.0			
12_101_0005	Florida	Pasco	72.0			
12_101_2001	Florida	Pasco	76.7			
12_103_0004	Florida	Pinellas	74.7	75.1	74.5	72.9
12_103_0018	Florida	Pinellas	71.0	71.0	69.8	67.5
12_103_5002	Florida	Pinellas	73.7			
12_105_6005	Florida	Polk	74.3	68.6	65.8	62.3
12_105_6006	Florida	Polk	76.3			
12_111_1002	Florida	St. Lucie	67.3			
12_113_0014	Florida	Santa Rosa	81.3	74.4	71.0	66.3
12_115_1002	Florida	Sarasota				
12_115_1005	Florida	Sarasota	79.7	77.1	74.0	69.6
12_115_1006	Florida	Sarasota	74.7	73.3	70.3	66.1
12_115_2002	Florida	Sarasota				
12_117_1002	Florida	Seminole	77.5			
12_127_2001	Florida	Volusia	68.7	59.4	55.5	49.6
12_127_5002	Florida	Volusia	70.3	60.4	55.9	49.2
12_129_0001	Florida	Wakulla	75.0			
13_021_0012	Georgia	Bibb	88.0	76.5	71.5	66.1
13_051_0021	Georgia	Chatham	68.3	62.9	60.3	57.4
13_055_0001	Georgia	Chattooga				
13_057_0001	Georgia	Cherokee	78.0	69.5	65.4	58.7
13_059_0002	Georgia	Clarke	78.0	69.0	64.8	58.0
13_067_0003	Georgia	Cobb	91.0	81.7	76.4	68.4
13_077_0002	Georgia	Coweta	88.7	79.1	74.0	64.8
13_085_0001	Georgia	Dawson	80.0	71.9	67.6	61.3
13_089_0002	Georgia	DeKalb	89.7	81.8	76.9	69.9
13_089_3001	Georgia	DeKalb	91.0	82.9	77.7	70.2
13_097_0004	Georgia	Douglas	91.0	80.7	74.7	66.3
13_111_0094	Georgia	Fannin				
13_113_0001	Georgia	Fayette	85.3	76.5	71.7	65.0
13_121_0055	Georgia	Fulton	94.3	85.6	80.3	73.0
13_127_0006	Georgia	Glynn	72.0	65.0	62.3	58.5
13_135_0002	Georgia	Gwinnett	87.7	79.1	74.3	66.7
13_151_0002	Georgia	Henry	91.7	81.0	75.2	66.6
13_213_0003	Georgia	Murray	85.0	74.1	69.8	63.2
13_215_0008	Georgia	Muscogee	75.0	66.9	64.0	58.7
13_215_1003	Georgia	Muscogee	75.0	67.2	64.3	58.8
13_223_0003	Georgia	Paulding	88.0	76.0	70.6	63.2
13_245_0091	Georgia	Richmond	84.3	76.4	73.5	68.6
13_247_0001	Georgia	Rockdale	91.0	80.6	75.2	66.8
13_261_1001	Georgia	Sumter	75.0			
17_001_0006	Illinois	Adams	75.3	68.8	65.7	65.4
17_019_0004	Illinois	Champaign	75.0	65.4	64.2	61.0
17_023_0001	Illinois	Clark	73.0	61.5	60.2	55.3
17_031_0001	Illinois	Cook	79.7	75.7	75.3	71.5
17_031_0032	Illinois	Cook	85.3	83.5	81.3	80.5
17_031_0050	Illinois	Cook	73.0	71.4	69.6	68.9
17_031_0063	Illinois	Cook				

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
17_031_0064	Illinois	Cook	72.7	71.1	69.3	68.6
17_031_0072	Illinois	Cook	76.7	74.4	72.7	71.6
17_031_0075	Illinois	Cook				
17_031_0076	Illinois	Cook				
17_031_1003	Illinois	Cook	78.0	74.8	74.5	73.3
17_031_1601	Illinois	Cook	73.3	68.6	68.0	63.6
17_031_4002	Illinois	Cook	71.3	67.7	67.4	67.0
17_031_4007	Illinois	Cook	78.3	73.7	72.7	70.0
17_031_4201	Illinois	Cook				
17_031_7002	Illinois	Cook	83.3	79.8	79.0	77.0
17_031_8003	Illinois	Cook	72.0	70.3	67.9	67.5
17_043_6001	Illinois	DuPage	71.7	68.2	68.4	65.9
17_049_1001	Illinois	Effingham	74.7	65.0	63.2	59.4
17_065_0001	Illinois	Hamilton	79.0	68.0	67.3	61.9
17_083_1001	Illinois	Jersey	87.7	78.5	75.5	74.6
17_089_0005	Illinois	Kane	77.0	71.2	70.2	65.6
17_097_0001	Illinois	Lake				
17_097_1002	Illinois	Lake	79.7	74.4	72.8	70.0
17_097_1007	Illinois	Lake	84.7	79.1	77.4	74.4
17_097_3001	Illinois	Lake	77.0	72.9	71.9	68.6
17_111_0001	Illinois	McHenry	82.0	76.0	74.9	70.5
17_113_2003	Illinois	McLean	76.0	66.5	65.2	60.5
17_115_0013	Illinois	Macon	75.0	63.9	62.8	60.6
17_117_0002	Illinois	Macoupin	78.0	66.3	64.2	61.6
17_119_0008	Illinois	Madison	85.7	77.6	74.9	72.6
17_119_1009	Illinois	Madison	82.7	74.3	72.4	69.9
17_119_2007	Illinois	Madison	81.0	73.9	71.9	69.7
17_119_3007	Illinois	Madison	80.3	72.7	70.2	68.1
17_143_0024	Illinois	Peoria	71.7	65.7	64.6	58.0
17_143_1001	Illinois	Peoria	78.0	71.5	70.3	63.1
17_157_0001	Illinois	Randolph	77.0	65.7	65.1	59.1
17_161_3002	Illinois	Rock Island	68.7	62.5	60.6	59.1
17_163_0010	Illinois	Saint Clair	83.0	75.4	74.0	71.1
17_167_0010	Illinois	Sangamon	75.3	61.6	59.6	56.0
17_197_1008	Illinois	Will	76.3	70.2	69.0	63.6
17_197_1011	Illinois	Will	78.3	71.2	69.9	64.5
17_201_0009	Illinois	Winnebago	75.0	68.6	66.6	63.5
17_201_2001	Illinois	Winnebago	72.7	66.5	64.5	61.5
18_003_0002	Indiana	Allen	87.0	77.7	75.3	69.9
18_003_0004	Indiana	Allen	84.0	75.0	72.7	67.5
18_011_0001	Indiana	Boone	88.0	80.1	77.8	72.0
18_015_0002	Indiana	Carroll	83.0	74.6	72.2	66.3
18_019_0003	Indiana	Clark	90.0	82.0	81.4	73.4
18_035_0010	Indiana	Delaware	85.5	75.7	73.2	67.2
18_039_0002	Indiana	Elkhart				
18_039_0007	Indiana	Elkhart	87.0	76.8	74.6	70.5
18_043_1004	Indiana	Floyd	84.3	77.2	76.4	69.5
18_051_0011	Indiana	Gibson	73.0	62.9	61.7	55.1
18_055_0001	Indiana	Greene	87.0	74.3	72.8	65.4
18_057_1001	Indiana	Hamilton	93.7	84.0	80.9	74.5

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
18_059_0003	Indiana	Hancock	91.3	81.8	78.9	72.8
18_063_0004	Indiana	Hendricks	84.7	76.8	74.6	69.9
18_069_0002	Indiana	Huntington	83.3	74.4	72.3	67.2
18_071_0001	Indiana	Jackson	83.3	71.3	69.3	64.5
18_081_0002	Indiana	Johnson	85.3	74.9	72.5	67.5
18_089_0022	Indiana	Lake	82.0	82.2	81.3	80.4
18_089_0024	Indiana	Lake	80.0	73.1	71.4	68.3
18_089_0030	Indiana	Lake				
18_089_2008	Indiana	Lake	88.3	88.0	87.3	85.8
18_091_0005	Indiana	LaPorte	90.3	87.5	86.0	83.6
18_091_0010	Indiana	LaPorte	84.7	79.8	78.0	75.1
18_095_0010	Indiana	Madison	91.7	81.3	78.1	71.8
18_097_0042	Indiana	Marion	80.7	74.5	72.6	68.4
18_097_0050	Indiana	Marion	90.0	81.5	79.1	73.7
18_097_0057	Indiana	Marion	83.7	77.0	75.0	70.4
18_097_0073	Indiana	Marion	88.0	79.9	77.5	72.4
18_109_0005	Indiana	Morgan	85.0	75.7	73.5	68.6
18_123_0008	Indiana	Perry				
18_123_0009	Indiana	Perry				
18_127_0020	Indiana	Porter	84.5	83.3	82.5	80.6
18_127_0024	Indiana	Porter	86.3	85.5	84.8	83.0
18_127_0026	Indiana	Porter	85.3	88.4	88.5	86.1
18_129_0003	Indiana	Posey	84.0	73.5	72.1	65.1
18_141_0010	Indiana	St. Joseph	82.7	73.1	71.2	67.9
18_141_1007	Indiana	St. Joseph	90.3	79.5	77.4	73.7
18_141_1008	Indiana	St. Joseph	86.3	75.7	73.7	70.5
18_145_0001	Indiana	Shelby	91.3	81.3	78.7	73.6
18_163_0012	Indiana	Vanderburgh	82.7	72.2	70.6	62.8
18_163_0013	Indiana	Vanderburgh	75.7	65.4	64.1	56.8
18_167_0018	Indiana	Vigo	74.3	64.7	63.0	57.9
18_167_0024	Indiana	Vigo	85.0	74.6	72.6	67.1
18_173_0008	Indiana	Warrick	80.3	70.6	69.6	63.1
18_173_0009	Indiana	Warrick	79.7	68.6	67.4	60.4
18_173_0011	Indiana	Warrick	84.0	74.5	73.3	66.7
19_017_0011	Iowa	Bremer	69.3			
19_045_0021	Iowa	Clinton	76.3	70.5	69.1	67.0
19_113_0028	Iowa	Linn	67.7			
19_113_0033	Iowa	Linn	69.0			
19_137_0002	Iowa	Montgomery	67.0	63.5	60.3	59.1
19_147_1002	Iowa	Palo Alto	63.7			
19_153_0058	Iowa	Polk	57.3	53.0	51.1	50.5
19_163_0014	Iowa	Scott	77.7	70.1	67.6	66.0
19_163_2011	Iowa	Scott	75.3	69.2	67.1	65.4
19_169_0011	Iowa	Story	60.7	55.5	53.7	52.5
19_177_0005	Iowa	Van Buren	73.3			
19_181_0022	Iowa	Warren	60.0			
20_045_0004	Kansas	Douglas				
20_091_0010	Kansas	Johnson				
20_103_0003	Kansas	Leavenworth				
20_107_0002	Kansas	Linn	74.3			

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
20_209_0021	Kansas	Wyandotte	78.7	73.6	68.7	67.8
21_013_0002	Kentucky	Bell	82.3	68.5	64.9	58.9
21_015_0003	Kentucky	Boone	83.7	73.5	71.4	66.0
21_019_0017	Kentucky	Boyd	88.3	78.9	77.5	74.6
21_029_0006	Kentucky	Bullitt	80.7	73.1	72.9	65.3
21_037_0003	Kentucky	Campbell	90.7	82.7	80.5	74.6
21_043_0500	Kentucky	Carter	77.0	65.5	64.6	61.2
21_047_0006	Kentucky	Christian	84.0	68.6	66.4	60.6
21_059_0005	Kentucky	Daviess	75.3	66.8	65.8	62.2
21_061_0501	Kentucky	Edmonson	80.3	71.3	69.1	63.5
21_067_0001	Kentucky	Fayette	71.3	62.3	59.6	56.2
21_067_0012	Kentucky	Fayette	75.0	65.5	62.7	59.1
21_083_0003	Kentucky	Graves	79.0	70.4	68.7	63.5
21_089_0007	Kentucky	Greenup	81.3	71.2	69.9	67.1
21_091_0012	Kentucky	Hancock	81.7	73.3	72.4	66.5
21_093_0006	Kentucky	Hardin	78.3	69.8	69.5	62.5
21_101_0013	Kentucky	Henderson				
21_101_0014	Kentucky	Henderson	78.7	69.0	67.8	61.2
21_111_0027	Kentucky	Jefferson	79.7	72.8	72.2	65.4
21_111_0051	Kentucky	Jefferson	82.7	76.1	74.9	68.5
21_111_1021	Kentucky	Jefferson	79.3	72.5	71.5	65.6
21_113_0001	Kentucky	Jessamine	76.3	67.0	64.8	59.9
21_117_0007	Kentucky	Kenton	85.0	77.5	75.2	69.8
21_139_0003	Kentucky	Livingston	82.7	72.8	71.5	66.2
21_139_0004	Kentucky	Livingston				
21_145_1024	Kentucky	McCracken	79.0	71.6	70.4	66.0
21_149_0001	Kentucky	McLean	82.0	70.9	69.5	63.6
21_185_0004	Kentucky	Oldham	85.3	75.0	74.5	67.9
21_193_0003	Kentucky	Perry	75.7			
21_195_0002	Kentucky	Pike	73.3			
21_199_0003	Kentucky	Pulaski	77.3	69.2	66.0	61.8
21_209_0001	Kentucky	Scott	68.3	58.2	56.9	52.3
21_213_0004	Kentucky	Simpson	79.7	69.2	66.1	60.0
21_221_0013	Kentucky	Trigg	73.0	62.3	60.4	54.6
21_227_0008	Kentucky	Warren	82.0	72.5	70.2	64.3
22_005_0004	Louisiana	Ascension	79.3	73.4	72.9	70.5
22_011_0002	Louisiana	Beauregard	73.3			
22_015_0008	Louisiana	Bossier	79.7	71.7	60.8	70.2
22_017_0001	Louisiana	Caddo	77.3	70.0	62.7	67.6
22_019_0002	Louisiana	Calcasieu	78.7	74.1	71.6	71.7
22_019_0008	Louisiana	Calcasieu	73.0	68.4	65.0	65.8
22_019_0009	Louisiana	Calcasieu	78.3	73.1	71.5	70.1
22_033_0003	Louisiana	E Btn Rouge	87.0	80.7	78.3	77.9
22_033_0009	Louisiana	E Btn Rouge	81.7	76.7	75.6	74.2
22_033_0013	Louisiana	E Btn Rouge	78.7	73.4	73.8	71.4
22_033_1001	Louisiana	E Btn Rouge	85.0	81.2	79.8	79.3
22_043_0001	Louisiana	Grant	75.0			
22_047_0007	Louisiana	Iberville	79.7	72.6	74.0	69.0
22_047_0009	Louisiana	Iberville	77.7	72.7	72.5	70.0
22_047_0012	Louisiana	Iberville	84.3	79.3	78.8	77.0

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
22_051_1001	Louisiana	Jefferson	83.0	77.8	74.0	75.9
22_055_0005	Louisiana	Lafayette	79.0	71.2	71.2	67.9
22_057_0004	Louisiana	Lafourche	78.0	72.7	71.6	67.9
22_063_0002	Louisiana	Livingston	79.3	74.4	75.3	72.1
22_071_0012	Louisiana	Orleans	69.7	64.8	62.2	62.2
22_073_0004	Louisiana	Ouachita	77.7	71.1	57.7	69.4
22_077_0001	Louisiana	Pt Coupee	73.3	69.0	68.7	67.0
22_087_0002	Louisiana	St. Bernard	78.0	73.4	67.6	68.1
22_089_0003	Louisiana	St. Charles	78.7	73.7	70.5	72.1
22_093_0002	Louisiana	St. James	74.0	69.9	70.0	66.4
22_095_0002	Louisiana	St. JhnBaptist	78.7	74.7	72.3	70.8
22_101_0003	Louisiana	St. Mary	74.7	69.9	70.5	66.4
22_121_0001	Louisiana	W Btn Rouge	84.0	78.8	77.7	76.3
24_003_0014	Maryland	Anne Arundel	98.3	86.1	78.7	75.1
24_003_0019	Maryland	Anne Arundel	97.0	85.8	78.7	75.5
24_005_1007	Maryland	Baltimore	88.7	78.9	72.1	69.2
24_005_3001	Maryland	Baltimore	91.3	79.7	72.5	70.1
24_009_0010	Maryland	Calvert				
24_013_0001	Maryland	Carroll	88.7	76.9	69.7	66.2
24_015_0003	Maryland	Cecil	97.7	81.7	73.5	70.4
24_017_0010	Maryland	Charles	93.0	78.8	71.9	68.1
24_021_0037	Maryland	Frederick	87.3	75.3	69.7	66.5
24_023_0002	Maryland	Garrett				
24_025_1001	Maryland	Harford	100.3	87.1	79.4	76.8
24_025_9001	Maryland	Harford	97.0	83.4	75.7	72.9
24_029_0002	Maryland	Kent	95.3	81.7	74.6	71.1
24_031_3001	Maryland	Montgomery	86.7	76.4	70.0	66.4
24_033_0002	Maryland	Prnc George's	94.0	83.3	76.8	73.2
24_033_8001	Maryland	Prnc George's				
24_033_8003	Maryland	Prnc George's	94.0	82.6	75.6	71.8
24_043_0009	Maryland	Washington	85.3	74.3	69.1	65.7
24_510_0053	Maryland	Baltimore				
25_005_1002	Massachusetts	Bristol	91.0	80.7	74.7	71.3
25_013_0003	Massachusetts	Hampden	83.0	73.5	67.3	62.9
25_013_0008	Massachusetts	Hampden	92.0	81.5	74.5	69.6
26_005_0003	Michigan	Allegan	94.0	85.1	83.6	79.5
26_021_0014	Michigan	Berrien	88.0	80.4	78.8	75.3
26_027_0003	Michigan	Cass	90.7	78.6	76.6	72.2
26_037_0001	Michigan	Clinton	82.7	74.0	72.4	67.9
26_049_0021	Michigan	Genesee	84.7	76.2	74.0	68.4
26_049_2001	Michigan	Genesee	86.3	76.9	74.5	68.7
26_063_0007	Michigan	Huron	83.0	76.0	74.8	70.5
26_065_0012	Michigan	Ingham	82.3	73.7	72.0	67.5
26_077_0008	Michigan	Kalamazoo	82.7	73.2	71.4	67.0
26_081_0020	Michigan	Kent	81.3	73.1	70.7	66.1
26_081_0022	Michigan	Kent	84.7	76.7	74.2	68.8
26_091_0007	Michigan	Lenawee	85.0	77.4	75.5	70.9
26_099_0009	Michigan	Macomb	92.3	87.6	85.8	82.3
26_099_1003	Michigan	Macomb	90.0	87.2	86.4	81.6
26_105_0007	Michigan	Mason	86.0	76.5	74.4	70.3

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
26_121_0039	Michigan	Muskegon	90.0	81.5	79.7	75.9
26_125_0001	Michigan	Oakland	87.7	83.6	82.8	78.3
26_139_0005	Michigan	Ottawa	86.0	77.5	75.8	71.5
26_147_0005	Michigan	St. Clair	88.0	80.9	78.9	74.6
26_161_0008	Michigan	Washtenaw	87.3	81.8	80.5	75.7
26_163_0001	Michigan	Wayne	80.3	75.4	74.4	69.4
26_163_0016	Michigan	Wayne	84.0	79.6	78.9	74.5
26_163_0019	Michigan	Wayne	86.0	82.2	81.3	77.0
28_001_0004	Mississippi	Adams	77.7			
28_011_0001	Mississippi	Bolivar	75.0			
28_033_0002	Mississippi	DeSoto	83.3	75.6	72.9	66.3
28_045_0001	Mississippi	Hancock	81.0	74.3	71.3	69.1
28_045_0002	Mississippi	Hancock	76.5	72.3	69.0	64.4
28_047_0008	Mississippi	Harrison	80.3	75.3	71.2	64.7
28_047_0009	Mississippi	Harrison	74.0	70.0	66.1	59.1
28_049_0010	Mississippi	Hinds	72.7	64.9	61.4	55.9
28_059_0006	Mississippi	Jackson	80.0	75.3	71.8	66.0
28_059_0007	Mississippi	Jackson	74.0	70.0	66.2	61.1
28_075_0003	Mississippi	Lauderdale	73.3			
28_081_0005	Mississippi	Lee	78.3			
28_089_0002	Mississippi	Madison	74.3			
28_149_0004	Mississippi	Warren	73.7	66.1	63.7	59.7
29_037_0003	Missouri	Cass	77.7	72.9	67.4	65.3
29_039_0001	Missouri	Cedar	79.3			
29_047_0003	Missouri	Clay	79.3	75.3	69.9	68.5
29_047_0005	Missouri	Clay	83.7	79.4	73.8	71.9
29_047_0006	Missouri	Clay	82.0	77.4	71.8	70.8
29_047_0025	Missouri	Clay				
29_049_0001	Missouri	Clinton				
29_077_0026	Missouri	Greene	74.5	66.5	64.0	61.7
29_077_0036	Missouri	Greene	71.7	64.0	61.6	59.4
29_095_0036	Missouri	Jackson				
29_099_0012	Missouri	Jefferson	84.7	79.1	77.6	75.8
29_137_0001	Missouri	Monroe	76.7			
29_157_0001	Missouri	Perry				
29_165_0023	Missouri	Platte	80.3	75.6	70.6	69.8
29_183_1002	Missouri	Saint Charles	90.0	81.7	79.6	77.6
29_183_1004	Missouri	Saint Charles	90.0	81.8	80.1	78.7
29_186_0005	Missouri	SteGenevieve	82.7	75.9	72.9	72.7
29_189_0004	Missouri	Saint Louis	88.3	83.2	81.9	80.3
29_189_0006	Missouri	Saint Louis	86.0	79.6	78.3	77.2
29_189_3001	Missouri	Saint Louis	83.3	78.8	77.7	76.3
29_189_5001	Missouri	Saint Louis	85.7	78.7	77.8	75.6
29_189_7003	Missouri	Saint Louis	84.3	79.7	78.6	77.3
29_510_0007	Missouri	St. Louis City	82.5	76.9	75.9	73.3
29_510_0072	Missouri	St. Louis City	72.3	67.6	66.8	64.5
29_510_0086	Missouri	St. Louis City	87.7	82.0	81.0	78.2
34_001_0005	New Jersey	Atlantic	88.0	80.2	75.6	71.5
34_003_0005	New Jersey	Bergen	91.3	83.5	80.6	79.3
34_007_0003	New Jersey	Camden	98.0	86.8	81.4	78.4

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
34_007_1001	New Jersey	Camden	99.7	87.9	81.6	77.5
34_011_0007	New Jersey	Cumberland	94.0	82.8	77.3	73.9
34_013_0011	New Jersey	Essex				
34_013_0016	New Jersey	Essex	67.0	60.5	57.9	55.3
34_015_0002	New Jersey	Gloucester	98.0	86.3	80.7	77.9
34_017_0006	New Jersey	Hudson	84.0	75.9	73.7	71.6
34_019_0001	New Jersey	Hunterdon	94.7	84.4	77.8	73.8
34_021_0005	New Jersey	Mercer	97.7	88.6	82.0	78.5
34_023_0011	New Jersey	Middlesex	96.0	84.7	78.3	74.0
34_025_0005	New Jersey	Monmouth	95.3	86.7	81.8	77.2
34_027_3001	New Jersey	Morris	95.3	83.1	77.6	72.7
34_029_0006	New Jersey	Ocean	105.7	93.5	86.9	81.7
34_031_5001	New Jersey	Passaic	86.7	77.7	73.0	69.0
36_005_0080	New York	Bronx				
36_005_0083	New York	Bronx	82.7	75.7	75.6	74.9
36_005_0110	New York	Bronx	80.0	71.7	72.0	70.8
36_013_0006	New York	Chautauqua	93.0	81.8	80.2	74.0
36_013_0011	New York	Chautauqua	87.0	77.4	76.1	70.4
36_015_0003	New York	Chemung	80.3			
36_027_0007	New York	Dutchess	92.0	82.1	75.8	71.0
36_029_0002	New York	Erie	95.7	85.1	84.8	78.3
36_053_0006	New York	Madison	79.7			
36_055_1007	New York	Monroe	84.0	75.0	71.6	67.7
36_061_0010	New York	New York				
36_063_1006	New York	Niagara	91.7	81.7	80.8	75.8
36_071_5001	New York	Orange	84.7	74.5	67.7	63.8
36_079_0005	New York	Putnam	91.3	81.7	76.5	73.1
36_081_0098	New York	Queens	73.7	66.0	66.3	65.2
36_081_0124	New York	Queens	84.5	76.7	74.4	71.4
36_085_0067	New York	Richmond	93.0	84.8	80.0	75.7
36_103_0002	New York	Suffolk	93.7	89.3	86.1	82.5
36_103_0004	New York	Suffolk	85.0	77.5	72.7	70.0
36_103_0009	New York	Suffolk	97.0	91.1	87.7	84.7
36_111_1005	New York	Ulster	81.3			
36_119_2004	New York	Westchester	91.3	84.3	82.7	81.2
37_003_0004	North Carolina	Alexander	86.7	76.3	72.9	67.7
37_011_0002	North Carolina	Avery	77.7	69.6	67.5	63.8
37_021_0030	North Carolina	Buncombe	80.0	70.3	67.8	63.3
37_027_0003	North Carolina	Caldwell	83.3	74.3	71.2	66.0
37_029_0099	North Carolina	Camden				
37_033_0001	North Carolina	Caswell	87.7	73.6	69.9	64.0
37_037_0004	North Carolina	Chatham	81.3	70.4	66.6	60.9
37_051_0008	North Carolina	Cumberland	85.3	73.2	69.1	62.1
37_051_1003	North Carolina	Cumberland	86.0	74.3	69.8	62.3
37_059_0002	North Carolina	Davie	91.3	77.4	72.8	66.4
37_061_0002	North Carolina	Duplin	80.0			
37_063_0013	North Carolina	Durham	88.3	76.6	72.1	65.3
37_065_0099	North Carolina	Edgecombe	87.3	75.6	71.1	64.9
37_067_0022	North Carolina	Forsyth	91.3	75.3	70.9	64.9
37_067_0027	North Carolina	Forsyth	81.7	68.3	64.6	59.7

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
37_067_0028	North Carolina	Forsyth	86.3	71.1	67.2	61.8
37_067_1008	North Carolina	Forsyth	88.3	74.5	70.3	64.1
37_069_0001	North Carolina	Franklin	89.7	78.2	74.0	67.2
37_075_0001	North Carolina	Graham				
37_077_0001	North Carolina	Granville	92.3	79.4	75.1	68.4
37_081_0011	North Carolina	Guilford	88.7	75.8	71.5	64.6
37_087_0004	North Carolina	Haywood	78.3	70.5	68.5	64.8
37_087_0035	North Carolina	Haywood	83.0	74.8	72.8	69.2
37_087_0036	North Carolina	Haywood	84.7	74.9	72.5	68.3
37_099_0005	North Carolina	Jackson	86.0	76.1	73.3	68.8
37_101_0002	North Carolina	Johnston	84.3	72.8	68.5	61.2
37_107_0004	North Carolina	Lenoir	80.0	70.3	67.0	61.1
37_109_0004	North Carolina	Lincoln	90.7	78.0	74.0	68.4
37_117_0001	North Carolina	Martin	80.3	71.5	68.1	63.4
37_119_0041	North Carolina	Mecklenburg	95.3	84.1	80.3	73.0
37_119_1005	North Carolina	Mecklenburg	84.7	74.4	71.0	64.5
37_119_1009	North Carolina	Mecklenburg	97.3	84.6	80.0	72.0
37_129_0002	North Carolina	New Hanover	77.3	68.6	66.2	60.2
37_131_0002	North Carolina	Northampton	84.0	72.6	68.9	64.8
37_145_0003	North Carolina	Person	89.3	73.8	71.0	64.2
37_147_0099	North Carolina	Pitt	82.0	70.9	66.9	60.4
37_151_0004	North Carolina	Randolph	83.5	71.2	67.3	61.1
37_157_0099	North Carolina	Rockingham	88.3	71.3	66.8	61.1
37_159_0021	North Carolina	Rowan	97.3	83.4	78.6	71.6
37_159_0022	North Carolina	Rowan	97.0	83.9	79.1	71.5
37_173_0002	North Carolina	Swain	72.7	64.3	61.9	57.8
37_179_0003	North Carolina	Union	87.0	76.3	72.4	65.2
37_183_0014	North Carolina	Wake	90.7	78.7	74.4	66.8
37_183_0015	North Carolina	Wake	92.5	80.3	75.9	68.1
37_183_0016	North Carolina	Wake	87.0	75.7	71.7	64.6
37_183_0017	North Carolina	Wake	85.3	74.5	70.5	63.5
37_199_0003	North Carolina	Yancey	83.0	73.0	70.0	65.3
39_003_0002	Ohio	Allen	88.0	78.3	76.2	71.6
39_007_1001	Ohio	Ashtabula	95.7	85.5	84.7	78.6
39_017_0004	Ohio	Butler	89.7	81.3	79.1	72.8
39_017_1004	Ohio	Butler	87.7	78.9	76.4	70.3
39_023_0001	Ohio	Clark	88.3	77.4	74.8	68.8
39_023_0003	Ohio	Clark	85.3	76.4	74.1	67.1
39_025_0022	Ohio	Clermont	89.3	81.4	79.2	71.4
39_027_1002	Ohio	Clinton	94.3	82.5	80.1	71.6
39_035_0034	Ohio	Cuyahoga	78.3	69.1	68.9	64.6
39_035_0064	Ohio	Cuyahoga	81.7	75.8	76.2	71.5
39_035_5002	Ohio	Cuyahoga	88.0	78.6	78.4	73.6
39_041_0002	Ohio	Delaware	89.0	78.6	75.7	70.0
39_049_0028	Ohio	Franklin	86.0	77.4	75.0	69.2
39_049_0029	Ohio	Franklin	93.0	82.1	79.3	73.7
39_049_0037	Ohio	Franklin	85.3	77.1	74.9	69.3
39_049_0081	Ohio	Franklin	84.0	75.7	73.6	68.2
39_055_0004	Ohio	Geauga	99.0	89.9	89.4	82.4
39_057_0006	Ohio	Greene	87.7	76.9	74.5	67.7

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
39_061_0006	Ohio	Hamilton	90.3	81.8	79.4	73.0
39_061_0010	Ohio	Hamilton	85.7	77.9	75.7	70.3
39_061_0040	Ohio	Hamilton	86.0	79.1	77.0	71.1
39_081_0017	Ohio	Jefferson	84.0	70.6	69.1	64.6
39_083_0002	Ohio	Knox	87.0	76.4	73.7	68.0
39_085_0003	Ohio	Lake	92.7	82.3	81.9	77.3
39_085_3002	Ohio	Lake	83.3	74.6	74.1	69.8
39_087_0006	Ohio	Lawrence	81.7	71.6	70.2	67.4
39_087_0011	Ohio	Lawrence	76.7	63.0	62.2	58.5
39_089_0005	Ohio	Licking	88.0	76.6	73.8	68.2
39_093_0017	Ohio	Lorain	87.0	80.4	80.1	75.4
39_095_0024	Ohio	Lucas	83.3	75.8	75.2	70.0
39_095_0027	Ohio	Lucas	82.0	73.3	71.4	66.5
39_095_0034	Ohio	Lucas	90.0	81.9	81.1	75.6
39_095_0081	Ohio	Lucas	88.7	80.7	80.1	74.6
39_097_0007	Ohio	Madison	88.7	77.6	74.8	68.4
39_099_0013	Ohio	Mahoning	87.0	77.4	75.3	70.0
39_103_0003	Ohio	Medina	87.0	75.8	74.0	68.3
39_109_0005	Ohio	Miami	87.0	76.5	73.6	67.4
39_113_0019	Ohio	Montgomery	86.5	77.3	75.0	68.3
39_113_0033	Ohio	Montgomery				
39_133_1001	Ohio	Portage	91.0	80.9	78.9	72.6
39_135_1001	Ohio	Preble	80.0	70.9	68.8	63.1
39_151_0016	Ohio	Stark	88.0	76.6	74.4	69.3
39_151_0021	Ohio	Stark	86.3	74.8	72.5	67.6
39_151_1009	Ohio	Stark	88.3	77.5	75.1	69.9
39_151_4005	Ohio	Stark	88.3	77.8	75.3	69.6
39_153_0020	Ohio	Summit	93.3	83.0	80.8	74.9
39_155_0009	Ohio	Trumbull	88.0	77.8	75.7	70.0
39_155_0011	Ohio	Trumbull	92.0	82.1	80.0	74.0
39_159_1001	Ohio	Union				
39_165_0007	Ohio	Warren	90.7	81.2	78.7	71.8
39_167_0004	Ohio	Washington	85.7	70.1	66.2	61.9
39_173_0003	Ohio	Wood	87.7	78.2	76.5	70.2
40_001_9009	Oklahoma	Adair				
40_021_9002	Oklahoma	Cherokee				
40_077_0441	Oklahoma	Latimer				
40_115_9004	Oklahoma	Ottawa	78.0			
40_121_0415	Oklahoma	Pittsburg	73.0			
40_143_0137	Oklahoma	Tulsa	83.0	77.2	74.0	71.0
40_143_0178	Oklahoma	Tulsa	79.5	73.3	71.8	67.7
40_143_1127	Oklahoma	Tulsa	78.7	73.1	70.3	68.3
42_001_0002	Pennsylvania	Adams	80.0	69.6	64.4	61.8
42_003_0008	Pennsylvania	Allegheny	89.3	79.6	77.5	74.3
42_003_0010	Pennsylvania	Allegheny	90.7	80.9	78.7	75.4
42_003_0067	Pennsylvania	Allegheny	89.3	77.8	75.8	72.1
42_003_0088	Pennsylvania	Allegheny				
42_003_1005	Pennsylvania	Allegheny	91.3	79.7	76.3	72.6
42_005_0001	Pennsylvania	Armstrong	90.7	77.9	74.5	70.0
42_007_0002	Pennsylvania	Beaver	91.3	80.2	78.3	74.8

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
42_007_0005	Pennsylvania	Beaver	89.7	78.0	76.1	72.5
42_007_0014	Pennsylvania	Beaver	85.0	73.6	71.7	68.0
42_011_0001	Pennsylvania	Berks	84.5	73.0	66.7	63.7
42_011_0009	Pennsylvania	Berks	88.7	76.5	69.8	66.6
42_013_0801	Pennsylvania	Blair	83.3	69.9	65.9	62.4
42_017_0012	Pennsylvania	Bucks	99.0	89.5	83.4	79.8
42_021_0011	Pennsylvania	Cambria	85.0	72.8	69.2	66.4
42_027_0100	Pennsylvania	Centre	84.3	70.6	67.1	63.8
42_027_4000	Pennsylvania	Centre	84.7	70.9	67.2	63.7
42_029_0050	Pennsylvania	Chester	95.0	80.7	73.6	70.1
42_029_0100	Pennsylvania	Chester	94.7	79.6	71.6	68.4
42_033_4000	Pennsylvania	Clearfield	87.3	72.0	68.9	65.4
42_043_0401	Pennsylvania	Dauphin	85.0	73.8	68.1	66.1
42_043_1100	Pennsylvania	Dauphin	86.7	74.7	68.6	66.1
42_045_0002	Pennsylvania	Delaware	91.7	80.3	74.9	72.1
42_049_0003	Pennsylvania	Erie	89.0	79.6	79.0	72.9
42_055_0001	Pennsylvania	Franklin	90.7	77.5	72.3	69.1
42_059_0002	Pennsylvania	Greene	87.7	73.7	72.7	64.8
42_069_0101	Pennsylvania	Lackawanna	83.3	71.1	65.9	63.1
42_069_2006	Pennsylvania	Lackawanna	82.0	70.0	64.9	62.1
42_071_0007	Pennsylvania	Lancaster	91.0	77.6	71.4	68.6
42_073_0015	Pennsylvania	Lawrence	78.3	67.3	64.9	60.7
42_077_0004	Pennsylvania	Lehigh	90.7	78.1	72.3	69.6
42_079_1100	Pennsylvania	Luzerne	81.7	68.5	64.0	60.9
42_079_1101	Pennsylvania	Luzerne	83.7	71.1	66.2	63.3
42_081_0100	Pennsylvania	Lycoming	82.0	69.2	64.5	61.8
42_081_0403	Pennsylvania	Lycoming				
42_081_4000	Pennsylvania	Lycoming	78.7	66.0	62.8	60.0
42_085_0100	Pennsylvania	Mercer	91.3	81.8	79.7	74.2
42_089_0001	Pennsylvania	Monroe				
42_091_0013	Pennsylvania	Montgomery	92.3	81.6	76.5	73.7
42_095_0025	Pennsylvania	Northampton	90.0	78.0	71.9	68.8
42_095_0100	Pennsylvania	Northampton				
42_095_8000	Pennsylvania	Northampton	88.0	76.5	70.4	67.6
42_099_0301	Pennsylvania	Perry	83.3	70.5	65.3	62.8
42_101_0004	Pennsylvania	Philadelphia	72.3	65.3	61.2	58.8
42_101_0014	Pennsylvania	Philadelphia	90.7	81.5	76.6	74.2
42_101_0024	Pennsylvania	Philadelphia	96.7	88.0	82.2	78.8
42_101_0136	Pennsylvania	Philadelphia	83.0	73.1	68.4	66.0
42_117_4000	Pennsylvania	Tioga	85.0			
42_125_0005	Pennsylvania	Washington	86.3	74.4	72.2	68.5
42_125_0200	Pennsylvania	Washington	85.3	72.8	71.0	66.3
42_125_5001	Pennsylvania	Washington	85.7	73.6	72.2	68.3
42_129_0006	Pennsylvania	Westmoreland	82.0	73.5	71.3	68.2
42_129_0008	Pennsylvania	Westmoreland	88.0	77.0	73.1	69.7
42_133_0008	Pennsylvania	York	89.0	77.3	71.6	68.9
44_003_0002	Rhode Island	Kent	93.0	82.2	75.9	72.5
44_007_1010	Rhode Island	Providence	92.0	82.5	77.0	72.9
44_009_0007	Rhode Island	Washington	92.7	82.5	76.6	73.1
45_001_0001	South Carolina	Abbeville	82.3	73.5	69.8	63.9

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
45_003_0003	South Carolina	Aiken	82.7	74.5	71.6	66.7
45_007_0003	South Carolina	Anderson	85.3	76.8	73.2	67.6
45_011_0001	South Carolina	Barnwell	79.0	69.2	66.3	60.8
45_015_0002	South Carolina	Berkeley	71.5	65.2	62.8	59.4
45_015_0042	South Carolina	Berkeley	71.3	64.8	62.1	58.3
45_019_0046	South Carolina	Charleston	72.0	65.4	62.6	59.1
45_021_0002	South Carolina	Cherokee	83.7	74.2	70.8	65.2
45_023_0002	South Carolina	Chester	82.7	71.3	67.6	61.8
45_025_0001	South Carolina	Chesterfield	80.0	70.3	67.3	62.4
45_029_0002	South Carolina	Colleton	77.0	69.0	66.5	62.1
45_031_0003	South Carolina	Darlington	82.7	73.4	70.2	65.0
45_037_0001	South Carolina	Edgefield	79.7	71.8	69.1	63.6
45_073_0001	South Carolina	Oconee	82.5	73.5	70.0	65.1
45_077_0002	South Carolina	Pickens	83.0	74.0	70.5	65.3
45_079_0007	South Carolina	Richland	82.3	74.0	70.7	65.2
45_079_0021	South Carolina	Richland	76.0	66.4	63.4	58.7
45_079_1001	South Carolina	Richland	89.3	80.3	76.7	70.8
45_083_0009	South Carolina	Spartanburg	87.0	78.0	74.4	68.8
45_087_0001	South Carolina	Union	79.7	70.9	67.6	62.4
45_089_0001	South Carolina	Williamsburg	71.7			
45_091_0006	South Carolina	York	83.0	71.2	67.4	61.4
47_001_0101	Tennessee	Anderson	87.0	71.6	67.5	61.1
47_009_0101	Tennessee	Blount	92.3	77.3	73.1	66.0
47_009_0102	Tennessee	Blount	76.0	63.4	59.7	53.9
47_037_0011	Tennessee	Davidson	69.0	61.4	58.2	52.7
47_037_0026	Tennessee	Davidson	77.7	69.1	65.3	58.6
47_065_1011	Tennessee	Hamilton	88.3	77.5	73.5	67.0
47_065_4003	Tennessee	Hamilton	88.0	77.6	73.3	66.3
47_075_0003	Tennessee	Haywood	83.5	73.8	70.8	62.8
47_089_0002	Tennessee	Jefferson	91.0	76.3	71.8	64.5
47_093_0021	Tennessee	Knox	88.0	74.0	69.3	62.0
47_093_1020	Tennessee	Knox	92.0	77.9	73.2	65.9
47_099_0002	Tennessee	Lawrence	77.0			
47_105_0109	Tennessee	Loudon				
47_121_0104	Tennessee	Meigs	89.0	74.4	70.2	63.1
47_141_0004	Tennessee	Putnam	84.0	72.4	69.8	64.8
47_149_0101	Tennessee	Rutherford	80.7	70.9	67.0	60.9
47_155_0101	Tennessee	Sevier	91.3	76.9	72.6	66.0
47_155_0102	Tennessee	Sevier	92.3	80.9	77.4	71.6
47_157_0021	Tennessee	Shelby	83.7	75.3	71.9	66.3
47_157_1004	Tennessee	Shelby	87.7	79.2	75.9	69.7
47_163_2002	Tennessee	Sullivan	86.7	78.7	76.3	71.5
47_163_2003	Tennessee	Sullivan	86.3	78.5	76.1	71.1
47_165_0007	Tennessee	Sumner	85.7	75.9	71.8	64.9
47_165_0101	Tennessee	Sumner	82.7	73.1	69.3	63.7
47_187_0106	Tennessee	Williamson	84.3	73.7	69.8	63.4
47_189_0103	Tennessee	Wilson	82.0	72.2	68.8	62.8
48_039_1004	Texas	Brazoria	94.0	86.4	88.3	81.6
48_039_1016	Texas	Brazoria	89.0	78.5	82.4	74.3
48_167_0014	Texas	Galveston	89.7	79.9	84.8	78.6

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
48_167_1002	Texas	Galveston	79.0	71.4	71.3	70.3
48_183_0001	Texas	Gregg	84.3	76.4	71.2	73.9
48_201_0024	Texas	Harris	100.7	93.5	93.5	92.1
48_201_0026	Texas	Harris	88.5	81.7	79.0	79.9
48_201_0029	Texas	Harris	98.3	93.6	93.3	90.0
48_201_0046	Texas	Harris	86.7	80.5	80.5	79.3
48_201_0047	Texas	Harris	80.0	75.3	74.6	73.5
48_201_0051	Texas	Harris	100.0	93.0	94.5	89.4
48_201_0055	Texas	Harris	101.0	93.9	95.4	90.3
48_201_0062	Texas	Harris	91.7	84.5	86.2	81.6
48_201_0066	Texas	Harris	89.7	87.5	86.7	84.6
48_201_0070	Texas	Harris	92.3	88.4	87.3	86.5
48_201_0075	Texas	Harris	89.0	85.2	84.2	83.4
48_201_1015	Texas	Harris	97.0	89.6	86.6	87.6
48_201_1034	Texas	Harris	98.7	91.8	91.7	89.7
48_201_1035	Texas	Harris	95.0	88.3	88.3	86.3
48_201_1039	Texas	Harris	102.0	93.1	93.6	91.7
48_201_1050	Texas	Harris	89.5	81.3	81.4	80.0
48_203_0002	Texas	Harrison	78.5	71.5	63.2	69.0
48_245_0009	Texas	Jefferson	79.0	72.8	71.7	68.9
48_245_0011	Texas	Jefferson	80.0	74.3	68.7	72.2
48_245_0018	Texas	Jefferson	85.0	79.0	72.5	76.7
48_245_0022	Texas	Jefferson	76.7	68.9	70.2	64.3
48_245_0101	Texas	Jefferson	91.0	84.7	82.5	81.8
48_315_0050	Texas	Marion				
48_339_0078	Texas	Montgomery	88.3	82.5	82.1	77.2
48_361_1001	Texas	Orange	81.0	76.5	70.0	74.6
48_361_1100	Texas	Orange	74.7	68.8	67.2	65.6
48_423_0007	Texas	Smith	82.0	73.0	68.6	68.6
51_013_0020	Virginia	Arlington	96.7	87.0	81.2	77.0
51_033_0001	Virginia	Caroline	82.3	71.5	66.0	62.7
51_036_0002	Virginia	Charles	89.3	79.4	76.0	71.5
51_041_0004	Virginia	Chesterfield	84.7	75.7	72.2	68.3
51_059_0005	Virginia	Fairfax	87.0	75.9	70.7	65.3
51_059_0018	Virginia	Fairfax	96.7	86.8	81.0	77.0
51_059_0030	Virginia	Fairfax	94.7	84.4	79.2	75.2
51_059_1004	Virginia	Fairfax				
51_059_1005	Virginia	Fairfax	94.0	83.8	78.6	74.7
51_059_5001	Virginia	Fairfax	88.0	78.1	73.2	68.8
51_061_0002	Virginia	Fauquier	79.3	68.3	64.4	60.4
51_069_0010	Virginia	Frederick	82.7	72.5	68.4	64.8
51_085_0001	Virginia	Hanover				
51_085_0003	Virginia	Hanover	92.0	81.4	77.9	72.8
51_087_0014	Virginia	Henrico	88.3	77.9	74.3	69.6
51_107_1005	Virginia	Loudoun	90.0	78.3	73.7	68.7
51_113_0003	Virginia	Madison	84.7	73.8	71.4	67.2
51_139_0004	Virginia	Page	79.7	68.0	65.8	61.5
51_153_0009	Virginia	Prince William	85.0	73.4	69.3	65.0
51_161_1004	Virginia	Roanoke	83.7	73.6	70.4	66.0
51_163_0003	Virginia	Rockbridge	76.7	69.3	66.5	62.9

Site ID	State	County	DVC	2009 DVF	2012 DVF	2018 DVF
51_179_0001	Virginia	Stafford	86.0	75.2	69.1	64.7
51_197_0002	Virginia	Wythe	79.7	74.1	72.5	69.1
51_510_0009	Virginia	Alexandria	90.0	80.8	75.4	71.6
51_650_0004	Virginia	Hampton City	88.3	81.5	78.7	75.6
51_800_0004	Virginia	Suffolk City	87.0	80.1	77.3	74.5
51_800_0005	Virginia	Suffolk City	82.3	73.0	69.7	65.8
54_003_0003	West Virginia	Berkeley	83.0	72.4	68.2	64.7
54_011_0006	West Virginia	Cabell	85.7	77.2	75.8	72.6
54_025_0003	West Virginia	Greenbrier	78.7	68.5	66.6	63.0
54_029_1004	West Virginia	Hancock	84.7	73.1	71.4	67.6
54_039_0010	West Virginia	Kanawha	84.0	68.8	66.0	63.0
54_061_0003	West Virginia	Monongalia	78.7	67.5	67.0	61.7
54_069_0010	West Virginia	Ohio	83.3	71.9	70.6	65.1
54_107_1002	West Virginia	Wood	85.7	69.6	68.1	63.0
55_021_0015	Wisconsin	Columbia	76.3			
55_025_0041	Wisconsin	Dane	76.0			
55_027_0007	Wisconsin	Dodge	79.3			
55_039_0006	Wisconsin	Fond du Lac	77.3	71.6	70.6	67.3
55_045_0001	Wisconsin	Green	73.3			
55_055_0002	Wisconsin	Jefferson	80.0	71.6	69.9	66.3
55_059_0002	Wisconsin	Kenosha	96.0	89.3	87.0	83.4
55_059_0019	Wisconsin	Kenosha	98.3	91.4	89.1	85.4
55_059_0022	Wisconsin	Kenosha	90.5	83.9	81.8	78.3
55_071_0004	Wisconsin	Manitowoc	81.5	74.2	73.1	69.9
55_071_0007	Wisconsin	Manitowoc	87.0	79.9	78.1	74.1
55_079_0010	Wisconsin	Milwaukee				
55_079_0026	Wisconsin	Milwaukee	80.3	73.7	72.1	68.9
55_079_0041	Wisconsin	Milwaukee	86.0	79.0	77.3	73.8
55_079_0044	Wisconsin	Milwaukee	70.0	65.7	65.5	63.4
55_079_0048	Wisconsin	Milwaukee				
55_079_0085	Wisconsin	Milwaukee	91.0	83.6	81.8	78.1
55_079_1025	Wisconsin	Milwaukee	91.0	83.2	81.3	77.7
55_087_0009	Wisconsin	Outagamie	75.3	69.3	68.1	64.4
55_089_0008	Wisconsin	Ozaukee	88.7	83.0	82.0	78.5
55_089_0009	Wisconsin	Ozaukee	93.0	85.7	84.1	79.9
55_101_0017	Wisconsin	Racine	91.7	84.7	82.7	79.1
55_105_0021	Wisconsin	Rock				
55_105_0024	Wisconsin	Rock	81.7	74.3	72.7	69.2
55_111_0007	Wisconsin	Sauk	72.0			
55_117_0006	Wisconsin	Sheboygan	97.0	89.6	87.8	83.2
55_117_0007	Wisconsin	Sheboygan	85.0	78.5	77.0	72.9
55_123_0008	Wisconsin	Vernon	70.7			
55_127_0005	Wisconsin	Walworth	81.3	74.9	73.3	69.8
55_131_0009	Wisconsin	Washington	80.0	73.2	71.7	68.4
55_133_0017	Wisconsin	Waukesha	79.0	71.8	70.2	67.4
55_133_0027	Wisconsin	Waukesha				
55_139_0011	Wisconsin	Winnebago	80.0	73.7	72.3	69.0

5.0 ADDITIONAL SUPPORTING $PM_{2.5}$ ANALYSIS

This Chapter presents additional supporting analysis to the modeled future-year $PM_{2.5}$ projections presented in Chapter 4. These analyses may be used, along with additional state-specific analysis, as part of a weight of evidence (WOE) $PM_{2.5}$ attainment demonstration determination. The additional analysis includes the following:

- 2009 $PM_{2.5}$ projections using alternative projection software to EPA's Modeled Attainment Test Software (MATS) with the 2002 Base G2 and 2009 Base G4 CMAQ modeling results;
- 2009 $PM_{2.5}$ projections using an alternative model to CMAQ, the Comprehensive Air-quality Model with extensions (CAMx; ENVIRON, 2008); and
- PM Source Apportionment Technology (PSAT) modeling to estimate the contributions of specific nearby point sources to 2009 $PM_{2.5}$ concentrations in Kentucky, Tennessee, West Virginia and adjacent areas.

5.1 2009 $PM_{2.5}$ PROJECTIONS USING ALTERNATIVE PROJECTION SOFTWARE

EPA has developed a PC-based software tool entitled the Modeled Attainment Test Software (MATS) that includes the FRM $PM_{2.5}$ mass and STN/IMPROVE speciated $PM_{2.5}$ concentrations processed by the SANDWICH method. The Speciated Model Attainment Test (SMAT) presented in EPA's modeling guidance (EPA, 2007a) is codified in MATS. Several beta versions of MATS have been released with the annual $PM_{2.5}$ projection SMAT method first becoming available with the January 2008 release of MATS (Version 1.1.2). For the ASIP modeling performed in the 2006-2007 timeframe, the MATS tool with a $PM_{2.5}$ projection capability was not available. Thus, ASIP developed a $PM_{2.5}$ projection tool. The ASIP $PM_{2.5}$ projection tool is based on 2002 STN PM speciation data that were processed using the SANDWICH procedure (see Chapter 4) and are assigned to nearby FRM sites with the SMAT projection procedure performed using Excel spreadsheets to obtain future-year $PM_{2.5}$ Design Value projections.

Conceptually, the biggest difference between the MATS and ASIP Excel $PM_{2.5}$ projection approaches is how the SANDWICH PM speciation data are mapped to the FRM monitors. As noted above, the ASIP approach assigns SANDWICH STN PM speciation data from a nearby STN monitor to a FRM site so that SMAT can be applied. MATS, on the other hand, interpolates the SANDWICH speciated PM data and the Degree of Neutralization (DON) from the STN and IMPROVE sites to the FRM site to speciate the FRM $PM_{2.5}$ mass. Although how the FRM $PM_{2.5}$ mass is speciated is the biggest conceptual difference between the ASIP spreadsheet and MATS $PM_{2.5}$ projection approaches, in practice we have found several other differences in the two approaches as follows:

- Different methods for assigning SANDWICH PM speciation to FRM sites.
- Differences in the current-year (2000-2004) $PM_{2.5}$ Design Values that serve as the starting point for the projections.

- Differences in the STN SANDWICH speciation data used, including use of STN/IMPROVE data from different years in the ASIP spreadsheet (2002) and MATS (2002-2004) methods.
- Inclusion of Sea Salt in the MATS SANDWICH $PM_{2.5}$ speciation.

Sea Salt was included in the original SANDWICH paper (Frank, 2006a), however it was not included in the SANDWICH discussion in EPA's modeling guidance (EPA, 2007a). As the ASIP spreadsheet projection approach was based on EPA's final modeling guidance, Sea Salt was not included.

Below we compare the 2009 $PM_{2.5}$ Design Value projections using the 2002 Base G2 and 2009 Base G4 12 km CMAQ modeling results and the ASIP spreadsheet and EPA MATS projection tools. These comparisons are made using Version 1.2.1 (January 2008) of MATS, as compared to the latest Version 2.01 version of MATS that was used to make the future-year $PM_{2.5}$ Design Value projections presented in Chapter 4. Although the release notes for the latest publicly released version of MATS only mention updates to the 8-hour ozone and visibility projections, we did notice two changes in the $PM_{2.5}$ projections:

- Some minor changes to the rounding conventions used; and
- The treatment of two $PM_{2.5}$ monitoring sites in Birmingham, Alabama.

Regarding this latter difference, the North Birmingham and Wylam monitoring sites in Birmingham used to be treated as Community Monitoring Zone (CMZ) monitors whereby their $PM_{2.5}$ Design Values would be averaged, which is the way they were treated in MATS v1.2.1. However, this is no longer the case so the latest versions of MATS v1.5.1 was updated to treat them as separate monitoring sites.

5.1.1 Overview Comparison of MATS and ASIP Spreadsheet 2009 $PM_{2.5}$ Projections

Figure 5-1 displays a scatter plot of the 2009 projected $PM_{2.5}$ Design Values (DVFs) at FRM monitors in and nearby the ASIP region using the ASIP Excel spreadsheet and MATS projections methods. In general, there is good agreement between the projected DVFs using the two projection methods (r^2 = 0.982). However, there are some differences in the two methods' DVF projections, with the ASIP method sometimes estimating higher and sometimes lower DVFs than MATS; although it appears the MATS method is usually estimating lower DVFs than the ASIP Excel method. At most sites, the results of the two methods are within 0.1 $\mu g/m^3$ of each other. There are also some outliers with the largest two being sites where the ASIP Excel method estimates ~17.5 and ~14 $\mu g/m^3$ DVFs, whereas the MATS tool estimates ~16.5 and ~12 $\mu g/m^3$ DVFs, respectively.

One reason for the differences in projected DVFs is because the two methods are starting with different current year $PM_{2.5}$ Design Values (DVCs). Figure 5-2 displays a scatter plot of the DVCs in the ASIP Excel and MATS projection tools. Again there is good agreement between the two methods (r^2 = 0.986), but there are differences. It appears that the biggest reason for the differences in the two projected DVFs outliers given in the above paragraph is due to the starting point DVCs. With the exception of a few outliers most of the DVCs in the two methods agree to within a tenth of a $\mu g/m^3$.

Figure 5-3 displays the differences in the 2009 projected minus the current year $PM_{2.5}$ Design Values using the two methods. These differences will be mostly independent of the current year Design Values differences, so provide insight into the implementation of the SMAT and SANDWICH PM speciation in the ASIP Excel and MATS projection methods. Generally, the changes in Design Values (DVF-DVC) using the two methods agree within a few tenths of $\mu g/m^3$. But again, there are some differences.

Finally, to understand the effects in the different SANDWICH speciation data and the effects of the MATS interpolation of the STN/IMPROVE $PM_{2.5}$ speciation to the FRM monitoring site versus the ASIP method to assign an STN speciation, Figure 5-4 displays a comparison of the projected $PM_{2.5}$ Design Values using the two methods at FRM sites with co-located STN monitors. Note that the ASIP Excel spreadsheet tool relies on just 2002 STN data, whereas the MATS tool SANDWICH speciation was developed using three years (2002-2004) of STN and IMPROVE data. The agreement of the DVFs using the two methods at FRM sites with co-located STN data is extremely good and any differences are explained by the starting DVCs. Thus, Figure 5-4 demonstrates that the development of the modeled RRFs from the CMAQ output and the application of the SMAT in the ASIP Excel and MATS tools are the same and any differences in the projections can be completely explained by the differences in SANDWICH $PM_{2.5}$ speciation data and how they are assigned/interpolated to the FRM monitor site and the starting DVCs. It is unclear whether it is more appropriate to assign or interpolate $PM_{2.5}$ speciation data to FRM monitors without STN data and which approach is more valid would have to be evaluated on a case-by-case basis.

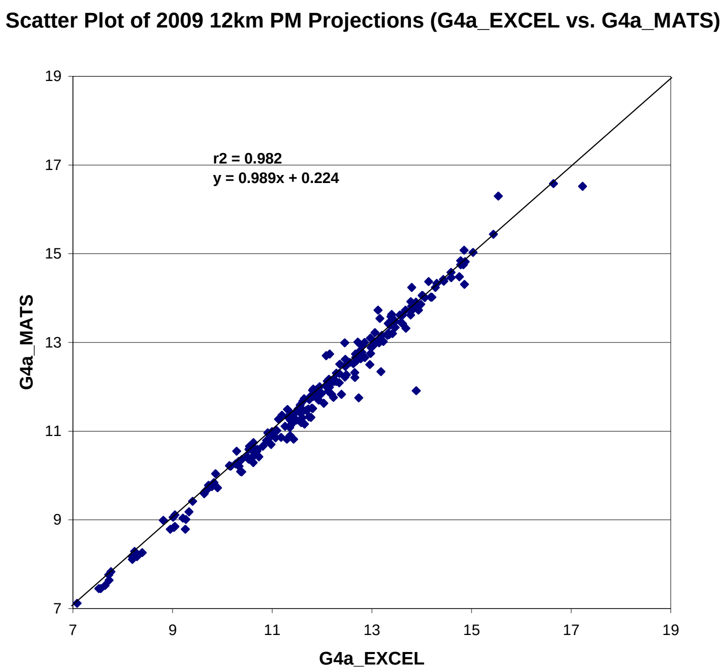


Figure 5-1. Comparison of ASIP Excel versus MATS projected 2009 $PM_{2.5}$ Design Values (DVFs) using the CMAQ 2002 Base G2 and 2009 Base G4 12 km modeling results.

Scatter Plot of 2002 12km PM DVC (G4a_EXCEL vs. G4a_MATS)

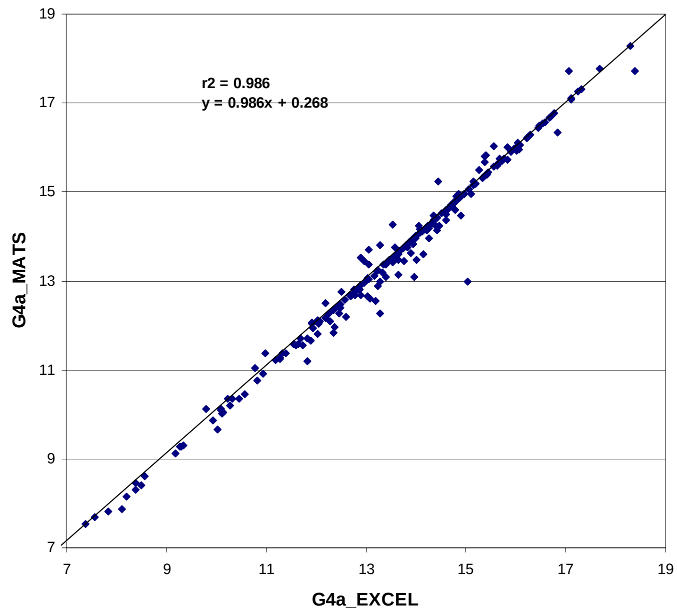


Figure 5-2. Comparison of Current Year Design Values (DVCs) implemented in the ASIP Excel spreadsheet and MATS 2009 $PM_{2.5}$ projections approaches.

Scatter Plot of 12km PM Difference (DVF - DVC)

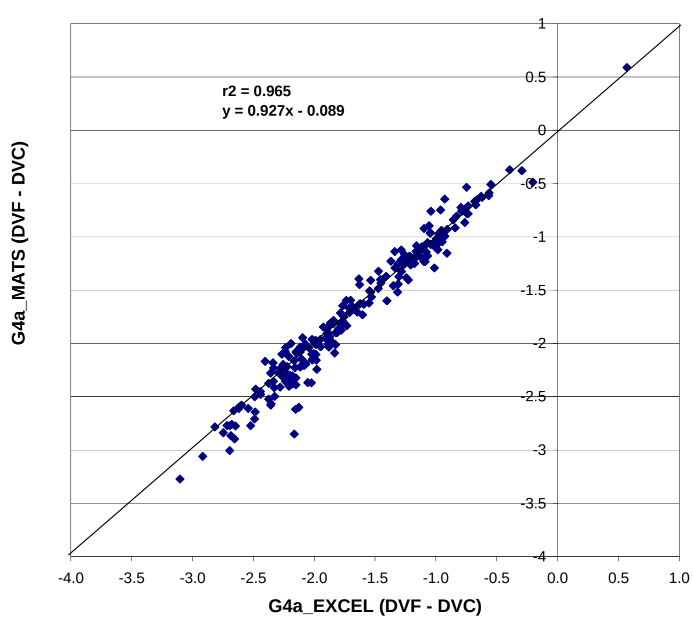


Figure 5-3. Differences in 2009 projection and current $PM_{2.5}$ Design Values using the ASIP Excel and MATS projection methods (DVF-DVC).

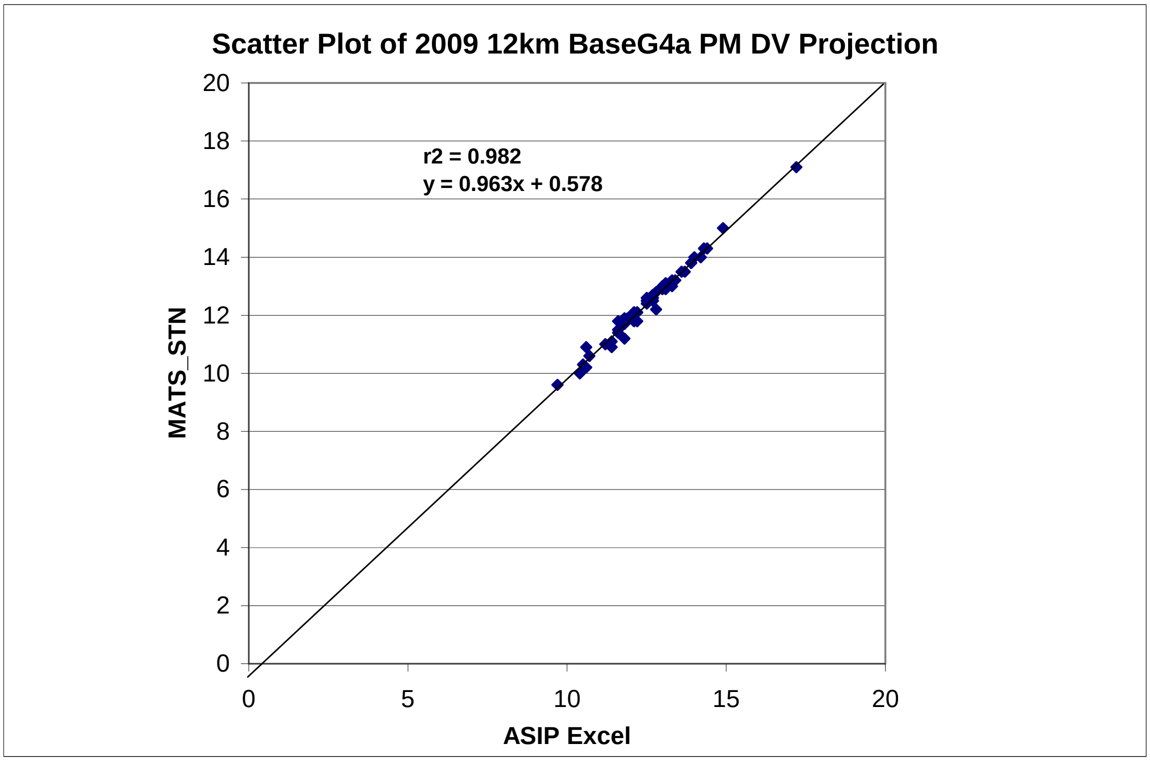


Figure 5-4. Comparison of the ASIP Excel and MATS 2009 $PM_{2.5}$ Design Value projection approach at FRM sites with co-located STN monitors.

5.1.2 Site-by-Site Comparison of MATS and ASIP Excel DVFs

Table 5-2 displays a tabular summary of the DVCs and DVFs using the ASIP Excel and MATS projection tools and their differences. One of the biggest differences in the two sets of DVFs is at the Birmingham Alabama NBHM (01-073-0023) and WYLM (01-073-2003) FRM monitoring sites; the ASIP approach has DVCs of 18.38 and 17.07 $\mu g/m^3$, respectively, whereas MATS has identical DVCs of 17.71 $\mu g/m^3$ for the two sites. As noted above, this is left over from when these two sites were considered Community Monitoring Zone (CMZ) sites whose results were averaged in the attainment demonstration. However, EPA revoked the CMZ status of these two monitors in 2007. MATS has been updated to treat each of these monitors individually.

Although there are differences in the DVCs and DVFs using these two methods, they are fairly consistent on which areas would attain the $PM_{2.5}$ NAAQS by 2009. The three nonattainment areas projected to continue to violate the $PM_{2.5}$ NAAQS in 2009 using the MATS discussed in Chapter 4 (Birmingham, Atlanta and Cincinnati NAAs), are also projected to be in continued nonattainment in 2009 using the ASIP Excel spreadsheet method. However, there is one site in the Atlanta area (Site No. 13-063-0091 in Clayton County, GA) that was projected to attain (i.e., < 15.05 $\mu g/m^3$) the $PM_{2.5}$ NAAQS using the ASIP Excel spreadsheet method (14.90 $\mu g/m^3$) but is projected to exceed the $PM_{2.5}$ NAAQS using MATS (15.08 $\mu g/m^3$). But the differences between the two projections is very small (0.18 $\mu g/m^3$).

In conclusion, all nonattainment areas (NAAs) that were projected to attain the $PM_{2.5}$ NAAQS by 2009 using the ASIP Excel spreadsheet method were also projected to attain the $PM_{2.5}$ NAAQS using the MATS tool. Conversely, all NAAS that were projected to continue to violate the $PM_{2.5}$ NAAQS in 2009 using the ASIP Excel method were also projected to violate the $PM_{2.5}$ NAAQS using MATS. Thus, despite the small differences in the ASIP Excel and MATS $PM_{2.5}$ projections, they are wholly consistent with each other on which areas are projected to attain and which areas are projected to not attain the $PM_{2.5}$ NAAQS by 2009.

Table 5-1. Comparison of ASIP Excel Spreadsheet and MATS v1.2.1 projection approach current year DVCs and 2009 projected DVFs using the CMAQ 2002 Base G2 and 2009 Base G4 12 km modeling results.

			ASIP Spreadsheet		MATS v1.2.1		Difference	
AIRS ID	State	County	2002 DVC	2009 DVF	2002 DVC	2009 DVF	2002 DVC	2009 DVF
01-003-0010	AL	Baldwin	11.32	10.60	11.38	10.59	-0.06	0.01
01-027-0001	AL	Clay	13.50	12.30	13.50	12.31	0.00	-0.01
01-033-1002	AL	Colbert	13.02	11.70	12.65	11.32	0.37	0.38
01-049-1003	AL	DeKalb	14.87	13.30	14.95	13.43	-0.08	-0.13
01-053-0002	AL	Escambia	12.77	11.90	12.82	11.88	-0.05	0.02
01-073-0023	AL	Jefferson	18.38	17.20	17.71	16.52	0.67	0.68
01-073-1005	AL	Jefferson	14.97	13.80	14.96	13.71	0.01	0.09
01-073-1009	AL	Jefferson	13.02	11.80	13.01	11.79	0.01	0.01
01-073-2003	AL	Jefferson	17.07	15.50	17.71	16.30	-0.64	-0.80
01-073-2006	AL	Jefferson	15.07	13.80	15.06	13.81	0.01	-0.01
01-073-5002	AL	Jefferson	14.00	12.70	13.95	12.73	0.05	-0.03
01-073-5003	AL	Jefferson	14.09	12.80	14.08	12.78	0.01	0.02
01-089-0014	AL	Madison	14.20	12.70	14.20	12.79	0.00	-0.09
01-097-0002	AL	Mobile	12.87	12.10	12.8	12.06	0.07	0.04
01-097-2005	AL	Mobile	11.91	11.10	12.03	11.27	-0.12	-0.17
01-101-0007	AL	Montgomery	14.61	13.50	14.5	13.34	0.11	0.16
01-103-0011	AL	Morgan	13.05	11.80	13.36	11.95	-0.31	-0.15
01-113-0001	AL	Russell	16.06	14.80	15.96	14.75	0.10	0.05
01-119-0002	AL	Sumter	12.26	11.30	12.26	11.32	0.00	-0.02
01-121-0002	AL	Talladega	14.96	13.80	14.96	13.82	0.00	-0.02
11-001-0041	DC	DC	15.67	13.00	15.75	12.88	-0.08	0.12
11-001-0042	DC	DC	14.81	12.30	14.9	12.12	-0.09	0.18
11-001-0043	DC	DC	15.14	12.50	15.17	12.27	-0.03	0.23
12-001-0023	FL	Alachua	9.94	9.00	9.87	8.79	0.07	0.21
12-001-0024	FL	Alachua	9.80	8.80	10.12	8.99	-0.32	-0.19
12-005-1004	FL	Bay	10.79	9.90	11.04	10.04	-0.25	-0.14
12-009-0007	FL	Brevard	8.13	7.10	7.88	7.12	0.25	-0.02
12-011-1002	FL	Broward	8.21	7.60	8.14	7.52	0.07	0.08
12-011-2004	FL	Broward	8.39	7.70	8.3	7.64	0.09	0.06
12-011-3002	FL	Broward	8.39	7.80	8.45	7.83	-0.06	-0.03
12-017-0005	FL	Citrus	9.19	8.20	9.13	8.11	0.06	0.09
12-031-0098	FL	Duval	10.09	9.00	10.13	9.06	-0.04	-0.06
12-031-0099	FL	Duval	10.24	9.40	10.34	9.42	-0.10	-0.02
12-033-0004	FL	Escambia	11.60	12.20	11.56	12.14	0.04	0.06
12-057-0030	FL	Hillsborough	11.27	9.80	11.25	9.84	0.02	-0.04
12-071-0005	FL	Lee	8.49	7.50	8.42	7.45	0.07	0.05
12-073-0012	FL	Leon	12.72	11.80	12.67	11.51	0.05	0.29

AIRS ID	State	County	ASIP Spreadsheet 2002 DVC	ASIP Spreadsheet 2009 DVF	MATS v1.2.1 2002 DVC	MATS v1.2.1 2009 DVF	Difference 2002 DVC	Difference 2009 DVF
12-083-0003	FL	Marion	10.13	9.00	10.04	8.83	0.09	0.17
12-086-1016	FL	Miami-Dade	10.02	9.30	9.66	8.79	0.36	0.51
12-086-6001	FL	Miami-Dade	7.85	7.60	7.83	7.45	0.02	0.15
12-095-1004	FL	Orange	10.29	9.20	10.19	9.04	0.10	0.16
12-095-2002	FL	Orange	10.12	9.00	10.03	8.85	0.09	0.15
12-099-0009	FL	Palm Beach	7.58	6.90	7.69	7.02	-0.11	-0.12
12-099-2005	FL	Palm Beach	7.38	6.40	7.54	6.89	-0.16	-0.49
12-103-0018	FL	Pinellas	10.58	9.30	10.46	9.01	0.12	0.29
12-105-6006	FL	Polk	10.47	9.30	10.36	9.18	0.11	0.12
12-111-1002	FL	St. Lucie	8.58	7.70	8.61	7.76	-0.03	-0.06
12-115-0013	FL	Sarasota	9.28	8.30	9.28	8.17	0.00	0.13
12-117-1002	FL	Seminole	9.34	8.40	9.31	8.26	0.03	0.14
12-127-5002	FL	Volusia	9.30	8.20	9.28	8.18	0.02	0.02
13-021-0007	GA	Bibb	15.71	14.30	15.71	14.33	0.00	-0.03
13-021-0012	GA	Bibb	13.75	12.50	13.75	12.62	0.00	-0.12
13-051-0017	GA	Chatham	13.87	12.80	13.87	12.63	0.00	0.17
13-051-0091	GA	Chatham	13.76	12.70	13.44	12.21	0.32	0.49
13-059-0001	GA	Clarke	15.76	13.90	15.75	13.91	0.01	-0.01
13-063-0091	GA	Clayton	16.48	14.90	16.48	15.08	0.00	-0.18
13-067-0003	GA	Cobb	16.30	14.60	16.29	14.58	0.01	0.02
13-089-0002	GA	DeKalb	15.91	14.40	15.91	14.42	0.00	-0.02
13-089-2001	GA	DeKalb	16.22	14.40	16.22	14.38	0.00	0.02
13-095-0007	GA	Dougherty	14.25	13.20	14.24	13.16	0.01	0.04
13-115-0005	GA	Floyd	15.71	14.00	15.71	14.05	0.00	-0.05
13-121-0032	GA	Fulton	16.45	14.90	16.45	14.81	0.00	0.09
13-121-0039	GA	Fulton	18.29	16.60	18.29	16.58	0.00	0.02
13-127-0006	GA	Glynn	11.90	10.60	11.65	10.39	0.25	0.21
13-135-0002	GA	Gwinnett	16.06	14.30	16.06	14.24	0.00	0.06
13-139-0003	GA	Hall	15.14	13.40	15.24	13.39	-0.10	0.01
13-153-0001	GA	Houston	13.28	11.90	12.99	11.85	0.29	0.05
13-185-0003	GA	Lowndes	12.38	11.40	11.97	10.9	0.41	0.50
13-215-0001	GA	Muscogee	14.87	13.70	14.94	13.73	-0.07	-0.03
13-215-0011	GA	Muscogee	14.87	13.60	14.87	13.61	0.00	-0.01
13-223-0003	GA	Paulding	14.30	12.80	14.30	12.79	0.00	0.01
13-245-0005	GA	Richmond	15.57	13.80	16.03	14.24	-0.46	-0.44
13-245-0091	GA	Richmond	15.05	13.40	15.05	13.45	0.00	-0.05
13-295-0002	GA	Walker	15.65	13.90	15.65	13.81	0.00	0.09
13-303-0001	GA	Washington	14.47	13.00	14.23	12.9	0.24	0.10
13-319-0001	GA	Wilkinson	15.15	13.80	15.15	13.92	0.00	-0.12
18-019-0006	IN	Clark	16.84	14.90	16.33	14.31	0.51	0.59
18-043-1004	IN	Floyd	14.90	13.00	14.90	12.93	0.00	0.07
21-013-0002	KY	Bell	14.79	12.80	14.78	12.78	0.01	0.02
21-019-0017	KY	Boyd	14.89	12.80	14.88	12.93	0.01	-0.13
21-029-0006	KY	Bullitt	14.89	13.10	14.88	12.98	0.01	0.12
21-037-0003	KY	Campbell	14.00	12.00	14.00	11.84	0.00	0.16
21-043-0500	KY	Carter	12.18	10.20	12.18	10.21	0.00	-0.01
21-047-0006	KY	Christian	13.48	11.90	13.47	11.9	0.01	0.00
21-059-0014	KY	Daviess	14.71	13.00	14.7	13.1	0.01	-0.10

AIRS ID	State	County	ASIP Spreadsheet 2002 DVC	ASIP Spreadsheet 2009 DVF	MATS v1.2.1 2002 DVC	MATS v1.2.1 2009 DVF	Difference 2002 DVC	Difference 2009 DVF
21-067-0012	KY	Fayette	14.88	12.70	14.87	12.74	0.01	-0.04
21-067-0014	KY	Fayette	15.63	13.40	15.60	13.18	0.03	0.22
21-073-0006	KY	Franklin	13.67	11.60	13.67	11.47	0.00	0.13
21-093-0006	KY	Hardin	13.97	12.20	13.97	12.07	0.00	0.13
21-101-0006	KY	Henderson	14.34	12.70	14.46	13.01	-0.12	-0.31
21-111-0044	KY	Jefferson	16.59	14.80	16.58	14.48	0.01	0.32
21-111-0048	KY	Jefferson	16.06	14.20	16.06	14.02	0.00	0.18
21-111-0051	KY	Jefferson	15.44	13.60	15.44	13.42	0.00	0.18
21-117-0007	KY	Kenton	14.88	12.70	14.88	12.58	0.00	0.12
21-145-1004	KY	McCracken	13.40	12.20	13.10	11.83	0.30	0.37
21-151-0003	KY	Madison	13.54	11.40	13.53	11.38	0.01	0.02
21-193-0003	KY	Perry	13.65	11.60	13.15	11.16	0.50	0.44
21-195-0002	KY	Pike	13.68	11.60	13.67	11.59	0.01	0.01
21-227-0007	KY	Warren	13.82	12.10	13.81	12.13	0.01	-0.03
24-003-0014	MD	Anne Arundel	12.28	9.90	12.10	9.72	0.18	0.18
24-003-0019	MD	Anne Arundel	13.23	10.60	12.89	10.29	0.34	0.31
24-003-1003	MD	Anne Arundel	15.38	12.60	15.36	12.52	0.02	0.08
24-003-2002	MD	Anne Arundel	14.41	11.80	14.14	11.52	0.27	0.28
24-031-3001	MD	Montgomery	12.83	10.40	12.82	10.36	0.01	0.04
24-043-0009	MD	Washington	14.40	11.70	14.25	11.47	0.15	0.23
28-001-0004	MS	Adams	11.82	11.40	11.20	10.82	0.62	0.58
28-011-0001	MS	Bolivar	13.19	12.40	12.56	11.83	0.63	0.57
28-033-0002	MS	DeSoto	13.08	12.00	12.60	11.63	0.48	0.37
28-035-0004	MS	Forrest	13.35	12.70	13.37	12.66	-0.02	0.04
28-045-0001	MS	Hancock	10.33	9.70	10.34	9.70	-0.01	0.00
28-047-0008	MS	Harrison	11.56	11.40	11.57	11.08	-0.01	0.32
28-049-0010	MS	Hinds	12.90	12.20	13.53	12.74	-0.63	-0.54
28-049-0018	MS	Hinds	13.29	12.50	13.80	12.99	-0.51	-0.49
28-059-0006	MS	Jackson	12.35	11.60	11.84	11.30	0.51	0.30
28-067-0002	MS	Jones	14.90	13.90	14.48	13.73	0.42	0.17
28-075-0003	MS	Lauderdale	13.05	12.10	13.71	12.7	-0.66	-0.60
28-081-0005	MS	Lee	12.48	11.40	12.48	11.35	0.00	0.05
28-087-0001	MS	Lowndes	15.05	13.90	13.00	11.91	2.05	1.99
28-109-0001	MS	Pearl River	11.82	11.30	11.70	11.11	0.12	0.19
28-121-0001	MS	Rankin	13.96	13.20	13.10	12.34	0.86	0.86
28-123-0001	MS	Scott	11.93	11.20	12.07	11.36	-0.14	-0.16
28-149-0004	MS	Warren	13.29	12.70	12.26	11.75	1.03	0.95
37-001-0002	NC	Alamance	13.93	11.80	13.93	11.31	0.00	0.49
37-021-0034	NC	Buncombe	13.33	11.20	13.19	10.86	0.14	0.34
37-025-0004	NC	Cabarrus	14.72	12.20	14.68	12.17	0.04	0.03
37-033-0001	NC	Caswell	13.42	11.30	13.43	10.82	-0.01	0.48
37-035-0004	NC	Catawba	15.64	13.00	15.60	13.02	0.04	-0.02
37-037-0004	NC	Chatham	12.35	10.40	12.34	10.09	0.01	0.31
37-051-0009	NC	Cumberland	14.09	12.10	14.17	12.02	-0.08	0.08
37-057-0002	NC	Davidson	16.01	13.30	15.94	13.16	0.07	0.14
37-061-0002	NC	Duplin	12.09	10.30	12.08	10.32	0.01	-0.02
37-063-0001	NC	Durham	14.08	11.90	14.09	11.70	-0.01	0.20
37-067-0022	NC	Forsyth	14.77	12.00	14.79	12.00	-0.02	0.00

AIRS ID	State	County	ASIP Spreadsheet 2002 DVC	ASIP Spreadsheet 2009 DVF	MATS v1.2.1 2002 DVC	MATS v1.2.1 2009 DVF	Difference 2002 DVC	Difference 2009 DVF
37-067-0024	NC	Forsyth	14.26	11.60	13.96	11.19	0.30	0.41
37-071-0016	NC	Gaston	14.25	12.10	14.23	12.00	0.02	0.10
37-081-0013	NC	Guilford	13.54	11.40	14.27	11.41	-0.73	-0.01
37-087-0010	NC	Haywood	13.64	11.50	13.48	11.25	0.16	0.25
37-099-0006	NC	Jackson	12.46	10.30	12.27	10.26	0.19	0.04
37-107-0004	NC	Lenoir	11.56	9.70	11.57	9.78	-0.01	-0.08
37-111-0004	NC	McDowell	14.43	12.10	14.41	11.99	0.02	0.11
37-119-0010	NC	Mecklenburg	15.19	12.90	15.19	13.00	0.00	-0.10
37-119-0041	NC	Mecklenburg	14.41	12.10	14.41	12.17	0.00	-0.07
37-119-0042	NC	Mecklenburg	14.27	12.10	14.2	12.03	0.07	0.07
37-121-0001	NC	Mitchell	13.60	11.40	13.56	11.21	0.04	0.19
37-123-0001	NC	Montgomery	12.41	10.30	12.40	10.21	0.01	0.09
37-133-0005	NC	Onslow	11.27	9.70	11.27	9.64	0.00	0.06
37-135-0007	NC	Orange	13.25	11.10	13.24	10.85	0.01	0.25
37-147-0005	NC	Pitt	12.48	10.50	12.40	10.42	0.08	0.08
37-155-0005	NC	Robeson	12.78	10.90	12.69	10.79	0.09	0.11
37-173-0002	NC	Swain	12.89	10.80	12.67	10.66	0.22	0.14
37-183-0014	NC	Wake	13.97	11.60	13.96	11.68	0.01	-0.08
37-183-0015	NC	Wake	13.57	11.30	13.76	11.49	-0.19	-0.19
37-191-0005	NC	Wayne	13.84	11.70	13.76	11.71	0.08	-0.01
39-017-0003	OH	Butler	16.05	14.10	16.12	14.01	-0.07	0.09
39-017-0016	OH	Butler	15.68	13.40	15.68	13.40	0.00	0.00
39-017-0017	OH	Butler	15.39	13.40	15.68	13.58	-0.29	-0.18
39-061-0014	OH	Hamilton	17.67	15.40	17.76	15.44	-0.09	-0.04
39-061-0040	OH	Hamilton	15.56	13.30	15.57	13.21	-0.01	0.09
39-061-0041	OH	Hamilton	15.40	13.20	15.83	13.54	-0.43	-0.34
39-061-0042	OH	Hamilton	17.11	14.90	17.10	14.82	0.01	0.08
39-061-0043	OH	Hamilton	15.76	13.50	15.76	13.48	0.00	0.02
39-061-7001	OH	Hamilton	16.26	14.00	16.26	14.06	0.00	-0.06
39-061-8001	OH	Hamilton	17.25	15.00	17.25	15.03	0.00	-0.03
39-087-0010	OH	Lawrence	15.71	13.70	15.70	13.32	0.01	0.38
39-145-0013	OH	Scioto	17.12	14.80	17.11	14.75	0.01	0.05
45-013-0007	SC	Beaufort	10.94	9.80	10.91	9.75	0.03	0.05
45-019-0048	SC	Charleston	12.04	10.70	11.80	10.42	0.24	0.28
45-019-0049	SC	Charleston	11.40	10.40	11.38	10.08	0.02	0.32
45-025-0001	SC	Chesterfield	12.38	10.50	12.37	10.37	0.01	0.13
45-037-0001	SC	Edgefield	12.75	11.10	12.71	11.02	0.04	0.08
45-041-0002	SC	Florence	12.69	10.90	12.66	10.77	0.03	0.13
45-043-0009	SC	Georgetown	12.78	11.40	12.75	11.15	0.03	0.25
45-045-0008	SC	Greenville	15.84	13.60	15.73	13.62	0.11	-0.02
45-045-0009	SC	Greenville	14.79	12.60	14.60	12.55	0.19	0.05
45-047-0003	SC	Greenwood	13.41	11.50	13.36	11.49	0.05	0.01
45-051-0002	SC	Horry	11.18	9.60	11.22	9.59	-0.04	0.01
45-063-0008	SC	Lexington	13.93	12.10	13.87	11.99	0.06	0.11
45-073-0001	SC	Oconee	10.82	9.10	10.76	9.11	0.06	-0.01
45-079-0007	SC	Richland	13.17	11.40	13.11	11.24	0.06	0.16
45-079-0019	SC	Richland	14.15	12.20	13.61	11.76	0.54	0.44
45-083-0010	SC	Spartanburg	13.94	11.80	13.82	11.78	0.12	0.02

AIRS ID	State	County	ASIP Spreadsheet 2002 DVC	ASIP Spreadsheet 2009 DVF	MATS v1.2.1 2002 DVC	MATS v1.2.1 2009 DVF	Difference 2002 DVC	Difference 2009 DVF
47-009-0011	TN	Blount	14.61	12.70	14.36	12.32	0.25	0.38
47-037-0023	TN	Davidson	14.44	13.10	15.25	13.73	-0.81	-0.63
47-045-0004	TN	Dyer	12.06	11.00	12.05	10.99	0.01	0.01
47-065-1011	TN	Hamilton	13.95	12.30	13.83	12.09	0.12	0.21
47-065-4002	TN	Hamilton	15.35	13.60	15.34	13.62	0.01	-0.02
47-093-0028	TN	Knox	15.38	13.40	15.79	13.63	-0.41	-0.23
47-093-1017	TN	Knox	16.67	14.60	16.67	14.46	0.00	0.14
47-093-1020	TN	Knox	15.98	13.90	15.97	13.77	0.01	0.13
47-099-0002	TN	Lawrence	11.94	10.70	11.94	10.55	0.00	0.15
47-107-1002	TN	McMinn	15.10	13.20	14.96	13.02	0.14	0.18
47-119-2007	TN	Maury	12.90	11.60	12.90	11.73	0.00	-0.13
47-125-1009	TN	Montgomery	13.22	11.80	13.21	11.77	0.01	0.03
47-141-0001	TN	Putnam	13.54	11.90	13.43	11.79	0.11	0.11
47-145-0004	TN	Roane	14.32	12.50	14.31	12.49	0.01	0.01
47-157-0014	TN	Shelby	13.91	12.90	13.63	12.66	0.28	0.24
47-157-0038	TN	Shelby	14.00	13.00	13.47	12.50	0.53	0.50
47-157-0047	TN	Shelby	14.12	13.10	14.12	13.22	0.00	-0.12
47-157-1004	TN	Shelby	11.65	10.50	11.59	10.66	0.06	-0.16
47-163-1007	TN	Sullivan	14.60	12.40	14.59	12.51	0.01	-0.11
47-165-0007	TN	Sumner	13.59	12.20	13.58	12.12	0.01	0.08
51-013-0020	VA	Arlington	14.62	12.10	14.61	11.90	0.01	0.20
51-036-0002	VA	Charles City	12.81	10.70	12.80	10.59	0.00	0.11
51-041-0003	VA	Chesterfield	13.74	11.60	13.73	11.42	0.01	0.18
51-059-0030	VA	Fairfax	13.64	11.00	13.60	10.96	0.04	0.04
51-059-5001	VA	Fairfax	14.21	11.70	14.15	11.50	0.06	0.20
51-087-0014	VA	Henrico	13.80	11.60	13.80	11.45	0.00	0.15
51-087-0015	VA	Henrico	13.03	11.00	13.07	10.70	-0.04	0.30
51-107-1005	VA	Loudoun	13.64	11.10	13.63	11.01	0.01	0.09
51-139-0004	VA	Page	12.96	10.60	12.96	10.46	0.00	0.14
51-520-0006	VA	Bristol	14.51	12.50	14.51	12.46	0.00	0.04
51-550-0012	VA	Chesapeake	12.51	10.60	12.75	10.74	-0.24	-0.14
51-650-0004	VA	Hampton	12.19	10.30	12.51	10.55	-0.32	-0.25
51-700-0013	VA	Newport News	12.04	10.10	12.13	10.22	-0.09	-0.12
51-710-0024	VA	Norfolk	12.97	11.00	12.97	10.86	0.00	0.14
51-760-0020	VA	Richmond	14.07	11.80	14.24	11.92	-0.17	-0.12
51-770-0014	VA	Roanoke	14.37	11.90	14.36	11.93	0.01	-0.03
51-775-0010	VA	Salem	14.79	12.30	14.78	12.30	0.01	0.00
51-810-0008	VA	Virginia Beach	12.59	10.60	12.58	10.61	0.01	-0.01
54-003-0003	WV	Berkeley	16.24	13.60	16.23	13.45	0.01	0.15
54-009-0005	WV	Brooke	16.69	13.80	16.69	13.62	0.00	0.18
54-011-0006	WV	Cabell	16.54	14.10	16.54	14.37	0.00	-0.27
54-029-0011	WV	Hancock	15.84	13.10	16	12.99	-0.16	0.11
54-029-1004	WV	Hancock	17.31	14.20	17.3	14.02	0.01	0.18
54-033-0003	WV	Harrison	14.00	11.60	13.99	11.46	0.01	0.14
54-039-0010	WV	Kanawha	15.42	13.20	15.38	13.10	0.04	0.10
54-039-1005	WV	Kanawha	17.12	14.80	17.08	14.84	0.04	-0.04
54-049-0006	WV	Marion	15.33	13.00	15.32	12.75	0.01	0.25
54-051-1002	WV	Marshall	15.62	13.40	15.61	13.20	0.01	0.20

AIRS ID	State	County	ASIP Spreadsheet 2002 DVC	ASIP Spreadsheet 2009 DVF	MATS v1.2.1 2002 DVC	MATS v1.2.1 2009 DVF	Difference 2002 DVC	Difference 2009 DVF
54-055-0002	WV	Mercer	12.68	10.50	12.67	10.59	0.01	-0.09
54-061-0003	WV	Monongalia	14.82	12.50	14.81	12.22	0.01	0.28
54-081-0002	WV	Raleigh	13.06	10.90	13.05	10.96	0.01	-0.06
54-089-0001	WV	Summers	10.10	8.20	10.10	8.29	0.00	-0.09
54-107-1002	WV	Wood	16.07	14.00	16.07	13.86	0.00	0.14

5.2 2009 $PM_{2.5}$ PROJECTIONS USING AN ALTERNATIVE MODEL

ASIP applied the CAMx model for the 2002 annual period using a 12/4 km grid focusing on a portion of the ASIP region. The primary purpose of the ASIP CAMx application was to use its PM Source Apportionment Technology (PSAT) to obtain contributions of specific local sources to the 2009 $PM_{2.5}$ concentrations at nearby $PM_{2.5}$ monitors in and near several northern ASIP States (i.e., KY, TN and WV). In performing the 2002 and 2009 CAMx simulations to analyze local source contributions, projected 2009 $PM_{2.5}$ Design Values were also generated that can be compared with those obtained using the CMAQ modeling discussed in Chapter 4. Thus, below we compare the 2009 $PM_{2.5}$ Design Values projected by CMAQ and CAMx using the 2002 Base G2 and 2009 Base G4 emission scenarios. We also discuss the contributions of the local sources to 2009 $PM_{2.5}$ concentrations. As these two discussions share a common CAMx application, the CAMx application approach is described first.

5.2.1 CAMx Model Application Methodology

The CAMx model was run with a 12/4 km grid configuration (Figure 5-5) for the 2002 annual period and the 2002 Base G2 and 2009 Base G4 emission scenarios. The CAMx 12 km grid covered the upper portion of the ASIP region and adjacent areas. Four 4 km nested-grids were embedded in the 12 km grid domain that covered the following Nonattainment Areas (NAAs) and nearby regions (See Figure 5-5):

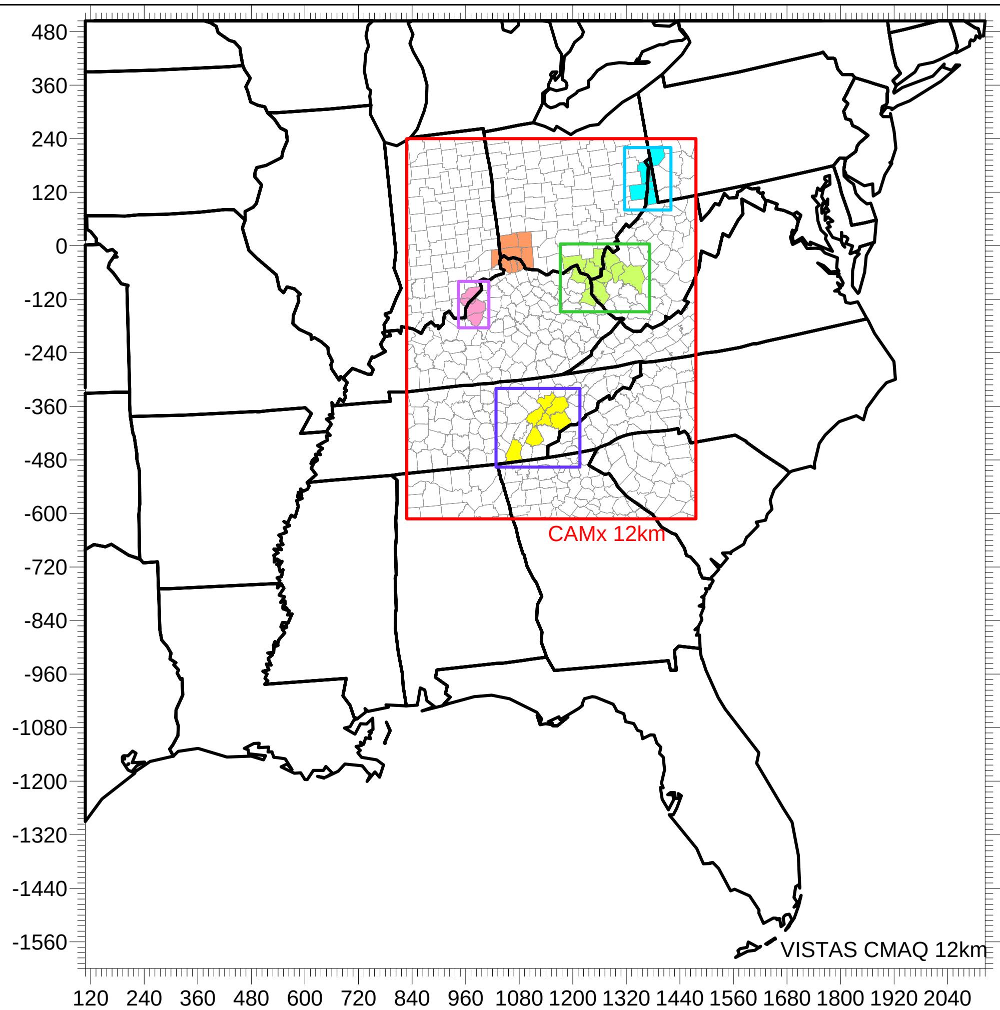
- Knoxville and Chattanooga, TN NAAs;
- Charleston, Ashland and Huntington, WV-OH-KY NAAs;
- Wheeling-Weirton-Steubenville, WV-OH-PA NAAs; and
- Louisville, KY-OH NAA.

The 12 km meteorological inputs were generated using the MM5CAMx processor and the VISTAS 2002 12 km MM5 simulation output (Olerud and Sims, 2004). The meteorological inputs for the 4 km nested grids were obtained using the CAMx flexi-nest feature. That is, the CAMx model internally interpolates the 12 km MM5 meteorological data to the 4 km grids. The CAMx 12/4 km nested-grid structure was run using two-way interactive grid nesting. That is concentrations can transfer both ways between the 12 km and 4 km domain boundaries. This is in contrast to the CMAQ 36/12 km modeling that uses one-way grid nesting where the CMAQ model is run first for the 36 km grid whose results are processed to obtain boundary conditions (BCs) for the 12 km grid domains. Thus, in one-way nesting mass can transfer from the 36 km grid into the 12 km grid but can not transfer from the 12 km grid to the 36 km grid.

The SMOKE emissions model was used to process the 2002 Base G2 emissions inputs to generate a CAMx-style point source stack input file on the CAMx 12 km grid domain. One major difference between the CAMx and CMAQ inputs is for point source emissions; in CMAQ point source plume rise is calculated external to the model and three-dimensional emission inputs are provided (note that the latest version of CMAQ released in fall 2008 has an option of calculating plume rise internal to the model). However, in CAMx, the emission inputs consist of a two-dimensional input of surface emissions (e.g., biogenics, mobile, area, etc.) that are emitted directly into the lowest layer of the model and a stack point source file that includes the stack coordinates, parameters and emissions. In CAMx, plume rise is calculated internal to the model and emissions from the point source are injected into the proper vertical layer. The CAMx two-dimensional low-level emissions were generated using the CMAQ 2002 Base G2 emissions and the CMAQ2CAMx converter. Point source fire emissions were also processed using the CMAQ2CAMx converter. The CAMx model was then run for the 2002 Base G2 emissions scenario on the 12/4 km nested-grid shown in Figure 5-5. Boundary conditions (BCs) for the CAMx 12 km grid were generated by processing the output from the CMAQ 2002 Base G2 12 km model simulation (i.e., one-way grid nesting between the CMAQ 12 km and CAMx 12 km grid domains). The CAMx 12/4 km 2002 Base G2 modeling results were evaluated against available measurements and its model performance compared against CMAQ. The CAMx 2002 model performance evaluation and comparison against the CMAQ performance is presented in Appendix D, with highlights provided in Section 5.2.2 below.

Similarly, the SMOKE emissions model was used to simulate the 2009 Base G4 point sources to generate a CAMx-ready point source stack input file. The remainder of the CAMx emissions inputs for the 2009 Base G4 emissions scenario were generated using the CMAQ2CAMx converter. There were two major update made to the 2009 Base G4 emissions for the CAMx simulation that was different than the CMAQ 2009 Base G4 simulation. The first was an addition of 65,000 tons per year of SO2 at the W. H. Sammis EGU in northern West Virginia. EGU emissions for the 2009 Base G4 emissions scenario were based on a 2010 Integrated Planning Model (IPM) EGU emissions forecast model. As the Sammis plant plans are to install a scrubber for SO2 emissions control between 2009 and 2010, the 2010 SO2 emissions are much lower than they should be in 2009. This difference was determined after the CMAQ 2009 Base G4 base case simulation had been completed. The second major change was the inclusion of SO2 and primary PM emissions for Jefferson County, Kentucky (Louisville) in the CAMx 2002 and 2009 modeling. As discussed in Chapter 2, these emissions were inadvertently left out of the CMAQ 2002 and 2009 modeling because when updated Jefferson County emissions were provided it only included ozone precursor emissions. The CAMx 2009 Base G4 simulation was also configured to apply the PM Source Apportionment Technology (PSAT) to generate separate PM contributions due to 31 individual facilities, which is discussed in Section 5.4.

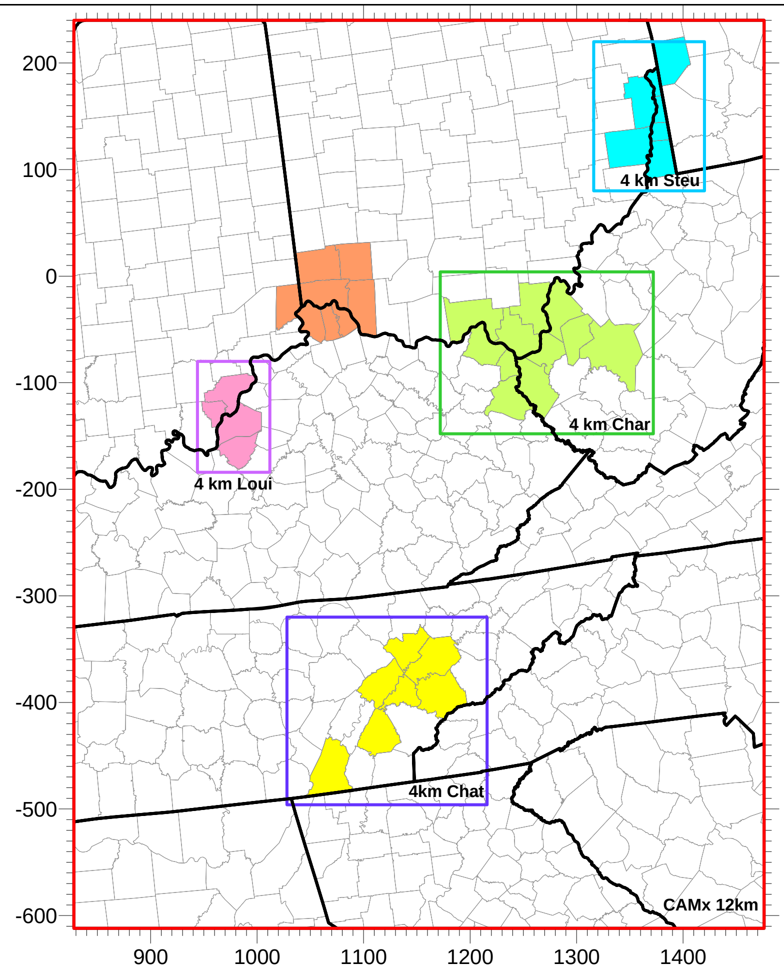
The CAMx model was applied to the updated 2009 Base G4 emissions scenario to generate the standard model and PSAT source apportionment modeling output. The 2009 Base G4 and 2002 Base G2 CAMx standard model output were processed using the ASIP Excel projection tool to generate projected 2009 $PM_{2.5}$ Design Values that are compared to those generated by the ASIP Excel projections tool using the CMAQ 2002 Base G2 and 2009 Base G4 12 km modeling results.



VISTAS CMAQ 12 km: 168 x 177 (108, -1620) to (2124, 504)
CAMx 12km: 54 x 71 (828, -612) to (1476, 240)

CAMx 04km (includes buffer cells):
Steubenville/Wierton 26 x 35 (1316, 80) to (1420, 220)
Charleston 50 x 38 (1172, -148) to (1372, 4)
Louisville 17 x 26 (944, -184) to (1012, -80)
Chattanooga/Knoxville 47 x 44 (1028, -496) to (1216, -320)

Figure 5-5a. Nesting of the CAMx 12 km modeling domain within the CMAQ 12 km modeling domain.



CAMx 12km:	54 x 71	(828, -612) to (1476, 240)
CAMx 04km (includes buffer cells):		
Steubenville/Wierton	26 x 35	(1316, 80) to (1420, 220)
Charleston	50 x 38	(1172, -148) to (1372, 4)
Louisville	17 x 26	(944, -184) to (1012, -80)
Chattanooga/Knoxville	47 x 44	(1028, -496) to (1216, -320)

Figure 5-5b. CAMx 12/4 km nested-grid structure.

5.2.2 Summary Model Performance Evaluation

The model performance of the CAMx 12/4 km 2002 Base G2 model simulation was compared with CMAQ 12 km modeling results using observational data from the CAMx 12 km modeling domain. Note that the CMAQ 2002 Base G2 base case simulation used actual emissions for EGUs and fires, whereas the CAMx 12/4 km Base G2 base case used typical emissions. The CAMx and CMAQ models were evaluated using the same databases and procedures discussed in Chapter 3 and Appendices B and C, only limited to observations within the CAMx 12 km domain (see Figure 5-5).

Appendix D contains the complete evaluation of the CAMx and CMAQ models and compares their model performance over the CAMx 12 km domain. Below we summarize their model performance for the key species of sulfate (SO4) and $PM_{2.5}$ mass using Bugle Plots. SO4 is a key species because most of the $PM_{2.5}$ reductions between 2002 and 2009 are due to reductions in SO2 emissions, so the SO4 performance is critically important.

Figure 5-6 displays a Bugle Plot of monthly SO4 fractional bias and fractional gross error across sites for the CMAQ and CAMx 2002 base case simulations within the CAMx 12 km modeling domain. The SO4 model performance for both models achieves the model performance goal with CMAQ having a slight underestimation and CAMx having a slight overestimation bias.

The Bugle Plots for total $PM_{2.5}$ mass for the CMAQ and CAMx 2002 base case simulations are shown in Figure 5-7. Again, CAMx estimates slightly higher $PM_{2.5}$ concentrations than CMAQ; however both models achieve the model performance goal for $PM_{2.5}$ across most months and networks and always achieve the model performance criteria. For example, across the IMPROVE network during the winter when lower $PM_{2.5}$ concentrations occur both CMAQ and CAMx overpredict with the CAMx overprediction severe enough to fall between the model performance goal and criteria. However, in the summer, when there are higher $PM_{2.5}$ concentrations, the CMAQ model underprediction tendency falls between the model performance goal and criteria, whereas CAMx achieves the performance goal.

Even with these differences, the model performance for the two models is comparable with both models achieving the model performance goals most of the time.

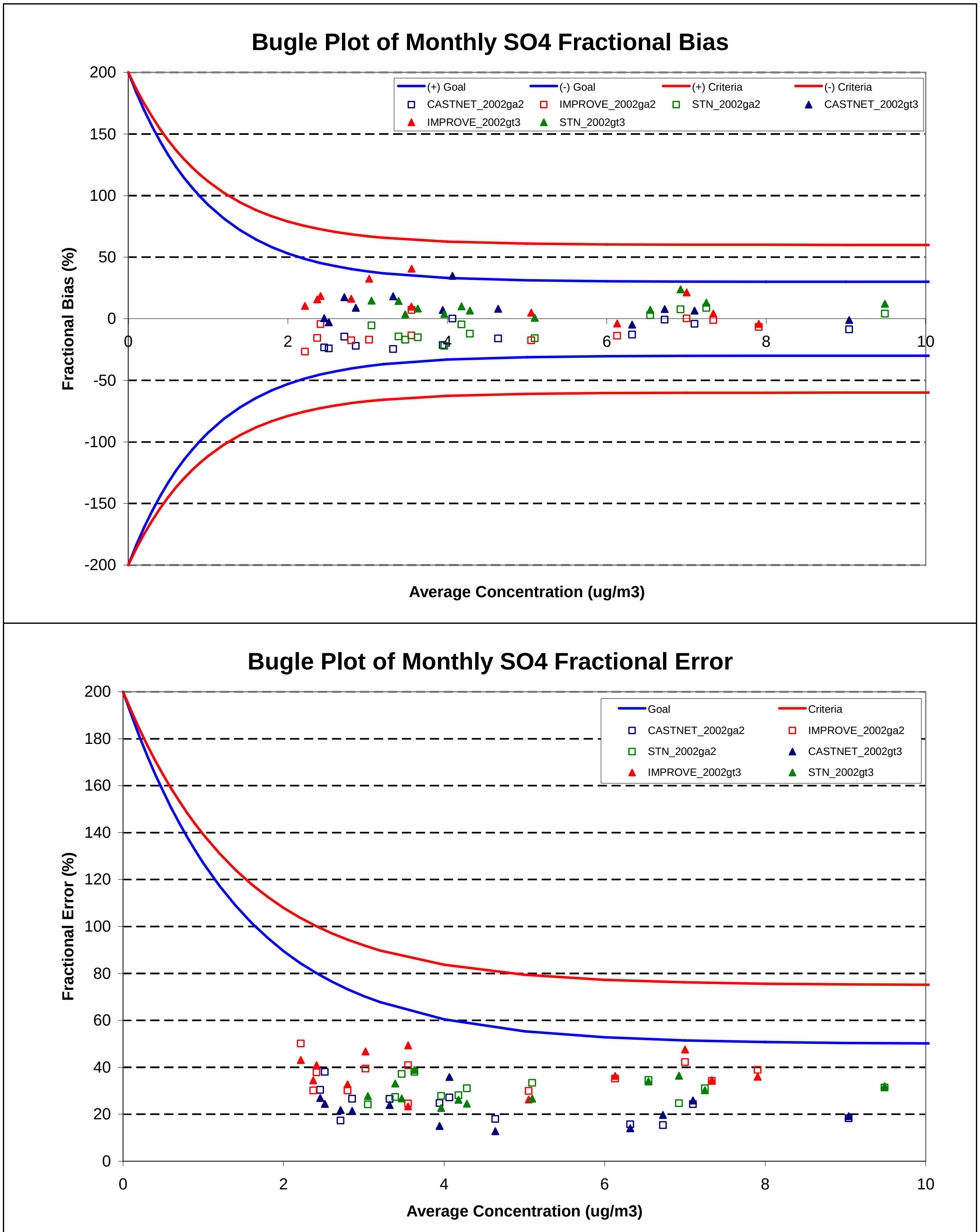
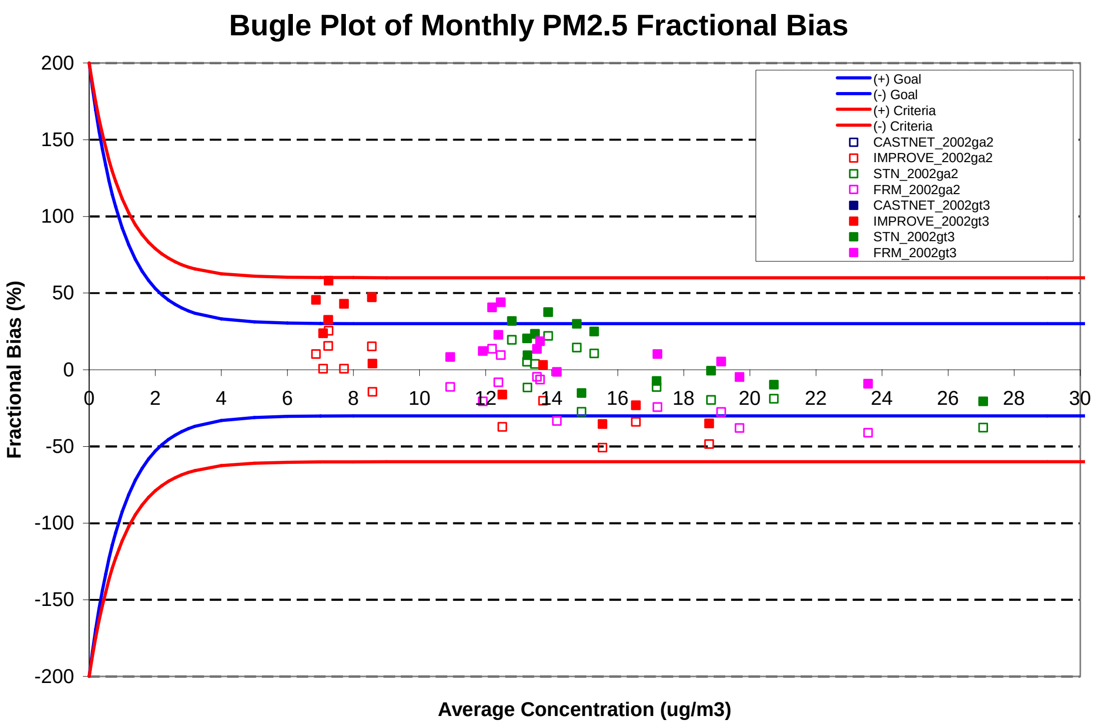


Figure 5-6. Bugle Plots of monthly fractional bias (top) and fractional error (bottom) for SO4 and comparison with model performance goals and criteria for the 2002 CMAQ Base.G2 Actual (open symbols) and CAMx Base G2 Typical (filled symbols) base case simulation.



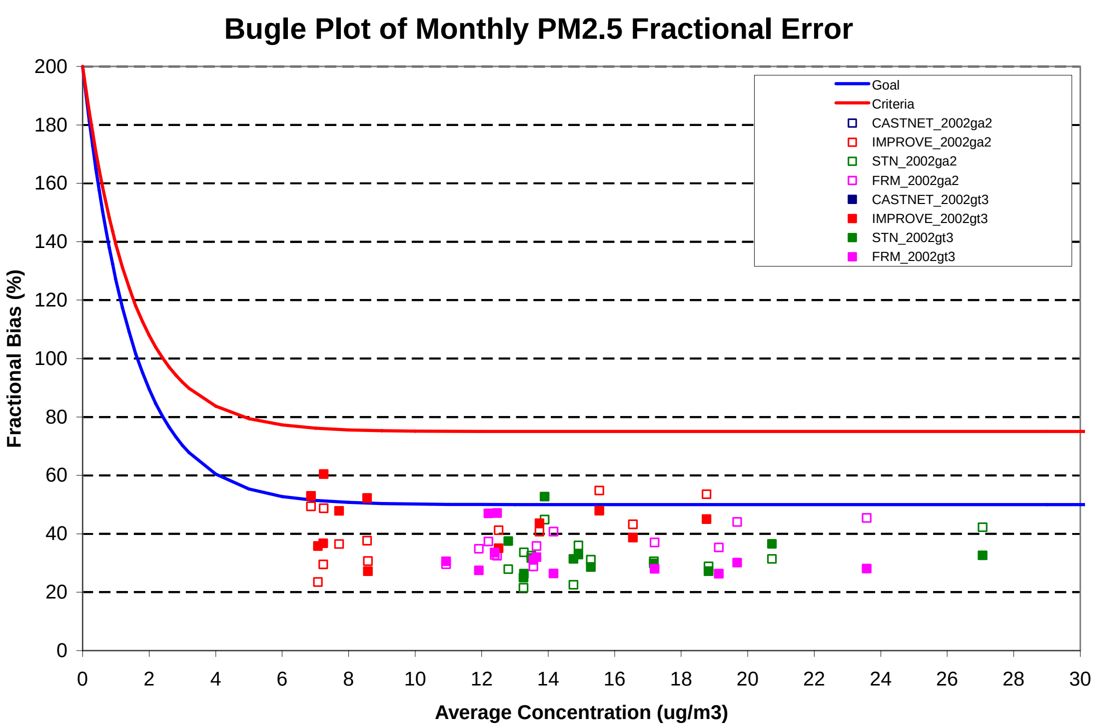


Figure 5-7. Bugle Plots of monthly fractional bias (top) and fractional error (bottom) for $PM_{2.5}$ mass and compared with model performance goals and criteria for the 2002 CMAQ Base.G2 Actual (open symbols) and CAMx Base G2 Typical (filled symbols) base case simulation.

Comparison of CMAQ and CAMx Projected 2009 $PM_{2.5}$ Design Values

Figure 5-8 and Table 5-2 compare the projected 2009 $PM_{2.5}$ Design Values using the CMAQ and CAMx 12 km modeling results for FRM sites within the CAMx 12 km grid domain (Figure 5-5). In general, CAMx estimates slightly higher projected 2009 $PM_{2.5}$ Design Values than CMAQ (i.e., there are less $PM_{2.5}$ reduction). In fact, there are five FRM sites that are estimated to attain the $PM_{2.5}$ NAAQS using the CMAQ modeling results that are above the NAAQS using the CAMx results, two in the Cincinnati NAA (in addition to the FRM site that both models estimate violate the annual $PM_{2.5}$ NAAQS in 2009) and three in the Louisville NAA. Although these differences have not been studied in detail, there are several reasons why the CAMx 2009 $PM_{2.5}$ projections are higher than CMAQ:

- The CAMx 2009 Base G4 run had an additional 65,000 tons per year of SO2 emissions from the Sammis EGU than the CMAQ 2009 Base G4 simulation;
- The CAMx 2002 and 2009 base case simulations included area source SO2 and PM emissions for Jefferson County Kentucky that were left out of the CMAQ modeling.
- The CAMx produces more SOA due to biogenic sources so that the changes in OCM between 2002 and 2009 in response to changes in anthropogenic OC emissions are less responsive in CAMx;
- The RRFs for almost all PM species appear to be higher in CAMx that CMAQ;
- CAMx was run on 12/4 km domains using two-way grid nesting where CMAQ was just run on a 12 km domain; and
- There are numerous model formulation issues in the two models including plume rise, transport, deposition, chemistry, etc.

The higher (i.e., closer to 1.0) RRFs in CAMx for most species is extremely small and likely not significant. The exception to this appears to be the SO4 and OCM RRFs, which is likely related in part to the higher SO2 emissions in the CAMx run and more biogenic SOA in CAMx than in the CMAQ 2009 Base G4 simulations.

With the exception of the Louisville NAA, the CAMx and CMAQ agree on which NAAs would attain and which NAAs are projected to continue to violate the annual $PM_{2.5}$ NAAQs in 2009. For the Louisville NAA, CAMx estimates projected 2009 $PM_{2.5}$ DVFs that are ~ 0.3 $\mu g/m^3$ higher than CMAQ so that they are >15.05 $\mu g/m^3$. As noted above, this is likely partly due to the inclusion of area source SO2 and PM emissions from Jefferson County, Kentucky in the CAMx runs that are projected to increase from 2002 to 2009. The Bar Charts of Jefferson County, Kentucky 2009 DVFs in Figure 5-8a indicate that the higher CAMx DVFs is mainly due to higher OCM contributions. Whether this higher OCM contribution is due to the inclusion of area source OCM emissions in Jefferson County or higher OCM contributions from biogenic VOCs is unclear. In any event, the projected $PM_{2.5}$ DVFs in the Louisville NAA by both the CMAQ and CAMx models are within the range where EPA guidance requires additional supporting WOE analysis based on both model projections.

The closeness of the projected 2009 $PM_{2.5}$ Design Values generated by the CMAQ and CAMx models and the agreement on which NAAs are projected to achieve $PM_{2.5}$ attainment in 2009 provides more confidence in the reliability of the 2009 $PM_{2.5}$ projections based on the CMAQ modeling presented in Chapter 4.

Table 5-2. Comparison of CMAQ and CAMx projected 2009 $PM_{2.5}$ Design Values at common FRM monitoring sites in the CAMx 12 km domain using CAMx and CMAQ 12 km modeling results and 2009 Base G4 emissions.

AIRS ID	State	County	City Name	CMAQ 12 km DVF	CAMx 12 km DVF
01-033-1002	**AL**	Colbert	Mus. Shoals	11.74	11.79
01-049-1003	**AL**	DeKalb	Crossville	13.33	13.45
01-089-0014	**AL**	Madison	Huntsville	12.75	12.85
01-103-0011	**AL**	Morgan	Decatur	11.82	11.91
13-059-0001	**GA**	Clarke	Athens	13.88	13.95
13-067-0003	**GA**	Cobb	Kennesaw	14.59	14.72
13-067-0004	**GA**	Cobb	Powder Springs	13.63	13.75
13-089-2001	**GA**	DeKalb	Doraville	14.44	14.58
13-115-0005	**GA**	Floyd	Rome	14.03	14.16
13-121-0032	**GA**	Fulton	Atlanta	14.86	14.87
13-121-0039	**GA**	Fulton	Atlanta	16.64	16.67
13-135-0002	**GA**	Gwinnett	Lawrenceville	14.28	14.44
13-139-0003	**GA**	Hall	Gainesville	13.36	13.46
13-223-0003	**GA**	Paulding		12.76	12.86
13-245-0005	**GA**	Richmond	Augusta	13.80	13.72
13-245-0091	**GA**	Richmond	Augusta	13.35	13.29
13-295-0002	**GA**	Walker	Rossville	13.92	14.03
18-019-0006	**IN**	Clark		14.86	15.17
18-043-1004	**IN**	Floyd		13.03	13.25
21-013-0002	**KY**	Bell		12.80	12.86
21-019-0017	**KY**	Boyd		12.79	12.94
21-029-0006	**KY**	Bullitt		13.06	13.27
21-037-0003	**KY**	Campbell		11.98	12.19
21-043-0500	**KY**	Carter		10.17	10.33
21-047-0006	**KY**	Christian		11.95	11.94
21-059-0014	**KY**	Daviess		12.97	12.97
21-067-0012	**KY**	Fayette		12.67	12.88
21-067-0014	**KY**	Fayette		13.35	13.56
21-073-0006	**KY**	Franklin		11.59	11.78
21-093-0006	**KY**	Hardin		12.16	12.27
21-101-0014	**KY**	Henderson		12.29	12.11
21-111-0043	**KY**	Jefferson		14.85	15.16
21-111-0044	**KY**	Jefferson		14.76	15.14
21-111-0048	**KY**	Jefferson		14.18	14.54
21-111-0051	**KY**	Jefferson		13.62	13.87
21-117-0007	**KY**	Kenton		12.68	12.94
21-151-0003	**KY**	Madison		11.43	11.58
21-193-0003	**KY**	Perry		11.65	11.74
21-195-0002	**KY**	Pike		11.56	11.69
21-227-0007	**KY**	Warren		12.10	12.16
37-021-0034	**NC**	Buncombe	Asheville	11.18	11.31
37-025-0004	**NC**	Cabarrus	Kannapolis	12.23	12.33
37-035-0004	**NC**	Catawba	Hickory	13.04	13.21
37-035-0005	**NC**	Catawba	Hickory	11.61	11.75
37-071-0016	**NC**	Gaston	Gastonia	12.13	12.14

AIRS ID	State	County	City Name	CMAQ 12 km DVF	CAMx 12 km DVF
37-087-0010	NC	Haywood	Waynesville	11.48	11.66
37-099-0006	NC	Jackson		10.26	10.58
37-111-0004	NC	McDowell	Marion	12.10	12.27
37-119-0010	NC	Mecklenburg	Charlotte	12.85	13.06
37-119-0041	NC	Mecklenburg	Charlotte	12.14	12.27
37-119-0042	NC	Mecklenburg	Charlotte	12.10	12.22
37-121-0001	NC	Mitchell	Spruce Pine	11.42	11.56
37-173-0002	NC	Swain	Bryson	10.81	10.95
39-017-0003	OH	Butler		14.06	14.20
39-017-0016	OH	Butler		13.40	13.61
39-017-0017	OH	Butler		13.38	13.53
39-061-0014	OH	Hamilton		15.44	15.68
39-061-0040	OH	Hamilton		13.33	13.56
39-061-0041	OH	Hamilton		13.16	13.36
39-061-0042	OH	Hamilton		14.87	15.10
39-061-0043	OH	Hamilton		13.47	13.68
39-061-7001	OH	Hamilton		14.01	14.24
39-061-8001	OH	Hamilton		15.03	15.27
39-087-0010	OH	Lawrence		13.68	13.71
39-145-0013	OH	Scioto		14.78	15.00
45-037-0001	SC	Edgefield		11.08	11.14
45-045-0008	SC	Greenville	Greenville	13.57	13.65
45-045-0009	SC	Greenville	Taylors	12.56	12.68
45-047-0003	SC	Greenwood	Greenwood	11.51	11.58
45-063-0008	SC	Lexington		12.15	12.17
45-073-0001	SC	Oconee		9.05	9.14
45-079-0007	SC	Richland		11.37	11.44
45-079-0019	SC	Richland	Columbia	12.23	12.35
45-083-0010	SC	Spartanburg		11.82	11.86
47-009-0011	TN	Blount	Maryville	12.66	12.73
47-037-0023	TN	Davidson	Nashville	13.12	13.17
47-037-0036	TN	Davidson	Nashville	12.12	12.16
47-065-0031-1	TN	Hamilton	Chattanooga	14.39	14.55
47-065-1011	TN	Hamilton		12.35	12.41
47-065-4002	TN	Hamilton	Chattanooga	13.56	13.70
47-093-0028	TN	Knox	Knoxville	13.40	13.49
47-093-1013	TN	Knox	Knoxville	13.86	14.03
47-093-1017	TN	Knox	Knoxville	14.59	14.70
47-093-1020	TN	Knox	Knoxville	13.91	14.01
47-099-0002	TN	Lawrence		10.69	10.74
47-107-1002	TN	McMinn	Athens	13.23	13.42
47-119-2007	TN	Maury	Columbia	11.64	12.00
47-125-1009	TN	Montgomery	Clarksville	11.77	11.75
47-141-0001	TN	Putnam	Cookeville	11.91	11.98
47-145-0004	TN	Roane	Harriman	12.48	12.64
47-163-1007	TN	Sullivan	Kingsport	12.36	12.88
47-165-0007	TN	Sumner		12.24	12.26
51-520-0006	VA	Bristol		12.47	12.65

AIRS ID	State	County	City Name	CMAQ 12 km DVF	CAMx 12 km DVF
54-009-0005	WV	Brooke		13.78	13.52
54-011-0006	WV	Cabell		14.14	14.46
54-029-0011	WV	Hancock		13.15	12.85
54-029-1004	WV	Hancock		14.21	13.91
54-033-0003	WV	Harrison		11.63	11.77
54-039-0010	WV	Kanawha		13.16	13.33
54-039-1005	WV	Kanawha		14.78	14.96
54-049-0006	WV	Marion		12.97	13.13
54-051-1002	WV	Marshall		13.41	13.52
54-055-0002	WV	Mercer		10.53	10.69
54-061-0003	WV	Monongalia		12.46	12.61
54-069-0010	WV	Ohio		12.73	12.80
54-081-0002	WV	Raleigh		10.91	11.08
54-089-0001	WV	Summers		8.24	8.38
54-107-1002	WV	Wood		13.98	14.15

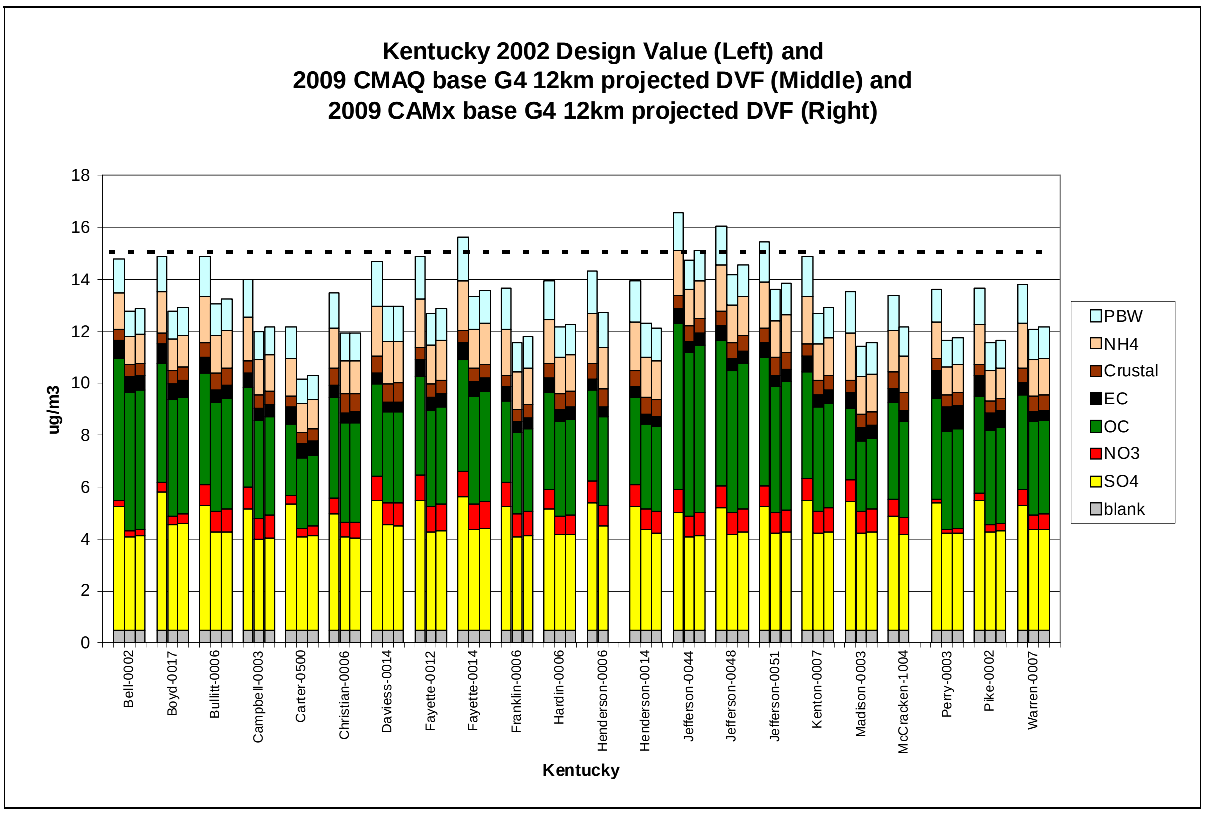


Figure 5-8a. Comparison of CMAQ and CAMx projected 2009 $PM_{2.5}$ Design Values (DVFs) in Kentucky using the 12 km modeling results.

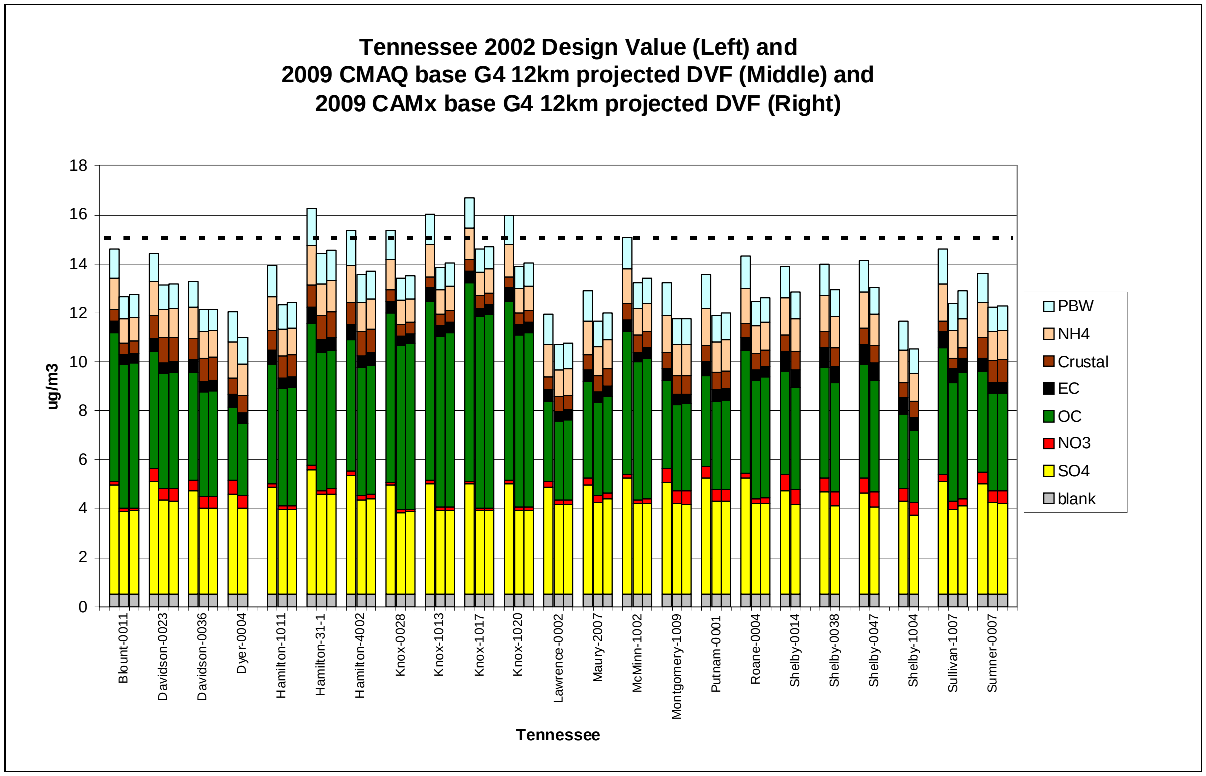


Figure 5-8b. Comparison of CMAQ and CAMx projected 2009 $PM_{2.5}$ Design Values (DVFs) in Tennessee using the 12 km modeling results.

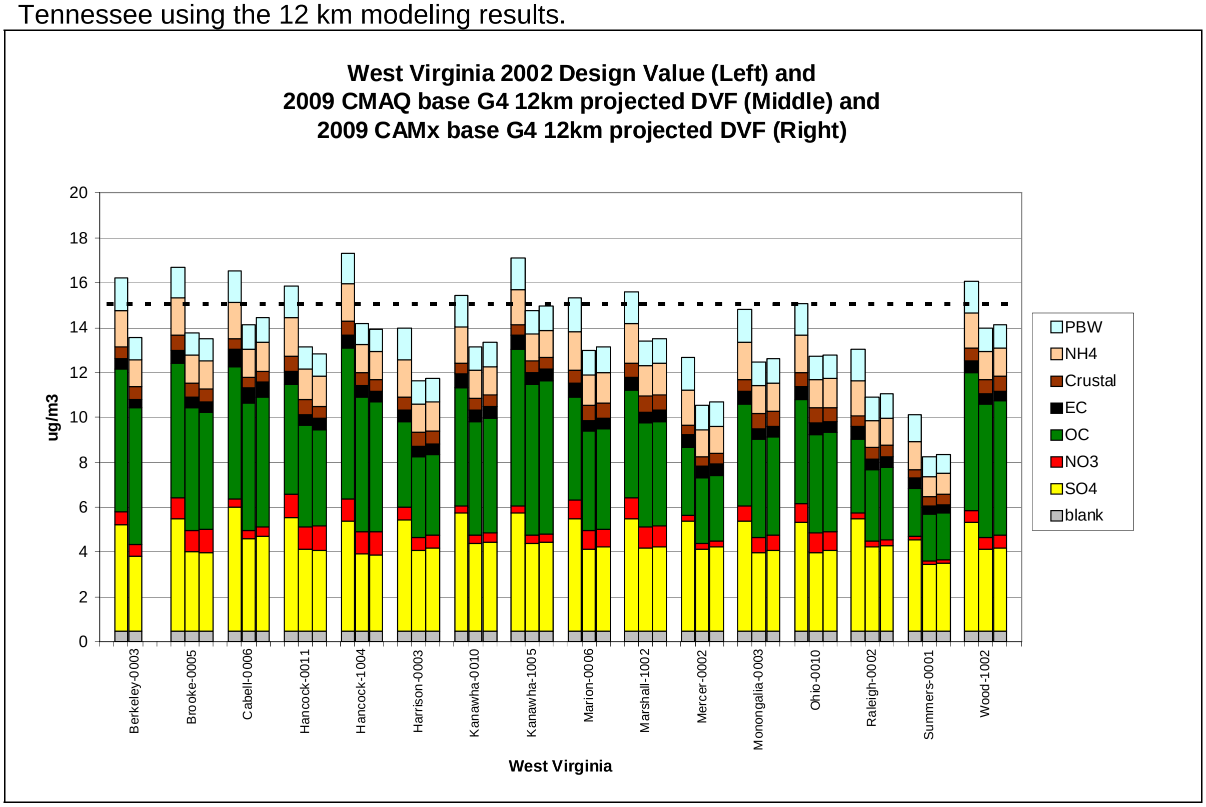


Figure 5-8c. Comparison of CMAQ and CAMx projected 2009 $PM_{2.5}$ Design Values (DVFs) in West Virginia using the 12 km modeling results.

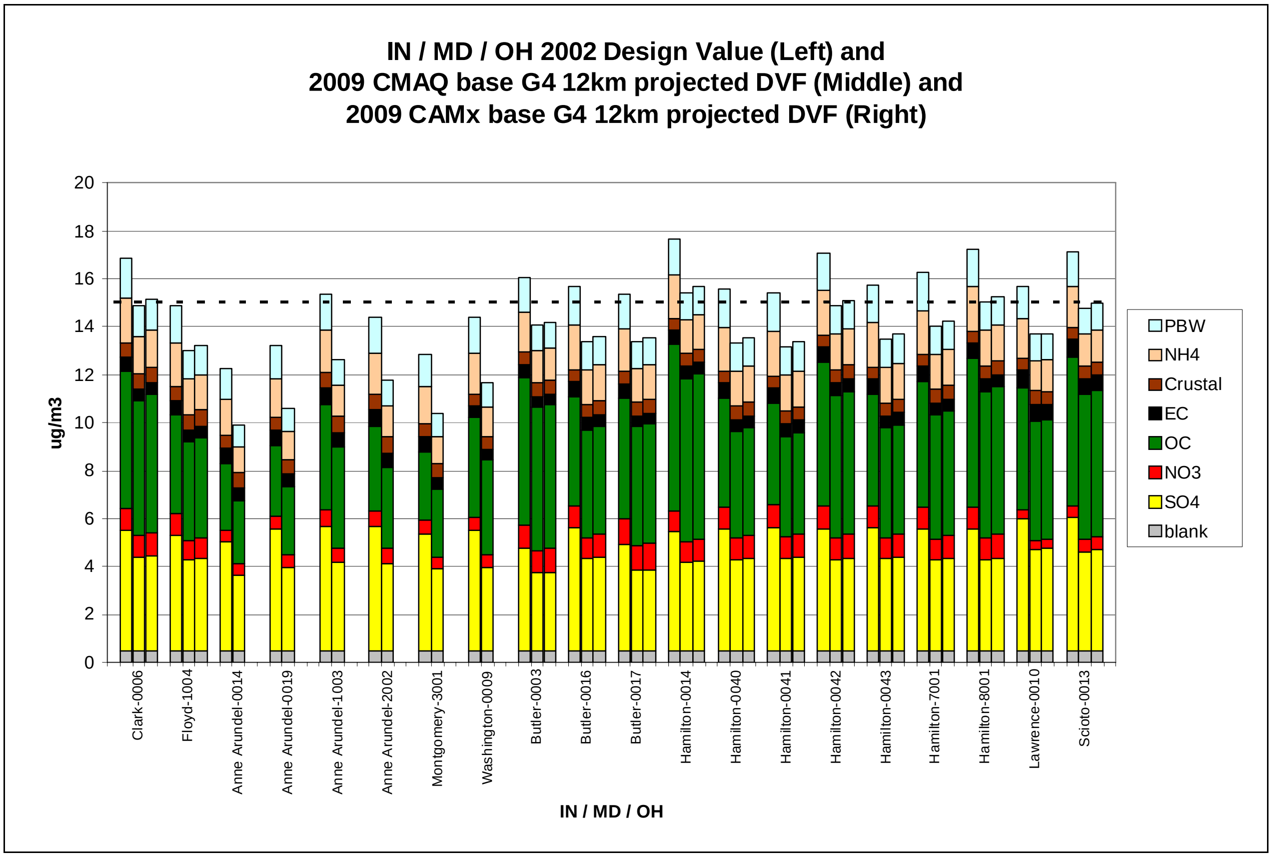


Figure 5-8d. Comparison of CMAQ and CAMx projected 2009 $PM_{2.5}$ Design Values (DVFs) in Indiana and Ohio using the 12 km modeling results.

5.3 PSAT PM SOURCE APPORTIONMENT MODELING

As noted in Section 5.2.1, CAMx was used with its PSAT PM source apportionment option to generate the separate contributions of 31 facilities to projected 2009 $PM_{2.5}$ Design Values in the CAMx 12/4 km domain (Figure 5-5). PSAT was configured to obtain the separate SO4 and primary PM contributions of 31 different facilities in the CAMx 12/4 km modeling domain. The NO3/NH4 and SOA components of the PSAT PM source apportionment approach were not used because NO3 is an extremely small component of annual $PM_{2.5}$ levels in the ASIP region and SOA is dominated by biogenic emission sources; the facilities selected also have very small VOC emissions and consequently insignificant contribution to SOA. The formulation of the PSAT and testing and evaluation can be found in the CAMx user's guide (ENVIRON, 2008) and technical papers that are available on the CAMx website (www.camx.com). The emissions for these 31 facilities are given in Table 5-3. These 31 facilities totaled approximately 425,000 tons per year of SO2 emissions and 18,000 tons per year of $PM_{2.5}$ emissions. PSAT was used to estimate the contributions of the 31 PSAT facilities to the projected 2009 $PM_{2.5}$ Design Values at FRM monitors within each of the 4 km domains. The PSAT results are presented for each group of FRM monitoring sites within each of the four 4 km modeling domains (Figure 5-5).

Table 5-3. 31 separate facilities that PSAT SO4 and Primary PM source apportion were modeled using the CAMx model.

ID	SO2	$PM_{2.5}$
18-43-00004; PSI ENERGY – GALLAGHER	28294.95	417.57
21-19-2101900004; MARATHON ASHLAND PET LLC	7064.66	221.10
21-19-2101900005; AK STEEL CORP	2535.82	591.17
21-89-2108900001; E I DUPONT INC	1760.97	10.42
21-127-2112700003; KENTUCKY POWER BIG SANDY PLANT	47735.20	381.23
39-13-0607130015; R. E. BURGER PLANT	19506.90	1019.21
39-53-0627000003; OHIO VALLEY ELECTRIC CORP. KYGER CREEK	7570.10	1102.11
39-53-0627010056; GAVIN POWER PLANT	14237.10	2803.07
39-81-0641050002; CARDINAL POWER PLANT	18948.90	2066.81
39-81-0641090010; WHEELING-PITTSBURGH STEEL CORP	641.13	376.65
39-81-0641160017; W. H. SAMMIS PLANT	84918.10	2929.55
42-7-420070005; PA POWER CO/BRUCE MANSFIELD PLT	19565.70	3062.99
47-65-2730; E. I. du Pont de Nemours and Company	1166.00	94.99
47-107-0012; BOWATER NEWSPRINT & DIRECTORY - CALHOUN	5458.85	425.67
54-9-0002; WHEELING-PITTSBURGH STEEL CORPORATION	517.60	137.42
54-11-0007; HUNTINGTON ALLOYS - A SPECIAL METALS CO.	0.61	128.61
54-11-0009; SWVA, INC.	122.66	210.68
54-29-0001; ISG WEIRTON	1047.33	803.96
54-39-0001; DUPONT – BELLE	992.28	44.23
54-39-0002; FMC CORPORATION – STEAM PLANT	822.18	0.60
54-39-0003; UNION CARBIDE (DOW) SO. CHARLESTON PLANT	971.57	29.19
54-39-0006; APPALACHIAN POWER - KANAWHA RIVER PLANT	18763.20	129.26
54-39-0007; BAYER CROPSCIENCE	3552.66	52.88
54-39-0011; CLEARON CORP.	0.78	35.79
54-51-0002; PPG INDUSTRIES, INC.	12563.65	22.30
54-51-0005; OHIO POWER - MITCHELL PLANT	15467.09	169.45
54-51-0006; OHIO POWER - KAMMER PLANT	28490.00	72.72
54-53-0001; APPALACHIAN POWER CO.-PHILIP SPORN PLANT	46293.31	136.13
54-53-0009; APPALACHIAN POWER - MOUNTAINEER PLANT	10395.45	144.83
54-79-0001; FLEXSYS - NITRO PLANT	693.56	6.98
54-79-0006; APPALACHIAN POWER - JOHN E AMOS PLANT	26296.70	337.33
Grand Total	**426395.02**	**17964.90**

5.3.1 Charleston-Huntington-Ashland, WV-KY-OH 4 km Domain

Figure 5-9 displays the Charleston-Huntington-Ashland 4 km modeling domain, the locations of the facilities treated by PSAT and the locations of the FRM monitoring sites in the region. Figure 5-10 displays the contribution of SO2 and primary PM emissions from the 31 PSAT facilities (Table 5-3), the remainder sources in the CAMx 12/4 km domain (Figure 5-5) and BCs on the CAMx 12 km domain to the SO4 plus primary PM components of the projected 2009 $PM_{2.5}$ Design Values in the Charleston - Huntington - Ashland domain. The contributions of the BCs and other sources in the CAMx modeling domain dominate the 2009 PM contributions. Thus, in Figure 5-11 we display stacked bar charts that focuses on the contributions of the 31 PSAT sources to the SO4 and primary PM components of the 2009 $PM_{2.5}$ Design Values projected for the FRM monitors in the 4 km domain. The top panel in Figure 5-11 displays each facilities contribution to the total SO4 plus primary PM emissions component of the projected 2009 $PM_{2.5}$ Design Values, whereas the bottom two panels show the separate contributions for SO4 and primary PM components. Also shown in the top panel of Figure 5-11 are the CAMx projected $PM_{2.5}$ Design Values using the 4 km CAMx results at the top of each stacked bar. These CAMx 4 km projections may be slightly different that the projections using the CAMx 12 km results that were compared to the CMAQ 12 km projections given in Table 5-2. The total contribution due to all of the 31 PSAT sources to the 2009 $PM_{2.5}$ Design Values in the Charleston - Huntington - Ashland 4 km domain ranged from 0.5 to 2.5 µg/m^3.

The largest single facility contribution was 2.1 µg/m^3 from the Ak Steel facility for the FRM monitor in Lawrence County, Ohio. The 2.1 µg/m^3 contribution from Ak Steel to the Lawrence County monitor is about evenly split between primary PM (52%) and SO2 (48%) precursors. However, care should be taken in the interpretation of the Ak Steel facility's impact on the OH Lawrence County monitor because it appears to be located in the same 4 km grid cell as the monitor (see Figure 5-9). Emissions from a source that is located in the same grid cell as a monitor would impact the monitor even if the monitor was upwind of the facility, since when emissions injected in a grid cell they are instantly diffused across the grid cell. More refined analysis using a higher resolution grid or local-scale model may be needed to simulate the impacts of sources that this close to the monitoring site.

The next highest single facility contributor to the projected 2009 $PM_{2.5}$ Design Value at any monitor in the Charleston-Huntington-Ashland 4 km domain is the Swva, Inc. facility that contributes 0.6 µg/m^3 to the Cabell County, West Virginia FRM monitor. Again the contribution due to primary PM and SO4 is about the same. The next two highest facility contributors are the Ak Steel and Union Carbide (Dow) sources that contribute ~0.17 µg/m^3 to the Boyd County, Kentucky and Kanawha County, West Virginia FRM monitors, respectively.

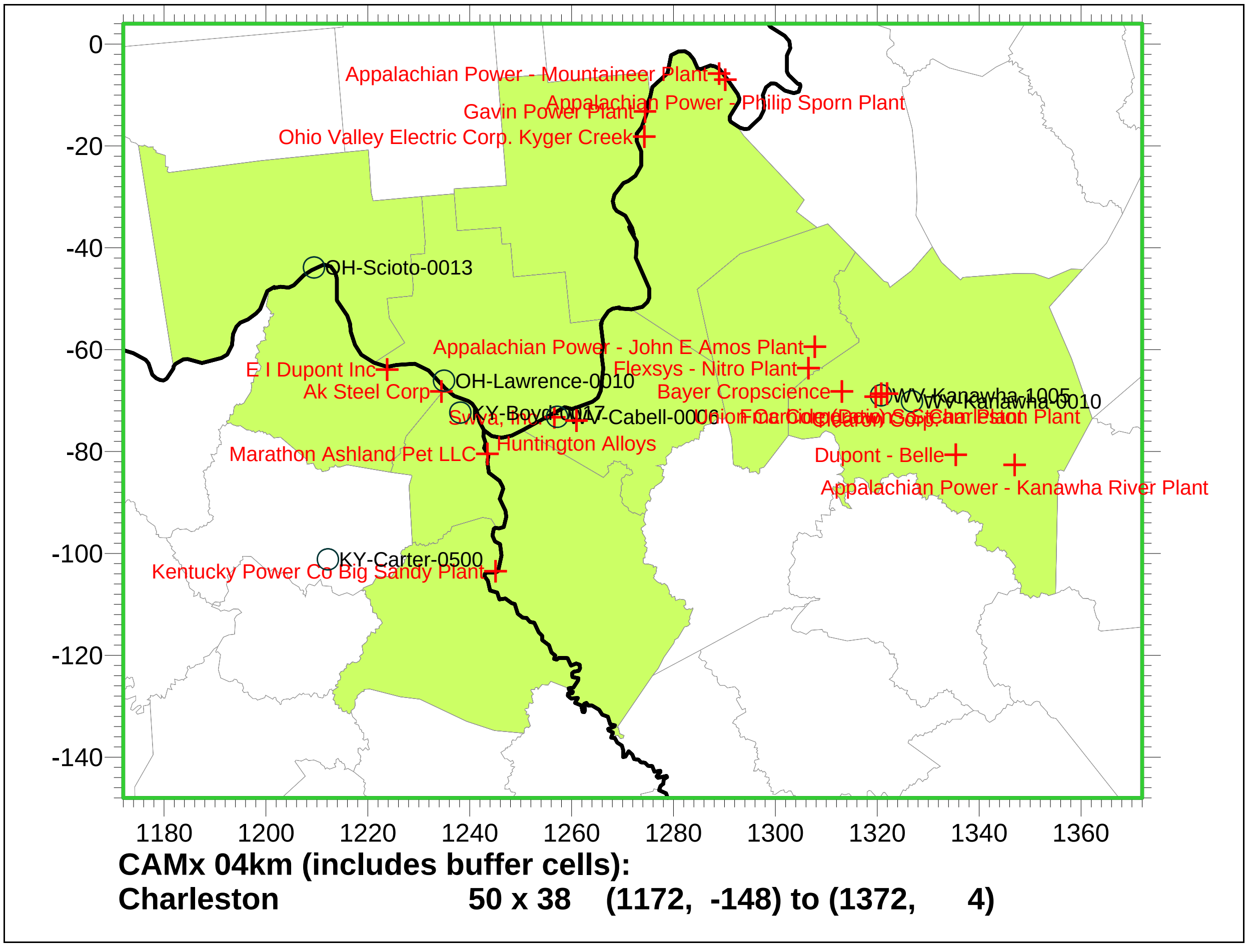


Figure 5-9. Charleston-Huntington-Ashland 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

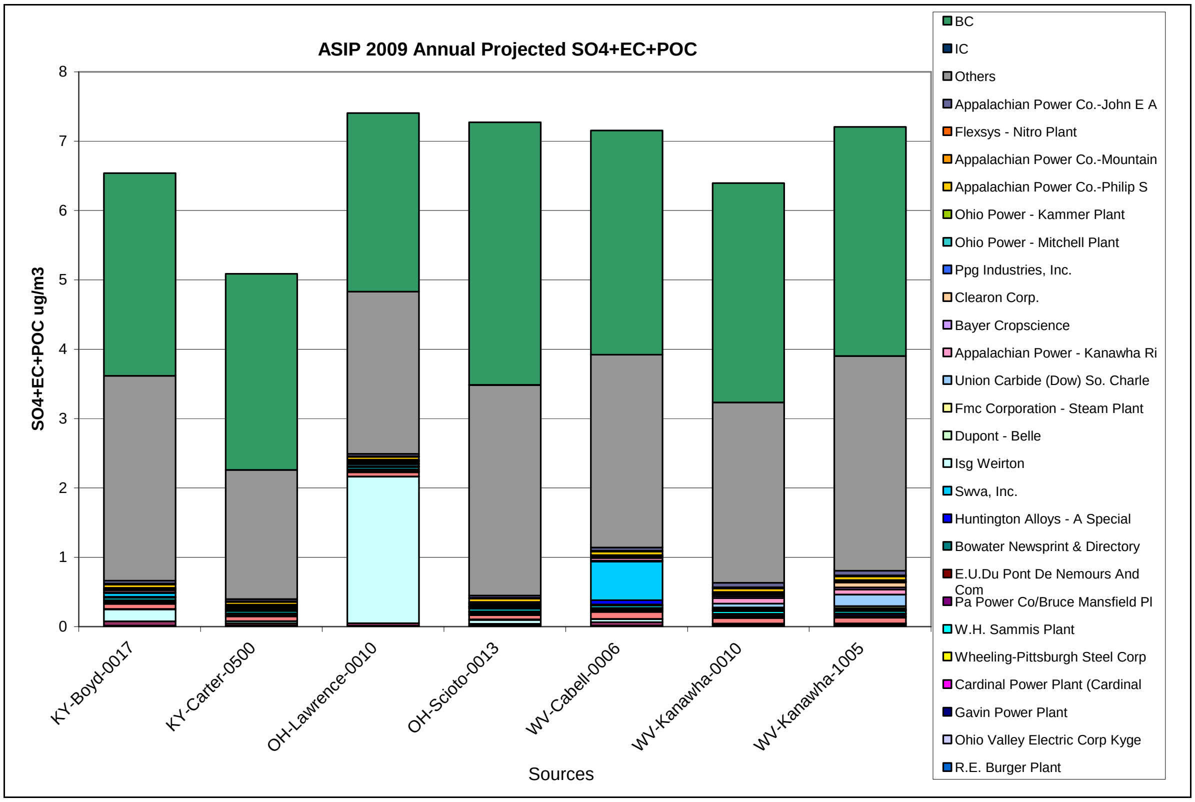


Figure 5-10. PSAT annual 2009 $PM_{2.5}$ source apportionment from 31 PSAT facilities plus all other sources in CAMx 12/4 km domain and BCs for the Charleston-Huntington-Ashland 4 km domain and total $PM_{2.5}$ mass due to SO4 and primary PM emissions.

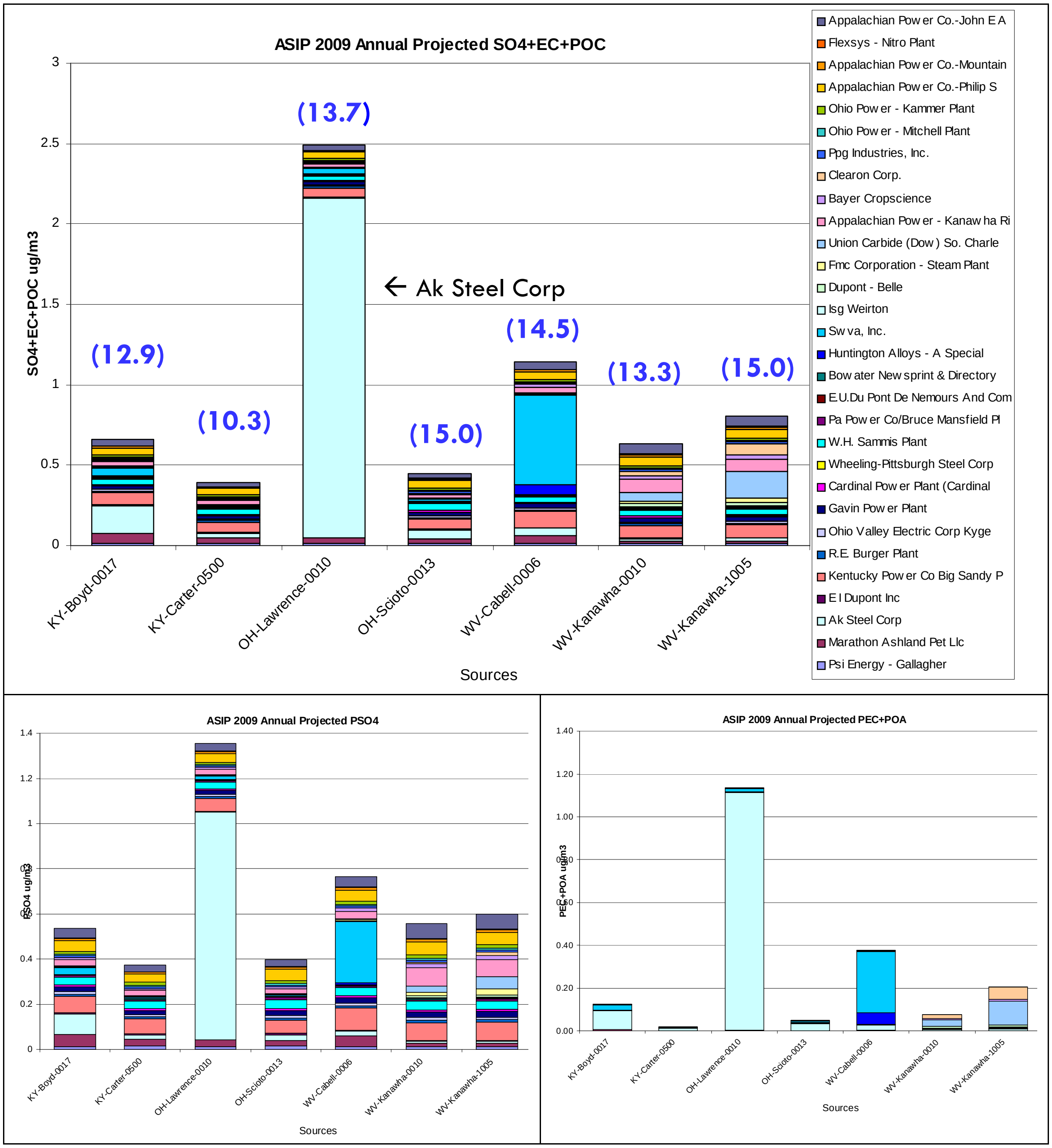


Figure 5-11. PSAT annual 2009 $PM_{2.5}$ source apportionment from 31 PSAT facilities for the Charleston-Huntington-Ashland 4 km domain and total $PM_{2.5}$ mass due to SO4 and primary PM emissions (top) and separately by SO4 (bottom left) and primary PM (bottom right).

5.3.2 Wheeling-Weirton-Steubenville 4 km Domain

Figure 5-12 displays the locations of the PSAT facilities and FRM monitors in the Wheeling-Weirton-Steubenville 4 km domain. The $PM_{2.5}$ contributions to the projected 2009 $PM_{2.5}$ Design Values from the 31 PSAT facilities are shown in Figure 5-13. The Isg Weirton source has the largest contribution of any facility in this 4 km domain contributing 1.4 and 1.1 µg/m^3 to the projected 2009 $PM_{2.5}$ Design Values at the, respectively, Hancock County, West Virginia FRM monitoring sites numbered 1004 and 0011. A vast majority of this contribution (80-90%) is due to primary PM emissions from the Isg Weirton facility (Figure 5-13, bottom right). The next largest contributing source in this domain is the Wheeling Pittsburgh Steel facility that contributes 0.7 µg/m^3 to the Brooke County, West Virginia FRM monitoring site, as well as 0.20-0.24 µg/m^3 to the two Hancock County, West Virginia monitoring sites. The $PM_{2.5}$ contributions from the Wheeling-Pittsburgh Steel facility are more evenly split between primary PM and SO4 (60% due to primary PM). Both of these facilities are in close proximity to the monitors where they have the highest contributions. Given that these facilities have modest emissions compared to many of the other 31 PSAT facilities (see Table 5-3), clearly a source's proximity to an FRM monitor is as important a factor to its contribution as its emissions strength.

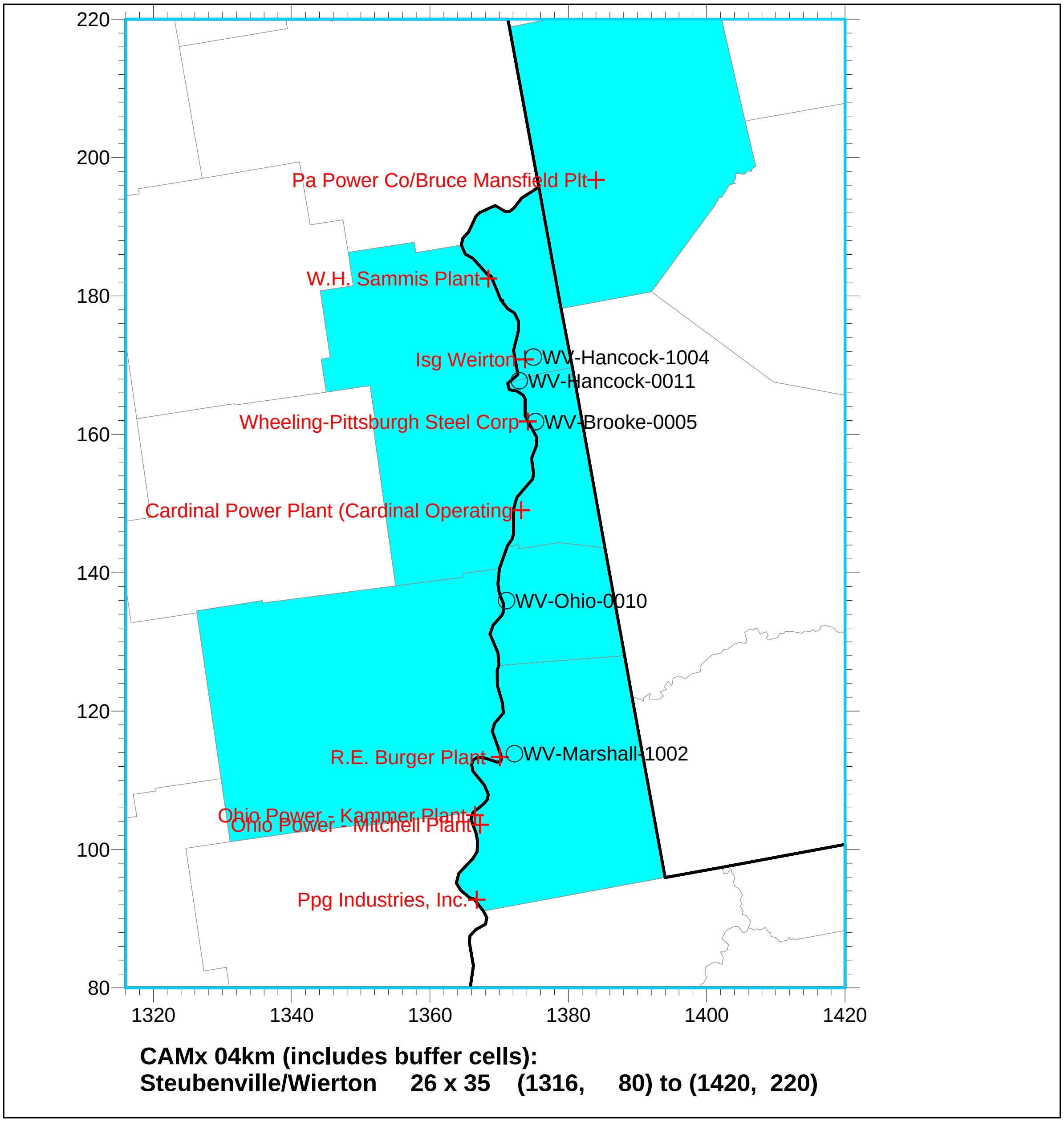


Figure 5-12. Wheeling-Weirton-Steubenville 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

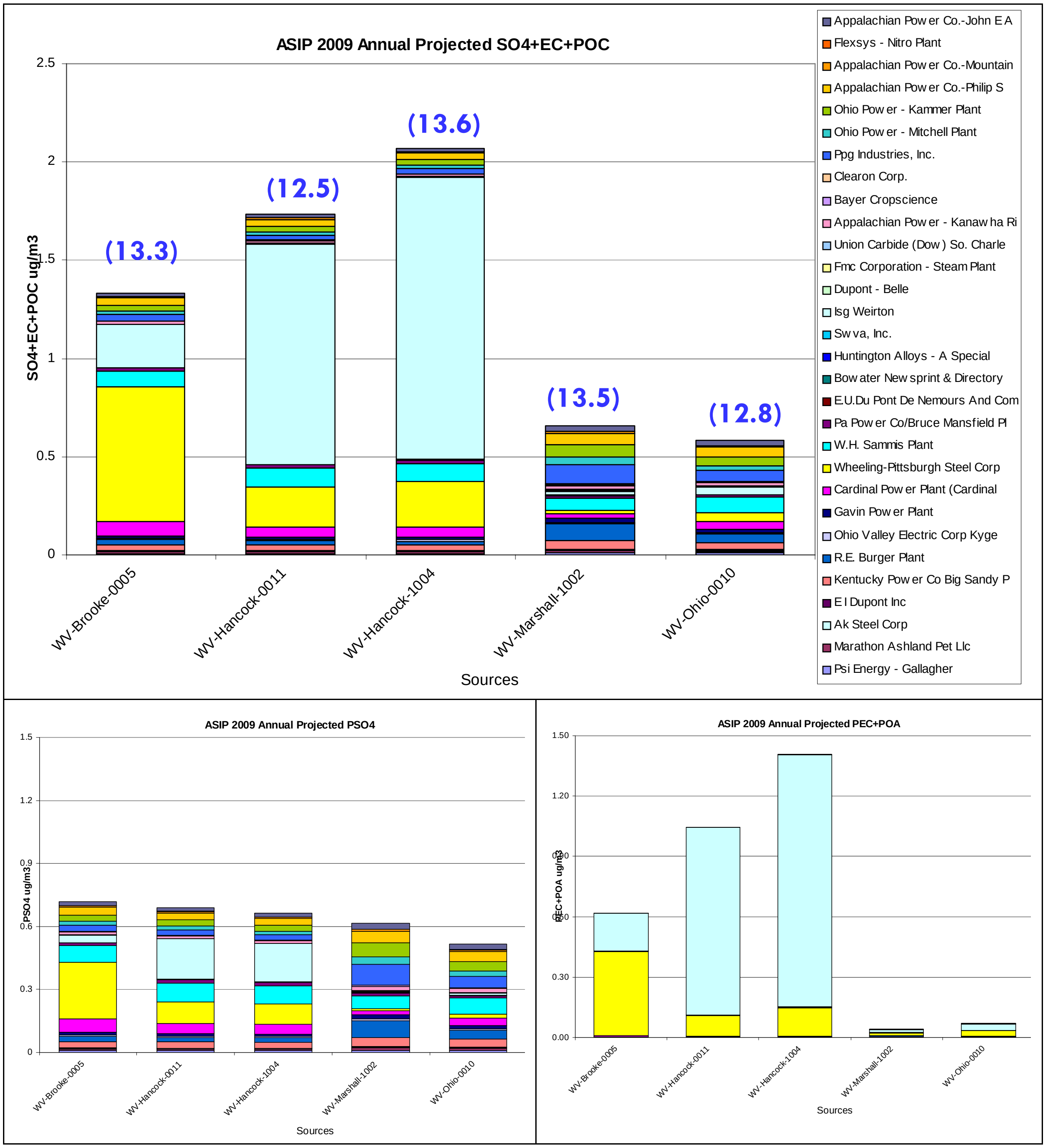


Figure 5-13. PSAT annual 2009 $PM_{2.5}$ source apportionment from 31 PSAT facilities for the Wheeling-Weirton-Steubenville 4 km domain and total $PM_{2.5}$ mass due to SO4 and primary PM emissions (top) and separately by SO4 (bottom left) and primary PM (bottom right).

5.3.3 Louisville 4 km Domain

Figure 5-14 displays the Louisville 4 km domain, the FRM monitors and the single source modeled by PSAT in the domain. The contributions of the 31 PSAT facilities to the projected 2009 $PM_{2.5}$ Design Values are shown in Figure 5-15. Note that the scale of the 31 PSAT source $PM_{2.5}$ contributions for the Louisville 4 km domain in Figure 5-15 is an order of magnitude lower than used for the Charleston-Huntington-Ashland (Figure 5-11) and Wheeling-Weirton-Steubenville (Figure 5-13) 31 source PSAT contributions reflecting the fact that, with the exception of PSI Energy Gallagher EGU, the remainder of the 31 PSAT facilities are farther away from the Louisville NAA. Given that it is the only one of the 31 facilities located in the Louisville 4 km domain it is not surprising that the PSI Gallagher facility is the largest contributor with $PM_{2.5}$ contributions of 0.05 to 0.20 $\mu g/m^3$ to the projected 2009 $PM_{2.5}$ Design Values at FRM monitors in the Louisville NAA. Because of the scale used in Figure 5-15, it appears some of the other sources may be contributing substantial amounts to the projected $PM_{2.5}$ Design Values at the Louisville monitors, but in reality their contributions are quite small. For example, the Kentucky Power Big Sandy EGU contribution (red stacked bar in Figure 5-15) is only 0.01 to 0.02 $\mu g/m^3$.

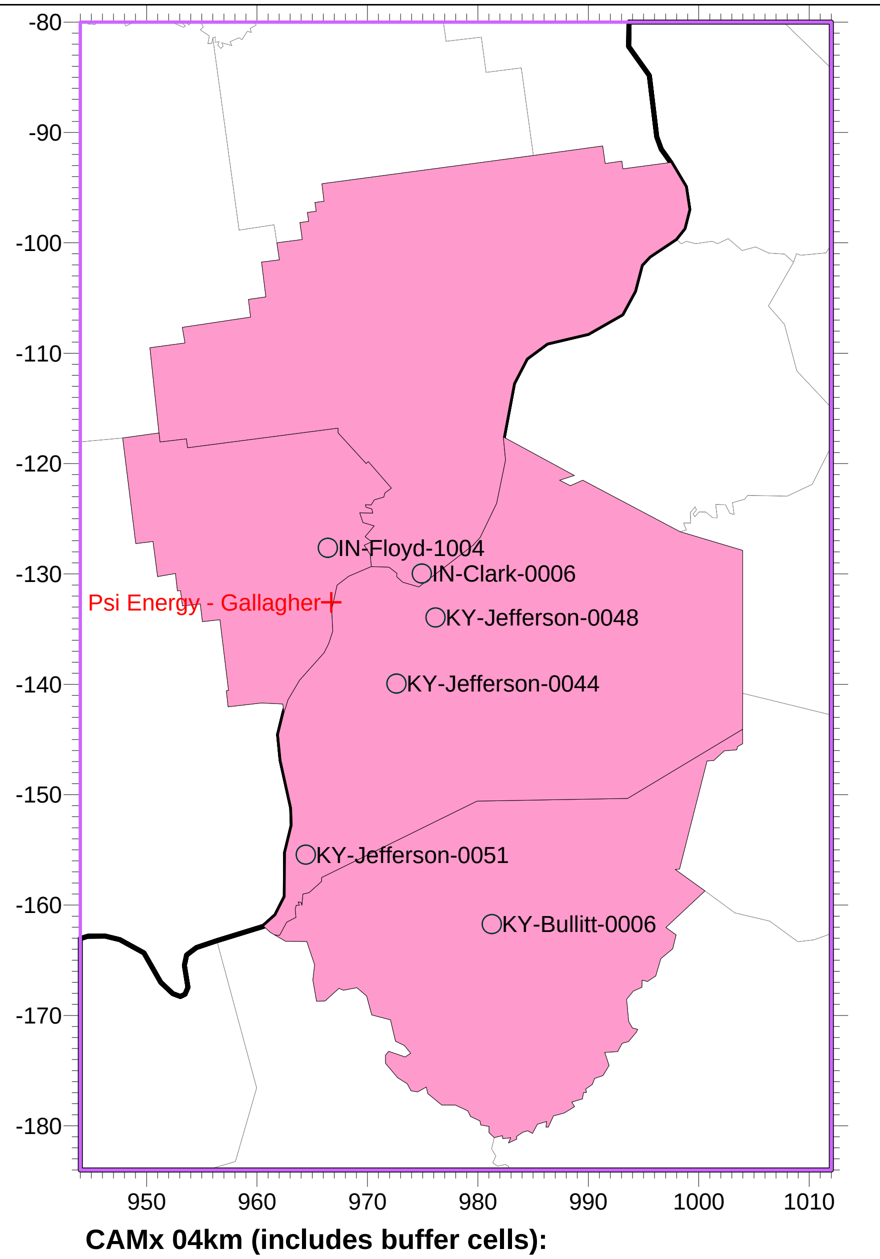


Figure 5-14. Louisville 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

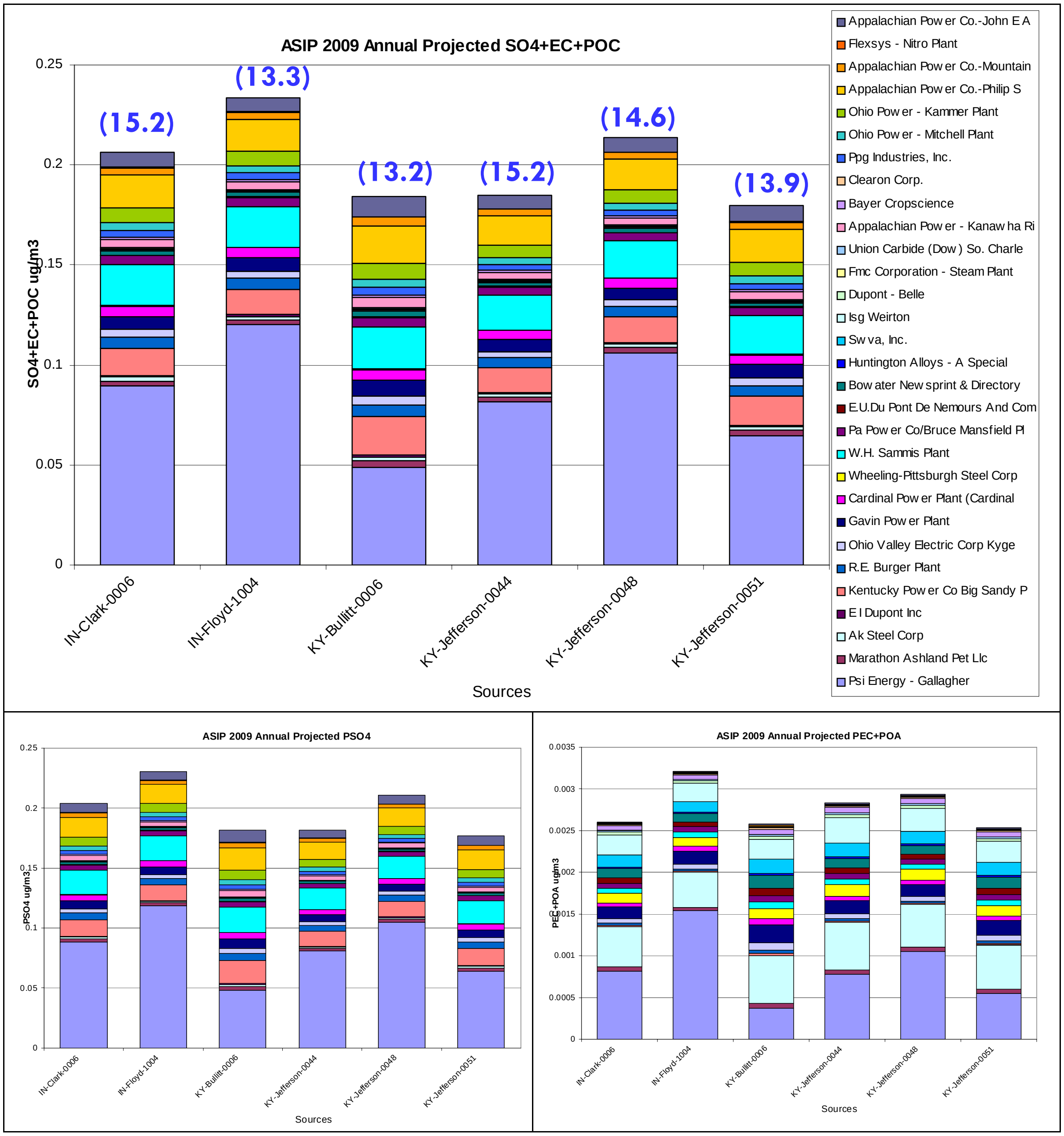


Figure 5-15. PSAT annual 2009 $PM_{2.5}$ source apportionment from 31 PSAT facilities for the Louisville 4 km domain and total $PM_{2.5}$ mass due to SO4 and primary PM emissions (top) and separately by SO4 (bottom left) and primary PM (bottom right).

5.3.4 Knoxville-Chattanooga 4 km Domain

Figure 5-16 displays the Knoxville-Chattanooga 4 km domain along with the FRM monitors therein and the two PSAT sources in the domain: Bowater and E. I. Du Pont. The largest contribution of any facility is 0.08 µg/m^3 that is due to the Bowater facility at the McMinn County, Tennessee FRM monitor (Figure 5-17). The next highest contributing facility is the E.I du Pont plant that contributes 0.05 µg/m^3 to the projected 2009 $PM_{2.5}$ Design Value at the Hamilton County, Tennessee 1011 monitoring site. Despite the fact that it is located fairly far away in the Charleston - Huntington - Ashland 4 km domain, the Kentucky Power Big Sandy EGU also has a relatively higher contribution (0.02-0.03 µg/m^3) to FRM monitors in the Knoxville 4 km domain, however, this contribution is small. This is undoubtedly due to its high SO2 emissions (~50,000 TPY) that are a factor of 10 greater than any of the local sources. As discussed for the Louisville 31 PSAT source contributions, the scale in the Knoxville-Chattanooga 4 km domain 31 PSAT source contributions is approximately an order magnitude lower than used for the Charleston-Huntington-Ashland and Wheeling-Weirton-Steubenville 4 km domain contributions.

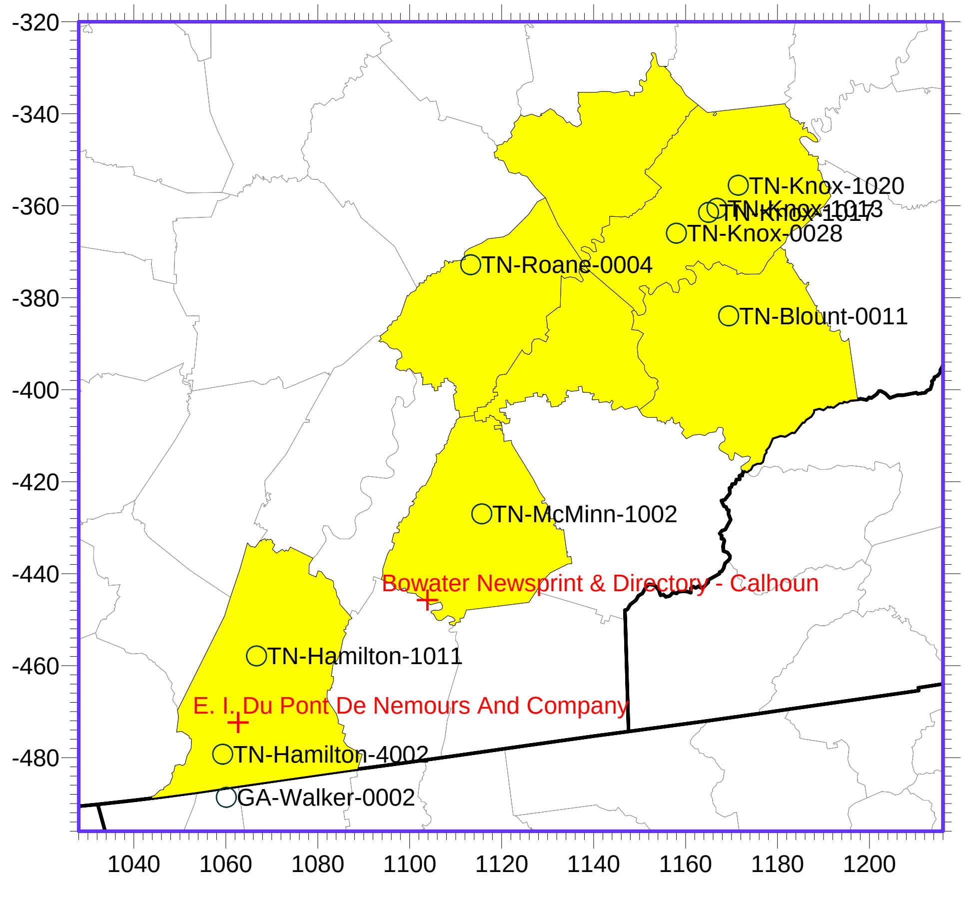


Figure 5-16. Knoxville-Chattanooga 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

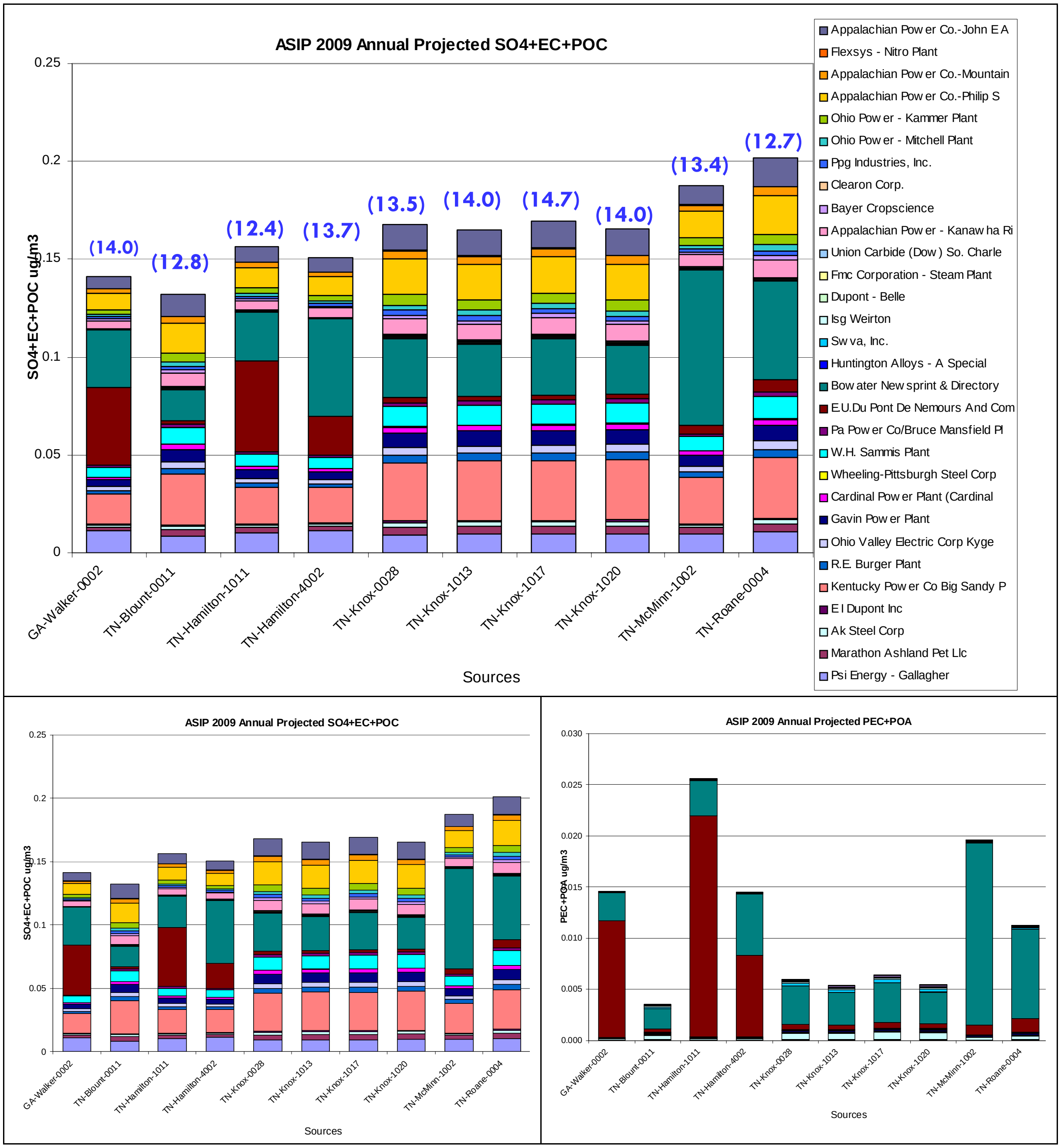


Figure 5-17. PSAT annual 2009 $PM_{2.5}$ source apportionment from 31 PSAT facilities for the Knoxville-Chattanooga 4 km domain and total $PM_{2.5}$ mass due to SO4 and primary PM emissions (top) and separately by SO4 (bottom left) and primary PM (bottom right).

5.3.5 Summary of PSAT Source Apportionment Modeling

Table 5-4 summaries the contribution from the 31 PSAT sources to projected 2009 $PM_{2.5}$ Design Values in the four 4 km nested-grid domains. The contributions of the 31 PSAT sources in the Charleston-Huntington-Ashland and Wheeling-Weirton-Steubenville 4 km domains is approximately a factor of 10 higher than seen for the Louisville and Knoxville-Chattanooga domains, which is due to the identification of many more PSAT sources in these two 4 km domains than the Louisville and Knoxville-Chattanooga 4 km domains, the close proximity of some of the PSAT sources to some of the FRM monitors in the Charleston-Huntington-Ashland and Wheeling-Weirton-Steubenville 4 km domains, and higher total emissions from all PSAT sources in the these two 4 km domains.

In some of the highest facility contribution cases in the Charleston-Huntington-Ashland and Wheeling-Weirton-Steubenville 4 km domains, the PSAT source is located very close to the FRM monitor that is impacted. Although the CAMx modeling used a finer grid (4 km) than the standard ASIP CMAQ modeling (12 km), the CAMx modeling is still using 12 km meteorology and did not attempt to simulate refined local-scale source-receptor relationships. However, the results do suggest that the close proximity of a source to an FRM monitor is as important a factor in its impact as the strength of its emissions. This is especially true for primary PM emission impacts.

Table 5-4. Summary of PSAT contributions to projected 2009 $PM_{2.5}$ Design Values at FRM monitors in each of the four 4 km domains.

4 km Domain	31 PSAT Source Contribution (µg/m^3)		Largest Single Facility Contribution (µg/m^3)
	Minimum	Maximum	
Charleston - Huntington - Ashland	0.4	2.5	2.1
Wheeling-Weirton-Steubenville	0.6	2.1	1.4
Louisville	0.18	0.23	0.20
Knoxville-Chattanooga	0.13	0.20	0.08

5.4 SUMMARY OF ADDITIONAL ANALYSIS

Alternative 2009 $PM_{2.5}$ Design Value projection methods (ASIP Excel spreadsheet method) corroborate the 2009 $PM_{2.5}$ Design Value projections presented in Chapter 4 using EPA's Modeled Attainment test Software (MATS). Although there were some small differences performing 2009 $PM_{2.5}$ Design Value projections using alternative procedures and models, they agreed on which NAAs would have 2009 $PM_{2.5}$ Design Values above and below the 15 µg/m^3 annual $PM_{2.5}$ NAAQS.

An alternative model to CMAQ (CAMx) also corroborates the CMAQ projected $PM_{2.5}$ Design Values. In general, CAMx projected slightly higher (0.1 to 0.3 µg/m^3) $PM_{2.5}$ Design Values than CMAQ. This appears to be primarily due to less reductions between 2002 and 2009 in SO4 and OCM in CAMx than CMAQ. The CAMx 2009 Base G4 emissions scenario did include more SO2 emissions than the CMAQ 2009 Base G4 scenario, which assumed that the W.H. Sammis EGU would have a scrubber and inadvertently neglected area source SO2 and PM emissions in Jefferson County, Kentucky. However, the differences in 2009 SO2 emissions does not explain the CAMx lower SO4 reductions between 2002 and 2009 for all monitors. The lower OCM reductions may be explained in part due to higher biogenic contributions in the CAMx OCM than CMAQ making the OCM RRFs less responsive to reductions in anthropogenic OCM emissions.

PM source apportionment was used to assess the contributions of 31 facilities to the projected 2009 $PM_{2.5}$ Design Values at FRM monitors in four 4 km modeling domains that covered portions of the KY, TN and WV ASIP and adjacent states. For the 31 facilities selected, there were higher contributions in the Charleston-Huntington-Ashland and Wheeling-Weirton-Steubenville 4 km domains than the Louisville and Knoxville-Chattanooga 4 km domains and the proximity of a source to an FRM monitor is as important a factor as its strength of emissions.

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APPENDIX A

Emission Processing
Selected QA Summary Reports, Figures, and Tables

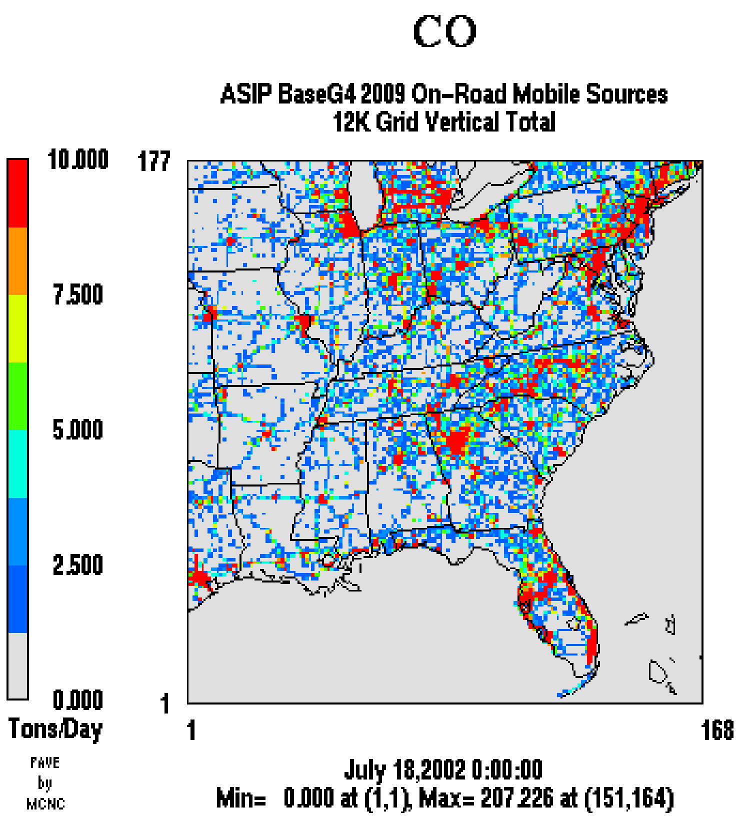

Figure A-1. ASIP BaseG4 2009 On-Road Mobile Source Emissions Summary – 12km Daily Emissions Density Plot (July 18, 2002 episode day)

NO

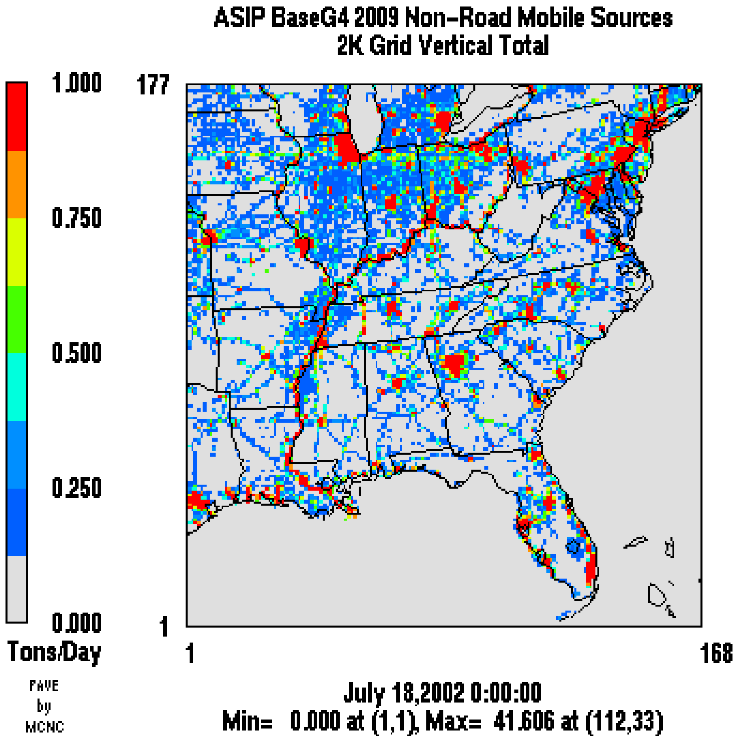

Figure A-2. ASIP BaseG4 2009 Non-Road Mobile Source Emissions Summary – 12km Daily Emissions Density Plot (July 18, 2002 episode day)

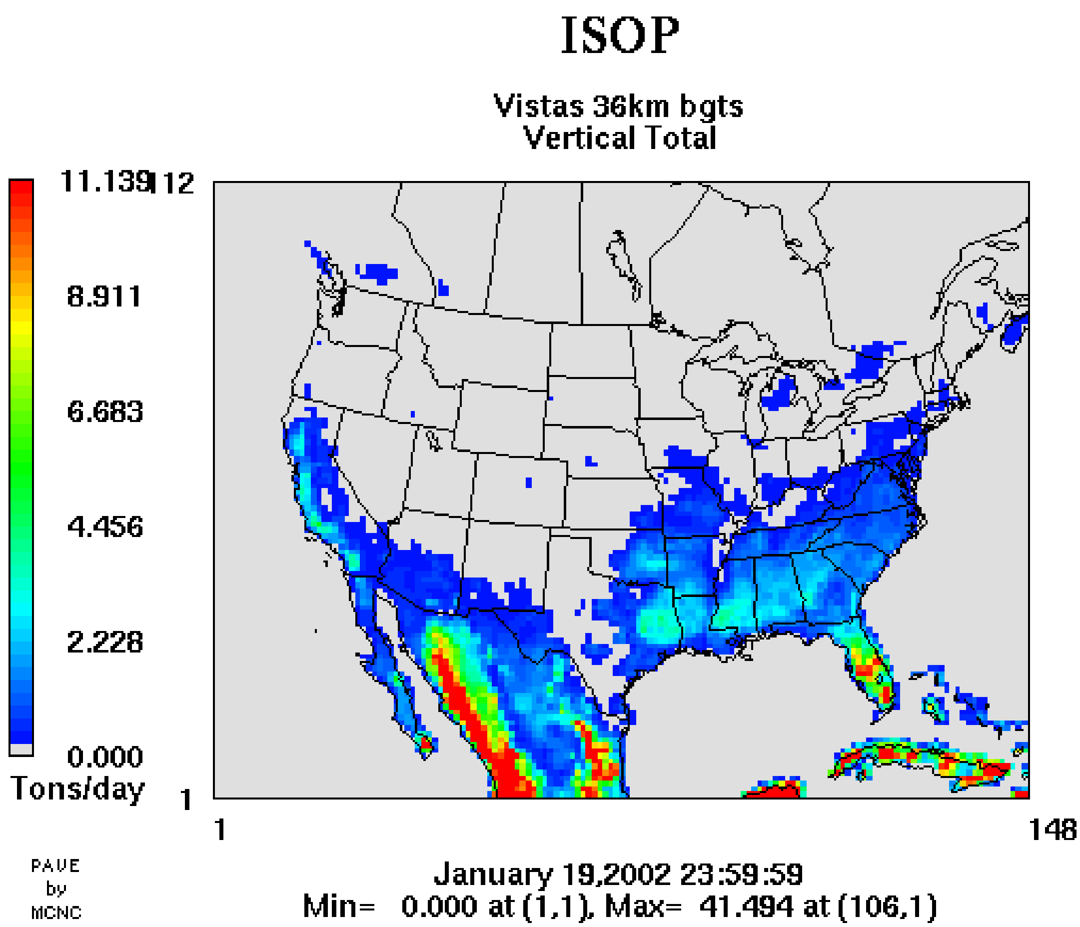

Figure A-3. ASIP BaseG4 2009 Biogenic Source Emissions Summary – 36km Daily Emissions Density Plot (January 17, 2002 episode day)

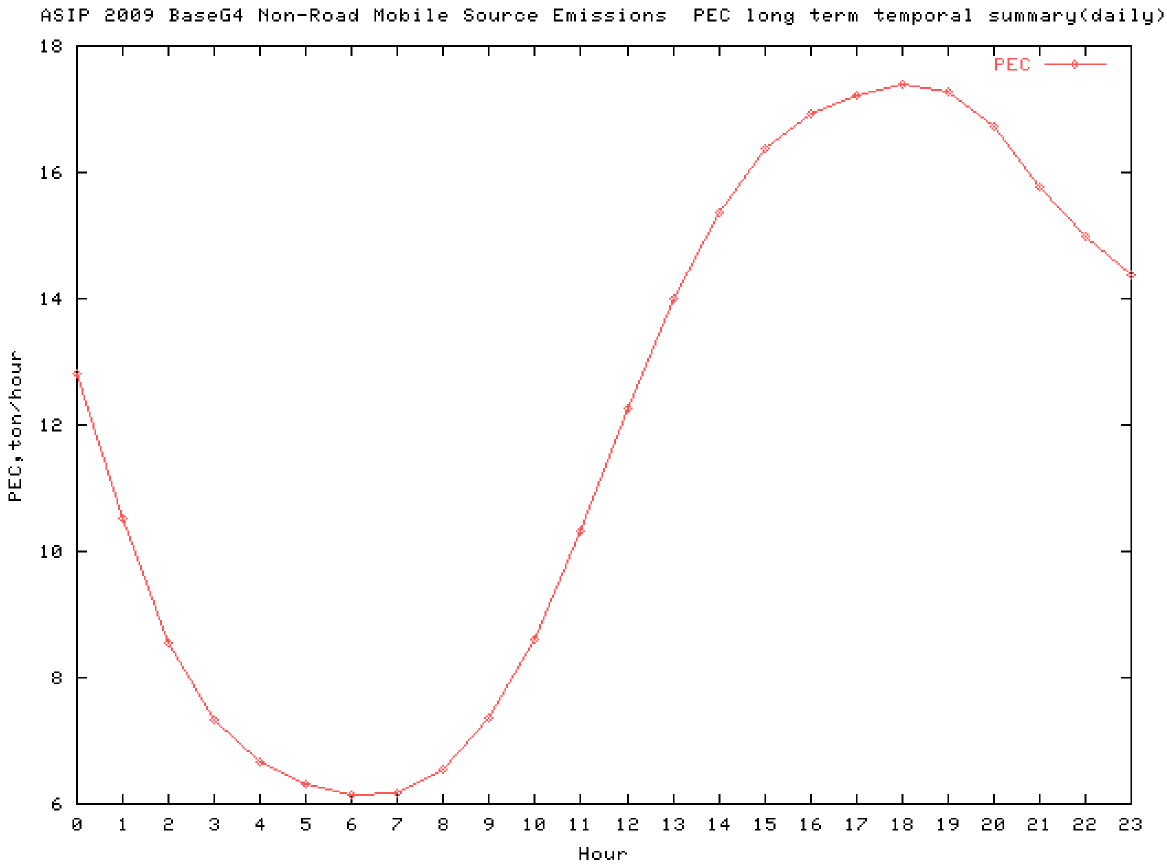

Figure A-4. ASIP BaseG4 2009 Non-Road Mobile Source Emissions Summary – Daily Domain-wide Diurnal Distribution – PEC

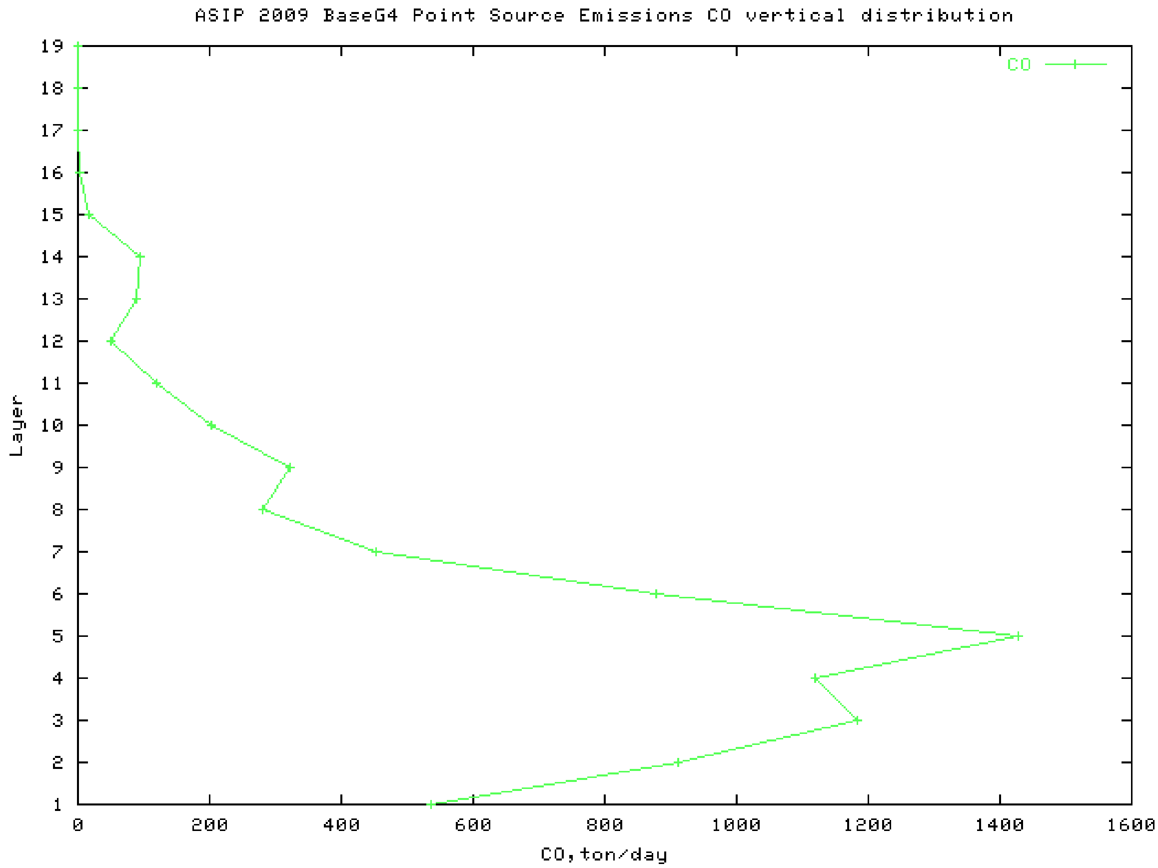

Figure A-5. ASIP BaseG4 2009 Elevated Point Source Emissions Summary – Daily Domain-wide Vertical Distribution – July 18, 2002 Episode Day

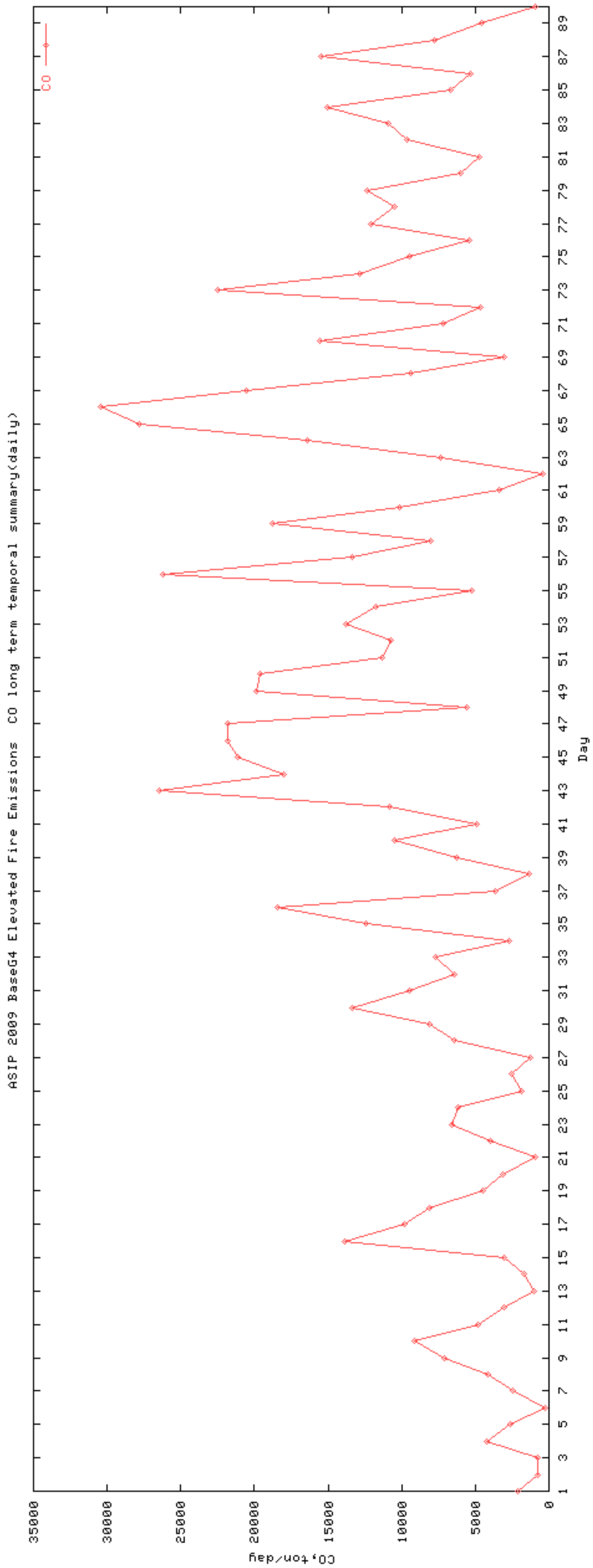

Figure A-6. ASIP 2009 BaseG4 Elevated Fire Source Emissions Summary – Daily Emissions Summary Distribution First Quarter – January 1 to March 31.

Table A.1 – ASIP BaseG4 2009 NonRoad Mobile Source Emissions Summary – 36km State Level Emission Totals (January 17, 2002).

Nonroad mobile
Processed as Area sources
Base inventory year 2009
Gridding matrix applied for gridVISTA36_148X112
No speciation matrix applied
Temporal factors applied for episode from
Thursday Jan. 17, 2002 at 000000 to
Thursday Jan. 17, 2002 at 230000
Annual total data basis in report

Date	Region; State	CO [tons/day]	NOX [tons/day]	VOC [tons/day]	NH3 [tons/day]	SO2 [tons/day]	PM10 [tons/day]	PM2_5 [tons/day]	PMC [tons/day]
01/17/2002	001000;Alabama	0.77865E+03	0.15024E+03	0.10446E+03	0.86291E-01	0.94093E+01	0.10274E+02	0.91981E+01	0.10757E+01
01/17/2002	004000;Arizona	0.76045E+03	0.13832E+03	0.77460E+02	0.11966E+00	0.29424E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	006000;California	0.22452E+04	0.78730E+03	0.20913E+03	0.10143E+01	0.55848E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	008000;Colorado	0.69675E+03	0.94612E+02	0.97577E+02	0.95172E-01	0.15233E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	009000;Connecticut	0.50333E+03	0.49702E+02	0.62212E+02	0.39323E-01	0.23313E+01	0.39601E+01	0.36387E+01	0.32138E+00
01/17/2002	010000;Delaware	0.11272E+03	0.39149E+02	0.12603E+02	0.10836E-01	0.77436E+01	0.22037E+01	0.19867E+01	0.21701E+00
01/17/2002	011000;District of Columbia	0.35258E+02	0.67478E+01	0.34977E+01	0.57324E-02	0.14597E+00	0.52089E+00	0.47947E+00	0.41422E-01
01/17/2002	012000;Florida	0.34329E+04	0.43545E+03	0.46093E+03	0.35181E+00	0.24388E+02	0.39503E+02	0.37692E+02	0.18113E+01
01/17/2002	013000;Georgia	0.14011E+04	0.22405E+03	0.13011E+03	0.15755E+00	0.72750E+01	0.18300E+02	0.17498E+02	0.80287E+00
01/17/2002	016000;Idaho	0.39577E+03	0.36337E+02	0.89537E+02	0.39590E-01	0.97623E+00	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	017000;Illinois	0.18639E+04	0.30163E+03	0.25692E+03	0.33064E+00	0.69106E+01	0.18093E+02	0.16843E+02	0.12508E+01
01/17/2002	018000;Indiana	0.93041E+03	0.14877E+03	0.12047E+03	0.16151E+00	0.34877E+01	0.86975E+01	0.80702E+01	0.62730E+00
01/17/2002	021000;Kentucky	0.64822E+03	0.24558E+03	0.80359E+02	0.76505E-01	0.24862E+02	0.13251E+02	0.12410E+02	0.84119E+00
01/17/2002	023000;Maine	0.64568E+03	0.19787E+02	0.20171E+03	0.64033E-01	0.48398E+00	0.63713E+01	0.58068E+01	0.56449E+00
01/17/2002	024000;Maryland	0.79195E+03	0.72560E+02	0.10271E+03	0.60667E-01	0.41926E+01	0.10397E+02	0.90197E+01	0.13776E+01
01/17/2002	025000;Massachusetts	0.96032E+03	0.80014E+02	0.12581E+03	0.65094E-01	0.23129E+01	0.69867E+01	0.63817E+01	0.60506E+00
01/17/2002	026000;Michigan	0.16026E+04	0.18726E+03	0.18386E+03	0.23085E+00	0.36873E+02	0.17667E+02	0.16164E+02	0.15036E+01
01/17/2002	027000;Minnesota	0.13860E+04	0.60144E+02	0.42542E+03	0.20616E+00	0.84378E+00	0.14535E+02	0.13373E+02	0.11626E+01
01/17/2002	028000;Mississippi	0.47783E+03	0.20929E+03	0.75756E+02	0.55070E-01	0.19467E+02	0.10089E+02	0.93831E+01	0.70556E+00
01/17/2002	030000;Montana	0.17965E+03	0.81511E+02	0.28581E+02	0.67906E-01	0.15620E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	032000;Nevada	0.20279E+03	0.62720E+02	0.19005E+02	0.52017E-01	0.11150E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	033000;New Hampshire	0.41356E+03	0.19188E+02	0.10308E+03	0.36456E-01	0.76568E+00	0.34504E+01	0.31524E+01	0.29800E+00
01/17/2002	034000;New Jersey	0.14395E+04	0.13541E+03	0.17557E+03	0.98075E-01	0.94267E+01	0.11788E+02	0.10670E+02	0.11175E+01
01/17/2002	035000;New Mexico	0.21317E+03	0.90111E+02	0.22721E+02	0.73462E-01	0.17830E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	036000;New York	0.31240E+04	0.20880E+03	0.48092E+03	0.22372E+00	0.82048E+01	0.21338E+02	0.19587E+02	0.17512E+01
01/17/2002	037000;North Carolina	0.14231E+04	0.18133E+03	0.14868E+03	0.16880E+00	0.49376E+01	0.14100E+02	0.13439E+02	0.66109E+00
01/17/2002	038000;North Dakota	0.19933E+03	0.69110E+02	0.42258E+02	0.63136E-01	0.15858E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	039000;Ohio	0.17922E+04	0.22867E+03	0.19693E+03	0.25401E+00	0.11609E+02	0.15083E+02	0.13981E+02	0.11027E+01
01/17/2002	041000;Oregon	0.57747E+03	0.78440E+02	0.75025E+02	0.79692E-01	0.20414E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	042000;Pennsylvania	0.19713E+04	0.18435E+03	0.25229E+03	0.14204E+00	0.40196E+01	0.21542E+02	0.18326E+02	0.32153E+01
01/17/2002	044000;Rhode Island	0.14636E+03	0.10126E+02	0.14812E+02	0.97075E-02	0.23399E+00	0.10776E+01	0.94451E+00	0.13306E+00
01/17/2002	045000;South Carolina	0.71582E+03	0.11419E+03	0.90595E+02	0.86171E-01	0.45882E+01	0.85111E+01	0.80913E+01	0.41985E+00
01/17/2002	046000;South Dakota	0.17337E+03	0.36245E+02	0.34105E+02	0.36564E-01	0.98274E+00	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	047000;Tennessee	0.93395E+03	0.22493E+03	0.11071E+03	0.10939E+00	0.15231E+02	0.13932E+02	0.13176E+02	0.75675E+00
01/17/2002	049000;Utah	0.45453E+03	0.85208E+02	0.76864E+02	0.87625E-01	0.19170E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	050000;Vermont	0.23615E+03	0.67930E+01	0.65873E+02	0.21886E-01	0.13370E+00	0.19964E+01	0.18315E+01	0.16487E+00
01/17/2002	051000;Virginia	0.11018E+04	0.12790E+03	0.12578E+03	0.10848E+00	0.41886E+01	0.17844E+02	0.16951E+02	0.89307E+00
01/17/2002	053000;Washington	0.10248E+04	0.11253E+03	0.12577E+03	0.11840E+00	0.29520E+01	0.00000E+00	0.00000E+00	0.00000E+00
01/17/2002	054000;West Virginia	0.25189E+03	0.78999E+02	0.32058E+02	0.22324E-01	0.91007E+00	0.37065E+01	0.34490E+01	0.25753E+00
01/17/2002	055000;Wisconsin	0.89964E+03	0.11109E+03	0.11719E+03	0.15546E+00	0.83519E+01	0.10475E+02	0.95652E+01	0.90961E+00
01/17/2002	056000;Wyoming	0.26635E+03	0.15093E+03	0.79582E+02	0.13725E+00	0.29205E+01	0.00000E+00	0.00000E+00	0.00000E+00

Table A.2 – ASIP BaseG4 2009 Point Source Emissions Summary – Example Facility-Stack Level Emission Totals.

```
Processed as Point sources
Base inventory year      2002
No gridding matrix applied
No speciation matrix applied
No temporal factors applied
Annual total data basis in report
```

Source ID	Region	SCC	Plant ID	Char 1	Char 2	Char 3	Stk Ht (m)	Stk Dm (m)	Stk Tmp (deg K)	Stk Vel (m/s)	Plt Name	CO [tons/day]	NOX [tons/day]	VOC [tons/day]	NH3 [tons/day]	SO2 [tons/day]	PM10 [tons/day]	PM2_5 [tons/day]	PMC [tons/day]
1	001001	2610000500	34	0	1		3.00	0.20	295.37	4.00	34	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
2	001001	2610000500	35	0	1		3.00	0.20	295.37	4.00	35	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
3	001001	2610000500	36	0	1		3.00	0.20	295.37	4.00	36	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
4	001001	2810001000	225	0	1		3.00	0.20	295.37	4.00	225	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
5	001003	2801500000	1032	0	1		3.00	0.20	295.37	4.00	1032	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
6	001003	2801500000	1033	0	1		3.00	0.20	295.37	4.00	1033	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
7	001003	2801500000	1034	0	1		3.00	0.20	295.37	4.00	1034	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
8	001003	2801500000	1035	0	1		3.00	0.20	295.37	4.00	1035	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
9	001003	2801500000	1036	0	1		3.00	0.20	295.37	4.00	1036	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
10	001003	2801500000	1037	0	1		3.00	0.20	295.37	4.00	1037	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
11	001003	2801500000	1038	0	1		3.00	0.20	295.37	4.00	1038	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
12	001003	2801500000	1039	0	1		3.00	0.20	295.37	4.00	1039	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
13	001003	2801500000	1040	0	1		3.00	0.20	295.37	4.00	1040	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
14	001003	2801500000	1041	0	1		3.00	0.20	295.37	4.00	1041	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
15	001003	2801500000	1042	0	1		3.00	0.20	295.37	4.00	1042	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
16	001003	2810001000	1257	0	1		3.00	0.20	295.37	4.00	1257	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
17	001003	2810001000	1258	0	1		3.00	0.20	295.37	4.00	1258	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
18	001003	2810001000	1259	0	1		3.00	0.20	295.37	4.00	1259	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
19	001003	2810001000	1260	0	1		3.00	0.20	295.37	4.00	1260	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
20	001003	2810015000	1697	0	1		3.00	0.20	295.37	4.00	1697	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
21	001003	2810015000	1698	0	1		3.00	0.20	295.37	4.00	1698	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
22	001005	2610000500	1794	0	1		3.00	0.20	295.37	4.00	1794	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
23	001005	2610000500	1795	0	1		3.00	0.20	295.37	4.00	1795	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
24	001005	2610000500	1796	0	1		3.00	0.20	295.37	4.00	1796	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
25	001005	2610000500	1797	0	1		3.00	0.20	295.37	4.00	1797	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
26	001005	2610000500	1798	0	1		3.00	0.20	295.37	4.00	1798	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
27	001005	2610000500	1799	0	1		3.00	0.20	295.37	4.00	1799	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
28	001005	2610000500	1800	0	1		3.00	0.20	295.37	4.00	1800	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
29	001005	2810001000	2008	0	1		3.00	0.20	295.37	4.00	2008	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
30	001005	2810001000	2009	0	1		3.00	0.20	295.37	4.00	2009	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
31	001005	2810015000	2222	0	1		3.00	0.20	295.37	4.00	2222	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
32	001005	2810015000	2223	0	1		3.00	0.20	295.37	4.00	2223	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
33	001007	2610000500	2287	0	1		3.00	0.20	295.37	4.00	2287	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
34	001007	2610000500	2288	0	1		3.00	0.20	295.37	4.00	2288	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
35	001007	2610000500	2289	0	1		3.00	0.20	295.37	4.00	2289	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
36	001007	2610000500	2290	0	1		3.00	0.20	295.37	4.00	2290	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
37	001007	2610000500	2291	0	1		3.00	0.20	295.37	4.00	2291	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
38	001007	2610000500	2292	0	1		3.00	0.20	295.37	4.00	2292	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
39	001007	2610000500	2293	0	1		3.00	0.20	295.37	4.00	2293	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
40	001007	2810001000	2395	0	1		3.00	0.20	295.37	4.00	2395	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
41	001009	2610000500	2826	0	1		3.00	0.20	295.37	4.00	2826	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
42	001009	2610000500	2827	0	1		3.00	0.20	295.37	4.00	2827	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
43	001009	2610000500	2828	0	1		3.00	0.20	295.37	4.00	2828	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
44	001009	2610000500	2829	0	1		3.00	0.20	295.37	4.00	2829	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
45	001009	2610000500	2830	0	1		3.00	0.20	295.37	4.00	2830	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
46	001009	2610000500	2831	0	1		3.00	0.20	295.37	4.00	2831	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
47	001009	2610000500	2832	0	1		3.00	0.20	295.37	4.00	2832	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
48	001009	2610000500	2833	0	1		3.00	0.20	295.37	4.00	2833	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
49	001009	2610000500	2834	0	1		3.00	0.20	295.37	4.00	2834	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
50	001009	2610000500	2835	0	1		3.00	0.20	295.37	4.00	2835	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
51	001009	2610000500	2836	0	1		3.00	0.20	295.37	4.00	2836	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
52	001009	2610000500	2837	0	1		3.00	0.20	295.37	4.00	2837	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
53	001009	2610000500	2838	0	1		3.00	0.20	295.37	4.00	2838	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
54	001009	2610000500	2839	0	1		3.00	0.20	295.37	4.00	2839	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
55	001009	2610000500	2840	0	1		3.00	0.20	295.37	4.00	2840	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
56	001009	2610000500	2841	0	1		3.00	0.20	295.37	4.00	2841	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
57	001009	2610000500	2842	0	1		3.00	0.20	295.37	4.00	2842	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
58	001009	2610000500	2843	0	1		3.00	0.20	295.37	4.00	2843	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
59	001009	2610000500	2844	0	1		3.00	0.20	295.37	4.00	2844	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
60	001009	2610000500	2845	0	1		3.00	0.20	295.37	4.00	2845	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
61	001009	2610000500	2846	0	1		3.00	0.20	295.37	4.00	2846	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
62	001009	2610000500	2847	0	1		3.00	0.20	295.37	4.00	2847	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
63	001009	2610000500	2848	0	1		3.00	0.20	295.37	4.00	2848	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
64	001009	2610000500	2849	0	1		3.00	0.20	295.37	4.00	2849	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
65	001009	2610000500	2850	0	1		3.00	0.20	295.37	4.00	2850	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
66	001009	2610000500	2851	0	1		3.00	0.20	295.37	4.00	2851	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
67	001009	2610000500	2852	0	1		3.00	0.20	295.37	4.00	2852	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
68	001009	2610000500	2853	0	1		3.00	0.20	295.37	4.00	2853	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
69	001009	2610000500	2854	0	1		3.00	0.20	295.37	4.00	2854	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
70	001009	2610000500	2855	0	1		3.00	0.20	295.37	4.00	2855	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
71	001009	2610000500	2856	0	1		3.00	0.20	295.37	4.00	2856	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
72	001009	2610000500	2857	0	1		3.00	0.20	295.37	4.00	2857	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
73	001009	2610000500	2858	0	1		3.00	0.20	295.37	4.00	2858	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
74	001009	2610000500	2859	0	1		3.00	0.20	295.37	4.00	2859	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
75	001009	2610000500	2860	0	1		3.00	0.20	295.37	4.00	2860	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
76	001009	2610000500	2861	0	1		3.00	0.20	295.37	4.00	2861	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
77	001009	2610000500	2862	0	1		3.00	0.20	295.37	4.00	2862	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
78	001009	2610000500	2863	0	1		3.00	0.20	295.37	4.00	2863	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06
79	001009	2610000500	2864	0	1		3.00	0.20	295.37	4.00	2864	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.27397E-06	0.54795E-06	0.27397E-06	0.27397E-06

Table A.3 – ASIP BaseG4 2009 Point Source Emissions Summary – Example Hourly SCC Level Emission Totals.

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Processed as Point sources
Base inventory year      2009
No gridding matrix applied
No speciation matrix applied
Temporal factors applied for episode from
     Thursday July 18, 2002  at 000000 to
     Friday July 19, 2002  at 000000
Annual total data basis in report
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Date	Hour	SCC	CO [tons/hr]	NOX [tons/hr]	VOC [tons/hr]	NH3 [tons/hr]	SO2 [tons/hr]	PM10 [tons/hr]	PM2_5 [tons/hr]	PMC [tons/hr]
07/18/2002	01	0000000000	0.14206E+00	0.11183E+00	0.17597E-01	0.66712E-02	0.27056E-01	0.37574E-01	0.68642E-02	0.30710E-01
07/18/2002	01	0010100101	0.87139E+00	0.45761E+00	0.19446E+00	0.33041E-02	0.23341E+01	0.12762E+00	0.82237E-01	0.45379E-01
07/18/2002	01	0010100102	0.59221E-04	0.34994E-03	0.89729E-05	0.00000E+00	0.00000E+00	0.10767E-04	0.64425E-05	0.43249E-05
07/18/2002	01	0010100201	0.10474E+01	0.96628E+01	0.10945E+00	0.62716E-01	0.26837E+02	0.26433E+01	0.23420E+01	0.30122E+00
07/18/2002	01	0010100202	0.68392E+01	0.57522E+02	0.78309E+00	0.37745E+00	0.15330E+03	0.16221E+02	0.12558E+02	0.36637E+01
07/18/2002	01	0010100203	0.95478E+00	0.56477E+01	0.20269E+00	0.54250E-01	0.21025E+02	0.23420E+01	0.22687E+01	0.73255E-01
07/18/2002	01	0010100204	0.46399E+00	0.13373E+01	0.51048E-02	0.15092E-02	0.65591E+01	0.19821E+00	0.13438E+00	0.63837E-01
07/18/2002	01	0010100205	0.13100E+00	0.30359E+00	0.20543E-02	0.53011E-03	0.11969E+01	0.80668E-01	0.30830E-01	0.49839E-01
07/18/2002	01	0010100211	0.39243E-01	0.24103E+00	0.31399E-02	0.21705E-02	0.11918E+01	0.85529E-01	0.83248E-01	0.22804E-02
07/18/2002	01	0010100212	0.30003E+01	0.35093E+02	0.35762E+00	0.17996E+00	0.68572E+02	0.77735E+01	0.60327E+01	0.17407E+01
07/18/2002	01	0010100215	0.59113E+00	0.18550E+01	0.70936E-01	0.35468E-01	0.95356E+01	0.13718E+01	0.10007E+01	0.37111E+00
07/18/2002	01	0010100217	0.45727E+01	0.93723E+00	0.13921E-01	0.78401E-02	0.45122E+01	0.89504E-01	0.67256E-01	0.22248E-01
07/18/2002	01	0010100218	0.18689E+00	0.89342E-01	0.14821E-02	0.21935E-03	0.12489E+00	0.11223E-01	0.21098E-02	0.91132E-02
07/18/2002	01	0010100221	0.17597E+01	0.51449E+00	0.49278E-02	0.27889E-02	0.56166E+00	0.37664E-01	0.29317E-01	0.83472E-02
07/18/2002	01	0010100222	0.74106E+01	0.59600E+02	0.82552E+00	0.36703E+00	0.11515E+03	0.81716E+01	0.52526E+01	0.29190E+01
07/18/2002	01	0010100223	0.16763E+01	0.18400E+02	0.36450E+00	0.97825E-01	0.34745E+02	0.12214E+01	0.11373E+01	0.84082E-01
07/18/2002	01	0010100224	0.39257E+00	0.50028E+00	0.36410E-02	0.99977E-03	0.14882E+01	0.29645E+00	0.37146E-01	0.25931E+00
07/18/2002	01	0010100225	0.89977E-01	0.77578E-01	0.59810E-03	0.00000E+00	0.13947E+00	0.35244E-01	0.61672E-03	0.34628E-01
07/18/2002	01	0010100226	0.70984E+01	0.52843E+02	0.84303E+00	0.42869E+00	0.12452E+03	0.81670E+01	0.55576E+01	0.26094E+01
07/18/2002	01	0010100235	0.26537E+00	0.55504E+00	0.31844E-01	0.15922E-01	0.47711E+01	0.29569E+00	0.18908E+00	0.10661E+00
07/18/2002	01	0010100238	0.46053E+00	0.13912E+00	0.12795E-02	0.76770E-03	0.36245E+00	0.15781E-01	0.11024E-01	0.47564E-02
07/18/2002	01	0010100301	0.23937E+01	0.39403E+01	0.99225E-01	0.43503E-01	0.10320E+02	0.88371E+00	0.73875E+00	0.14496E+00
07/18/2002	01	0010100302	0.21023E+01	0.10714E+02	0.24728E+00	0.11115E+00	0.31146E+02	0.17814E+01	0.15355E+01	0.24592E+00
07/18/2002	01	0010100303	0.27829E+00	0.43323E+01	0.32468E-01	0.13914E-01	0.22725E+01	0.20543E+00	0.18108E+00	0.24350E-01
07/18/2002	01	0010100401	0.51802E+00	0.18271E+01	0.77252E-01	0.80097E-02	0.92681E+00	0.70756E-01	0.59988E-01	0.10768E-01
07/18/2002	01	0010100404	0.21929E+00	0.68023E+00	0.22855E-01	0.83514E-02	0.24284E-01	0.23381E-01	0.17651E-01	0.57302E-02
07/18/2002	01	0010100405	0.30765E-04	0.36760E-03	0.41107E-05	0.18012E-05	0.88526E-03	0.52342E-04	0.39106E-04	0.13237E-04
07/18/2002	01	0010100501	0.54092E+00	0.77509E+01	0.81469E-01	0.18328E-01	0.34689E+01	0.26593E+00	0.23144E+00	0.34489E-01
07/18/2002	01	0010100504	0.11180E-01	0.45802E-01	0.32002E-03	0.77910E-03	0.37084E-02	0.10393E-02	0.99905E-03	0.40256E-04
07/18/2002	01	0010100505	0.96761E-04	0.11631E-02	0.15862E-04	0.62254E-05	0.39619E-03	0.27866E-03	0.28297E-04	0.25036E-03
07/18/2002	01	0010100601	0.89315E+01	0.16189E+02	0.72684E+00	0.30844E+00	0.11837E+02	0.15377E+01	0.14582E+01	0.79465E-01
07/18/2002	01	0010100602	0.58511E+00	0.71117E+00	0.34872E-01	0.23884E-01	0.47277E+00	0.13073E+00	0.11332E+00	0.17411E-01
07/18/2002	01	0010100604	0.58210E+00	0.13095E+01	0.39698E-01	0.21902E-01	0.25803E-02	0.49504E+00	0.84586E-01	0.41046E+00
07/18/2002	01	0010100701	0.10993E+00	0.24182E+00	0.15772E-01	0.22871E-02	0.18325E-01	0.88521E-01	0.72698E-01	0.15823E-01
07/18/2002	01	0010100702	0.56159E-01	0.68724E-01	0.32490E-02	0.20532E-04	0.19423E+00	0.15497E-01	0.82449E-02	0.72519E-02
07/18/2002	01	0010100801	0.17069E+00	0.22672E+01	0.23510E-01	0.61065E-01	0.11424E+01	0.75406E-01	0.62729E-01	0.12677E-01
07/18/2002	01	0010100818	0.68205E+00	0.93293E-01	0.18946E-02	0.15043E-01	0.70314E+00	0.14273E-01	0.11110E-01	0.31635E-02
07/18/2002	01	0010100901	0.12666E+00	0.14694E+00	0.39894E-02	0.00000E+00	0.68817E-01	0.42282E-01	0.19343E-01	0.22939E-01
07/18/2002	01	0010100902	0.18046E+01	0.69356E+00	0.68253E-01	0.62586E-06	0.23943E+00	0.85894E-01	0.49790E-01	0.36104E-01
07/18/2002	01	0010100903	0.96114E+00	0.57260E+00	0.74790E-01	0.22596E-02	0.22824E+00	0.12390E+00	0.10710E+00	0.16806E-01
07/18/2002	01	0010100911	0.28284E+00	0.14257E+00	0.13072E-01	0.13670E-03	0.41899E-03	0.10540E-01	0.76625E-02	0.28777E-02
07/18/2002	01	0010101002	0.41629E-03	0.17474E-01	0.60747E-04	0.00000E+00	0.21042E-04	0.67549E-04	0.39031E-04	0.28519E-04
07/18/2002	01	0010101101	0.16581E+00	0.84527E-01	0.11175E-01	0.00000E+00	0.28788E-01	0.60839E-02	0.36708E-02	0.24131E-02
07/18/2002	01	0010101201	0.26494E+00	0.16576E+01	0.14310E-01	0.14081E-02	0.15913E+00	0.16866E+01	0.16401E+01	0.46497E-01
07/18/2002	01	0010101202	0.30067E+00	0.58733E+00	0.12259E-01	0.59456E-06	0.12395E+00	0.23163E-01	0.18103E-01	0.50599E-02
07/18/2002	01	0010101301	0.11787E-02	0.34625E-01	0.10844E-02	0.00000E+00	0.11472E-02	0.65365E-03	0.37028E-03	0.28338E-03
07/18/2002	01	0010101302	0.55135E-04	0.20422E-03	0.10593E-04	0.00000E+00	0.52970E-03	0.90252E-05	0.21663E-05	0.68589E-05
07/18/2002	01	0010101502	0.00000E+00	0.00000E+00	0.15039E-01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
07/18/2002	01	0010102018	0.60868E-02	0.13212E+00	0.12174E-02	0.12174E-02	0.14577E+00	0.90768E-02	0.58419E-02	0.32349E-02
07/18/2002	01	0010200101	0.19448E+00	0.11306E+00	0.76803E-03	0.00000E+00	0.86405E+00	0.27186E-01	0.70978E-02	0.20088E-01
07/18/2002	01	0010200104	0.42899E-02	0.38964E-01	0.16096E-02	0.00000E+00	0.92728E-01	0.88879E-02	0.62159E-02	0.26720E-02
07/18/2002	01	0010200201	0.39882E+00	0.92351E+00	0.81989E-02	0.14564E-04	0.46885E+01	0.37063E-01	0.16882E-01	0.20181E-01
07/18/2002	01	0010200202	0.80034E+00	0.82808E+01	0.13156E+00	0.15969E-01	0.23662E+02	0.61985E+00	0.36466E+00	0.25518E+00
07/18/2002	01	0010200203	0.53920E-01	0.16566E+01	0.78848E-02	0.69142E-03	0.66819E+01	0.12856E+00	0.55291E-01	0.73272E-01
07/18/2002	01	0010200204	0.16193E+01	0.32889E+01	0.38583E-01	0.68327E-02	0.11922E+02	0.47499E+00	0.23067E+00	0.24431E+00
07/18/2002	01	0010200205	0.39529E+00	0.56348E+00	0.85890E-02	0.96798E-03	0.26017E+01	0.12033E+00	0.61200E-01	0.59132E-01
07/18/2002	01	0010200206	0.14693E+00	0.10437E+00	0.15627E-01	0.45554E-03	0.72235E+00	0.13111E-01	0.79703E-02	0.51403E-02
07/18/2002	01	0010200212	0.36085E-01	0.70155E+00	0.37655E-02	0.50228E-05	0.18296E+01	0.40154E-01	0.13162E-01	0.26992E-01
07/18/2002	01	0010200217	0.17093E+00	0.49767E+00	0.58210E-02	0.15958E-02	0.75120E+00	0.76522E-01	0.32568E-01	0.43954E-01
07/18/2002	01	0010200218	0.21020E+00	0.74540E-01	0.46674E-03	0.12215E-05	0.11085E+00	0.37580E-02	0.32402E-02	0.51780E-03
07/18/2002	01	0010200219	0.35811E+00	0.98098E+00	0.44985E-02	0.85304E-03	0.17158E+01	0.56318E-01	0.38838E-01	0.17481E-01
07/18/2002	01	0010200222	0.24774E-01	0.31022E+00	0.31324E-02	0.12530E-04	0.51193E+00	0.82465E-02	0.18935E-02	0.63529E-02
07/18/2002	01	0010200224	0.14103E+01	0.88343E+00	0.69713E-02	0.13452E-04	0.15155E+01	0.10873E+00	0.32923E-01	0.75804E-01
07/18/2002	01	0010200225	0.77683E-01	0.89629E-01	0.64661E-03	0.13699E-06	0.79553E+00	0.48493E-01	0.25819E-01	0.22674E-01
07/18/2002	01	0010200229	0.12668E-01	0.80910E-01	0.10519E-02	0.00000E+00	0.19728E-01	0.14364E-01	0.71709E-02	0.71935E-02
07/18/2002	01	0010200301	0.27484E-01	0.58438E+00	0.78002E-03	0.00000E+00	0.35286E+01	0.00000E+00	0.00000E+00	0.00000E+00
07/18/2002	01	0010200303	0.10918E-04	0.13057E-04	0.67534E-06	0.00000E+00	0.11256E-06	0.10130E-05	0.10130E-05	0.00000E+00
07/18/2002	01	0010200306	0.14952E-01	0.14426E-01	0.34361E-05	0.21470E-05	0.30948E-02	0.10861E-02	0.62489E-04	0.10236E-02
07/18/2002	01	0010200307	0.11933E-01	0.20813E-01	0.27500E-03	0.00000E+00	0.69667E-02	0.70417E-03	0.26250E-03	0.44167E-03
07/18/2002	01	0010200401	0.15318E+01	0.36599E+01	0.97386E-01	0.29508E-01	0.88657E+01	0.14242E+01	0.11764E+01	0.24781E+00
07/18/2002	01	0010200402	0.65563E+00	0.42159E+00	0.16454E-01	0.26986E-02	0.12173E+01	0.15516E+00	0.10200E+00	0.53163E-01
07/18/2002	01	0010200403	0.29658E-02	0.28122E-02	0.24292E-04	0.44258E-03	0.45624E-01	0.13409E-02	0.12838E-02	0.57078E-04
07/18/2002	01	0010200404	0.95133E-02	0.63116E-01	0.89864E-03	0.10095E-02	0.35107E+00	0.17634E-01	0.97231E-02	0.79106E-02
07/18/2002	01	0010200405	0.10003E-01	0.40358E-01	0.71310E-03	0.31341E-03	0.93559E-01	0.71166E-02	0.52921E-02	0.18244E-02
07/18/2002	01	0010200501	0.56322E+00	0.70032E+00	0.19557E-01	0.12738E-01	0.39554E+00	0.11201E+00	0.89965E-01	0.22043E-01
07/18/2002	01	0010200502	0.77112E-01	0.12147E+00	0.21053E-02	0.44255E-03	0.27628E+00	0.96862E-02	0.65881E-02	0.30981E-02
07/18/2002	01	0010200503	0.14068E-01	0.32650E-01	0.73711E-03	0.48636E-04	0.33071E-01	0.38675E-02	0.33773E-02	0.49013E-03
07/18/2002	01	0010200504	0.27701E+00	0.18970E+00	0.89498E-02	0.16029E-02	0.18747E+00	0.38039E-01	0.32382E-01	0.56571E-02

Table A.4 – ASIP BaseG4 2009 On-Road Mobile Source Emissions Summary – Daily State Level Emission Totals.

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Processed as Mobile sources
Base inventory year      2009
Gridding matrix applied for gridVISTA12_168X177
No speciation matrix applied
Temporal factors applied for episode from
     Thursday July 18, 2002  at 000000 to
     Thursday July 18, 2002  at 230000
Annual total data basis in report
Date       ; Region; State              ; EXR__CO      ; EXR__NOX     ; EXR__TOG     ; EXR__SO4     ; EXR__OCARB25 ; EXR__OCARBPMC; EXR__ECARB25 ; EXR__ECARBPMC; EXR__GASPM25 ; EXR__GASPMC  ; EXR__SO2     ;
EXR__NH3     ; EXS__CO      ; EXS__NOX     ; EXS__TOG     ; HOT__TOG     ; DNL__TOG     ; RST__TOG     ; EVR__TOG     ; CRC__TOG     ; BRK__BRAKE25 ; BRK__BRAKEPMC; TIR__TIRE25  ; TIR__TIREPMC ; RFL__TOG
             ;              ;                    ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ;
[tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]   ; [tons/day]
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--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------
 07/18/2002;  001000;Alabama              ;   0.16025E+04;   0.28512E+03;   0.69703E+02;   0.14807E+00;   0.11463E+01;   0.99680E-01;   0.22575E+01;   0.19630E+00;   0.10102E+01;   0.11029E+00;   0.24286E+01;
0.20843E+02;   0.52133E+03;   0.23710E+02;   0.36389E+02;   0.27976E+02;   0.17787E+01;   0.29219E+02;   0.38359E+02;   0.18637E+01;   0.11998E+01;   0.16221E+01;   0.53807E+00;   0.16142E+01;   0.13418E+02
 07/18/2002;  005000;Arkansas             ;   0.78179E+03;   0.16626E+03;   0.32265E+02;   0.81158E-01;   0.78852E+00;   0.68567E-01;   0.15514E+01;   0.13491E+00;   0.54516E+00;   0.61238E-01;   0.13773E+01;
0.10607E+02;   0.27362E+03;   0.12347E+02;   0.18606E+02;   0.13580E+02;   0.58160E+00;   0.14806E+02;   0.12522E+02;   0.94582E+00;   0.62692E+00;   0.84760E+00;   0.29603E+00;   0.88809E+00;   0.61432E+01
 07/18/2002;  009000;Connecticut          ;   0.61631E+03;   0.13079E+03;   0.17173E+02;   0.67558E-01;   0.51422E+00;   0.44715E-01;   0.10118E+01;   0.87979E-01;   0.54297E+00;   0.58382E-01;   0.12590E+01;
0.11410E+02;   0.24744E+03;   0.88419E+01;   0.11251E+02;   0.10935E+02;   0.77318E+00;   0.12069E+02;   0.82501E+01;   0.94716E+00;   0.64689E+00;   0.87459E+00;   0.28233E+00;   0.84700E+00;   0.51883E+01
 07/18/2002;  010000;Delaware             ;   0.19992E+03;   0.43844E+02;   0.76876E+01;   0.19238E-01;   0.18921E+00;   0.16453E-01;   0.38491E+00;   0.33470E-01;   0.16687E+00;   0.17152E-01;   0.32972E+00;
0.35337E+01;   0.64755E+02;   0.30096E+01;   0.35605E+01;   0.36277E+01;   0.21030E+00;   0.40858E+01;   0.43395E+01;   0.31246E+00;   0.20339E+00;   0.27498E+00;   0.91109E-01;   0.27333E+00;   0.18603E+01
 07/18/2002;  011000;District of Columbia;   0.81372E+02;   0.13661E+02;   0.29288E+01;   0.79815E-02;   0.35198E-01;   0.30607E-02;   0.68366E-01;   0.59448E-02;   0.66179E-01;   0.65805E-02;   0.12704E+00;
0.14310E+01;   0.28854E+02;   0.11925E+01;   0.15802E+01;   0.17162E+01;   0.11321E+00;   0.18666E+01;   0.23401E+01;   0.12828E+00;   0.80282E-01;   0.10854E+00;   0.34198E-01;   0.10259E+00;   0.84596E+00
 07/18/2002;  012000;Florida              ;   0.55953E+04;   0.89840E+03;   0.24131E+03;   0.49657E+00;   0.32712E+01;   0.28445E+00;   0.64395E+01;   0.55996E+00;   0.34424E+01;   0.37411E+00;   0.78881E+01;
0.71443E+02;   0.18314E+04;   0.81681E+02;   0.12544E+03;   0.10870E+03;   0.34380E+01;   0.10023E+03;   0.16996E+03;   0.64019E+01;   0.40651E+01;   0.54960E+01;   0.17758E+01;   0.53274E+01;   0.49217E+02
 07/18/2002;  013000;Georgia              ;   0.34226E+04;   0.57775E+03;   0.14107E+03;   0.29185E+00;   0.21016E+01;   0.18275E+00;   0.41911E+01;   0.36444E+00;   0.19775E+01;   0.20833E+00;   0.47820E+01;
0.41731E+02;   0.12128E+04;   0.64362E+02;   0.86235E+02;   0.98667E+02;   0.58158E+01;   0.91848E+02;   0.11674E+03;   0.40542E+01;   0.23905E+01;   0.32320E+01;   0.10667E+01;   0.32000E+01;   0.32709E+02
 07/18/2002;  017000;Illinois             ;   0.24696E+04;   0.45451E+03;   0.97256E+02;   0.26140E+00;   0.17948E+01;   0.15607E+00;   0.35245E+01;   0.30648E+00;   0.18484E+01;   0.20101E+00;   0.42591E+01;
0.38261E+02;   0.91827E+03;   0.37698E+02;   0.54629E+02;   0.50131E+02;   0.26163E+01;   0.51398E+02;   0.60652E+02;   0.34308E+01;   0.21787E+01;   0.29456E+01;   0.95531E+00;   0.28659E+01;   0.23140E+02
 07/18/2002;  018000;Indiana              ;   0.19453E+04;   0.34639E+03;   0.79692E+02;   0.18071E+00;   0.14249E+01;   0.12390E+00;   0.28006E+01;   0.24353E+00;   0.12662E+01;   0.13814E+00;   0.30373E+01;
0.26099E+02;   0.68004E+03;   0.29516E+02;   0.44573E+02;   0.38277E+02;   0.18093E+01;   0.34856E+02;   0.47923E+02;   0.23353E+01;   0.15004E+01;   0.20286E+01;   0.67252E+00;   0.20176E+01;   0.17707E+02
 07/18/2002;  019000;Iowa                 ;   0.77807E+03;   0.15309E+03;   0.32726E+02;   0.77516E-01;   0.63751E+00;   0.55436E-01;   0.12534E+01;   0.10899E+00;   0.56731E+00;   0.66211E-01;   0.12923E+01;
0.10249E+02;   0.27312E+03;   0.12517E+02;   0.17758E+02;   0.16456E+02;   0.11949E+01;   0.15113E+02;   0.19516E+02;   0.94236E+00;   0.60137E+00;   0.81306E+00;   0.27477E+00;   0.82430E+00;   0.81862E+01
 07/18/2002;  020000;Kansas               ;   0.33899E+03;   0.64087E+02;   0.14636E+02;   0.32986E-01;   0.26909E+00;   0.23399E-01;   0.52894E+00;   0.45994E-01;   0.22967E+00;   0.25552E-01;   0.54419E+00;
0.45376E+01;   0.11725E+03;   0.52286E+01;   0.79361E+01;   0.62284E+01;   0.41750E+00;   0.62972E+01;   0.77912E+01;   0.40623E+00;   0.26316E+00;   0.35579E+00;   0.11947E+00;   0.35841E+00;   0.29171E+01
 07/18/2002;  021000;Kentucky             ;   0.15337E+04;   0.27560E+03;   0.62246E+02;   0.13491E+00;   0.11064E+01;   0.96205E-01;   0.21778E+01;   0.18938E+00;   0.93712E+00;   0.10090E+00;   0.22881E+01;
0.19109E+02;   0.48183E+03;   0.21331E+02;   0.32183E+02;   0.25718E+02;   0.12942E+01;   0.24800E+02;   0.47114E+02;   0.17194E+01;   0.11076E+01;   0.14974E+01;   0.50413E+00;   0.15124E+01;   0.12000E+02
 07/18/2002;  022000;Louisiana            ;   0.11280E+04;   0.22796E+03;   0.46610E+02;   0.11207E+00;   0.10176E+01;   0.88490E-01;   0.20016E+01;   0.17405E+00;   0.75393E+00;   0.84424E-01;   0.18639E+01;
0.14759E+02;   0.37016E+03;   0.16988E+02;   0.25710E+02;   0.19718E+02;   0.11888E+01;   0.21426E+02;   0.20646E+02;   0.13182E+01;   0.86648E+00;   0.11715E+01;   0.40356E+00;   0.12107E+01;   0.93644E+01
 07/18/2002;  024000;Maryland             ;   0.11161E+04;   0.21532E+03;   0.38813E+02;   0.10011E+00;   0.82231E+00;   0.71505E-01;   0.16290E+01;   0.14165E+00;   0.93376E+00;   0.10318E+00;   0.17835E+01;
0.19257E+02;   0.37891E+03;   0.14451E+02;   0.20774E+02;   0.20863E+02;   0.14530E+01;   0.22386E+02;   0.21942E+02;   0.16335E+01;   0.11022E+01;   0.14902E+01;   0.49179E+00;   0.14754E+01;   0.10426E+02
 07/18/2002;  025000;Massachusetts        ;   0.71193E+02;   0.15044E+02;   0.27185E+01;   0.34112E-01;   0.51692E-01;   0.44950E-02;   0.10060E+00;   0.87482E-02;   0.74837E-01;   0.80771E-02;   0.50848E+00;
0.15129E+01;   0.26977E+02;   0.10196E+01;   0.11938E+01;   0.12214E+01;   0.94782E-01;   0.13237E+01;   0.16699E+01;   0.12691E+00;   0.86727E-01;   0.11725E+00;   0.38218E-01;   0.11465E+00;   0.70153E+00
 07/18/2002;  026000;Michigan             ;   0.30325E+04;   0.46791E+03;   0.12094E+03;   0.23226E+00;   0.17997E+01;   0.15649E+00;   0.35275E+01;   0.30674E+00;   0.16195E+01;   0.18528E+00;   0.38058E+01;
0.31729E+02;   0.21293E+04;   0.43636E+02;   0.90390E+02;   0.21223E+02;   0.13597E+01;   0.38574E+02;   0.39295E+02;   0.28780E+01;   0.18403E+01;   0.24881E+01;   0.82752E+00;   0.24826E+01;   0.16640E+02
 07/18/2002;  027000;Minnesota            ;   0.24769E+03;   0.40728E+02;   0.89434E+01;   0.20723E-01;   0.16273E+00;   0.14151E-01;   0.31969E+00;   0.27800E-01;   0.16093E+00;   0.18526E-01;   0.36146E+00;
0.30053E+01;   0.85319E+02;   0.36856E+01;   0.51856E+01;   0.53090E+01;   0.31183E+00;   0.42791E+01;   0.58112E+01;   0.27596E+00;   0.17419E+00;   0.23551E+00;   0.77859E-01;   0.23358E+00;   0.24991E+01
 07/18/2002;  028000;Mississippi          ;   0.10310E+04;   0.19988E+03;   0.39965E+02;   0.97987E-01;   0.92219E+00;   0.80191E-01;   0.18246E+01;   0.15866E+00;   0.63535E+00;   0.68167E-01;   0.16038E+01;
0.13290E+02;   0.30753E+03;   0.13693E+02;   0.21293E+02;   0.20691E+02;   0.12131E+01;   0.17140E+02;   0.32424E+02;   0.11501E+01;   0.78142E+00;   0.10565E+01;   0.36230E+00;   0.10869E+01;   0.83088E+01
 07/18/2002;  029000;Missouri             ;   0.17403E+04;   0.35379E+03;   0.72474E+02;   0.18131E+00;   0.15854E+01;   0.13786E+00;   0.31176E+01;   0.27110E+00;   0.12466E+01;   0.13908E+00;   0.30274E+01;
0.24533E+02;   0.63977E+03;   0.28525E+02;   0.41000E+02;   0.31094E+02;   0.18586E+01;   0.33827E+02;   0.33656E+02;   0.21929E+01;   0.14323E+01;   0.19364E+01;   0.65957E+00;   0.19788E+01;   0.14296E+02
 07/18/2002;  031000;Nebraska             ;   0.13102E+01;   0.29710E+00;   0.56305E-01;   0.14426E-03;   0.15314E-02;   0.13317E-03;   0.30149E-02;   0.26217E-03;   0.93297E-03;   0.10479E-03;   0.24809E-02;
0.18271E-01;   0.45972E+00;   0.21244E-01;   0.31253E-01;   0.27038E-01;   0.23404E-02;   0.26108E-01;   0.32392E-01;   0.16223E-02;   0.10913E-02;   0.14755E-02;   0.52759E-03;   0.15828E-02;   0.12812E-01
 07/18/2002;  034000;New Jersey           ;   0.13850E+04;   0.26610E+03;   0.50759E+02;   0.13451E+00;   0.10713E+01;   0.93157E-01;   0.21841E+01;   0.18992E+00;   0.11893E+01;   0.12058E+00;   0.22873E+01;
0.25348E+02;   0.48991E+03;   0.19657E+02;   0.26454E+02;   0.27397E+02;   0.17297E+01;   0.30294E+02;   0.31938E+02;   0.21644E+01;   0.14348E+01;   0.19398E+01;   0.61784E+00;   0.18535E+01;   0.12776E+02
 07/18/2002;  036000;New York             ;   0.19016E+04;   0.41003E+03;   0.70383E+02;   0.18428E+00;   0.17078E+01;   0.14851E+00;   0.34543E+01;   0.30037E+00;   0.16722E+01;   0.18636E+00;   0.31680E+01;
0.34526E+02;   0.83767E+03;   0.34632E+02;   0.40964E+02;   0.64067E+02;   0.28235E+01;   0.87697E+02;   0.58931E+02;   0.28911E+01;   0.19690E+01;   0.26621E+01;   0.86438E+00;   0.25931E+01;   0.12668E+02
 07/18/2002;  037000;North Carolina       ;   0.29024E+04;   0.54058E+03;   0.99308E+02;   0.26048E+00;   0.17444E+01;   0.15169E+00;   0.34160E+01;   0.29704E+00;   0.21152E+01;   0.25233E+00;   0.45741E+01;
0.39058E+02;   0.12183E+04;   0.51249E+02;   0.75709E+02;   0.77419E+02;   0.55694E+01;   0.78797E+02;   0.69244E+02;   0.36442E+01;   0.22489E+01;   0.30405E+01;   0.98572E+00;   0.29572E+01;   0.34262E+02
 07/18/2002;  039000;Ohio                 ;   0.27543E+04;   0.49051E+03;   0.10760E+03;   0.26177E+00;   0.19531E+01;   0.16983E+00;   0.38371E+01;   0.33366E+00;   0.18741E+01;   0.20404E+00;   0.43975E+01;
0.38674E+02;   0.96048E+03;   0.44352E+02;   0.60350E+02;   0.58516E+02;   0.32238E+01;   0.51871E+02;   0.78762E+02;   0.34644E+01;   0.22122E+01;   0.29909E+01;   0.98011E+00;   0.29403E+01;   0.27234E+02
 07/18/2002;  040000;Oklahoma             ;   0.22291E+03;   0.50960E+02;   0.98073E+01;   0.24628E-01;   0.25715E+00;   0.22361E-01;   0.50617E+00;   0.44015E-01;   0.15876E+00;   0.17946E-01;   0.41709E+00;
0.30642E+01;   0.80349E+02;   0.35986E+01;   0.54450E+01;   0.40090E+01;   0.20126E+00;   0.43114E+01;   0.40183E+01;   0.27250E+00;   0.18326E+00;   0.24776E+00;   0.88597E-01;   0.26579E+00;   0.18294E+01
 07/18/2002;  042000;Pennsylvania         ;   0.25916E+04;   0.50284E+03;   0.10560E+03;   0.20680E+00;   0.21557E+01;   0.18745E+00;   0.42388E+01;   0.36859E+00;   0.18841E+01;   0.21049E+00;   0.35592E+01;
0.38001E+02;   0.95749E+03;   0.45368E+02;   0.60367E+02;   0.63910E+02;   0.42901E+01;   0.59928E+02;   0.80717E+02;   0.35925E+01;   0.21927E+01;   0.29645E+01;   0.98859E+00;   0.29658E+01;   0.29430E+02
 07/18/2002;  044000;Rhode Island         ;   0.16042E+03;   0.25285E+02;   0.57163E+01;   0.13104E-01;   0.56618E-01;   0.49233E-02;   0.10905E+00;   0.94829E-02;   0.11081E+00;   0.11601E-01;   0.22100E+00;
0.24521E+01;   0.70501E+02;   0.32956E+01;   0.38973E+01;   0.40294E+01;   0.27717E+00;   0.42557E+01;   0.39121E+01;   0.23719E+00;   0.13865E+00;   0.18745E+00;   0.60056E-01;   0.18017E+00;   0.15185E+01
 07/18/2002;  045000;South Carolina       ;   0.15094E+04;   0.25930E+03;   0.54499E+02;   0.12657E+00;   0.10752E+01;   0.93491E-01;   0.21179E+01;   0.18416E+00;   0.88601E+00;   0.96848E-01;   0.21716E+01;
0.18206E+02;   0.47199E+03;   0.20658E+02;   0.31729E+02;   0.29612E+02;   0.17866E+01;   0.25381E+02;   0.35726E+02;   0.16265E+01;   0.10532E+01;   0.14239E+01;   0.47768E+00;   0.14330E+01;   0.13649E+02
 07/18/2002;  047000;Tennessee            ;   0.19984E+04;   0.41453E+03;   0.82966E+02;   0.19781E+00;   0.16105E+01;   0.14004E+00;   0.31666E+01;   0.27535E+00;   0.13777E+01;   0.16115E+00;   0.32348E+01;
0.25583E+02;   0.75172E+03;   0.35585E+02;   0.49887E+02;   0.49320E+02;   0.24861E+01;   0.45292E+02;   0.54455E+02;   0.24598E+01;   0.14997E+01;   0.20277E+01;   0.68614E+00;   0.20584E+01;   0.21906E+02
 07/18/2002;  048000;Texas                ;   0.17294E+04;   0.34650E+03;   0.67809E+02;   0.18189E+00;   0.14651E+01;   0.12740E+00;   0.28793E+01;   0.25038E+00;   0.12884E+01;   0.14293E+00;   0.30313E+01;
0.25567E+02;   0.59358E+03;   0.27986E+02;   0.38324E+02;   0.31442E+02;   0.17327E+01;   0.35808E+02;   0.31139E+02;   0.22892E+01;   0.14787E+01;   0.19992E+01;   0.66764E+00;   0.20029E+01;   0.14742E+02
 07/18/2002;  051000;Virginia             ;   0.22024E+04;   0.36674E+03;   0.68770E+02;   0.18232E+00;   0.10479E+01;   0.91122E-01;   0.20452E+01;   0.17784E+00;   0.14238E+01;   0.15163E+00;   0.33009E+01;
0.29962E+02;   0.76366E+03;   0.33918E+02;   0.46853E+02;   0.39289E+02;   0.26947E+01;   0.41808E+02;   0.33972E+02;   0.27106E+01;   0.16923E+01;   0.22880E+01;   0.72568E+00;   0.21770E+01;   0.19706E+02
 07/18/2002;  054000;West Virginia        ;   0.54159E+03;   0.95221E+02;   0.20965E+02;   0.48766E-01;   0.37544E+00;   0.32647E-01;   0.73748E+00;   0.64129E-01;   0.36718E+00;   0.41804E-01;   0.84695E+00;
0.71142E+01;   0.21313E+03;   0.85913E+01;   0.13258E+02;   0.10415E+02;   0.56082E+00;   0.96253E+01;   0.10815E+02;   0.65343E+00;   0.41107E+00;   0.55577E+00;   0.18280E+00;   0.54841E+00;   0.53384E+01
 07/18/2002;  055000;Wisconsin            ;   0.88662E+03;   0.15376E+03;   0.32948E+02;   0.85778E-01;   0.57421E+00;   0.49931E-01;   0.11275E+01;   0.98040E-01;   0.62083E+00;   0.66332E-01;   0.15154E+01;
0.14081E+02;   0.37304E+03;   0.14209E+02;   0.18462E+02;   0.12295E+02;   0.12339E+01;   0.10552E+02;   0.16342E+02;   0.12586E+01;   0.79195E+00;   0.10707E+01;   0.34047E+00;   0.10214E+01;   0.85330E+01
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Table A.5 – ASIP State typical 2002, 2009, and 2012 base case July Daily SO2 Emissions (Tons/Day)

July 2002 Daily SO2 Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	1,175.8	264.3	103.1	24.3	21.9	2.1	1,591.5
Florida	1,189.2	353.9	90.9	74.5	67.0	8.6	1,784.1
Georgia	1,453.1	153.4	159.1	32.8	35.1	0.5	1,834.0
Kentucky	1,381.1	104.7	137.4	42.6	19.0	0.1	1,684.8
Mississippi	156.6	102.4	0.6	33.7	14.6	0.0	307.8
North Carolina	1,352.1	142.7	8.6	29.2	39.7	0.2	1,572.4
South Carolina	598.8	161.3	30.3	17.2	19.0	0.2	826.7
Tennessee	885.3	218.7	77.9	33.8	29.3	0.0	1,244.8
Virginia	661.2	186.4	294.2	32.2	23.1	0.1	1,197.3
West Virginia	1,369.0	150.9	26.9	7.0	7.8	0.0	1,561.6
ASIP Total	**10,222.2**	**1,838.6**	**929.0**	**327.2**	**276.3**	**11.9**	**13,605.2**

July 2009 Daily SO2 Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	1,058.0	277.4	95.7	10.1	2.6	2.1	1,445.9
Florida	898.1	174.1	80.4	27.6	8.4	8.6	1,197.3
Georgia	1,139.0	150.8	159.5	8.9	5.1	0.6	1,463.8
Kentucky	764.4	100.2	141.4	25.8	2.4	0.0	1,034.2
Mississippi	198.8	74.2	0.6	20.2	1.7	0.0	295.5
North Carolina	675.9	145.1	9.4	6.5	4.8	0.2	842.0
South Carolina	360.0	148.8	30.7	5.3	2.3	0.2	547.4
Tennessee	715.7	178.7	79.2	16.4	3.4	0.0	993.4
Virginia	498.0	172.9	294.4	6.1	3.5	0.1	975.1
West Virginia	733.0	155.3	28.6	1.2	0.9	0.0	919.1
ASIP Total	**7,041.0**	**1,577.5**	**920.0**	**128.1**	**35.1**	**11.9**	**9,713.5**

July 2012 Daily SO2 Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	710.6	280.2	97.2	7.9	2.1	2.1	1,100.1
Florida	903.0	178.7	81.6	20.1	7.2	8.6	1,199.1
Georgia	649.3	158.0	161.3	4.9	4.2	0.6	978.2
Kentucky	708.5	105.0	143.1	23.3	1.8	0.0	981.8
Mississippi	147.1	79.4	0.6	18.1	1.3	0.0	246.6
North Carolina	413.5	149.6	9.7	2.7	4.1	0.2	580.0
South Carolina	288.9	155.3	31.1	3.4	1.9	0.2	480.7
Tennessee	521.4	182.4	80.4	13.8	2.7	0.0	800.6
Virginia	303.6	166.5	297.6	1.9	3.1	0.1	772.8
West Virginia	584.4	129.5	29.2	0.3	0.7	0.0	744.1
ASIP Total	**5,230.3**	**1,584.6**	**931.9**	**96.2**	**29.1**	**11.9**	**7,884.1**

Table A.6 – ASIP State typical 2002, 2009, and 2012 base case July Daily NOx Emissions (Tons/Day)

July 2002 Daily NOx Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	397.3	230.5	17.0	210.1	483.8	11.8	1,350.5
Florida	628.7	235.5	70.1	645.2	1,457.4	46.0	3,082.9
Georgia	350.8	140.7	78.9	338.7	936.8	9.1	1,855.0
Kentucky	438.1	122.0	157.1	323.4	459.6	0.2	1,500.4
Mississippi	115.1	166.0	2.3	267.9	340.5	0.1	891.9
North Carolina	353.3	138.3	69.7	302.4	973.1	0.7	1,837.5
South Carolina	227.1	124.8	46.0	171.8	428.3	2.3	1,000.4
Tennessee	365.8	179.7	30.1	311.8	711.0	0.0	1,598.4
Virginia	209.8	171.4	117.2	246.6	660.8	0.6	1,406.3
West Virginia	498.5	131.7	26.4	101.9	173.3	0.0	931.7
ASIP Total	**3,584.3**	**1,640.7**	**614.8**	**2,919.7**	**6,624.6**	**70.7**	**15,454.9**

July 2009 Daily NOx Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	216.0	192.9	17.7	181.1	308.9	11.8	928.4
Florida	352.4	164.4	67.7	574.6	980.2	46.0	2,185.2
Georgia	244.4	145.0	81.6	293.3	642.1	9.1	1,415.5
Kentucky	249.0	104.4	167.4	290.3	296.9	0.0	1,108.0
Mississippi	130.1	154.9	2.3	241.2	213.6	0.1	742.2
North Carolina	163.3	105.5	75.1	253.4	591.9	0.8	1,189.9
South Carolina	126.1	121.3	45.6	146.5	280.0	2.3	721.8
Tennessee	170.3	161.5	31.5	275.8	450.1	0.0	1,089.2
Virginia	167.1	155.1	119.9	211.8	400.7	0.6	1,055.2
West Virginia	203.1	107.5	28.1	91.5	103.8	0.0	534.0
ASIP Total	**2,021.7**	**1,412.5**	**637.0**	**2,559.5**	**4,268.1**	**70.6**	**10,969.5**

July 2012 Daily NOx Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	198.6	197.7	18.4	164.6	224.3	11.8	815.4
Florida	368.5	160.6	69.6	527.1	708.0	46.0	1,879.8
Georgia	216.1	146.0	83.6	265.1	476.9	9.1	1,196.6
Kentucky	233.6	107.7	170.4	271.5	207.4	0.0	990.5
Mississippi	108.6	159.6	2.4	226.7	153.0	0.1	650.5
North Carolina	173.0	106.4	77.9	223.7	423.6	0.8	1,005.3
South Carolina	140.2	124.8	46.5	131.1	203.1	2.3	647.9
Tennessee	180.1	166.4	32.3	254.2	323.5	0.0	956.5
Virginia	153.1	154.0	122.4	189.7	293.6	0.6	913.2
West Virginia	236.8	107.1	28.9	85.9	74.9	0.0	533.6
ASIP Total	**2,008.5**	**1,430.2**	**652.3**	**2,339.6**	**3,088.2**	**70.6**	**9,589.4**

Table A.7 – ASIP State typical 2002, 2009, and 2012 base case July Daily $PM_{2.5}$ Emissions (Tons/Day)

July 2002 Daily PM-2.5 Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	11.3	53.0	74.0	15.4	8.4	44.9	207.0
Florida	41.2	59.5	93.6	62.4	24.1	180.3	461.1
Georgia	14.0	48.6	136.1	29.4	15.7	33.1	276.9
Kentucky	7.5	31.9	85.1	20.3	8.2	1.0	153.9
Mississippi	3.6	27.0	81.5	15.4	6.3	0.4	134.2
North Carolina	45.6	29.9	62.9	26.0	13.9	2.8	181.1
South Carolina	49.8	28.6	52.3	14.0	7.5	11.9	164.1
Tennessee	31.8	76.3	77.8	22.3	11.9	0.0	220.2
Virginia	7.6	28.3	48.8	30.0	9.5	2.2	126.4
West Virginia	6.0	36.5	20.7	5.9	3.0	0.0	72.0
ASIP Total	**218.4**	**419.5**	**732.8**	**241.1**	**108.7**	**276.5**	**1,997.0**

July 2009 Daily PM-2.5 Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	11.1	52.7	77.4	12.7	6.2	44.9	204.9
Florida	43.2	74.5	104.9	51.9	19.0	180.3	473.7
Georgia	29.1	54.8	148.5	24.9	11.7	33.2	302.1
Kentucky	12.2	32.3	88.3	17.0	5.8	0.0	155.5
Mississippi	14.3	25.1	83.4	12.7	4.5	0.4	140.5
North Carolina	43.8	29.8	79.5	20.9	10.5	3.1	187.6
South Carolina	47.3	25.5	55.7	11.4	5.6	11.9	157.5
Tennessee	36.2	75.0	81.6	18.6	8.3	0.0	219.8
Virginia	12.4	28.0	51.6	25.0	6.9	2.2	126.1
West Virginia	8.2	21.0	20.8	5.1	2.1	0.0	57.2
ASIP Total	**257.8**	**418.7**	**791.6**	**200.1**	**80.7**	**276.0**	**2,024.9**

July 2012 Daily PM-2.5 Emissions (Tons/Day)

State	EGU	Other Point	Area	Nonroad	Onroad	Fire	All Sectors
Alabama	12.6	33.5	79.2	11.6	5.0	44.9	186.9
Florida	45.0	76.8	109.8	48.2	16.2	180.3	476.2
Georgia	31.4	57.1	153.8	23.1	9.7	33.2	308.2
Kentucky	13.8	34.4	89.7	15.7	4.5	0.0	158.0
Mississippi	14.6	24.2	84.0	11.7	3.6	0.4	138.6
North Carolina	48.2	32.9	82.0	18.9	8.6	3.1	193.7
South Carolina	50.5	28.0	57.3	10.5	4.6	11.9	162.7
Tennessee	36.7	81.8	83.3	17.2	6.7	0.0	225.6
Virginia	14.3	30.2	52.9	23.2	5.9	2.2	128.7
West Virginia	8.4	20.8	21.2	4.7	1.7	0.0	56.8
ASIP Total	**275.4**	**419.8**	**813.2**	**184.7**	**66.5**	**276.0**	**2,035.5**

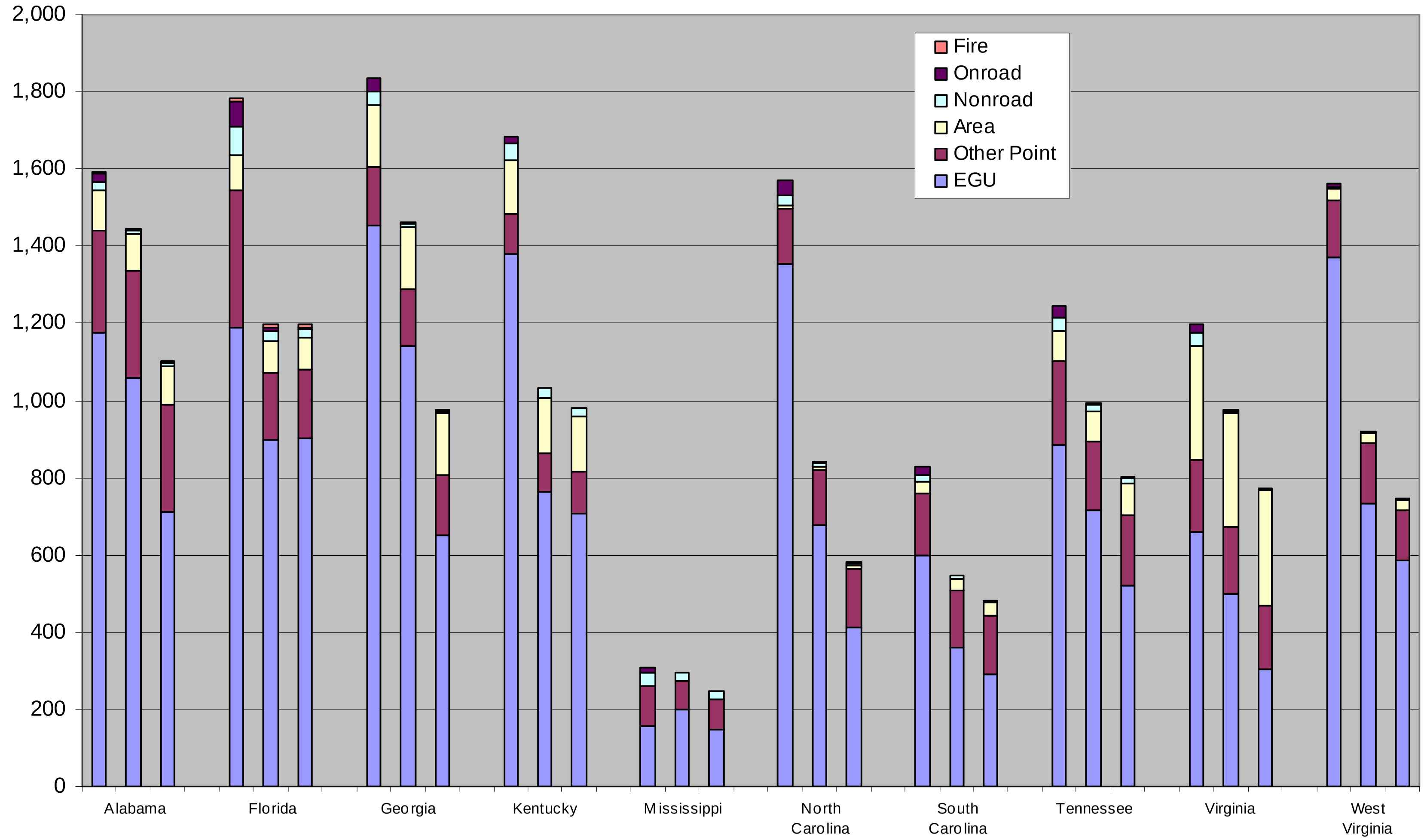


Figure A-7. ASIP State July Daily SO2 Emissions Summary by State and Source Sector. Stacked Bars 2002, 2009, 2012 from left to right.

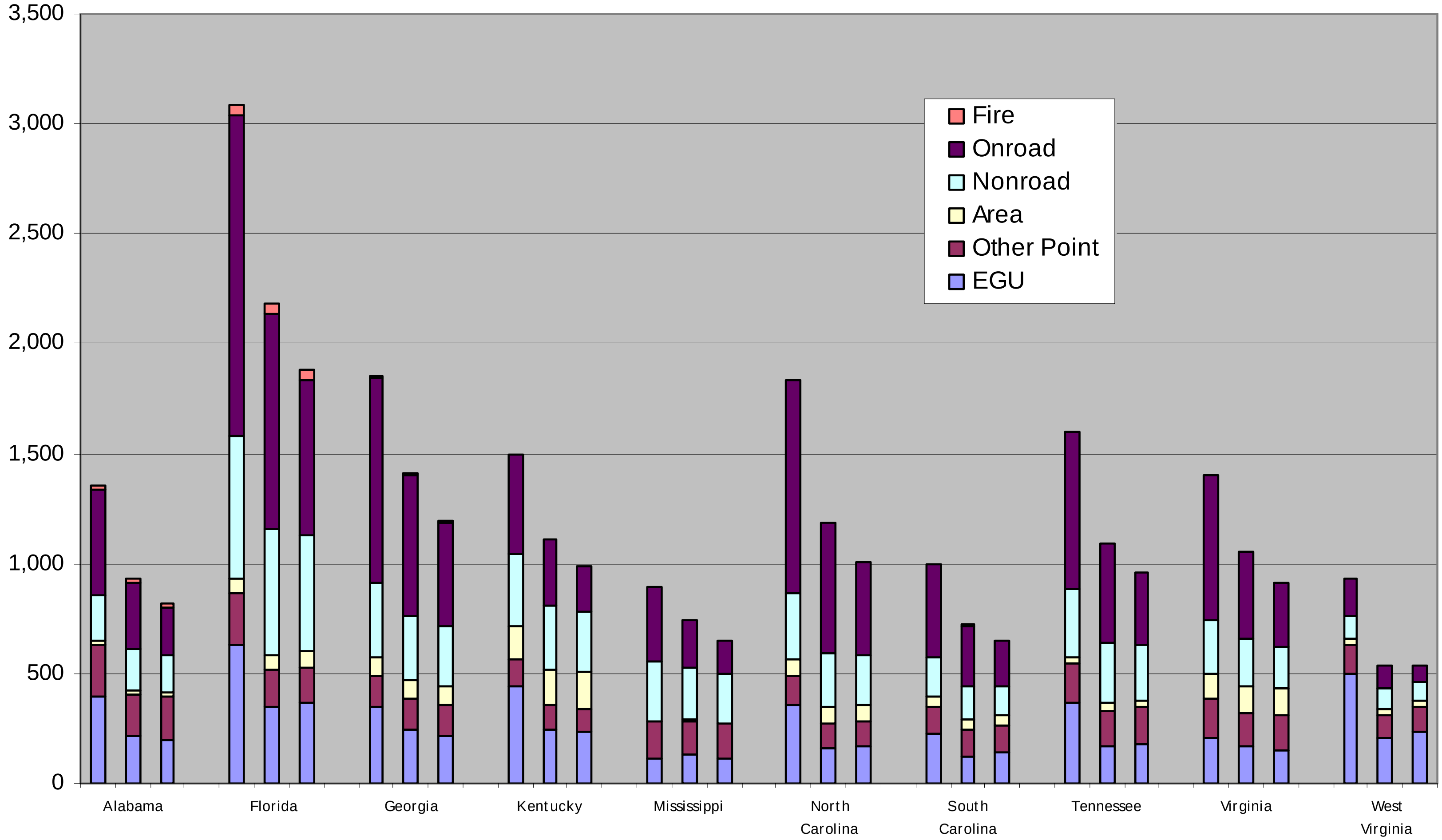


Figure A-8. ASIP State July Daily NOx Emissions Summary by State and Source Sector. Stacked Bars 2002, 2009, 2012 from left to right.

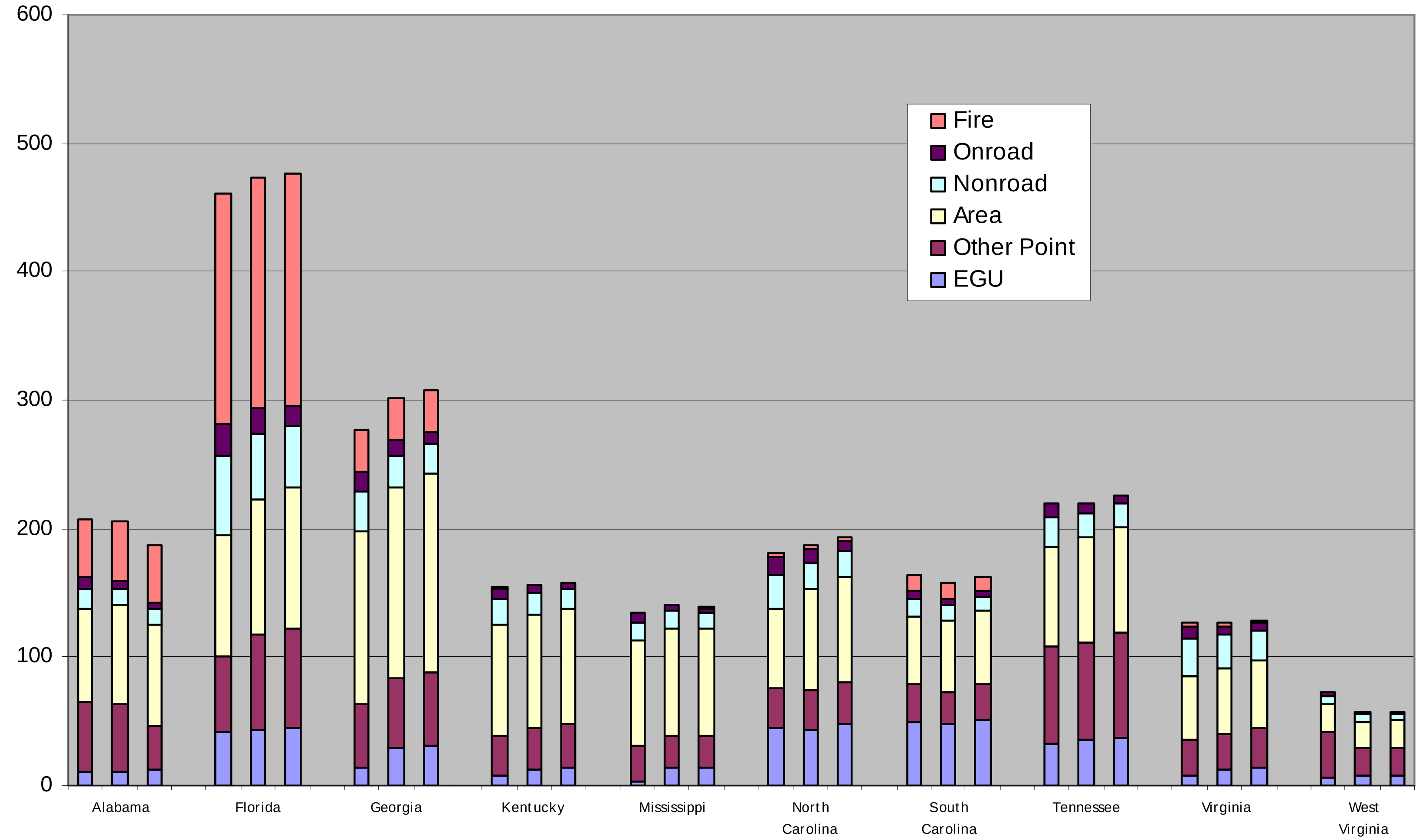


Figure A-9. ASIP State July Daily $PM_{2.5}$ Emissions Summary by State and Source Sector. Stacked Bars 2002, 2009, 2012 from left to right.

Table A.8 – Selected ASIP Border State typical 2002, 2009, and 2012 base case July Daily SO2 Emissions (Tons/Day)

July 2002 Daily SO2 Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	263.0	1.3	11.9	1.9	2.1	280.3
Maryland	1,099.8	16.8	26.7	19.2	0.1	1,162.6
New Jersey	245.3	8.0	49.0	23.0	0.0	325.3
Pennsylvania	2,841.5	73.8	30.9	38.7	0.2	2,985.0
Arkansas	272.9	77.6	18.9	15.4	2.1	386.9
Louisiana	867.5	232.5	50.8	19.6	0.1	1,170.4
Missouri	1,162.2	120.7	34.0	20.1	0.0	1,337.0
Illinois	1,825.5	10.6	66.0	28.6	0.5	1,931.2
Indiana	3,030.1	161.1	34.6	27.7	0.5	3,254.0
Ohio	3,558.2	22.3	60.2	48.8	0.2	3,689.7

July 2009 Daily SO2 Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	159.1	1.4	8.0	0.3	2.1	171.0
Maryland	345.8	18.7	5.4	1.9	0.6	372.3
New Jersey	136.7	8.0	10.7	2.4	0.0	157.9
Pennsylvania	947.8	78.1	6.2	3.8	0.0	1,035.8
Arkansas	324.5	75.7	3.5	1.5	2.1	407.2
Louisiana	1,078.3	232.4	26.9	2.0	0.6	1,340.2
Missouri	1,257.1	120.7	6.5	3.2	0.0	1,387.5
Illinois	1,467.0	11.4	13.0	4.5	0.6	1,496.5
Indiana	1,828.5	152.7	6.9	3.2	0.6	1,991.9
Ohio	1,841.2	34.5	17.0	4.7	0.2	1,897.6

July 2012 Daily SO2 Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	176.3	1.5	7.8	0.4	2.1	188.0
Maryland	320.6	19.3	2.0	1.8	0.6	344.2
New Jersey	166.1	8.0	3.6	2.4	0.0	180.2
Pennsylvania	818.1	78.5	2.0	3.6	0.0	902.1
Arkansas	392.2	75.9	8.6	1.2	2.1	480.1
Louisiana	801.4	6.4	85.7	1.6	0.6	895.7
Missouri	1,096.5	111.3	16.2	2.5	0.0	1,226.5
Illinois	1,416.4	10.9	23.6	3.8	0.6	1,455.2
Indiana	1,488.2	161.0	12.6	2.6	0.6	1,664.9
Ohio	1,546.3	42.3	27.2	3.8	0.2	1,619.8

Table A.9 – Selected ASIP Border State typical 2002, 2009, and 2012 base case July Daily NOx Emissions (Tons/Day)

July 2002 Daily NOx Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	63.0	4.0	53.8	75.5	11.8	208.1
Maryland	349.5	21.5	146.8	378.0	0.2	896.0
New Jersey	193.3	21.0	231.5	462.4	0.1	908.3
Pennsylvania	846.0	55.1	370.2	1,043.3	0.7	2,315.3
Arkansas	197.5	59.9	203.7	499.7	11.8	972.6
Louisiana	936.6	284.8	349.0	644.5	0.2	2,215.2
Missouri	600.2	64.2	347.3	608.3	0.1	1,620.2
Illinois	962.5	54.4	733.1	813.3	9.1	2,572.3
Indiana	1,171.8	53.3	381.9	628.8	9.1	2,244.9
Ohio	1,411.7	40.5	602.3	931.8	0.7	2,987.0

July 2009 Daily NOx Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	61.3	4.2	50.1	46.9	11.8	174.2
Maryland	115.5	23.3	123.8	229.8	9.1	501.5
New Jersey	98.3	21.4	191.8	285.8	0.1	597.4
Pennsylvania	546.3	57.6	279.2	548.2	0.0	1,431.4
Arkansas	198.7	63.3	167.3	178.6	11.8	619.8
Louisiana	910.8	287.9	320.6	245.0	9.1	1,773.4
Missouri	459.7	64.2	295.6	382.3	0.1	1,202.0
Illinois	471.3	60.8	568.8	492.2	9.1	1,602.2
Indiana	633.0	55.9	298.0	375.9	9.1	1,371.9
Ohio	513.8	48.8	463.3	534.9	0.8	1,561.6

July 2012 Daily NOx Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	65.6	4.3	48.0	32.8	11.8	162.6
Maryland	111.5	24.0	111.6	87.7	9.1	344.0
New Jersey	106.3	16.1	173.2	180.4	0.1	476.1
Pennsylvania	536.3	58.3	246.7	225.1	0.0	1,066.4
Arkansas	160.9	49.8	177.8	155.8	11.8	556.1
Louisiana	679.0	67.5	650.5	198.7	9.1	1,604.8
Missouri	350.0	63.3	358.2	267.6	0.1	1,039.1
Illinois	495.9	55.0	589.8	358.4	9.1	1,508.1
Indiana	602.8	54.8	300.2	266.7	9.1	1,233.6
Ohio	501.4	49.8	515.5	389.0	0.8	1,456.6

Table A.10 – Selected ASIP Border State typical 2002, 2009, and 2012 base case July Daily $PM_{2.5}$ Emissions (Tons/Day)

July 2002 Daily PM-2.5 Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	13.3	4.3	3.4	1.4	44.9	67.4
Maryland	16.6	47.8	16.0	5.9	1.0	87.4
New Jersey	15.8	13.1	18.5	7.2	0.4	55.0
Pennsylvania	56.5	115.1	30.7	15.7	2.8	220.9
Arkansas	21.0	212.7	17.6	10.0	44.9	306.3
Louisiana	142.6	282.8	29.6	11.5	1.0	467.4
Missouri	28.5	584.2	40.4	10.5	0.4	664.0
Illinois	20.7	360.5	48.3	15.1	33.1	477.7
Indiana	51.2	342.5	25.9	11.2	33.1	463.9
Ohio	37.7	193.1	42.2	15.6	2.8	291.4

July 2009 Daily PM-2.5 Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	13.3	4.6	3.0	1.0	44.9	66.9
Maryland	36.4	53.3	13.5	5.0	33.2	141.4
New Jersey	23.9	13.3	15.6	6.5	0.4	59.7
Pennsylvania	131.9	125.9	25.5	11.5	0.0	294.8
Arkansas	37.7	203.0	13.3	3.8	44.9	302.7
Louisiana	173.8	282.6	22.9	5.0	33.2	517.4
Missouri	84.7	584.2	29.5	8.0	0.4	706.8
Illinois	60.3	424.7	36.6	10.3	33.2	565.1
Indiana	119.6	366.6	19.6	7.7	33.2	546.7
Ohio	127.5	200.9	32.6	10.9	3.1	375.0

July 2012 Daily PM-2.5 Emissions (Tons/Day)

State	Point	Area	Nonroad	Onroad	Fire	All Sectors
Delaware	14.2	6.1	2.9	0.8	44.9	68.9
Maryland	36.5	78.1	12.7	2.4	33.2	162.9
New Jersey	25.4	20.3	13.8	4.6	0.4	64.6
Pennsylvania	120.3	259.2	23.8	4.7	0.0	408.1
Arkansas	37.0	148.7	11.3	3.7	44.9	245.6
Louisiana	63.6	125.6	26.7	4.7	33.2	253.8
Missouri	49.6	394.1	22.1	6.3	0.4	472.6
Illinois	64.6	308.6	35.8	8.5	33.2	450.7
Indiana	122.7	310.1	18.8	6.2	33.2	490.9
Ohio	125.3	261.7	32.8	8.9	3.1	431.9

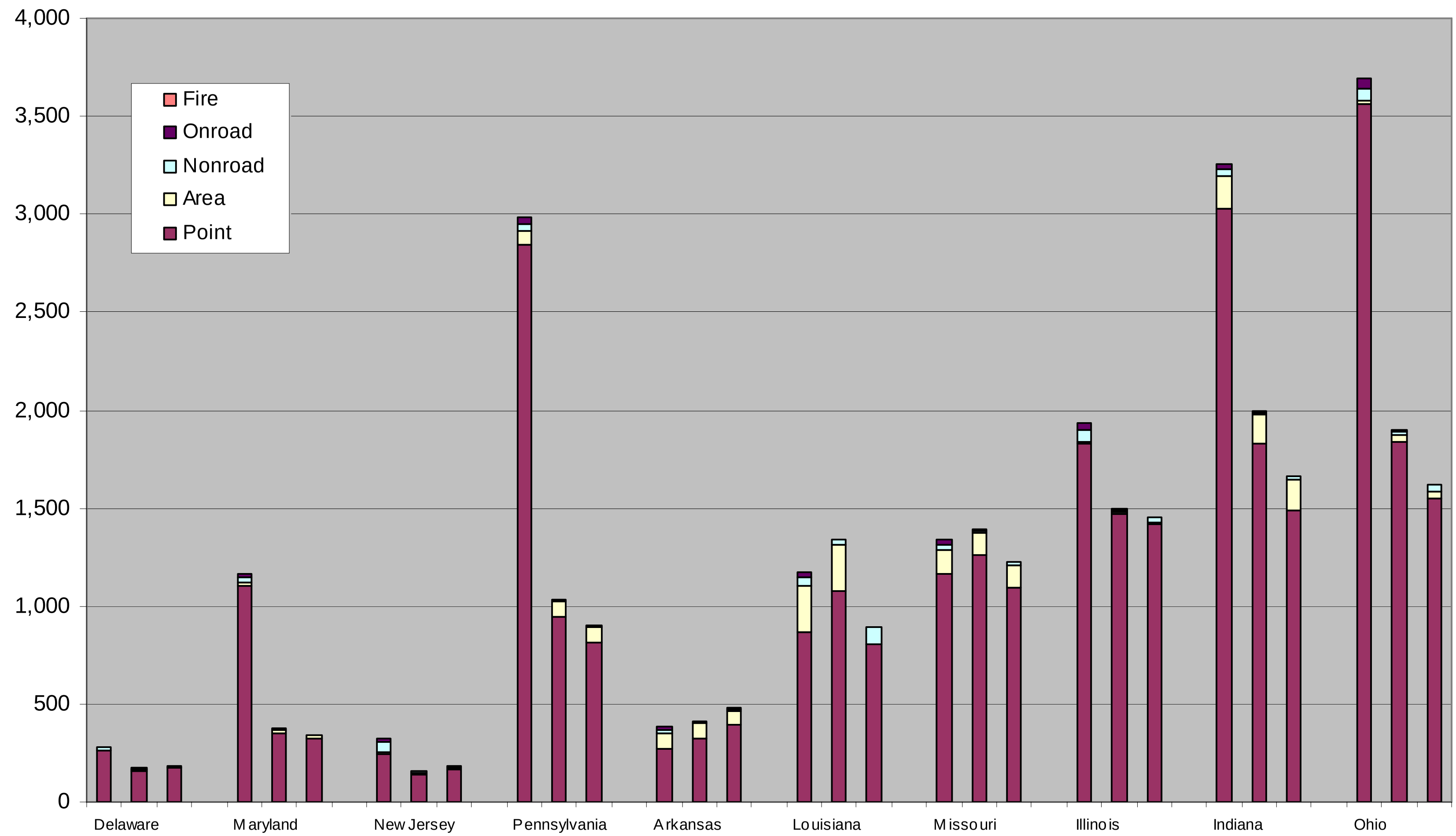


Figure A-10. Selected ASIP Border State July Daily SO2 Emissions Summary by State and Source Sector. Stacked Bars 2002, 2009, 2012 from left to right.

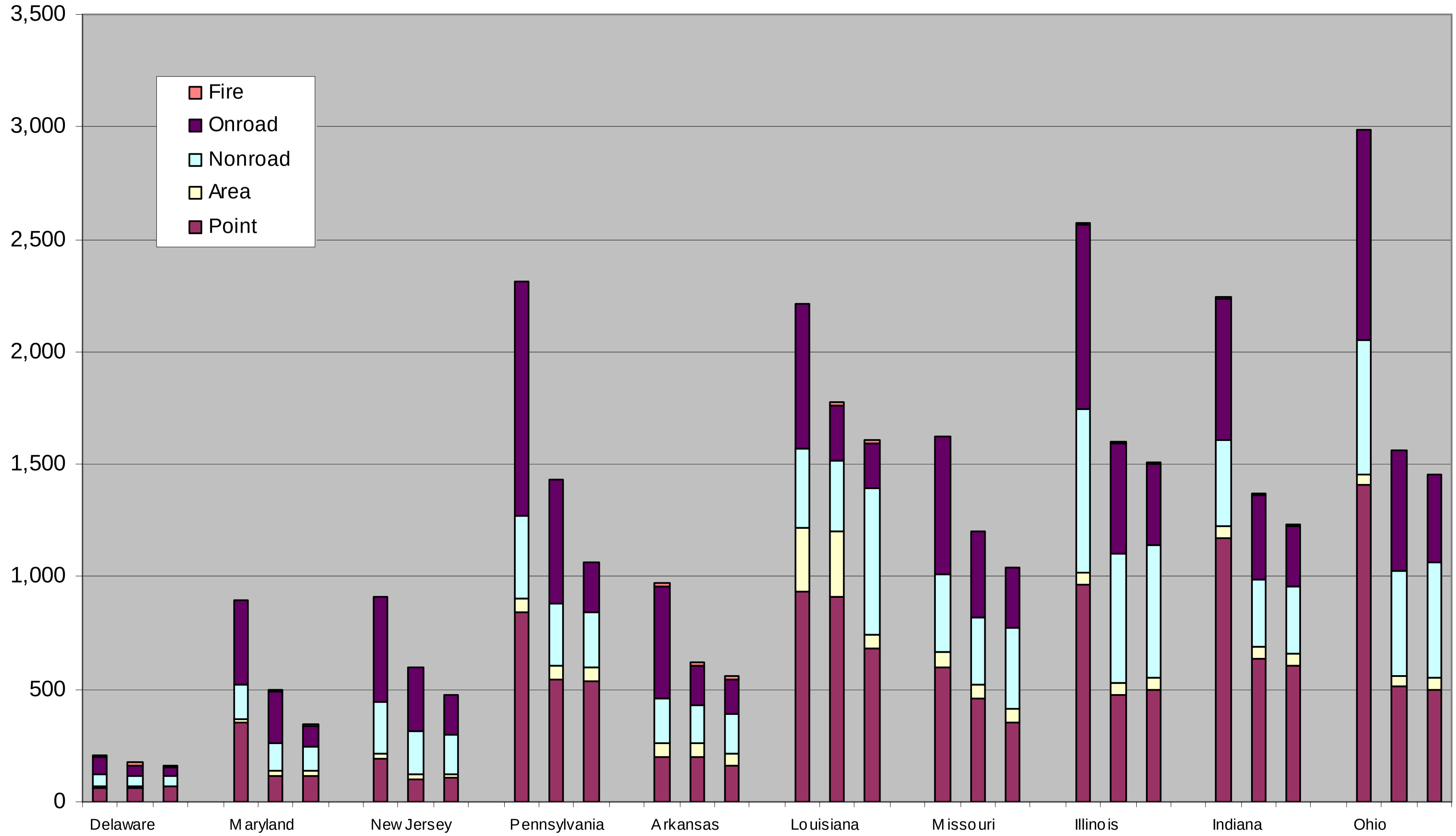


Figure A-11. Selected ASIP Border State July Daily NOx Emissions Summary by State and Source Sector. Stacked Bars 2002, 2009, 2012 from left to right.

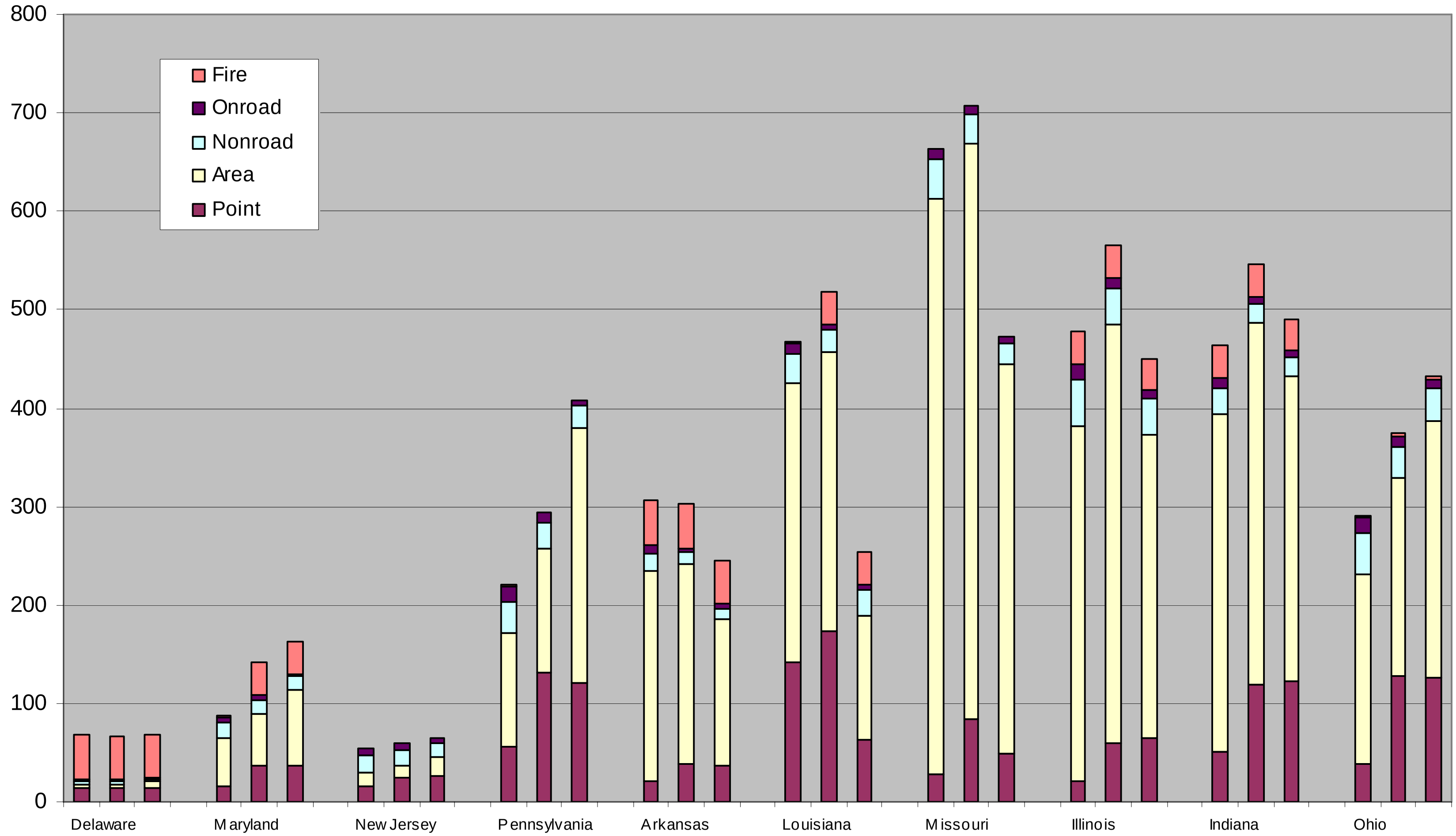


Figure A-12. Selected ASIP Border State July Daily $PM_{2.5}$ Emissions Summary by State and Source Sector. Stacked Bars 2002, 2009, 2012 from left to right.

APPENDIX B

Air Quality Model Performance Evaluation: State-by-State and Key Monitoring Site $PM_{2.5}$ Model Evaluation

B.1 OVERVIEW

The discussion of model performance evaluation in this Appendix focuses on the evaluation of the 2002 Base G2 Actual base case modeling results from the Community Multiscale Air Quality (CMAQ) modeling system Version 4.5 with SOAmods enhancement across each VISTAS state and at key $PM_{2.5}$ monitors within the VISTAS states. The CMAQ results are compared with observational data from the **S**peciated **T**rends **N**etwork (STN)[1], **F**ederal **R**eference **M**ethod (FRM) $PM_{2.5}$ mass and **S**outh **E**ast **A**erosol **R**esearch and **CH**aracterization (SEARCH) study monitoring networks. The evaluation focuses primarily on the air quality model's performance with respect to individual components of fine particulate matter ($PM_{2.5}$) and total fine particulate matter ($PM_{2.5}$) mass within $PM_{2.5}$ nonattainment areas (NAAs) in the ASIP region. Consequently, the focus is on the STN and FRM monitoring sites that are located within the $PM_{2.5}$ NAAs, although SEARCH also includes two sites in NAAs (Atlanta and Birmingham). Previously we have presented an evaluation of the CMAQ 2002 Base G2 Actual base case simulation focusing primarily on PM and visibility as part of the Visibility Improvements for States and Tribal Associations in the Southeast (VISTAS) that focused on the regional model performance and performance at Class I areas (Morris et al., 2009).

B.2 CMAQ EVALUATION METHODOLOGY

EPA's integrated ozone, $PM_{2.5}$ and regional haze modeling guidance calls for a comprehensive, multi-layered approach to model performance testing, consisting of the four major components: operational, diagnostic, mechanistic (or scientific) and probabilistic (EPA, 2007a).

B.2.1 Evaluation Approach

The CMAQ model performance evaluation effort focused on the first two components, namely:

- <u>Operational Evaluation:</u> Tests the ability of the model to estimate $PM_{2.5}$ concentrations and the components of $PM_{2.5}$ (i.e., sulfate, nitrate, ammonium, organic carbon, elemental carbon and other $PM_{2.5}$) within the $PM_{2.5}$ nonattainment areas. This evaluation examines whether the measurements are properly represented by the model predictions but does not necessarily ensure that the model is getting "the right answer for the right reason"; and
- <u>Diagnostic Evaluation:</u> Tests the ability of the model to predict PM chemical composition including PM precursors (e.g., SOx, NOx, and NH_3) and associated oxidants (e.g., ozone and nitric acid); PM size distribution; temporal variation; spatial variation; mass fluxes; and components of light extinction (i.e., scattering and absorption).

The diagnostic evaluation can also include the performance of diagnostic tests to better understand model performance and identify potential flaws in the modeling system that can be corrected. The diagnostic evaluation may also includes the use of "probing tools" to understand why the model obtains a given prediction; probing tools include Process Analysis (PA), decoupled direct method (DDM) and source apportionment (SA).

[1] The Speciated Trends Network (STN) is now referred to as the Chemical Speciation Network (CSN)

In this final model performance evaluation for the ASIP 2002 Actual Base G2 CMAQ 36/12 km base case simulation, the operational evaluation for $PM_{2.5}$ has been given the greatest attention since this is the primarily thrust of EPA's modeling guidance. However, we have also examined certain diagnostic features dealing with the model's ability to simulate sub-regional and monthly/diurnal gas phase and aerosol concentration distributions. In the course of the ASIP and VISTAS studies, numerous diagnostic sensitivity tests were performed to investigate and improve model performance. Key diagnostic tests performed are discussed and the results for the rest are available on the projects modeling website: http://pah.cert.ucr.edu/vistas/vistas2/.

B.2.2 Particulate Matter and Component Species

Fine particulate matter can be composed of varying amounts of several different species. The main components of $PM_{2.5}$ are as follows:

- Sulfate (SO4)
- Nitrate (NO3)
- Ammonium (NH4)
- Organic Carbon Matter (OCM)
- Elemental Carbon (EC)
- Soil (also known as crustal material, fine soil, major metal oxides, inorganic particulates, or other PM)
- Sea Salt (NaCl)
- Particle Bound Water (PBW)

B.2.3 Ambient Air Quality Data for ASIP Model Evaluation

A ground-level model evaluation database for 2002 was compiled by the modeling team using several routine and research-grade databases. The focus of the evaluation of the CMAQ model for use in simulating $PM_{2.5}$ mass concentrations in urban areas and NAAs. The primary monitoring networks available to evaluate this component of the CMAQ are: (a) EPA Federal Reference Method $PM_{2.5}$ and PM_{10} Mass Networks (EPA-FRM); (b) EPA Speciation Trends Network (STN) of $PM_{2.5}$ component species; and (c) two sites from the Southeastern Aerosol Research and Characterization (SEARCH). These PM monitoring networks may also provide ozone and other gas phase precursors and product species, and visibility measurements at some sites. There are also gas-phase criteria pollutant measurements in NAAs from the EPA's Air Quality System (AQS) that are available for use. In addition, there are several more monitoring networks that collect PM or PM related species that are more rural in nature, such as IMPROVE, CASTNet and NADP. The VISTAS model performance evaluation focused more on model performance at these more rural networks to perform a regional evaluation of the CMAQ 2002 Base G2 base case that is more relevant for regional haze modeling at Class I areas and is presented elsewhere (Morris et al., 2009). The study team has performed a detailed evaluation of the CMAQ 2002 base case simulation using the AQS that is available on the modeling website: http://pah.cert.ucr.edu/vistas/vistas2/mpe2.shtml. Table B-1 and Figure B-1 summarizes the species collected and locations of the monitoring sites for the FRM, STN and SEARCH monitoring networks use in the ASIP $PM_{2.5}$ model evaluation.

Table B-1a. Ambient $PM_{2.5}$ monitoring data available in $PM_{2.5}$ nonattainment areas in the ASIP region during 2002.

Monitoring Network	Chemical Species Measured	Sampling Frequency; Duration
SEARCH	24-hr PM_{25} (FRM Mass, OC, BC, SO_4, NO_3, NH_4, Elem.); 24-hr PM coarse (SO_4, NO_3, NH_4, elements); Hourly $PM_{2.5}$ (Mass, SO_4, NO_3, NH_4, EC, TC); and Hourly gases (O_3, NO, NO_2, NO_y, HNO_3, SO_2, CO)	Daily, Hourly;
EPA-FRM	Only total fine mass ($PM_{2.5}$)	1 in 3 days; 24 hr
EPA-STN	Speciated $PM_{2.5}$	Varies; Varies

B.3 MODEL PERFORMANCE STATISTICS

To quantify $PM_{2.5}$ model performance, several statistical measures were calculated and evaluated for all the monitors within each ASIP state with a NAA and at individual monitors within the NAAs. The statistical measures selected were based on the recommendations outlined in section 18.4.1 of the USEPA's *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze* (EPA, 2007a). VISTAS/ASIP has established model performance goals and criteria for $PM_{2.5}$ and components of fine particle mass based on previous model performance for ozone and fine particles that are shown in Table B-1b. EPA modeling guidance for fine particulate matter at the time noted that PM models might not be able to achieve the same level of performance as ozone models.

Table B-1b. Model performance goals and criteria for components of fine particle mass.

Fractional Bias	Fractional Error	Comment
$\leq$15%	$\leq$35%	Goal for PM model performance based on ozone model performance, considered excellent performance
$\leq$30%	$\leq$50%	Goal for PM model performance, considered good performance
$\leq$60%	$\leq$75%	Criteria for PM model performance, considered average performance. Exceeding this level of performance indicates fundamental concerns with the modeling system and triggers diagnostic evaluation.

B.4 $PM_{2.5}$ MODELING PERFORMANCE ACROSS THE ASIP STATES

In the following discussions we use selected monthly scatter plots, time series plots, soccer plots, bugle plots and model performance statistical measures from the UCR Analysis Tool application to the 2002 CMAQ Base G2 Actual base case simulation in an operational evaluation of the model for $PM_{2.5}$ mass and components of $PM_{2.5}$ within each ASIP state. These results represent just a small subset of the model performance evaluation products of the CMAQ 2002 36/12 km Base G2 base case simulation. Complete model evaluation products are available on the project website:

http://pah.cert.ucr.edu/vistas/vistas2/mpe2.shtml

The focus of the model performance evaluation in this Appendix is on $PM_{2.5}$ and $PM_{2.5}$ components within $PM_{2.5}$ nonattainment areas (NAAs) and urban areas in the ASIP region. The regional performance evaluation of the model for PM and visibility has been documented in the VISTAS Regional Haze SIP Technical Support Document (TSD; Morris et al., 2009), which in addition to the products available on the website includes:

- Regional operational and diagnostic model performance evaluation for PM and visibility across the VISTAS/ASIP region in the southeastern U.S. (Appendix B of VISTAS TSD);
- Model performance for PM and visibility at Class I areas in the VISTAS region. (Appendix C of VISTAS TSD); and
- Spatial model performance for PM components across the VISTAS/ASIP 12 km grid. (Appendix D of VISTAS TSD).

The performance of the ASIP/VISTAS CMAQ 2002 36/12 km Base G2 base case simulation for ozone has also been evaluated with the results discussed at the end of Chapter 3 with more details available at:

http://pah.cert.ucr.edu/vistas/vistas2/evaluation_results/2002ga2a.mpe/

B.4.1 Alabama

Figures B-2a-f contain scatter plots and model performance statistics for $PM_{2.5}$ component species at STN sites located in Alabama, the four quarters of 2002, Q1 (Jan-Mar), Q2 (Apr-Jun), Q3 (Jul-Sep) and Q4 (Oct-Dec) and the CMAQ 2002 36/12 km Base G2 base case simulation. Performance for SO4 is quite good with the scatter plots clustered tightly around the 1:1 line of perfect agreement (Figure B-2a) and fractional bias and error performance metrics mostly achieve the most stringent <±15% and < 35% performance goal for bias and error (Table B-1b). Performance for NO3 exhibits an underprediction tendency with fractional bias values of approximately -20% in Q1, -140% in Q2, -160% in Q4 and -30% in Q4 (Figure B-2b). The large summer NO3 underprediction bias occurs when both the model and measured NO3 values are extremely low with the modeled values near zero and with the STN NO3 observed values < 1 $\mu g/m^3$. Note that under these summer conditions, the NO3 will almost completely volatilize off the FRM filter so the FRM would measure insignificant $PM_{2.5}$ mass due to NO3. Thus, these large summer NO3 underpredictions are not a concern as NO3 is not an important component of $PM_{2.5}$ mass. Performance for NH4 is also fairly good achieving the <±30%/50% fractional bias/error goal for PM species (Figure B-2c), which is not surprising given its strong link to SO4.

With the exception of a few outliers, performance for organic carbon mass (OCM or OC) in Alabama is characterized by an underestimation bias that ranges from -40% to -70% (Figure B-2d). The reasons for the OCM underprediction includes measurement artifacts including the fact that the STN OC measurements are not blank corrected and have high uncertainties (see SANDWICH discussion in Chapter 4) and there are also large uncertainties in the OC emissions and the form of OC emissions as particles or semi-volatile organic gases. EC model performance at STN sites in Alabama is also fairly good, mostly achieving the PM model performance goal, albeit with an underestimation tendency in Q2, Q3 and Q4 (Figure B-2e).

The CMAQ performance for $PM_{2.5}$ mass at 3 STN and ~20 FRM monitoring sites in Alabama are shown in Figures B-2f and B-2g, respectively. Performance for $PM_{2.5}$ mass is generally good achieving the most stringent ozone performance goal in Q1 and Q4 and the PM goal all year round.

Time series of predicted (CMAQ 12 km results) and observed 24-hour $PM_{2.5}$ components and model performance statistics at the key North Birmingham STN site are shown in Figure B-3. As discussed in Chapter 4, this is the site with the highest projected 2009 $PM_{2.5}$ Design Value in the ASIP region. SO4 performance is quite good with annual fractional bias and errors of 6% and 29% achieving the most stringent ozone performance goal (Figure B-3a, top). The fractional bias for NO3 of -110% indicates a large underprediction bias that is driven by near zero modeled NO3 concentrations in the summer when the observed values are < 1 ug/m^3 (Figure B-3a, bottom). However, the NO3 performance in the winter, when observed values are above 1 ug/m^3 is much better. The EC and OCM performance at the North Birmingham STN site is characterized by an underprediction with fractional bias of -30% and -49%, respectively (Figure B-3b). This underprediction is due in part to uncertainties in the STN carbon measurements as well as the contributions of nearby industrial sources whose impacts are diluted across the 12 km CMAQ grid used. Performance for NH4 and $PM_{2.5}$ mass at the North Birmingham STN site are also quite good with fractional bias/error values of -5%/33% and 11%/29% achieving the more stringent ozone performance goal. The good performance of NH4 and $PM_{2.5}$ mass is not surprising given that they are closely tied to SO4 that exhibits good model performance.

Figure B-4 contains time series of predicted and observed PM components and performance statistics for the SEARCH BHM monitoring site also located at North Birmingham. Performance at the SEARCH BHM site is similar to the STN site at the same location with generally good performance for SO4, NH4 and $PM_{2.5}$ mass and an underprediction bias for EC and OCM. The SEARCH BHM site also includes performance for the "Soil" species that is greatly overestimated with annual fractional bias values of +164% (Figure B-4d, top)

Figure B-5 displays a soccer plot of monthly fractional bias versus gross error for $PM_{2.5}$ mass performance across ~20 FRM sites in Alabama and compares them with the three levels of bias/error performance goals in Table B-1b. $PM_{2.5}$ model performance is best in the winter months when the most stringent ozone < ±15%/35% bias/error goal is achieved. In the summer months the model tends to underestimate the FRM observed $PM_{2.5}$ mass by -15% to -25%, but still achieves the <±30%/50% PM model performance goal. The Bugle Plots of monthly $PM_{2.5}$ bias and error in Figure B-6 also confirm that the bias and error performance goals for PM are achieved across FRM sites in Alabama.

The $PM_{2.5}$ model performance products on the project website also include a day-by-day evaluation of the $PM_{2.5}$ model performance at STN sites. This is done with side-by-side stacked bar charts of $PM_{2.5}$ components for each sampling day in 2002 and each STN site in Alabama. These model performance displays can be found at:

> http://pah.cert.ucr.edu/vistas/vistas2/evaluation_results/2002/2002ga2a/MPE/stackbar/STN/AL_STN_stackbar_monthly.pdf

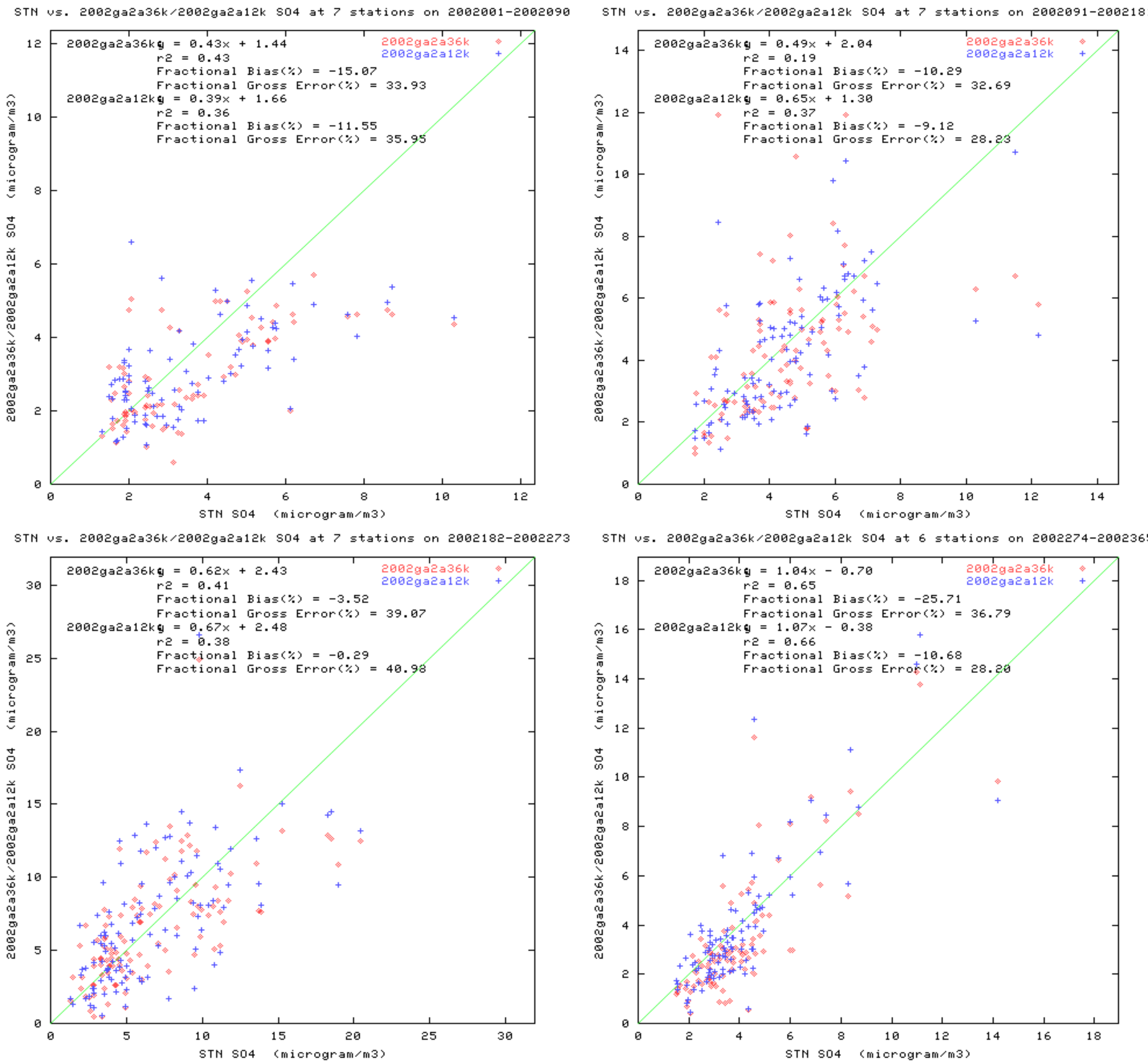


Figure B-2a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

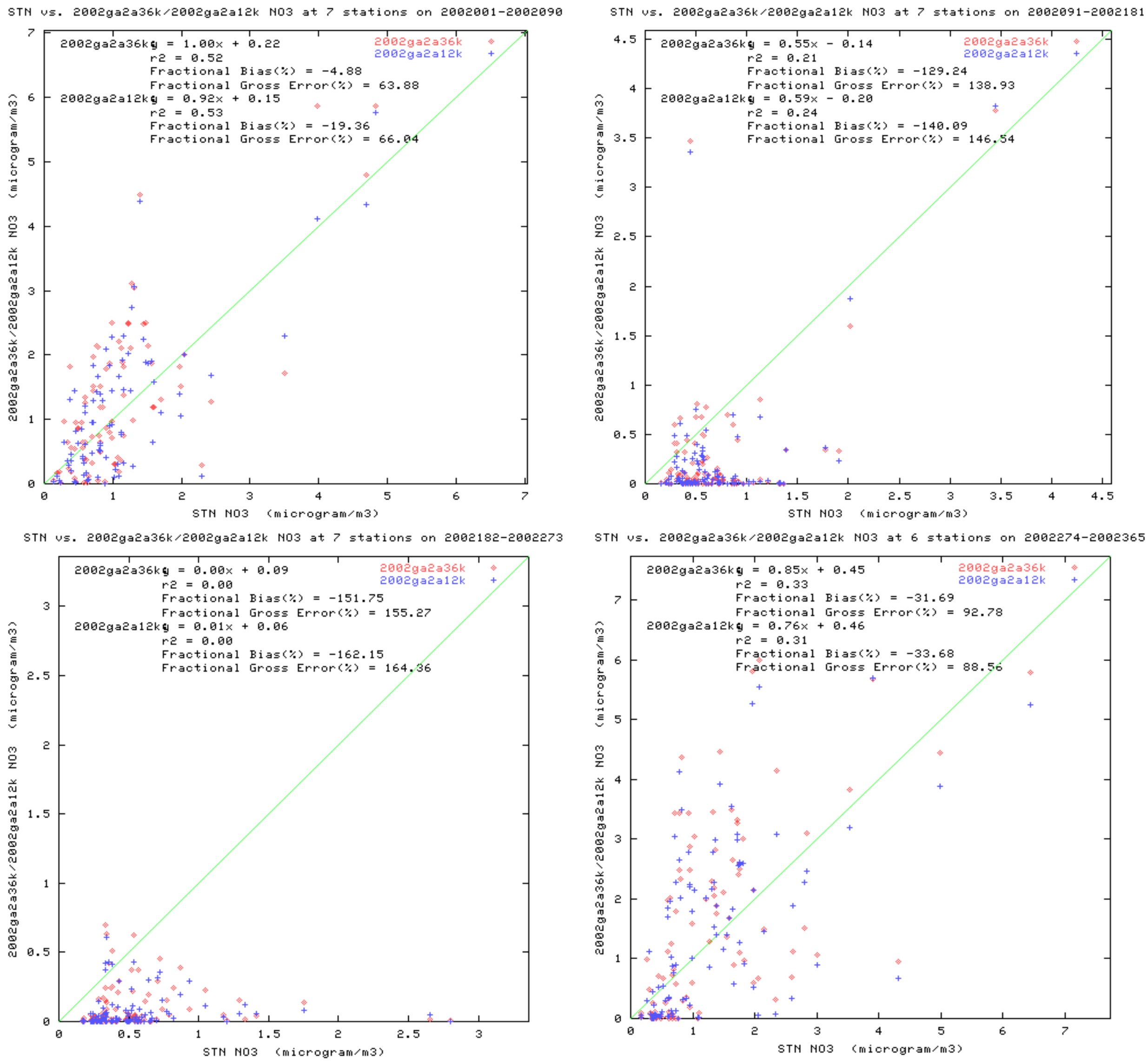


Figure B-2b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

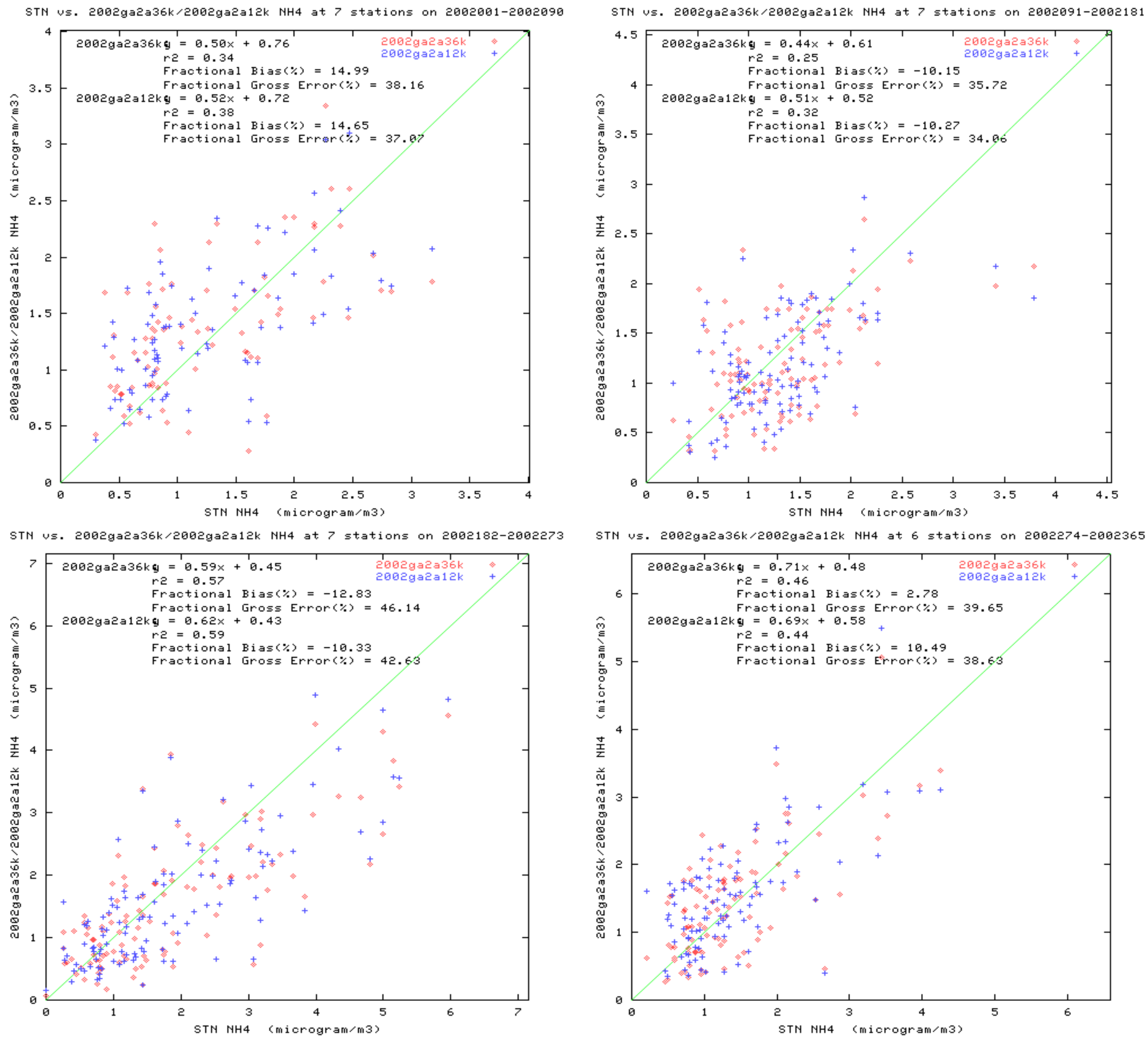


Figure B-2c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

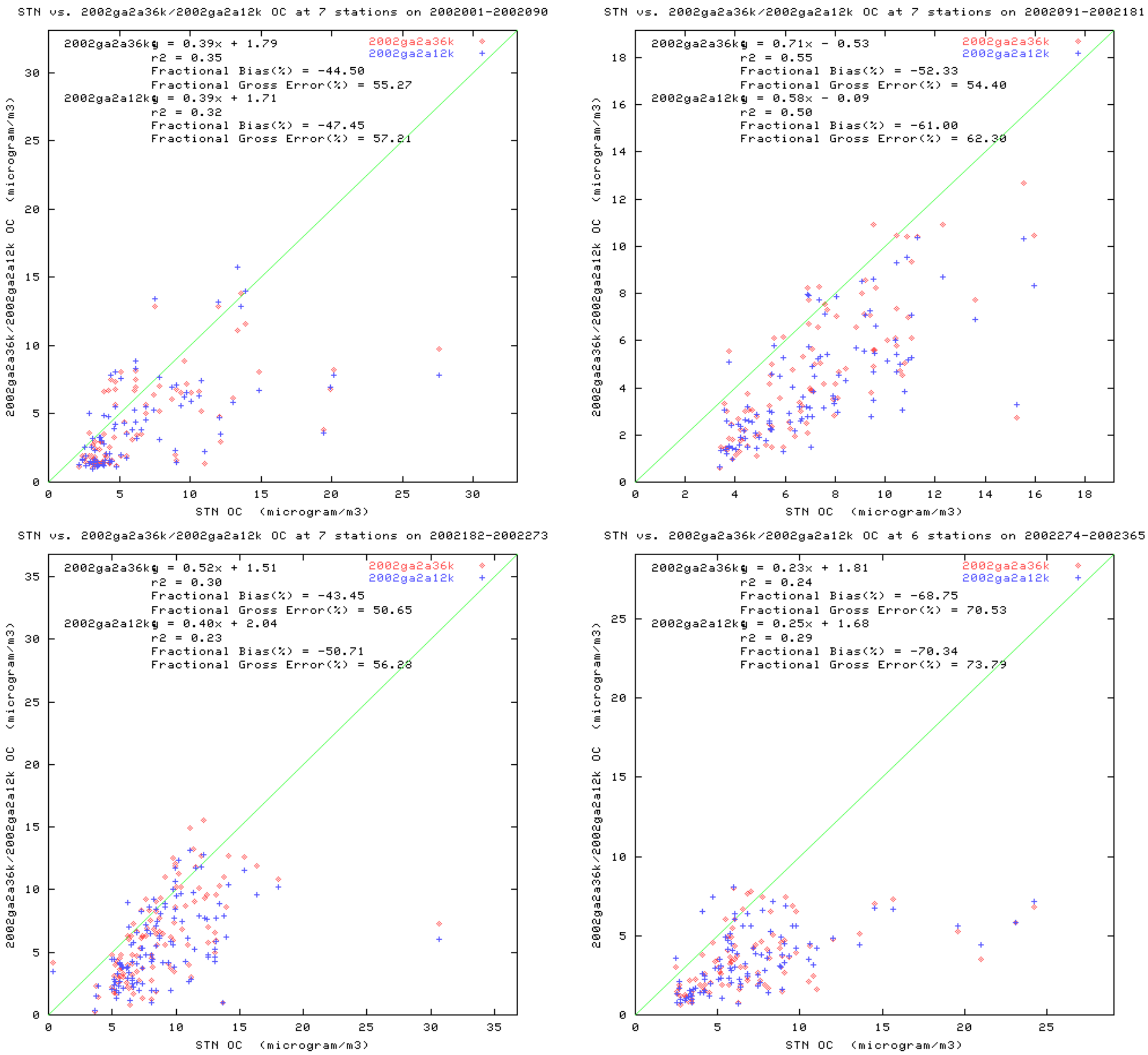


Figure B-2d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

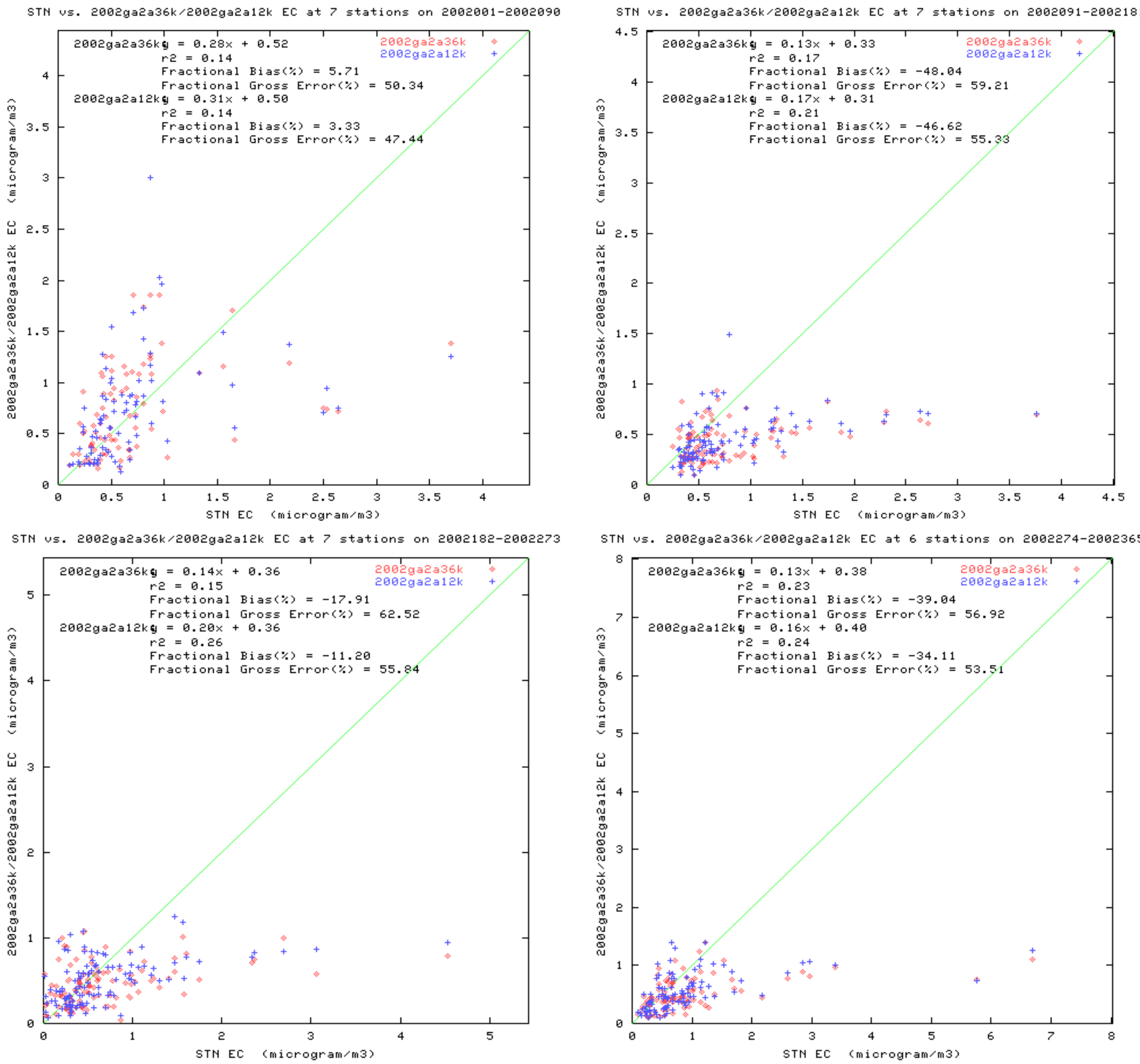


Figure B-2e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

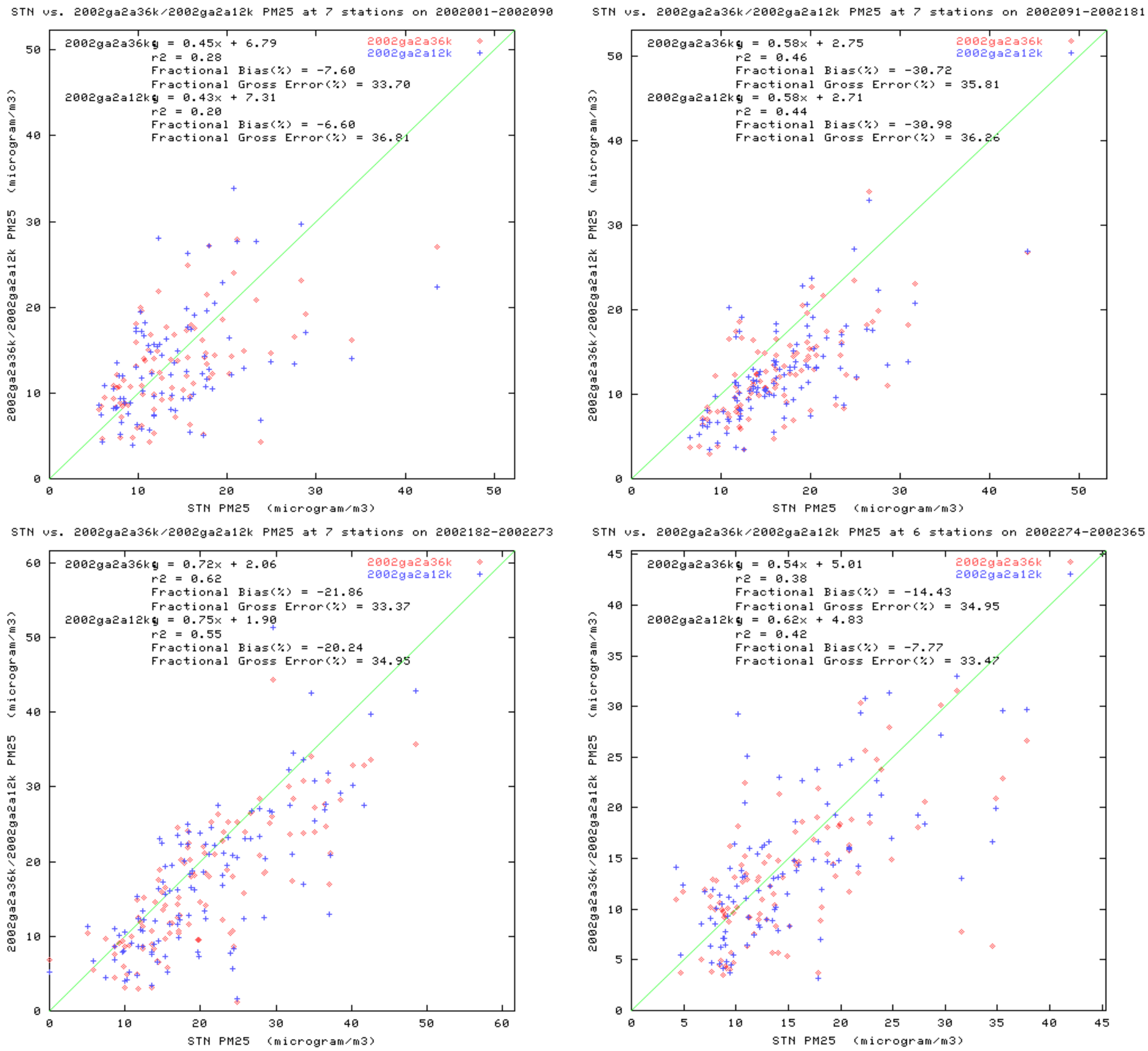


Figure B-2f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

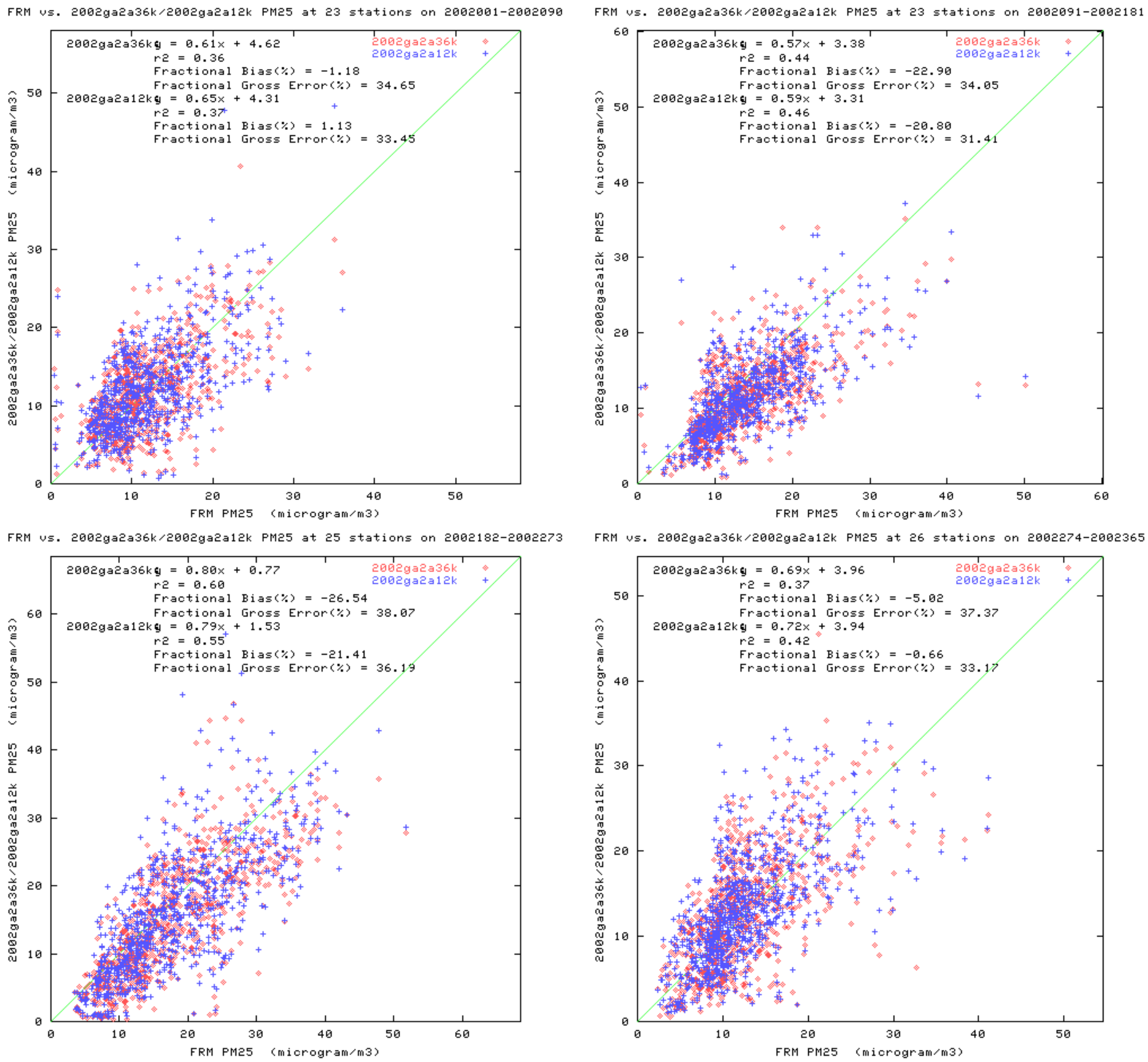


Figure B-2g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Alabama and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

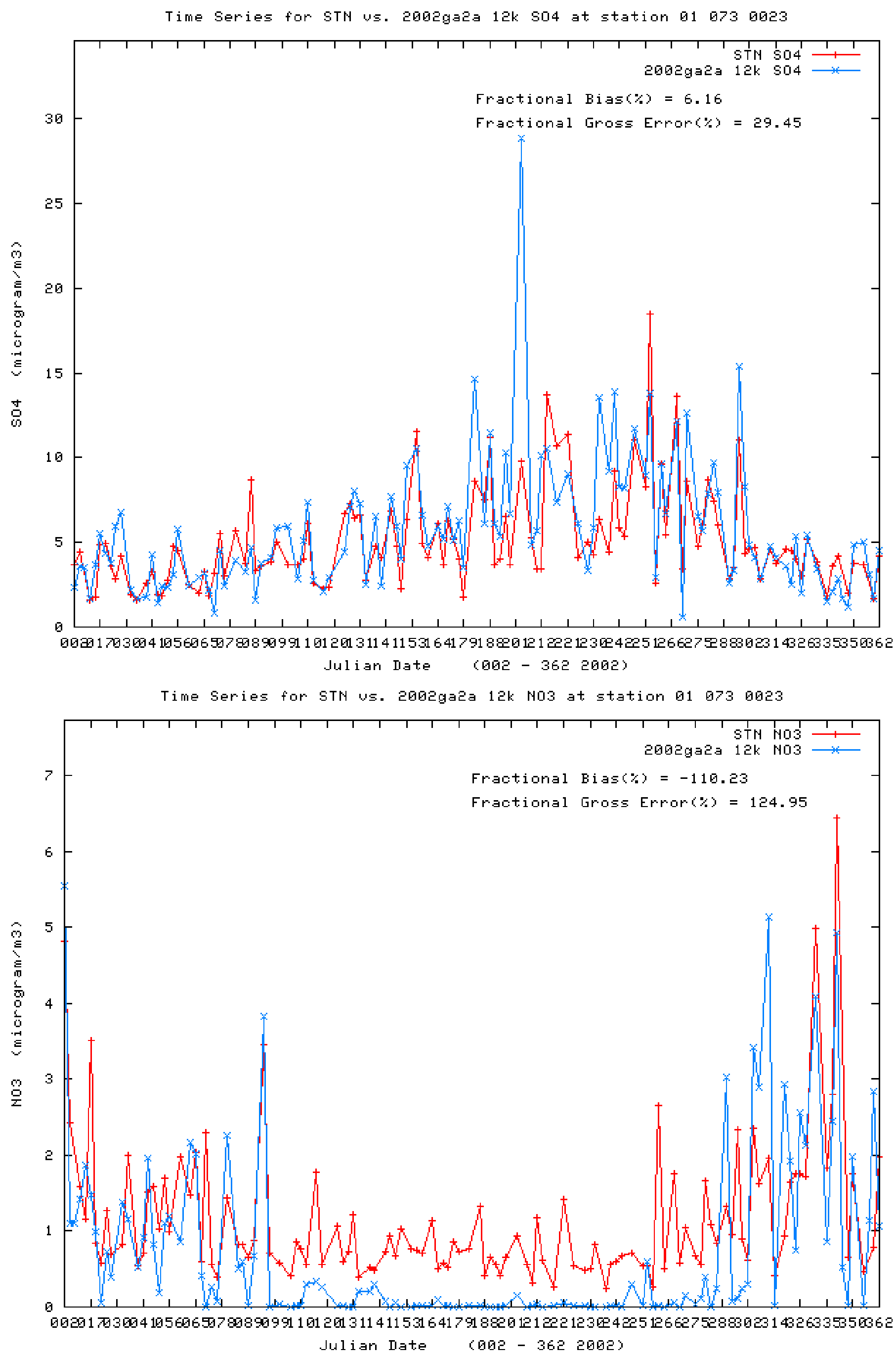
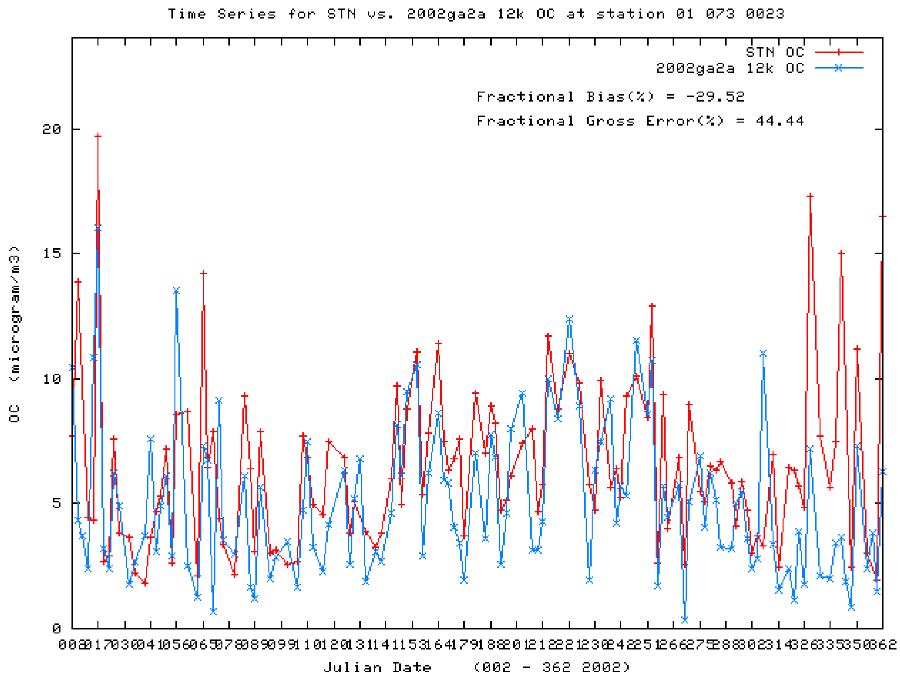


Figure B-3a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Jefferson County, Alabama Site No. 01-073-0023 (North Birmingham) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



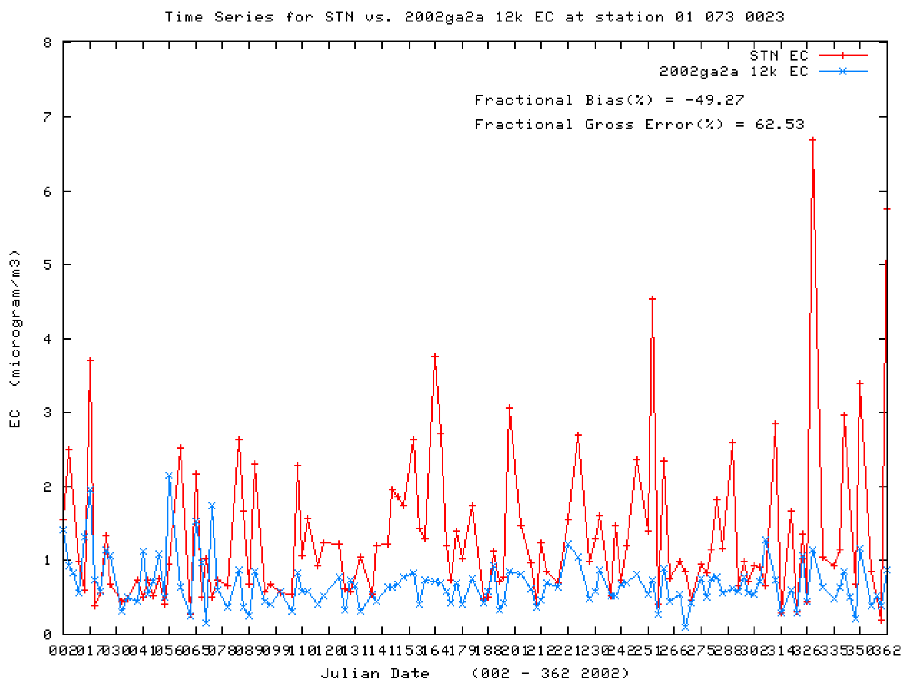
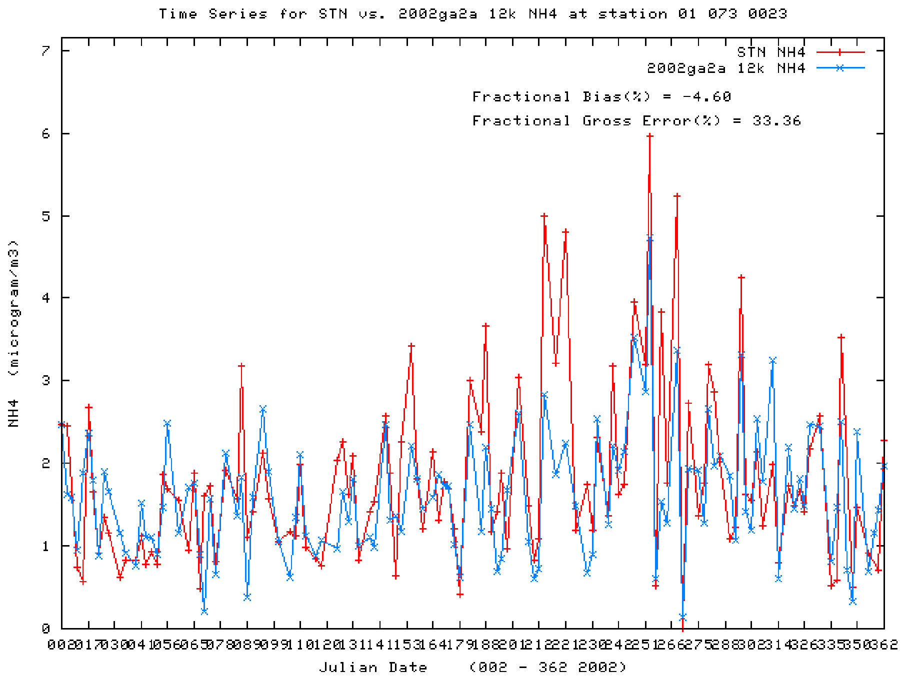


Figure B-3b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Jefferson County, Alabama Site No. 01-073-0023 (North Birmingham) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



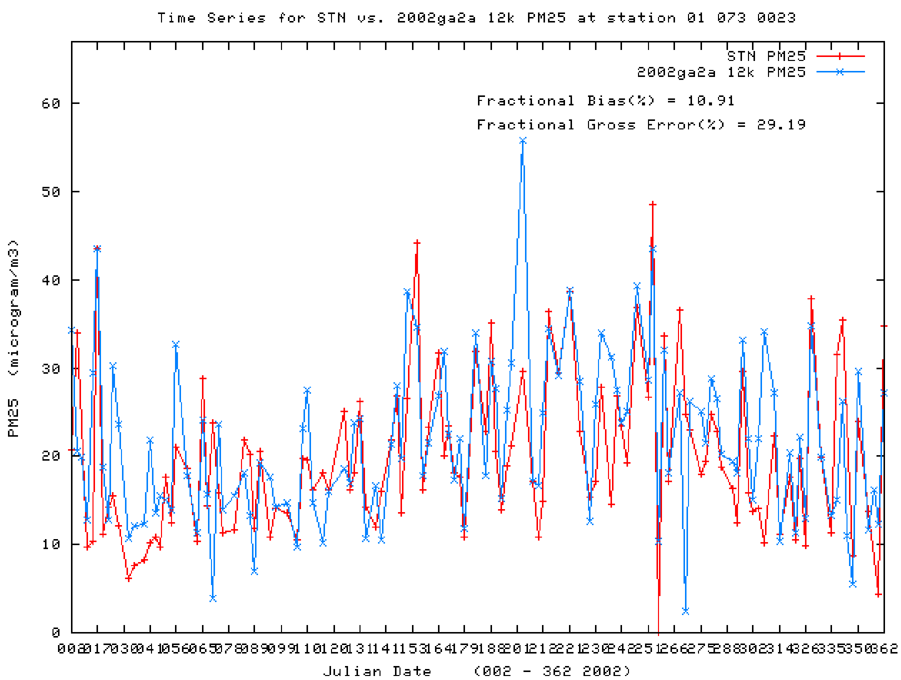
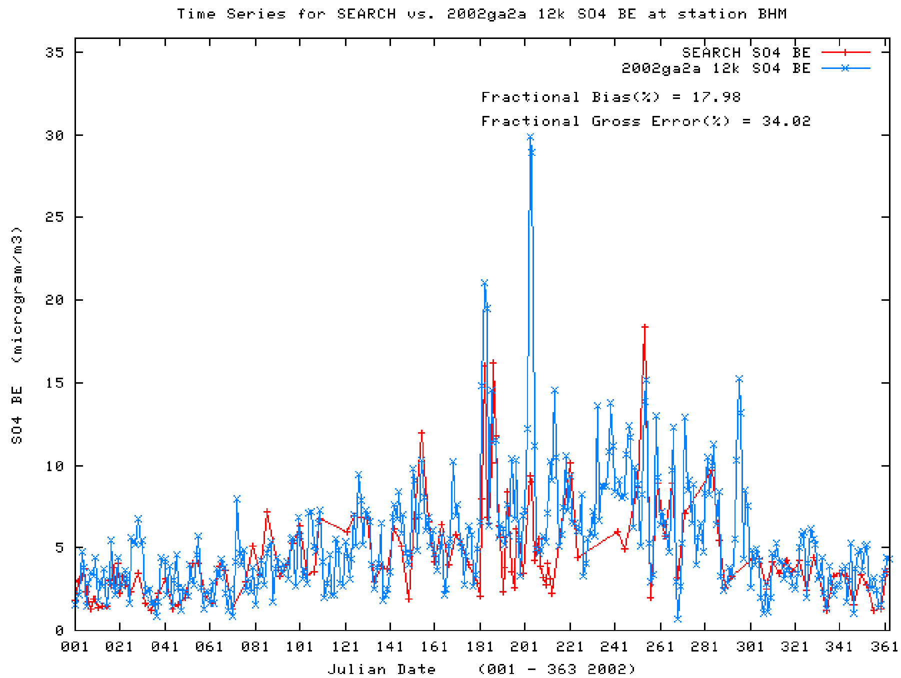


Figure B-3c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Jefferson County, Alabama Site No. 01-073-0023 (North Birmingham) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



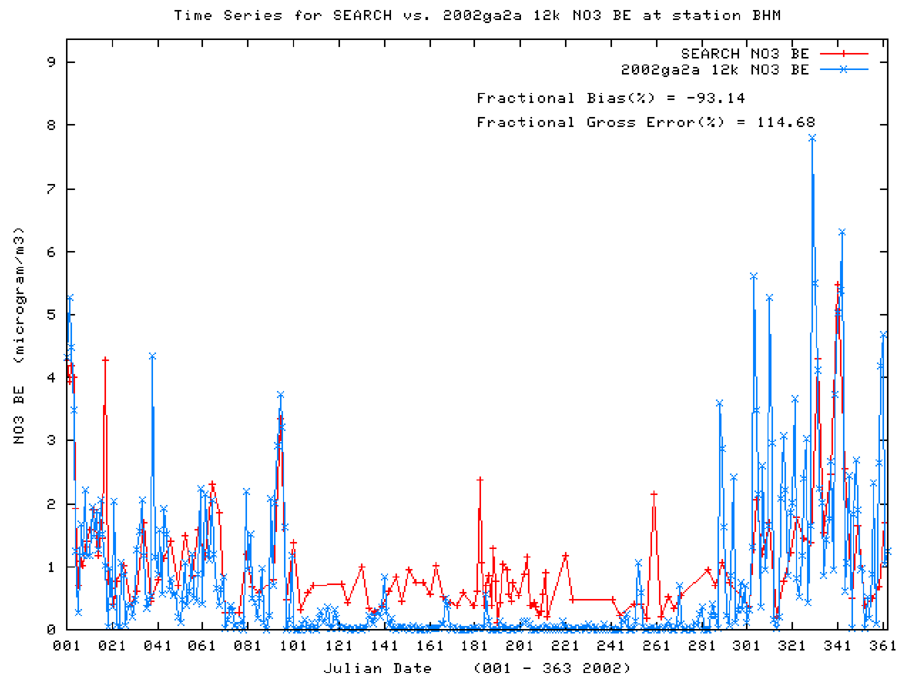
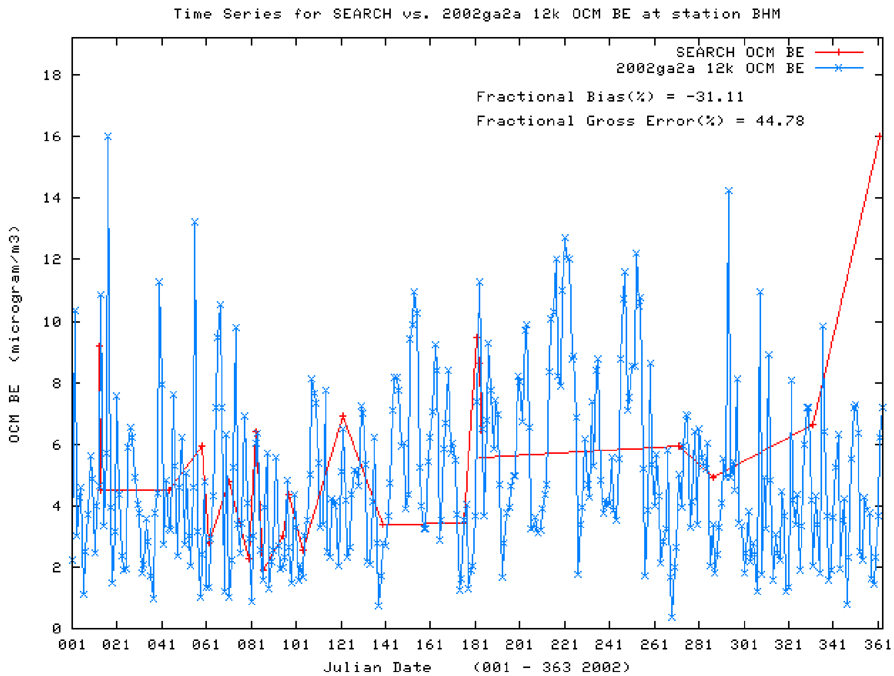


Figure B-4a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the SEARCH North Birmingham (NBHM) Alabama site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



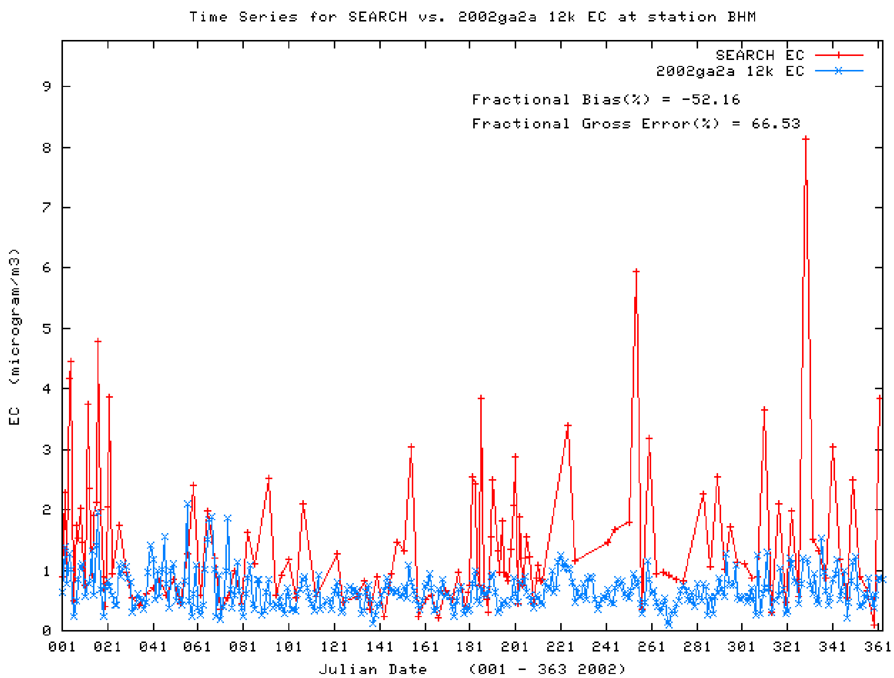


Figure B-4b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the SEARCH North Birmingham (NBHM) Alabama site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

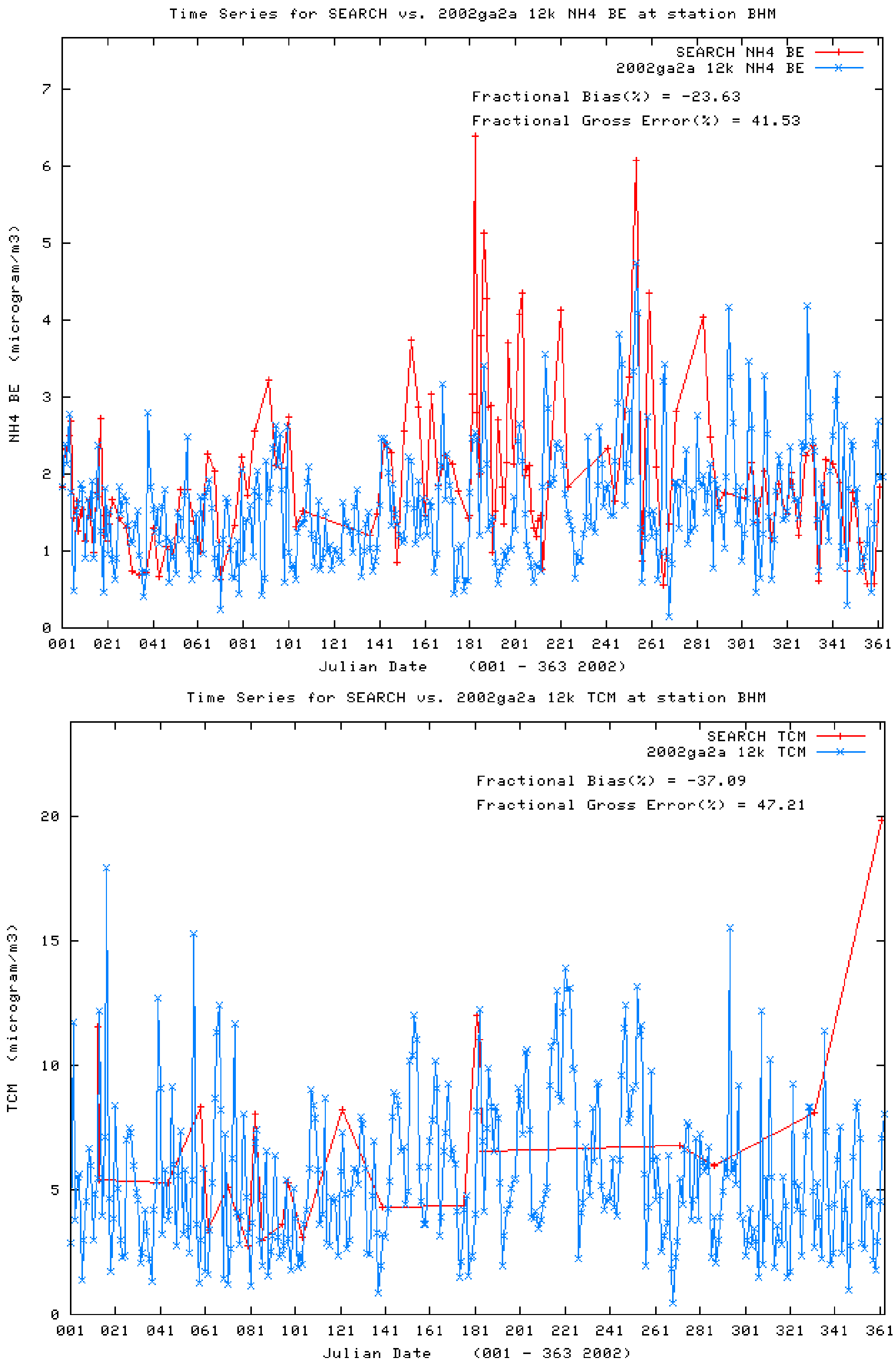
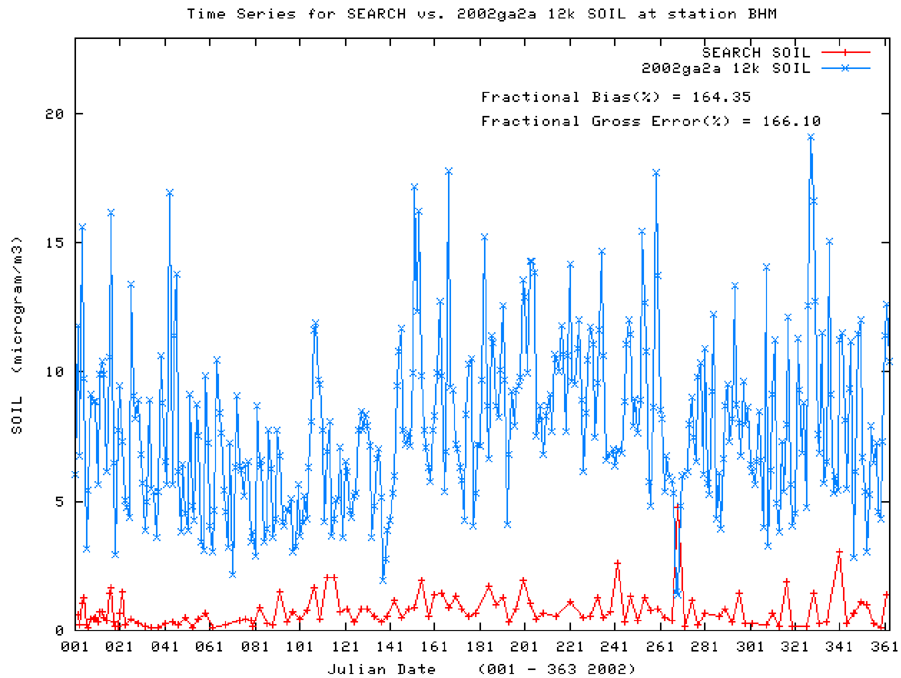


Figure B-4c. Time series of predicted and observed 24-hour ammonium (NH4, top) and total carbon mass (TCM, bottom) concentrations during 2002 at the SEARCH North Birmingham (BHM) Alabama site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



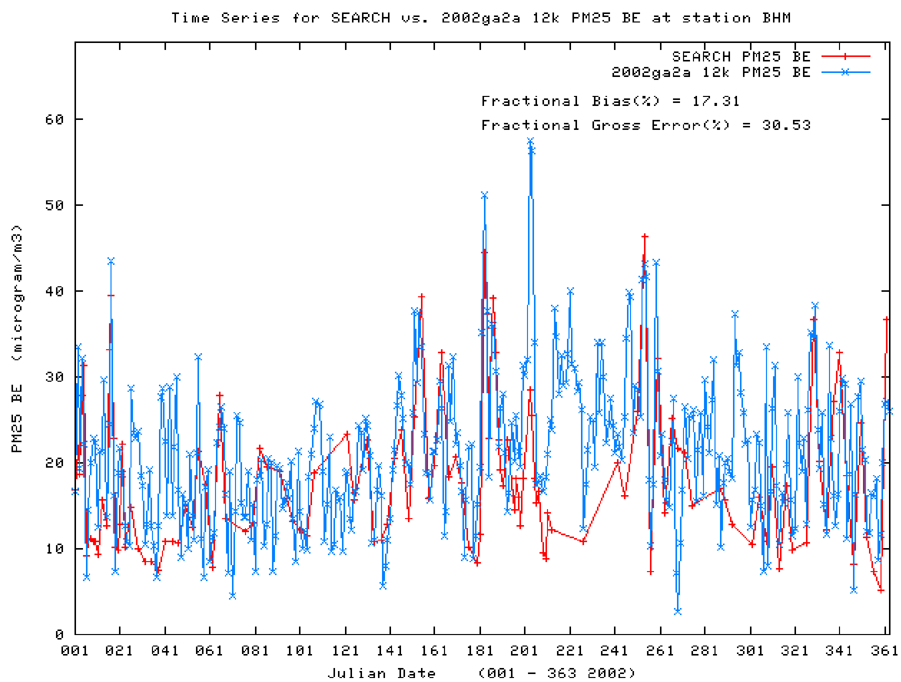


Figure B-4d. Time series of predicted and observed 24-hour other $PM_{2.5}$ (Soil, top) and total fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the SEARCH North Birmingham (BHM) Alabama site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

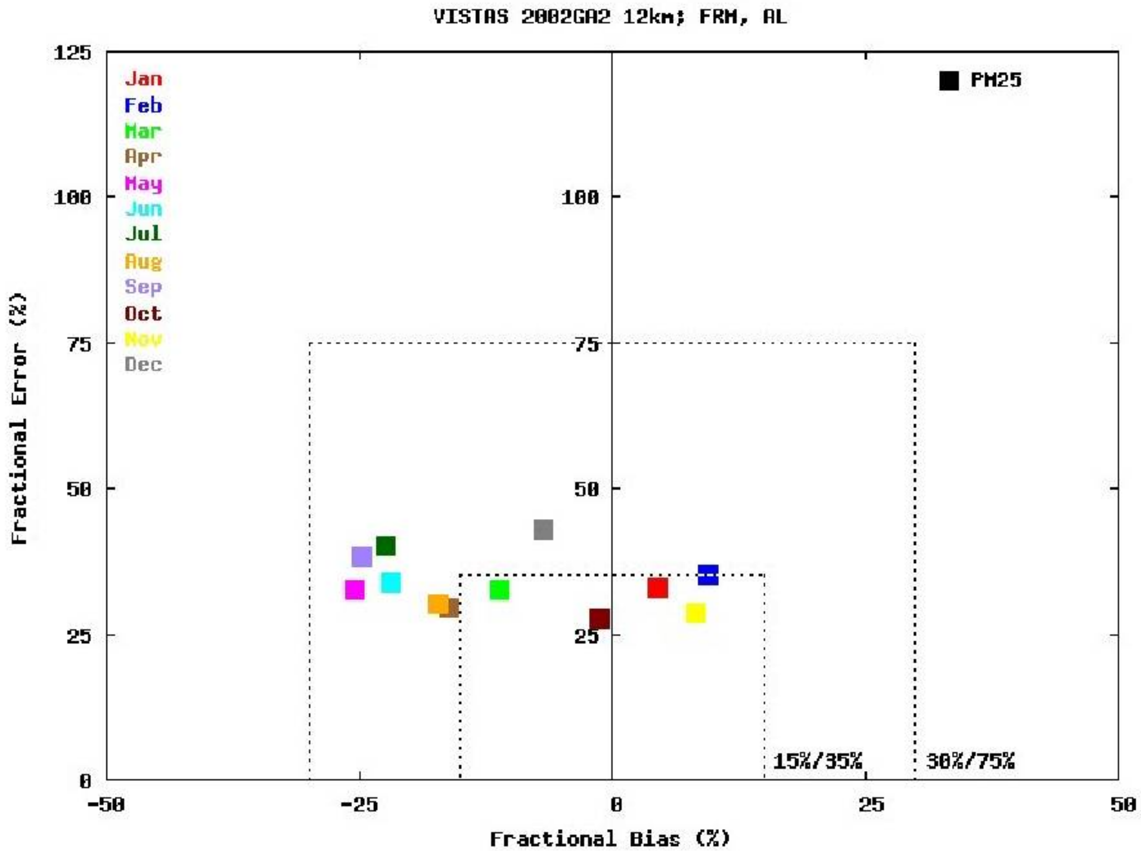


Figure B-5. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Alabama for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

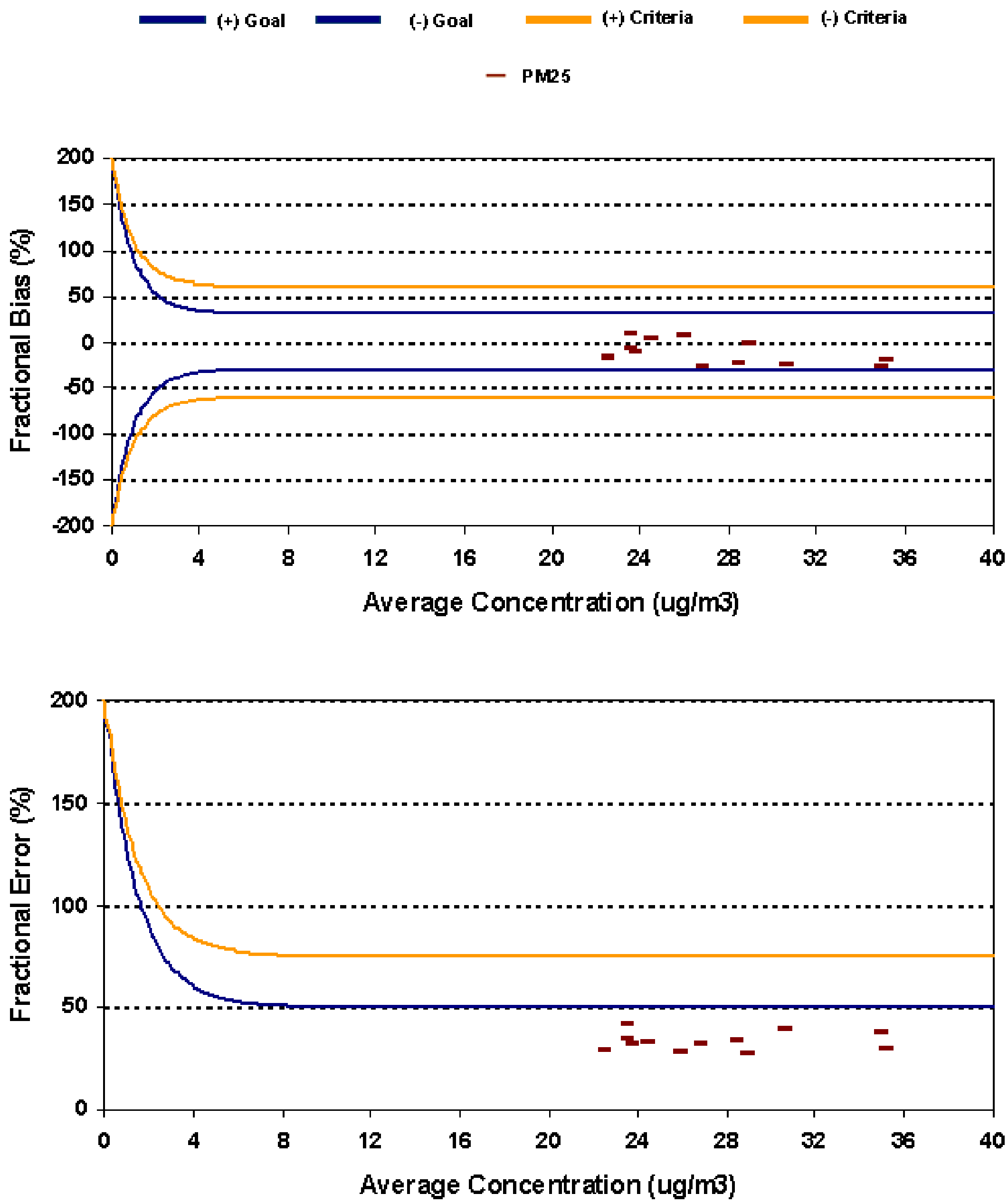


Figure B-6. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Alabama and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.2 Florida

Figure B-7 summarizes the CMAQ $PM_{2.5}$ species model performance across the ~4 STN sites in Florida and Q1, Q2, Q3 and Q4 2002. SO4 is underestimated at the Florida STN sites (Figure B-7a) with fractional bias values that are closer to zero in the winter than summer (e.g., -6% in Q4 versus -23% in Q3 for the 12 km CMAQ results) with the 12 km results exhibiting better performance than the 36 km results. Even with this underestimation bias SO4 performance at the Florida STN sites is fairly good. NO3 performance, on the other hand, exhibits a large underprediction bias with fractional bias values that range from -70% in Q4 to -170% in Q3 (Figure B-7b). NH4 performance at the Florida STN sites is fairly good always achieving the <±30%/50% PM performance goal and sometimes even achieving the more stringent <±15%/35% ozone performance goal (Figure B-7c). It is interesting that in Q1 and Q4 when both SO4 and NO3 exhibit an underprediction bias, NH4 exhibits a slight overprediction bias. Given the linked relationship between these species this is somewhat surprising and may be due to artifacts in the measurements, or the modeled SO4 being more fully neutralized by NH4 than in the measurements. The OCM and EC performance is characterized by underprediction tendency with the OCM fractional bias ranging from -75% to -110% with the CMAQ 36 km and 12 km producing nearly identical performance metrics (Figure B-7d). The EC performance is better with fractional bias values ranging from -2% to -53% with the 12 km modeling results producing significantly better EC performance metrics than the 36 km modeling results (Figure B-7e).

The $PM_{2.5}$ mass performance in Florida is summarizes across ~4 STN sites and 28 FRM sites in Figures B-7f and B-7g, respectively. Across the STN sites, the $PM_{2.5}$ fractional bias ranges from -27% to -75% for the four months examined, whereas across the FRM network the bias values are lower ranging from+2% to -69%. Given the underprediction tendency of SO4, NO3 and carbon the general underprediction of total $PM_{2.5}$ mass is not unexpected. Why the underprediction bias is greater across the STN network than the FRM network is unclear but is likely related to the locations of the 3 STN and 28 FRM monitoring networks and the measurement artifacts of the two sampling techniques (e.g., FRM will loose more of the volatile material).

An example predicted and observed time series and annual model performance metrics for 24-hour PM components at an STN site in Miami-Dade County Florida is shown in Figure B-8. The summer sulfate underprediction tendency results in an annual fractional bias of -30% with error of 44% just barely achieving the PM model performance goals (Figure B-8a, top). NO3 performance at this Miami site is very poor with a -180% fractional bias with modeled NO3 on most days near zero, compared to around 0.5 $\mu g/m^3$ measured values during the summer. OCM and EC are also underpredicted at the Miami site with fractional bias values of, respectively, -123% and -84% (Figure B-8b). Ammonium performance is fairly good meeting the most stringent ozone performance goal, whereas total $PM_{2.5}$ is underpredicted due to the underprediction of most of the PM components as discussed above (Figure B-8c).

The soccer plot of monthly $PM_{2.5}$ bias and error performance for FRM sites in Florida is shown in Figure B-9, with the Bugle Plots shown in Figure B-10. For the winter months of Nov, Dec, Jan and Feb the $PM_{2.5}$ performance statistics are quite good with bias/error values meeting the <±15%/35% ozone performance goal. The spring and fall months either achieve the <±30%/50% or <±50%/125% performance goal and criteria. The May-Jul summer months are at or exceed the -50% performance criteria levels (note that in the Soccer Plots if the symbol would be plotted outside of the range of the plot then it is plotted on the axis, such as the May and July -50% values in Figure B-9).

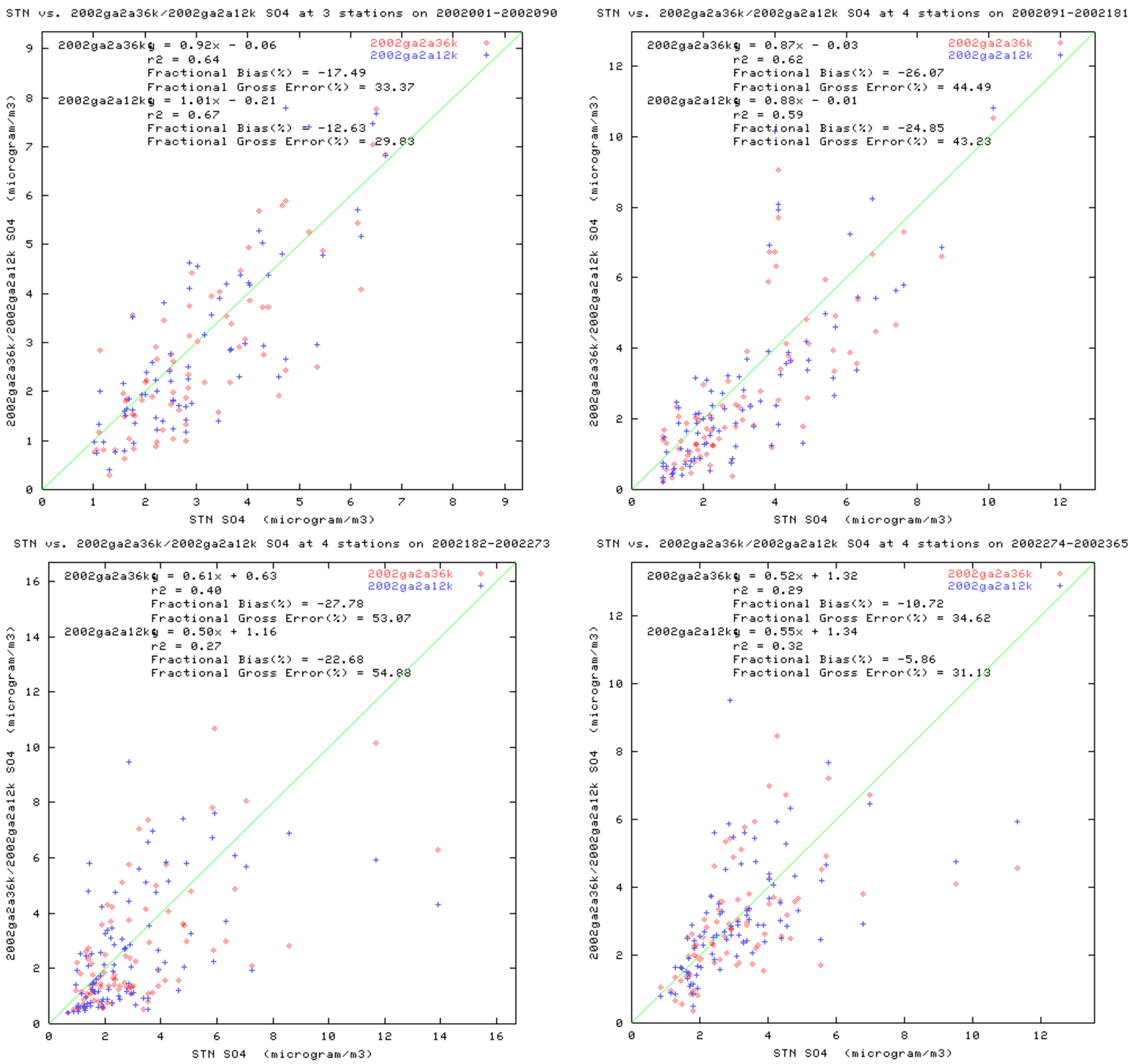


Figure B-7a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

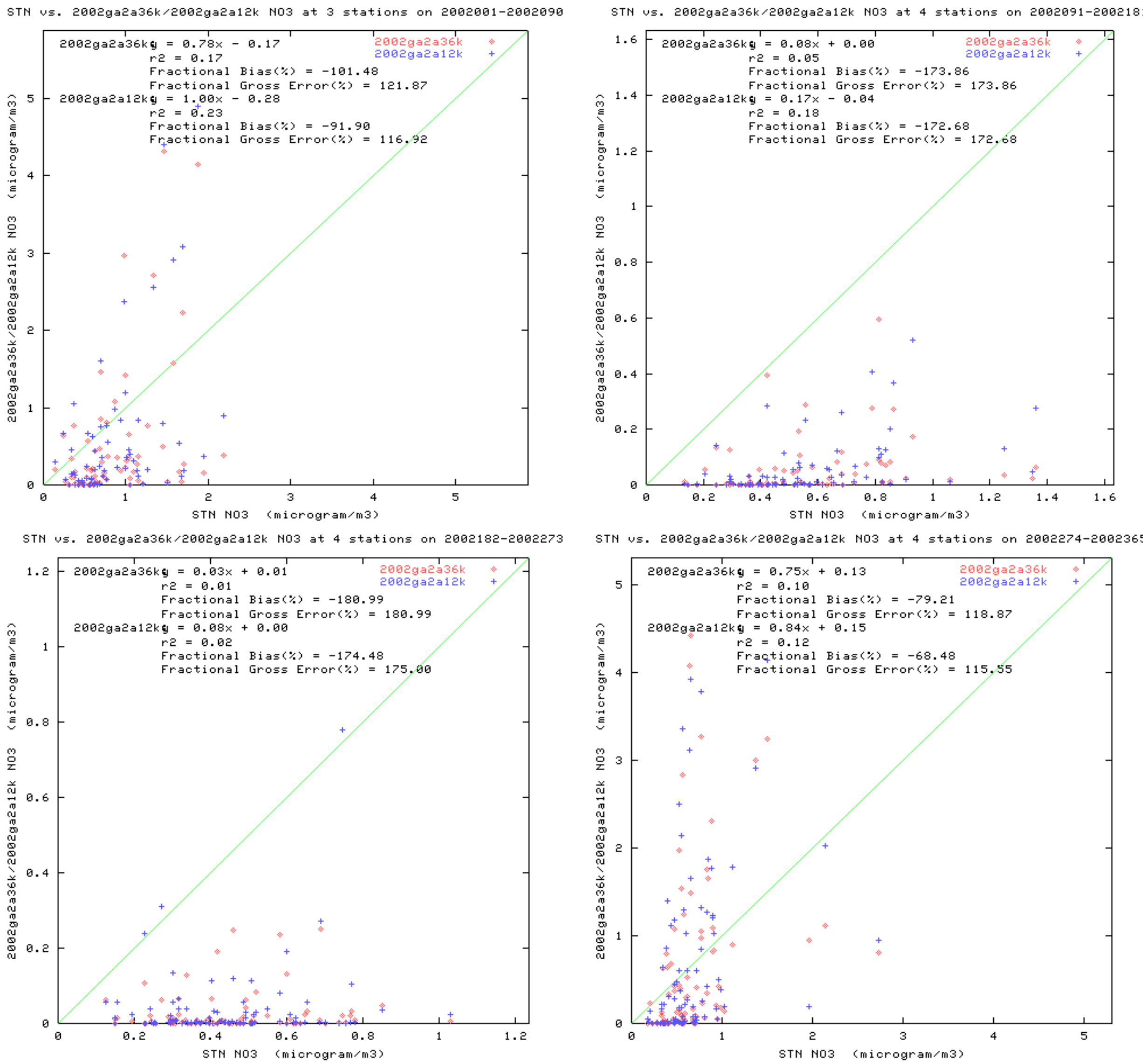


Figure B-7b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

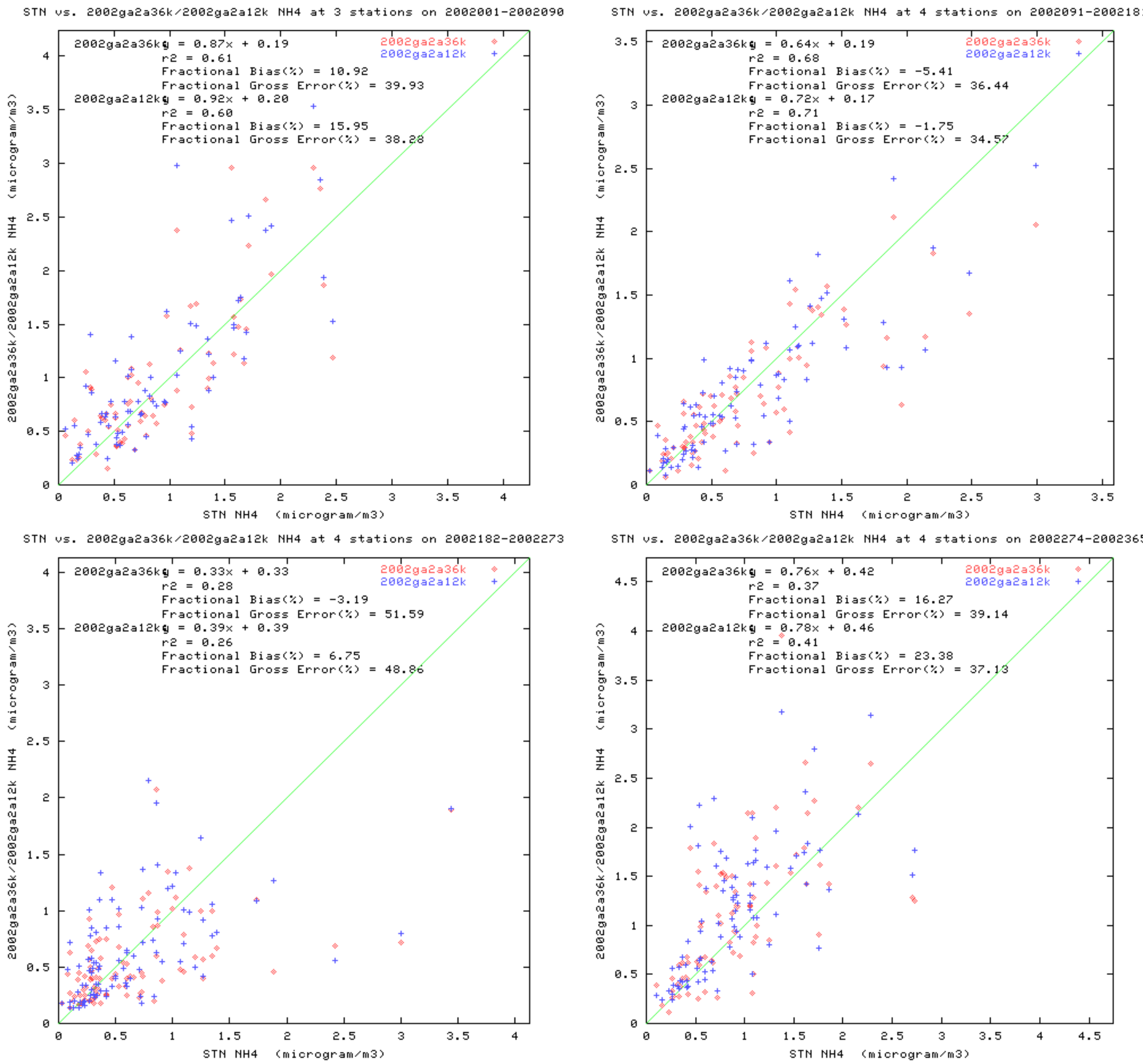


Figure B-7c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

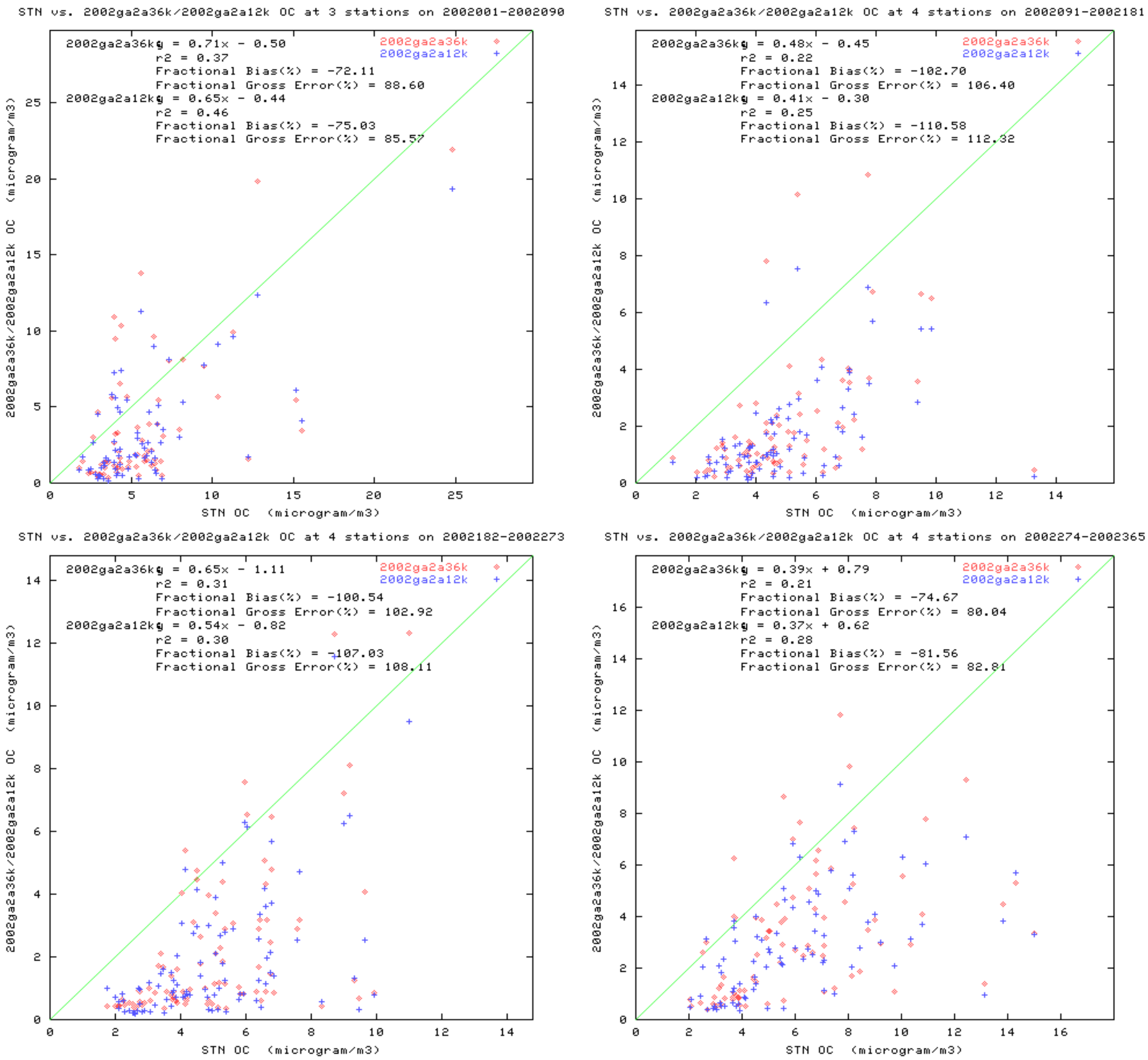


Figure B-7d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

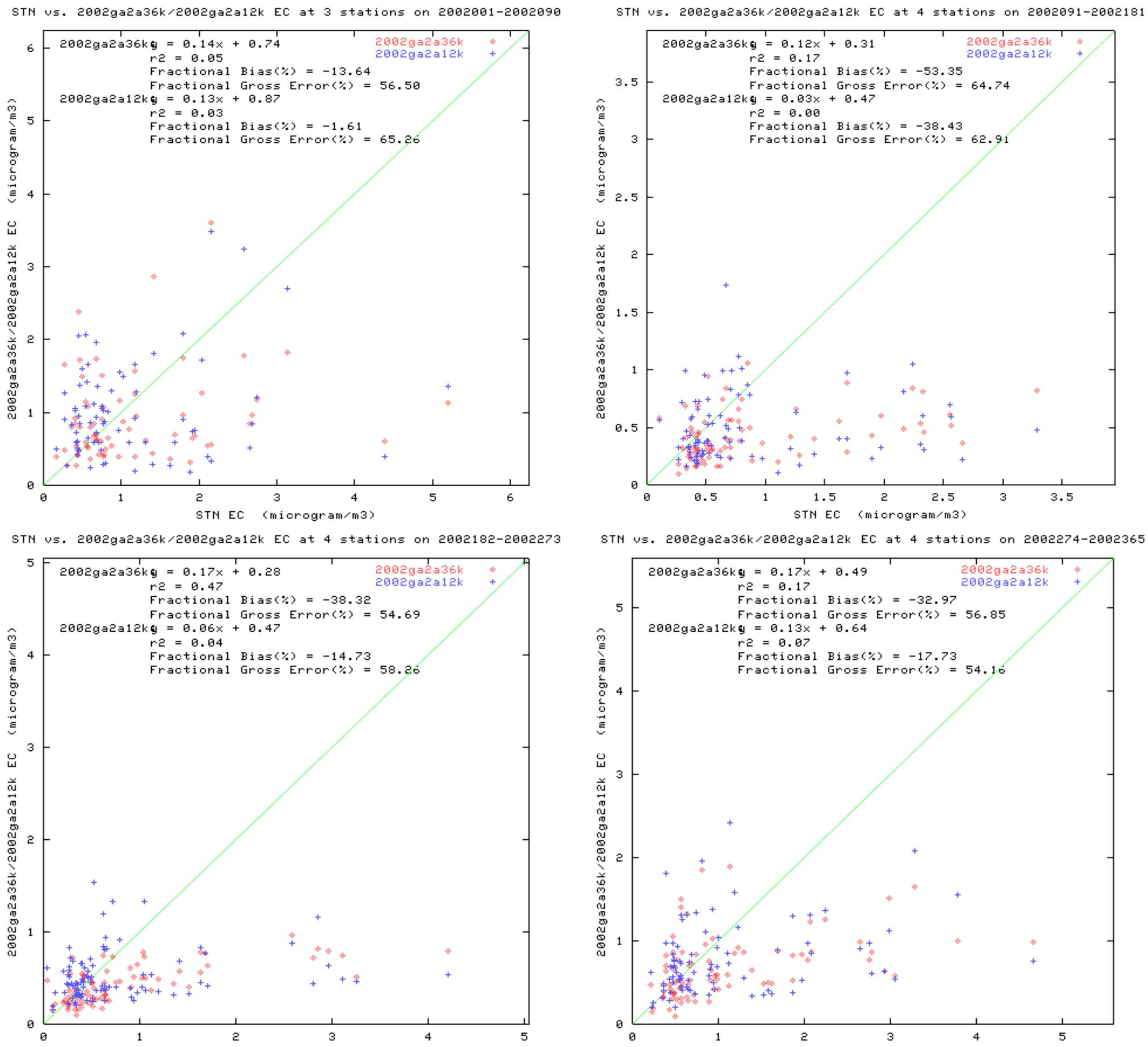


Figure B-7e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

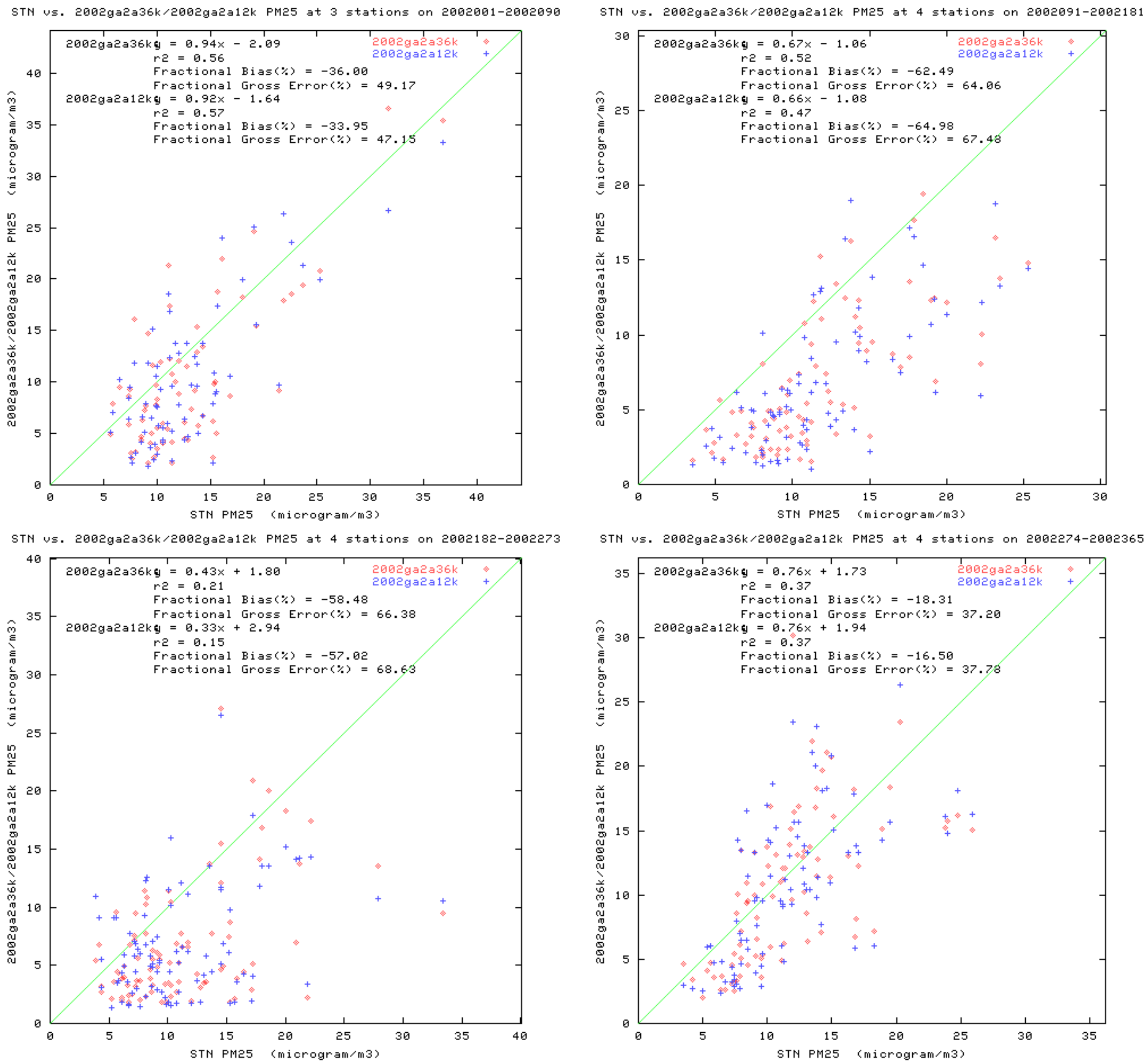


Figure B-7f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

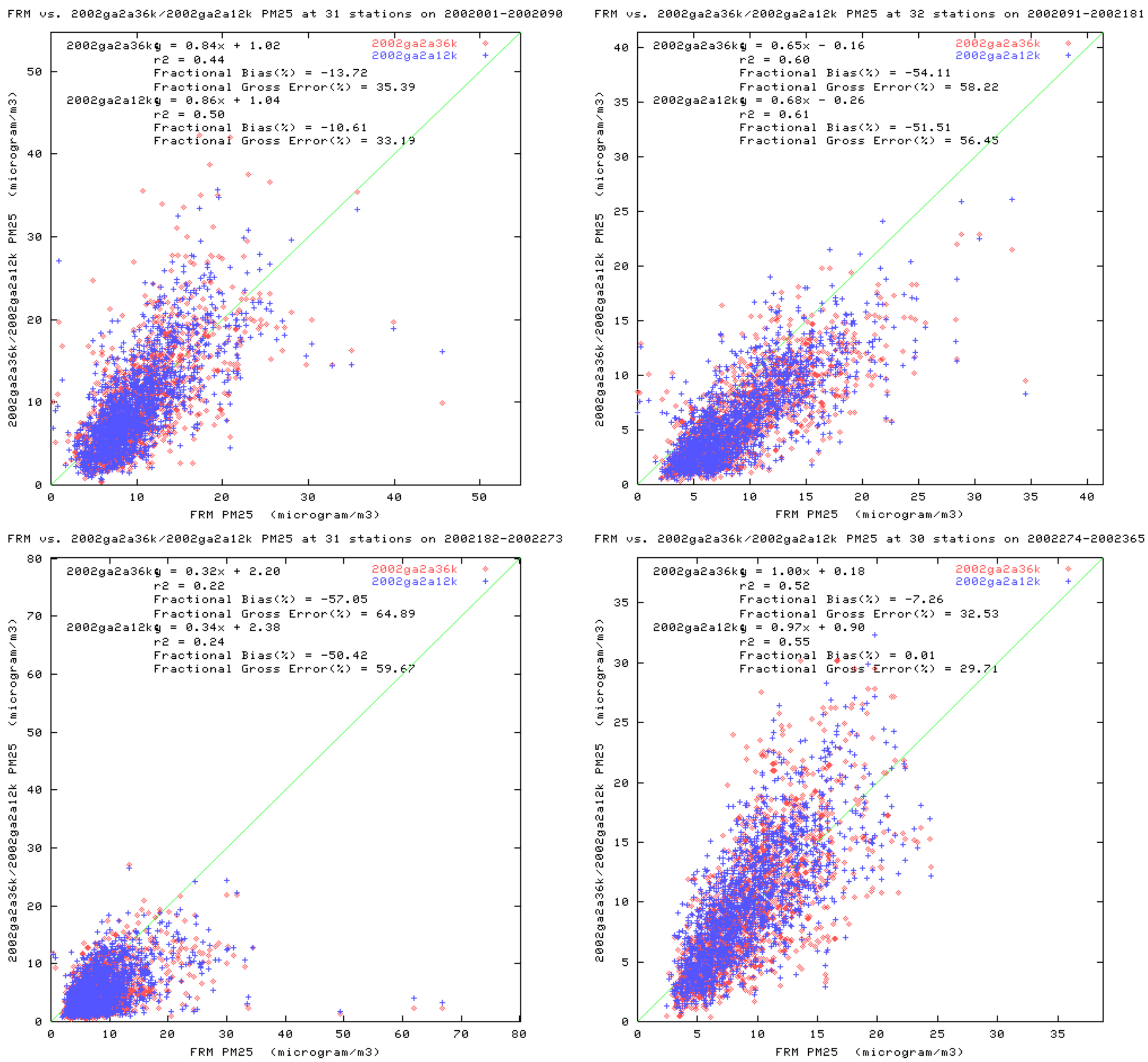
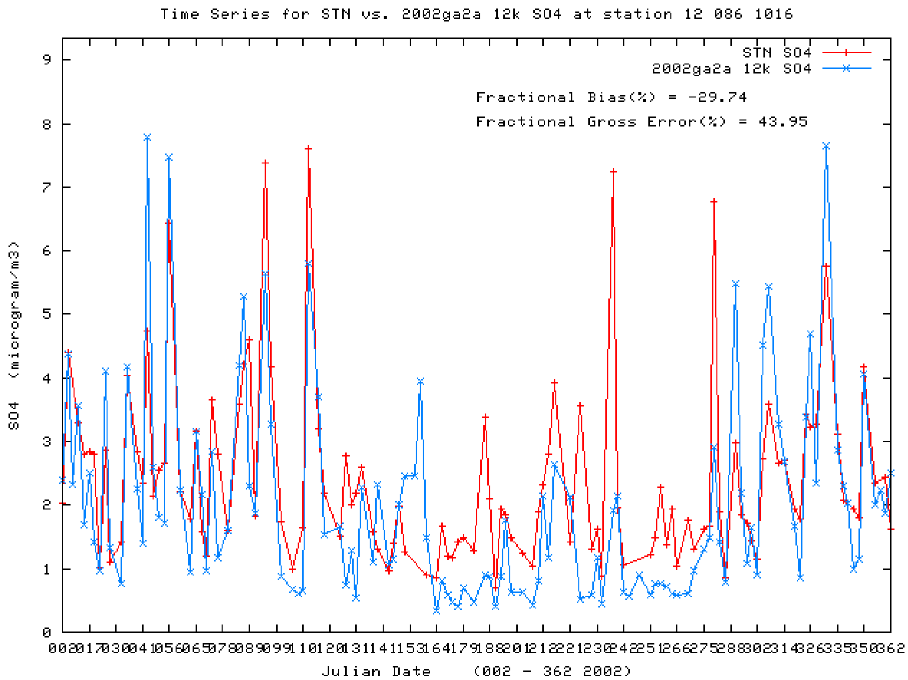


Figure B-7g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Florida and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.



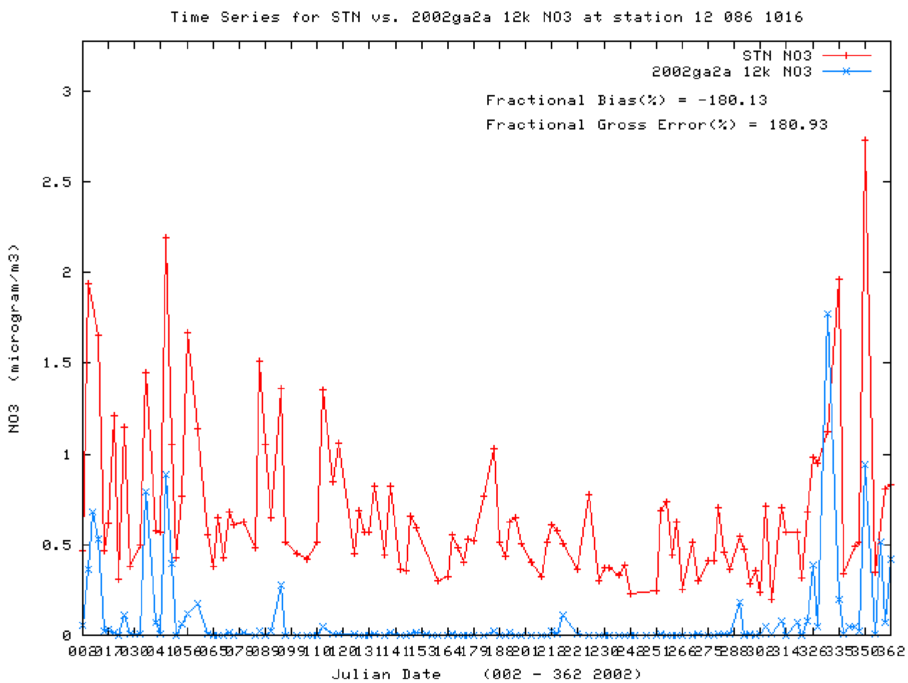
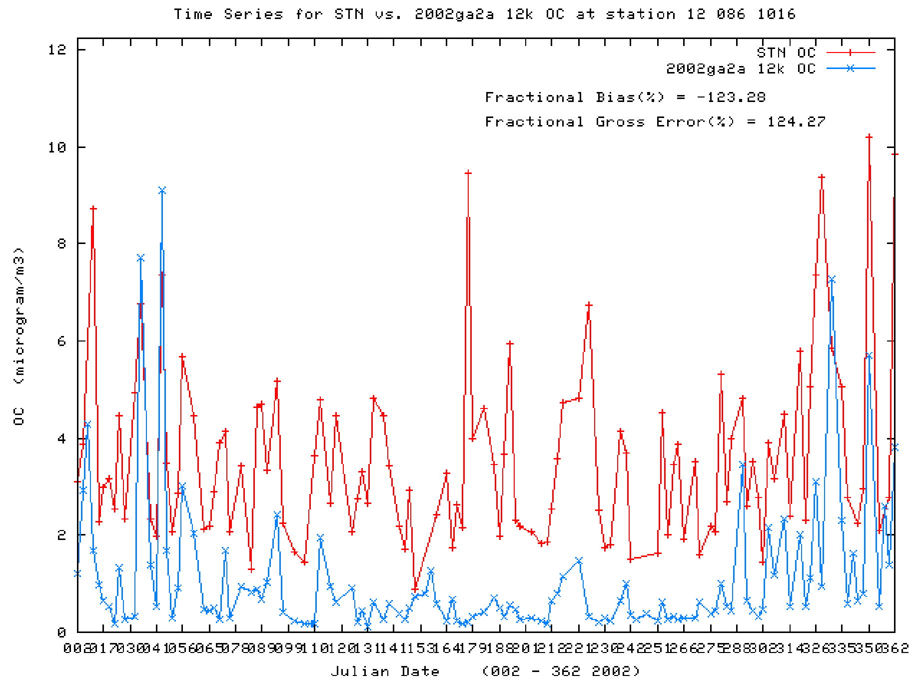


Figure B-8a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Miami-Dade County, Florida Site No. 12-086-1016 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



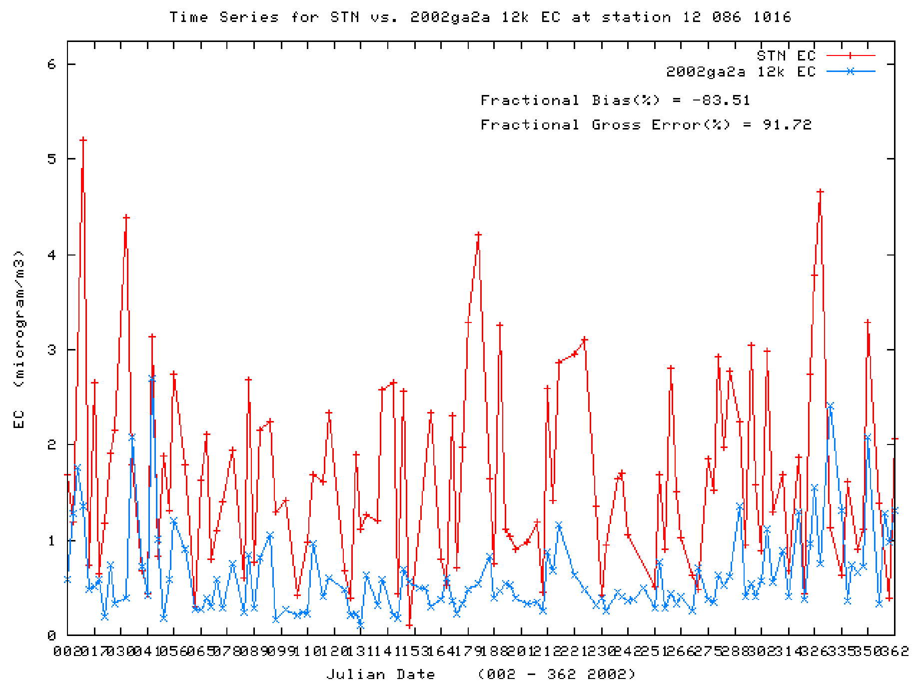
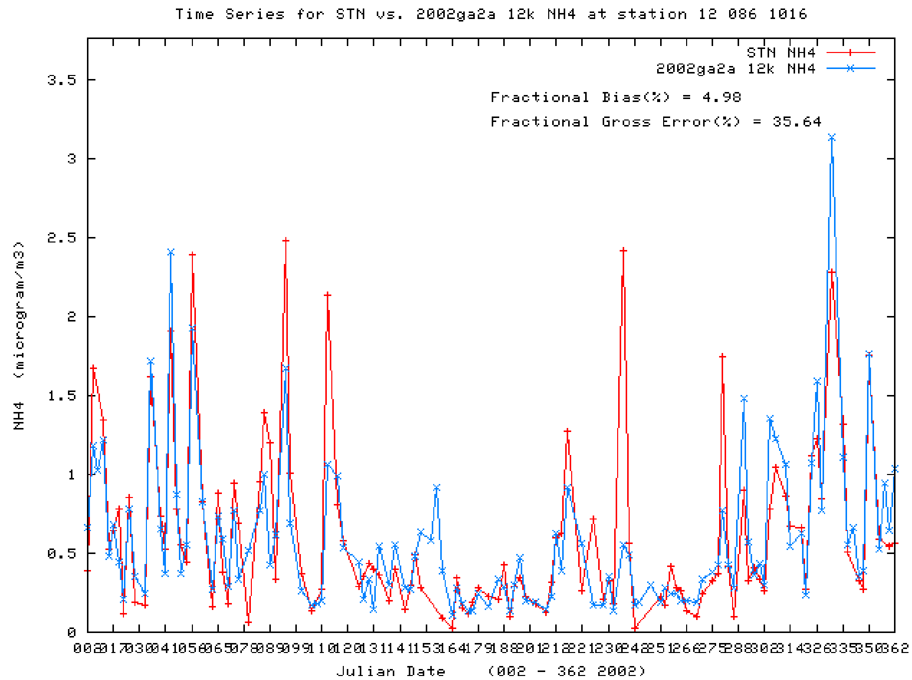


Figure B-8b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Miami-Dade County, Florida Site No. 12-086-1016 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



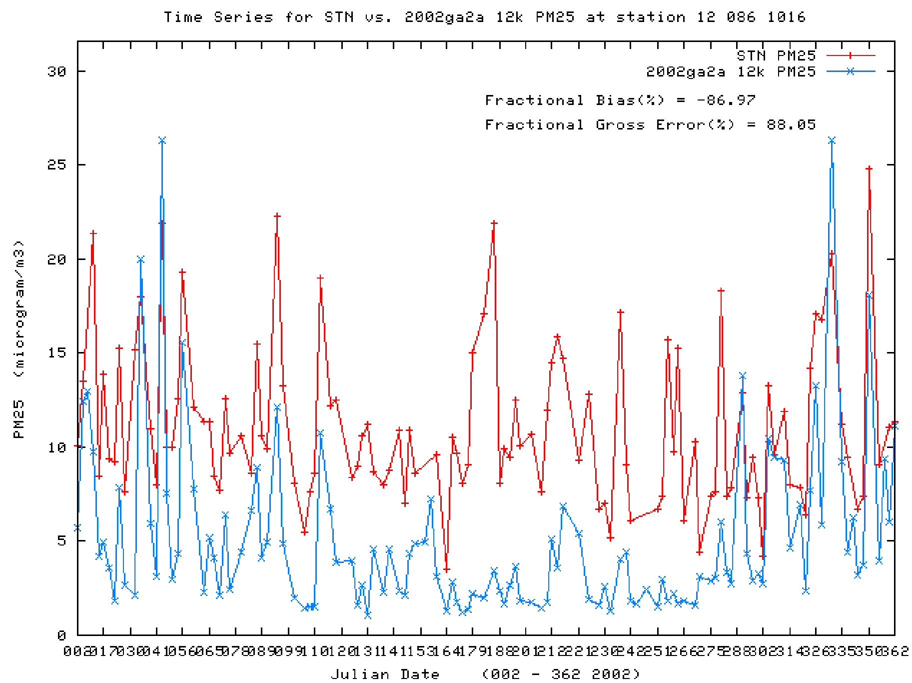


Figure B-8c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Miami-Dade County, Florida Site No. 12-086-1016 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

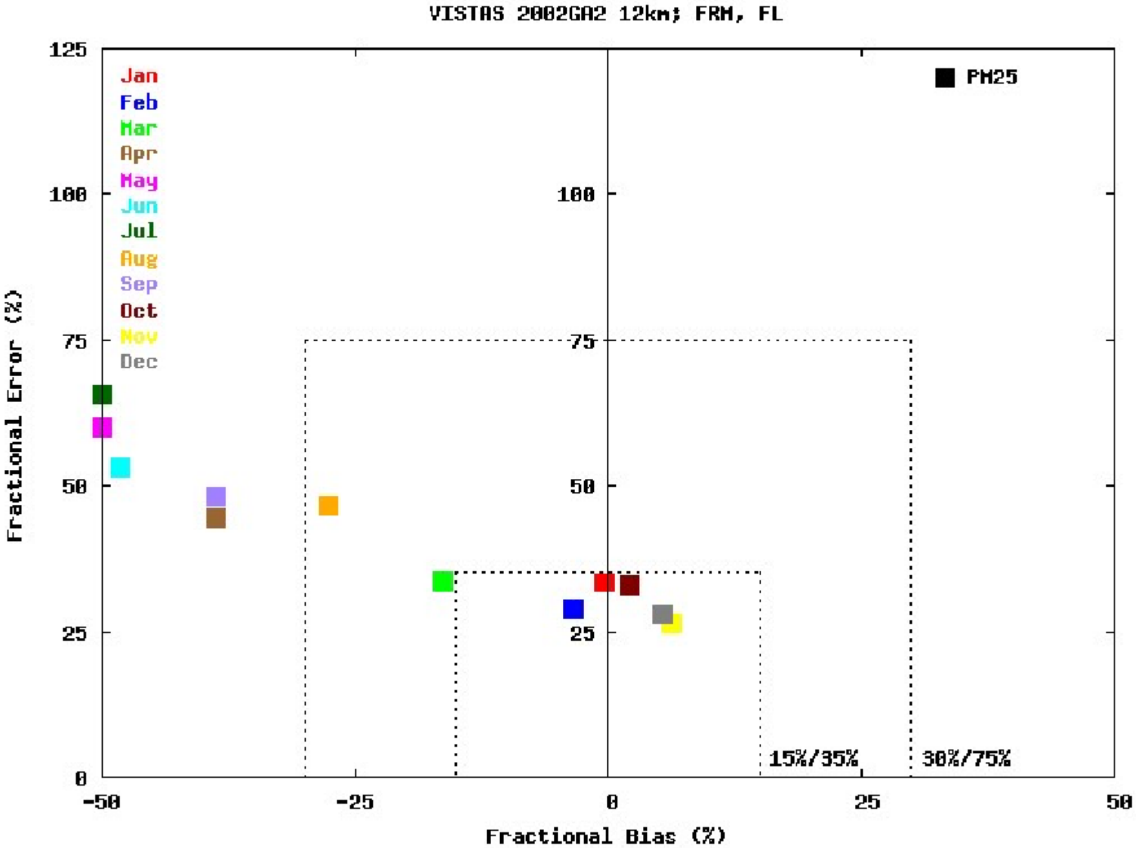


Figure B-9. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Florida for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

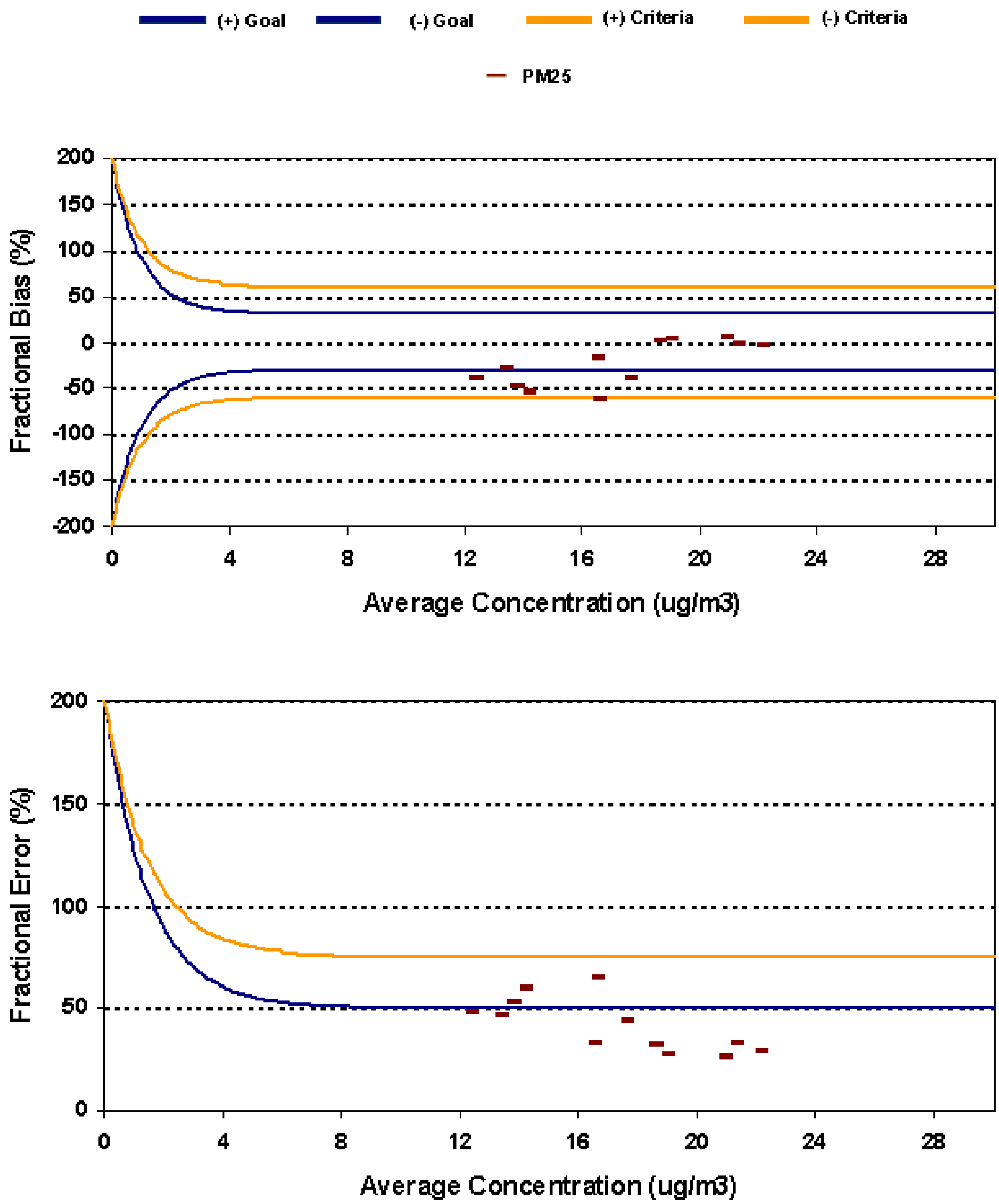


Figure B-10. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Florida and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.3 Georgia

There appears to be valid data capture issues in the 2002 STN MPE database for Georgia with several sites starting up during Q1 resulting in less comparisons than the other quarters. The CMAQ SO4 performance in Georgia is generally pretty good with bias/error frequently achieving the <±15%/35% ozone performance goal and always achieving the PM goal (Figure B-11a). The STN sites also have the summer nitrate underprediction performance issue as seen in the other states (Figure B-11b). The NH4 model performance falls between the SO4 and NO3 performance and achieves the <±30%/50% PM performance goal for all four quarters (Figure B-11c).

The carbon performance in Georgia appears to be slightly better than the other states, although still with an underestimation tendency ranging from -40% to -70%. The OCM model performance fails to achieve the PM performance goal, but does achieve the PM performance criteria (Figure B-11d). EC performance is variable with generally low bias but lots of scatter producing higher gross errors (Figure B-11e).

The performance of total $PM_{2.5}$ mass across the STN (Figure B-11f) and FRM (Figure B-11g) monitoring sites in Georgia is generally fairly good. Q3 exhibits an underprediction tendency with fractional bias values of approximately -25% (STN) and -18% (FRM) that is likely caused by the underestimation of SO4 and especially OCM. But in general the $PM_{2.5}$ performance statistics mostly achieve the most stringent ozone performance goal and always achieve the PM performance goal.

Example time series of predicted and observed PM concentrations and annual statistics for a site in the Atlanta Georgia (DeKalb County) is shown in Figure B-12. The model tracks the observed SO4 concentrations at this site extremely well producing low fractional bias (-5%) and gross error (27%). NO3 performance exhibits the underprediction tendency seen in the other states, but is not as severe with a -16% fractional bias and 77% error. The CMAQ 12 km results reproduces the OCM concentrations at this site surprisingly well with low bias (-14%) and error (31%). EC is overestimated (bias of 28%) at this Atlanta site with fairly high error (44%) but still achieves the PM performance goal. NH4 is overstated at this site on average (29% error) but also achieves the PM performance goal. Finally, the performance for $PM_{2.5}$ mass at the DeKalb County STN site is extremely good with very low bias (2%) and error (25%).

Figure B-13 displays another example of predicted and observed PM species, time series and annual statistics for a site in Atlanta, only this time for the SEARCH Jefferson Street (JST) site. Unlike the STN 1:3 sampling frequency, the SEARCH JST site collects 24-hour samples everyday so has a richer model evaluation database. The performance at the SEARCH JST Atlanta is similar to the STN DeKalb County site with good performance for SO4 that achieves the ozone performance goal, and NO3 performance that has an overall annual underestimation tendency (bias of -16%) and high error (80%). It appears the summer NO3 underestimation bias is being compensated by a winter NO3 overestimation bias that can be quite large (Figure B-13a, bottom). The SEARCH JST site had some data capture problems for OCM so the performance is not very meaningful, but does suggest and underprediction tendency as seen at other sites. Unlike the DeKalb County STN site that suggests an EC overestimation bias (28%), at the SEARCH JST site the CMAQ 12 km modeling results exhibits a zero bias and fractional gross error of 37% (Figure B-13b, bottom). The STN and SEARCH sites use different sampling techniques for carbon which may help explain these differences. The observed NH4 at the JST site is reproduced well (Figure B-13c, top) with a fractional bias of -5% and error of 37%. The

Soil term measures at the JST site is greatly overestimated with fractional bias of 136% (Figure B-13d). The Soil performance issue is discussed extensively in the VISTAS regional haze TSD (Morris et al., 2009) and two potential reasons for its poor performance are: (1) incompatibilities between the measured Soil that is built up from measured elements and the "Soil" in the modeling which is the other $PM_{2.5}$ that consists of $PM_{2.5}$ that is not explicitly speciated as SO4, NO3, OCM or EC; and (2) impacts of local fugitive dust sources at the monitor that are subgrid-scale to the CMAQ 36/12 km modeling so is not captured by the modeling. Performance for total $PM_{2.5}$ mass at the JST site is excellent (Figure B-13d, bottom) with a low bias (-3%) and error (24%).

Figure B-14 and B-15 displays Soccer and Bugle Plots, respectively, of monthly fractional bias and error across the 26 FRM sites in Georgia. All months achieve the PM performance goal and 8 of the 12 months even achieve the more stringent ozone performance goal. The months that the $PM_{2.5}$ mass performance doesn't achieve the ozone performance goal are due to an overestimation bias in January and underestimation bias in May-July.

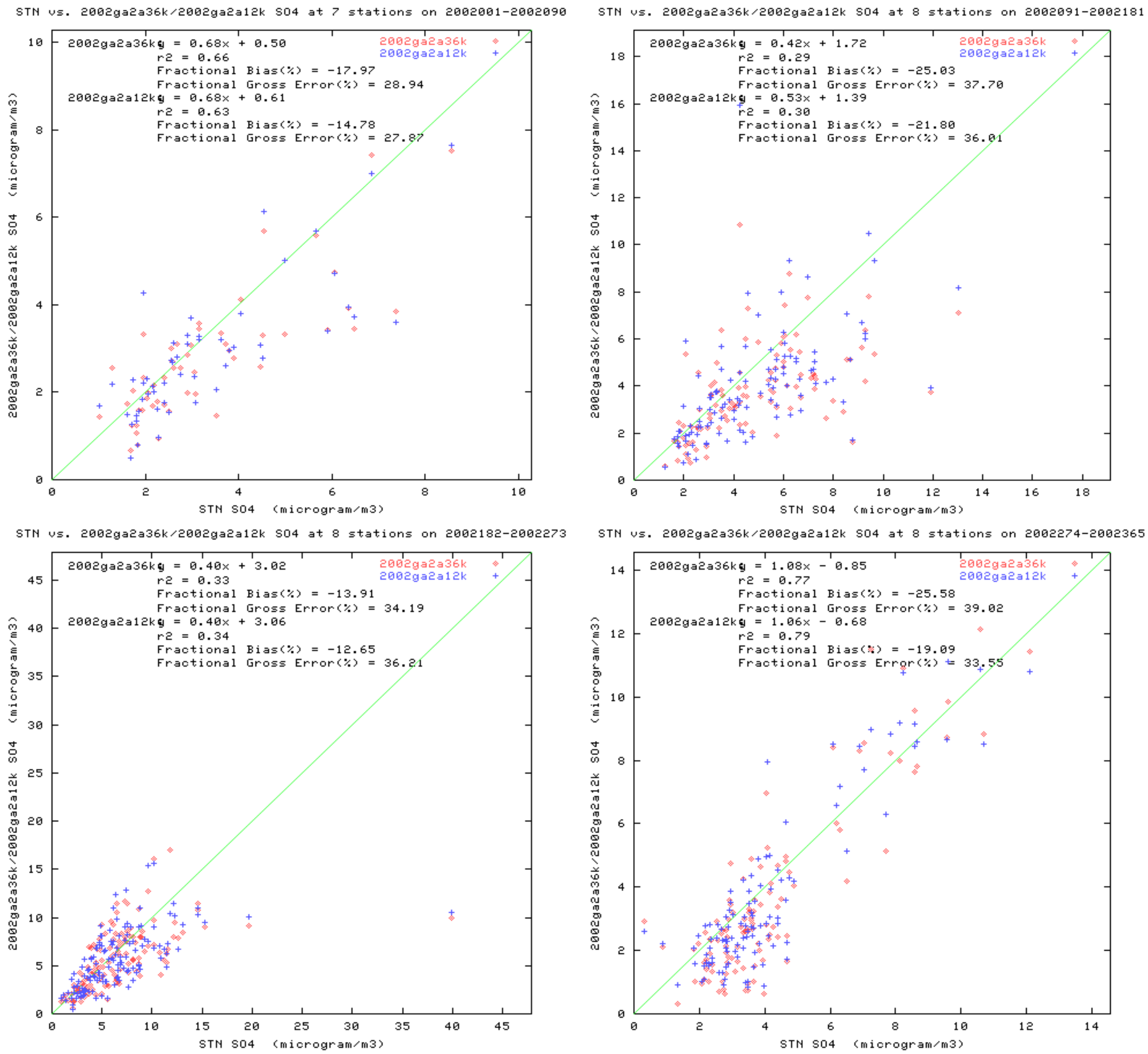


Figure B-11a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

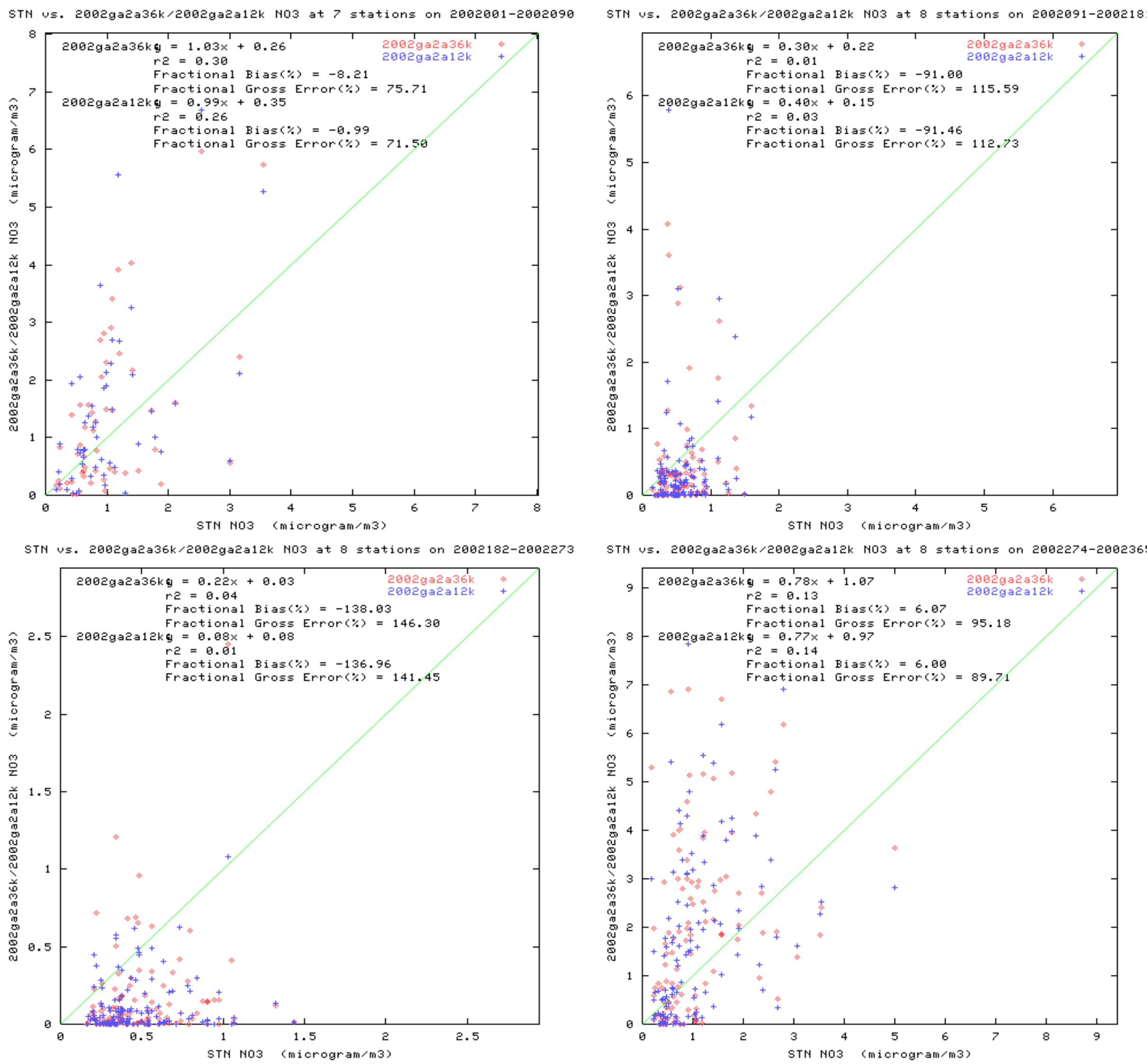


Figure B-11b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

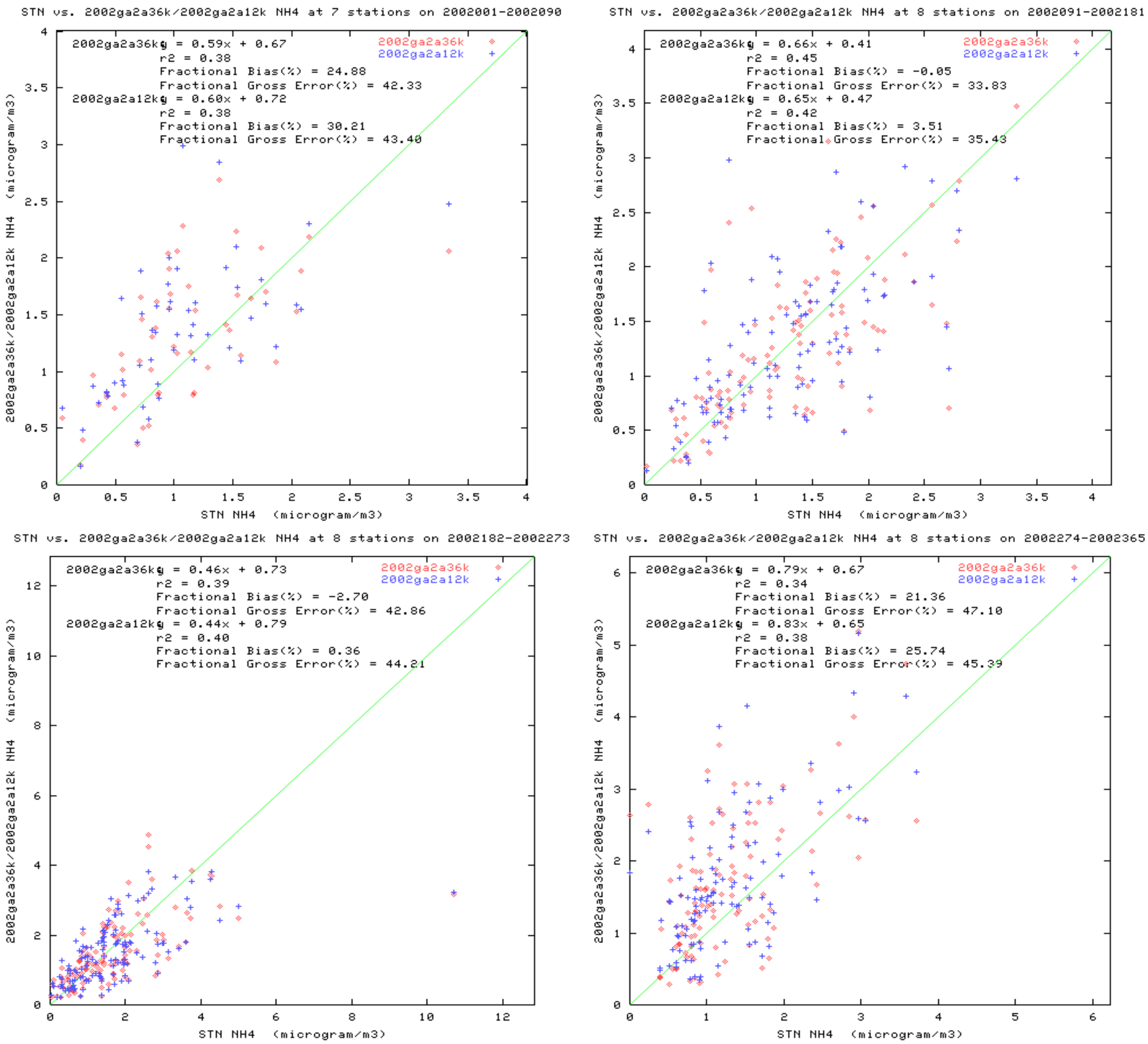


Figure B-11c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

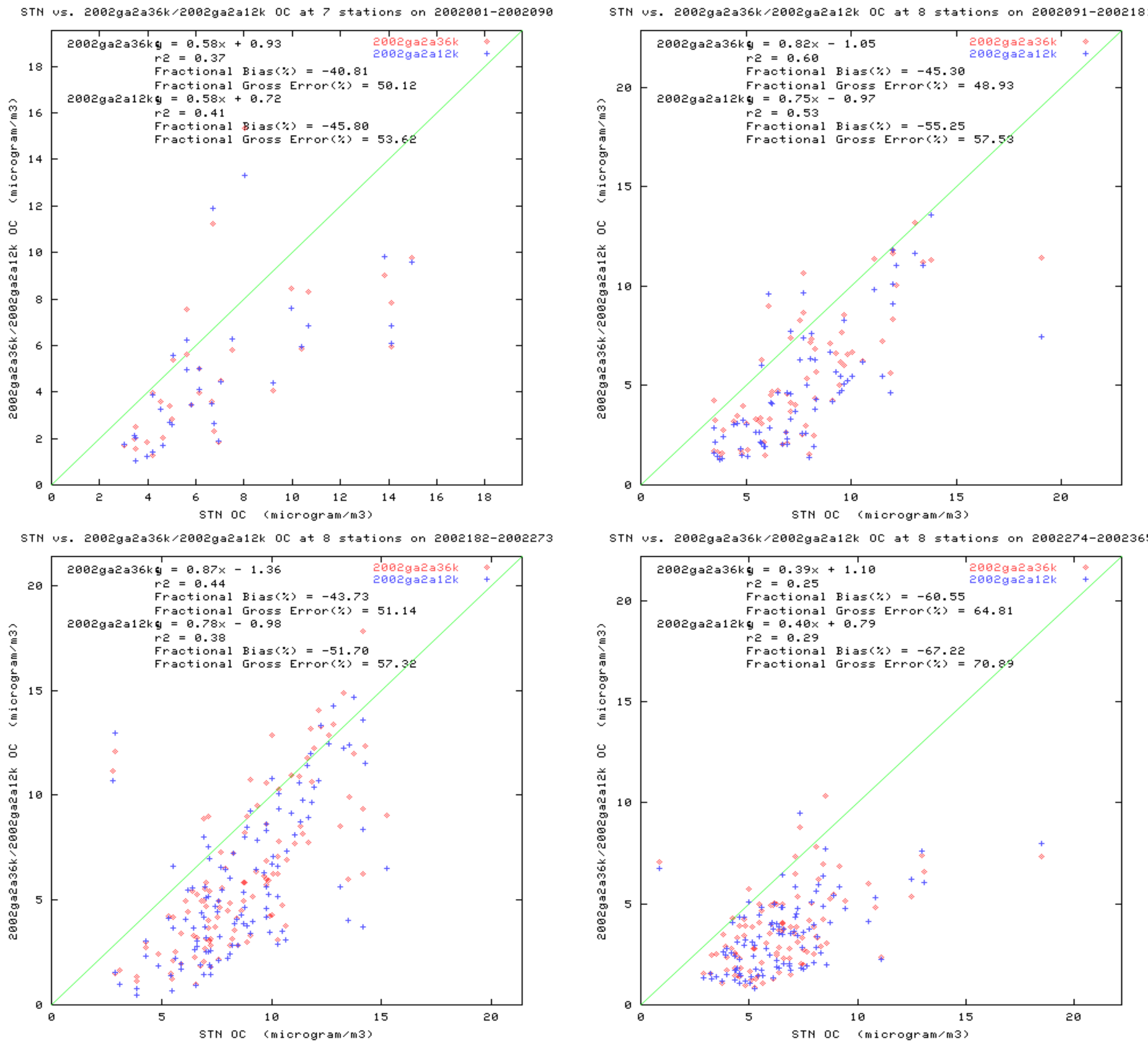


Figure B-11d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

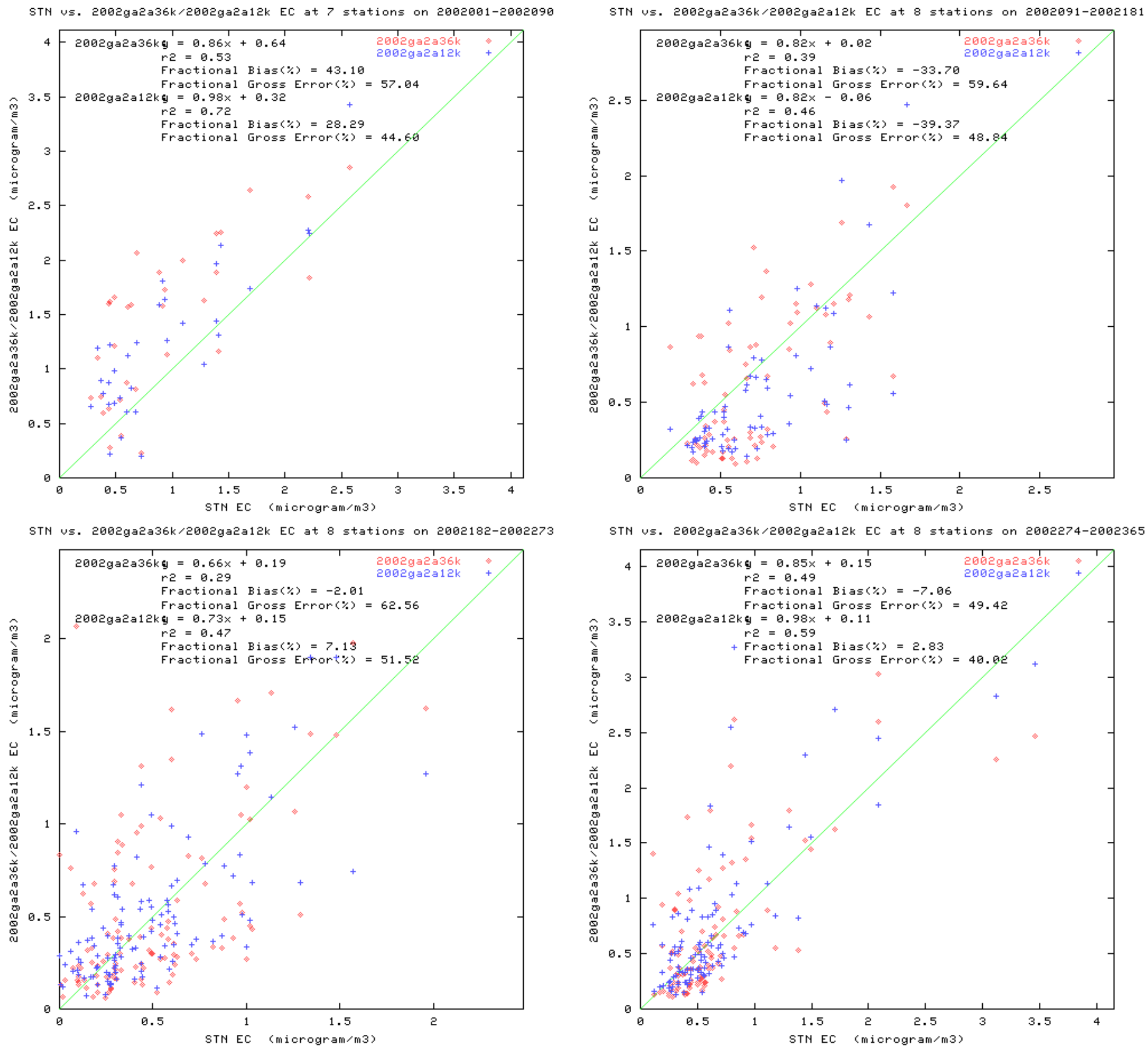


Figure B-11e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

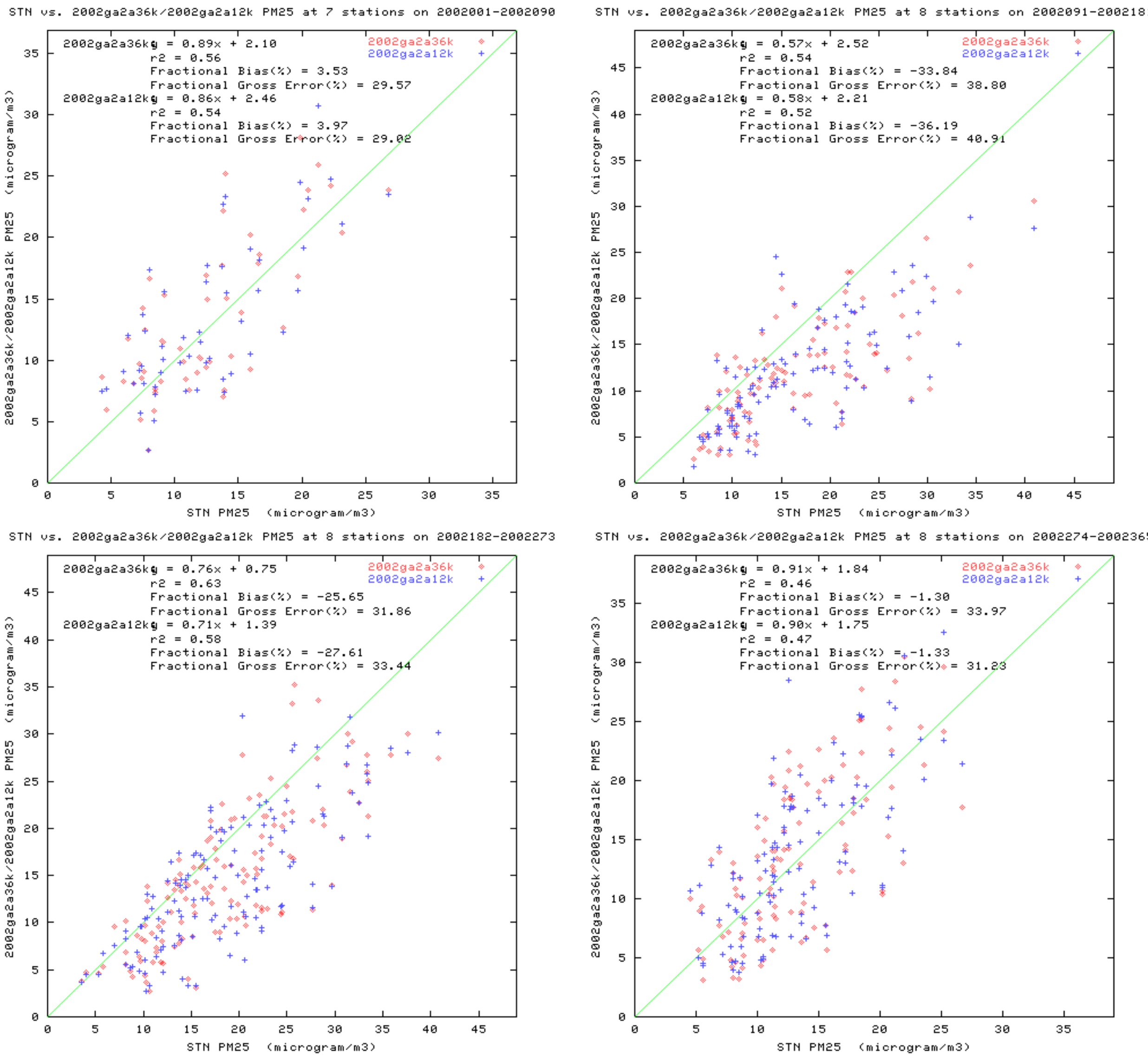


Figure B-11f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

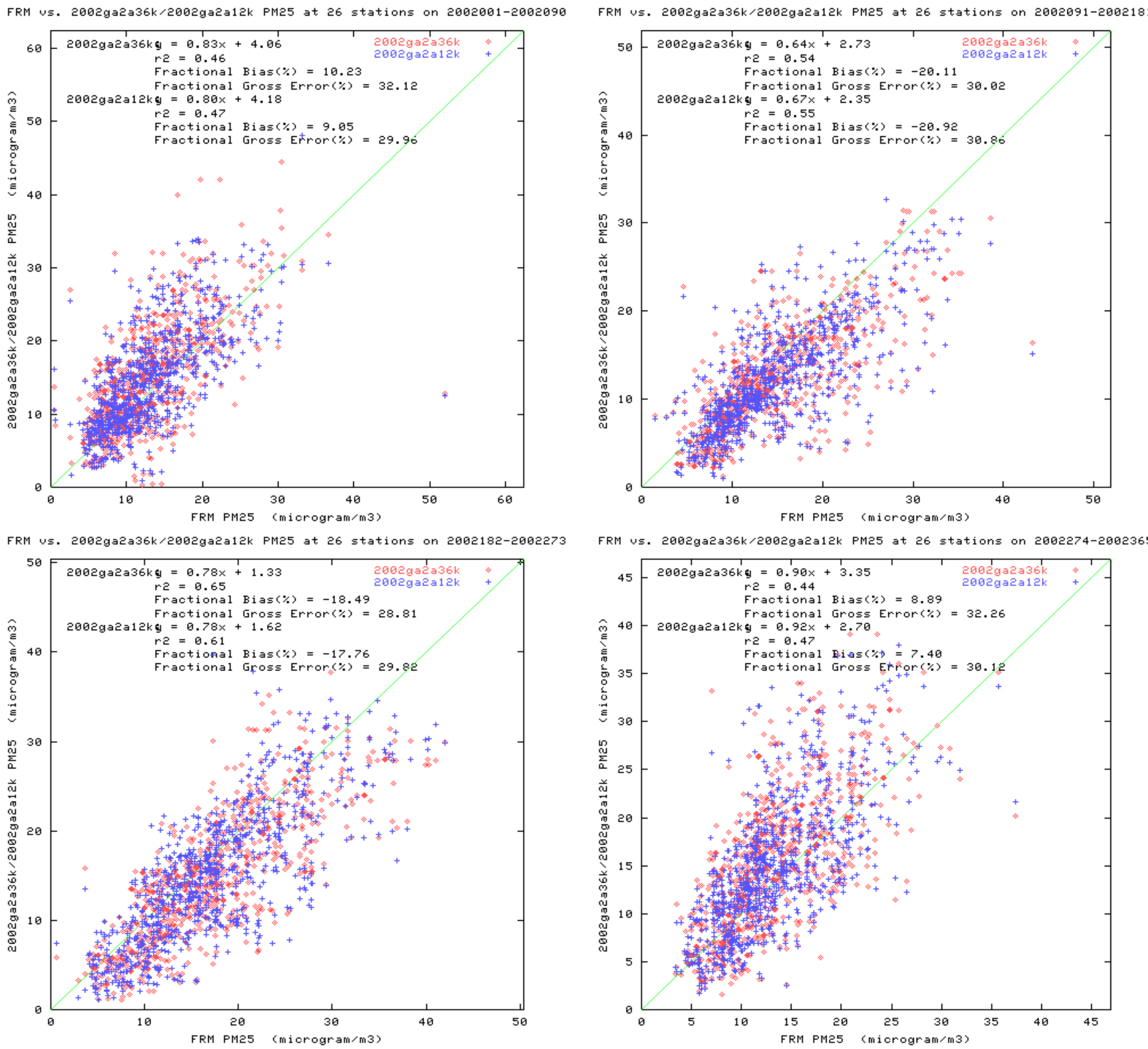
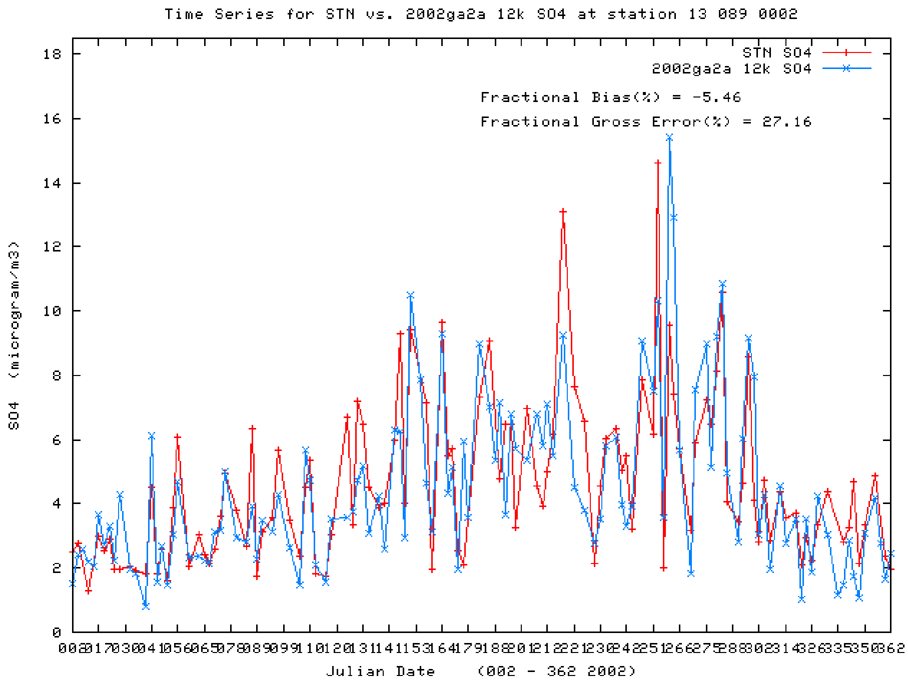


Figure B-11g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Georgia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.



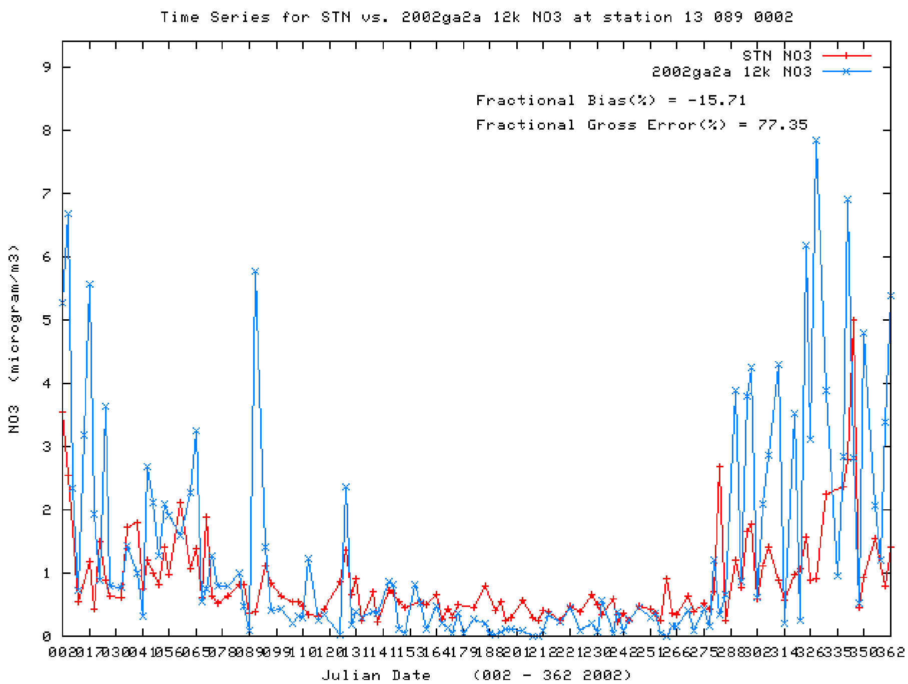
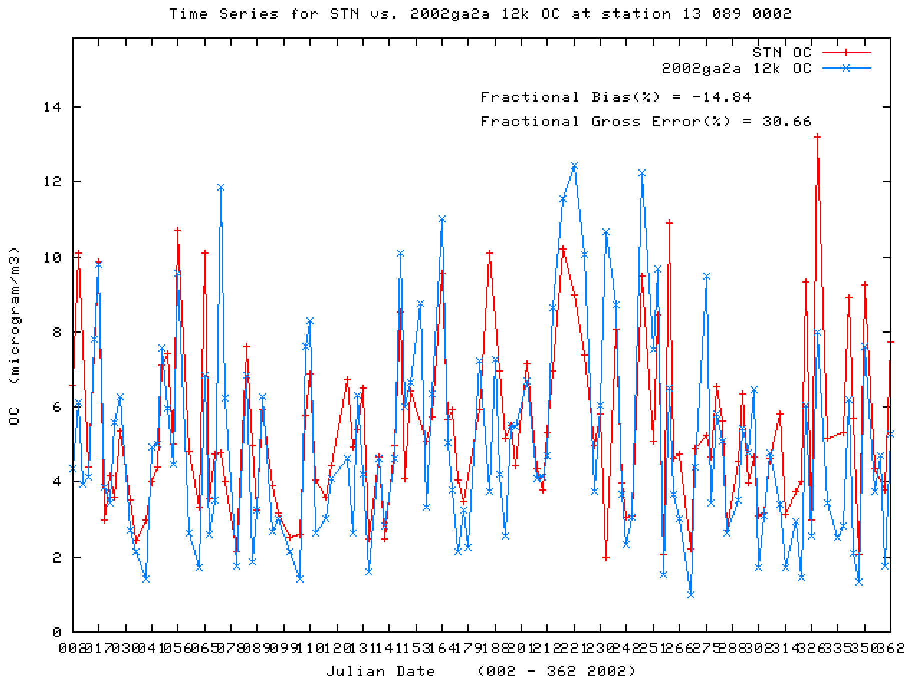


Figure B-12a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN DeKalb County, Georgia Site No. 13-089-0002 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



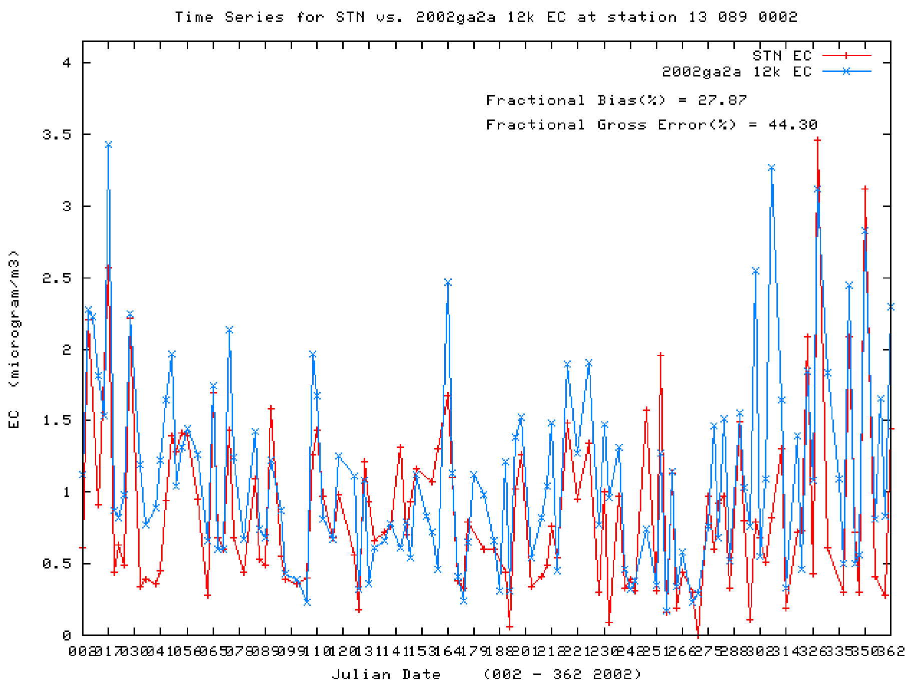


Figure B-12b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN DeKalb County, Georgia Site No. 13-089-0002 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

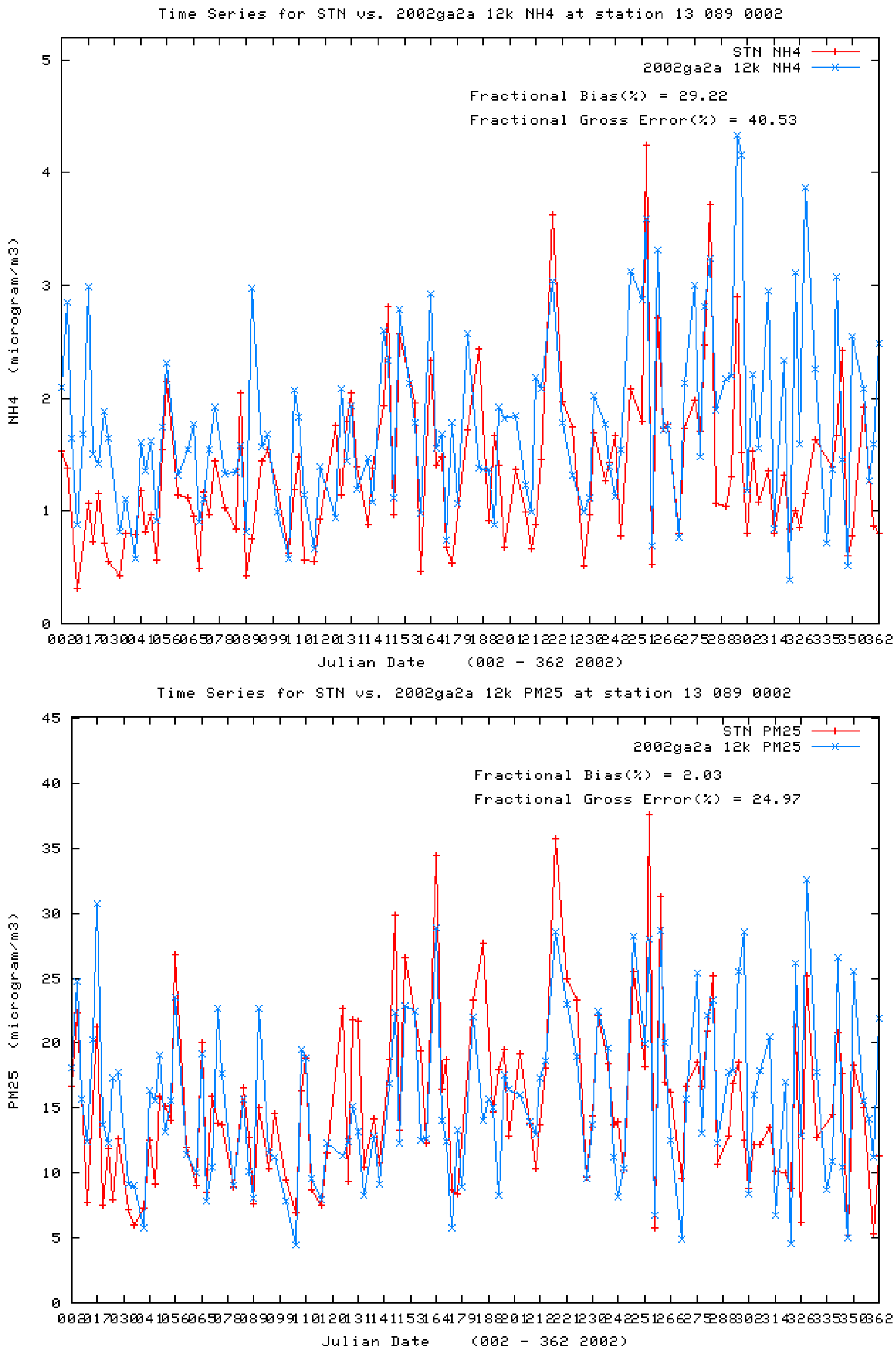
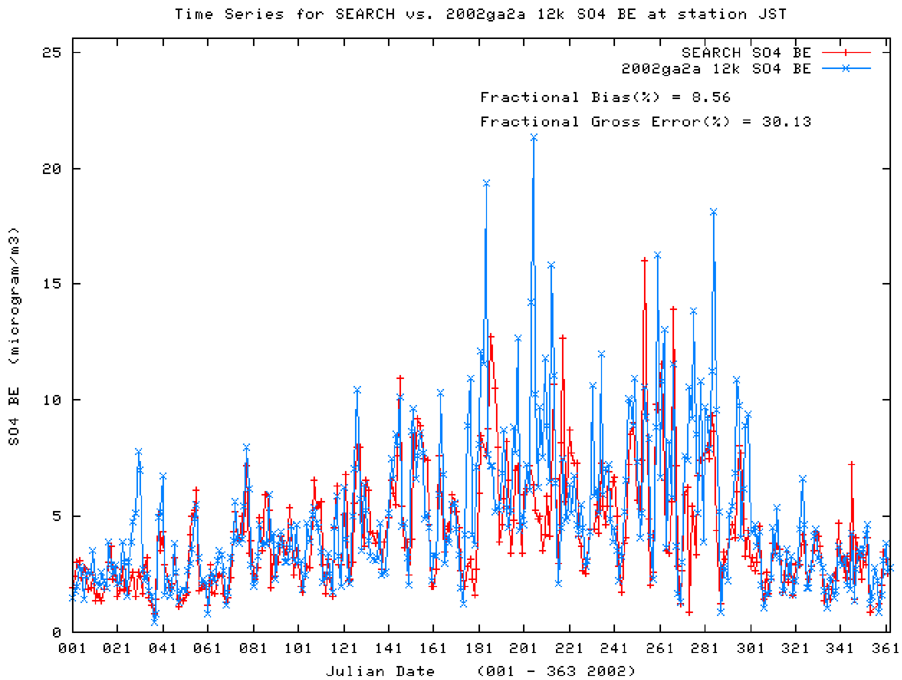


Figure B-12c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN DeKalb County, Georgia Site No. 13-089-0002for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



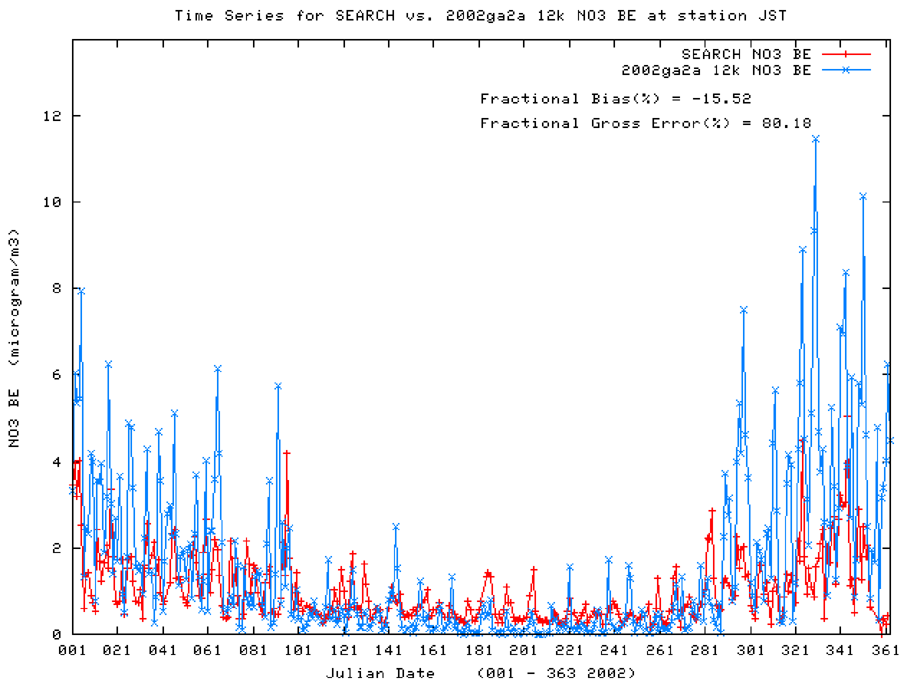
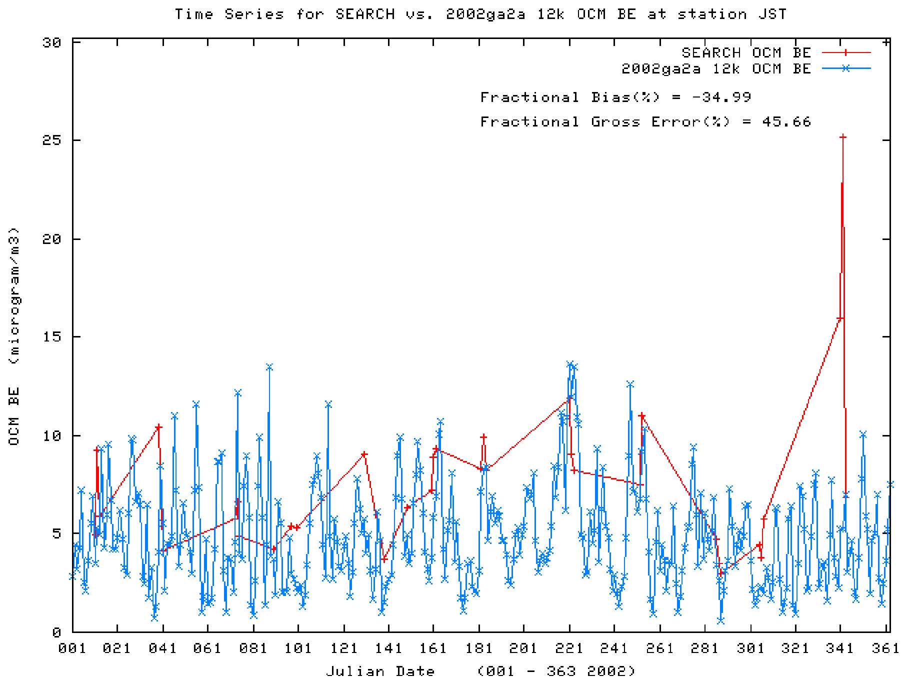


Figure B-13a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the SEARCH Jefferson Street (JST) Georgia site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



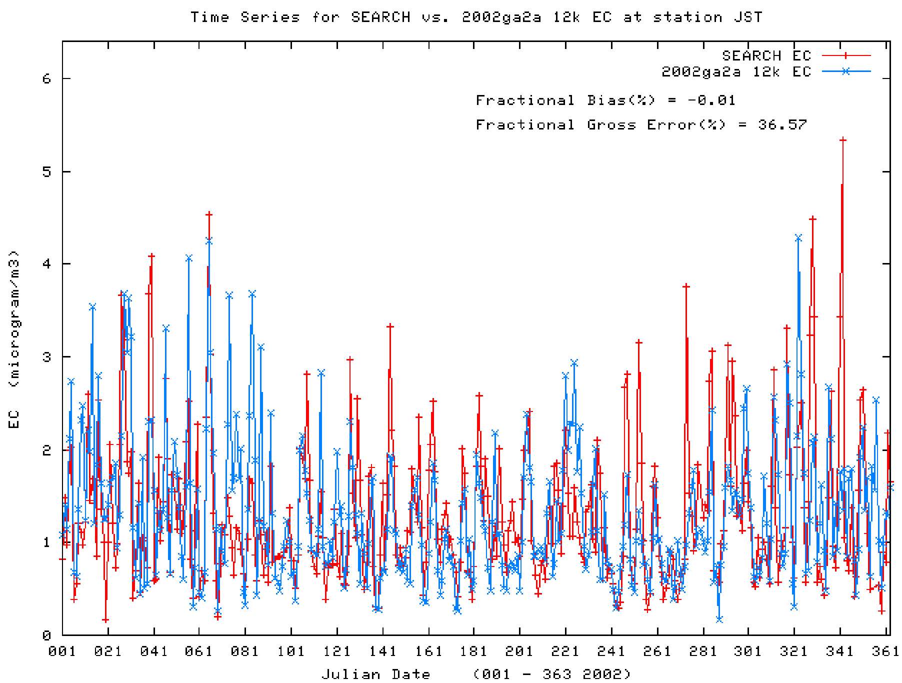
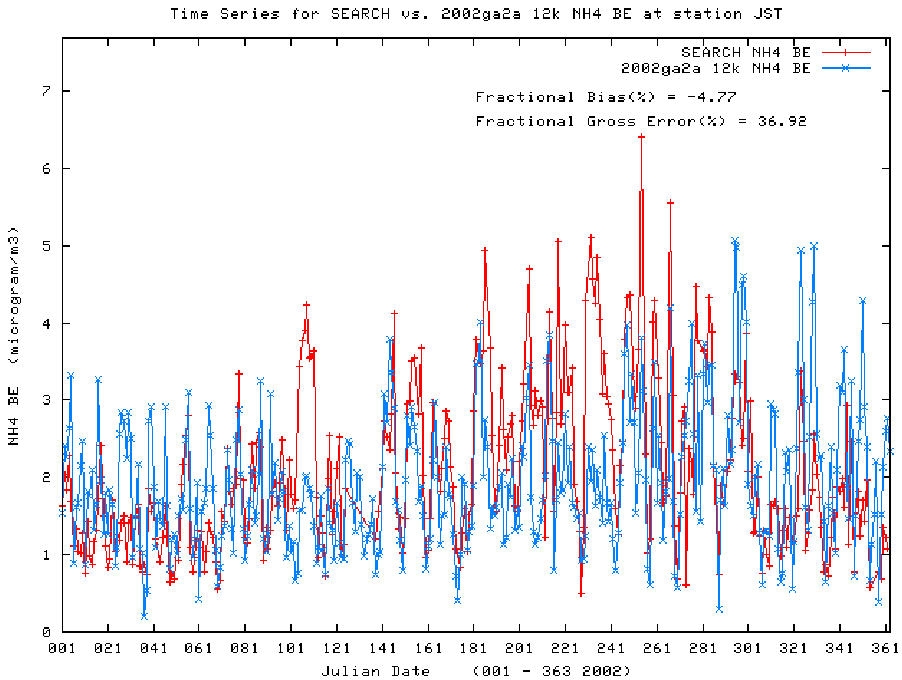


Figure B-13b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the SEARCH Jefferson Street (JST) Georgia site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



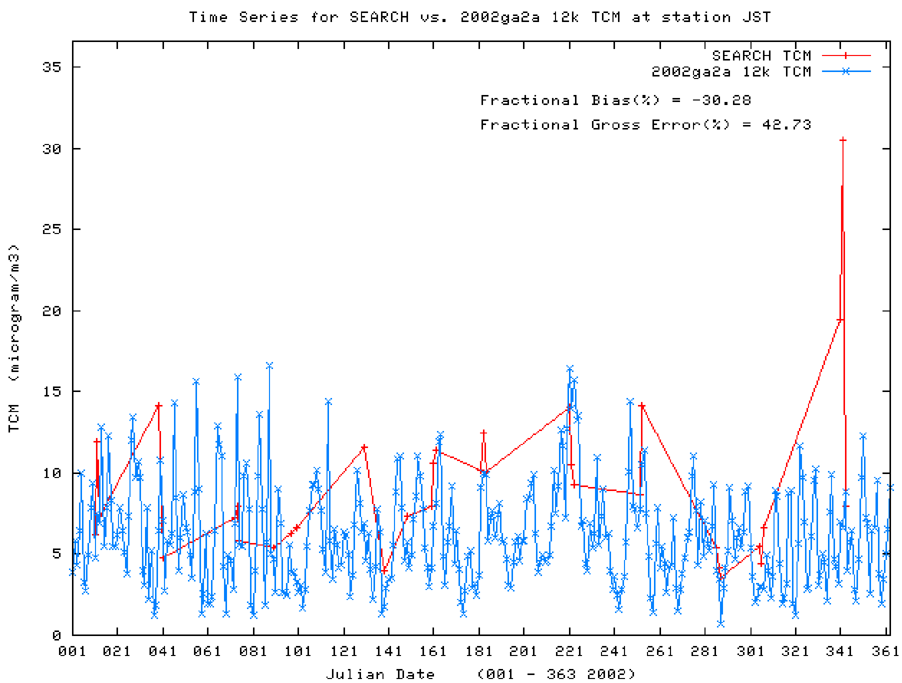
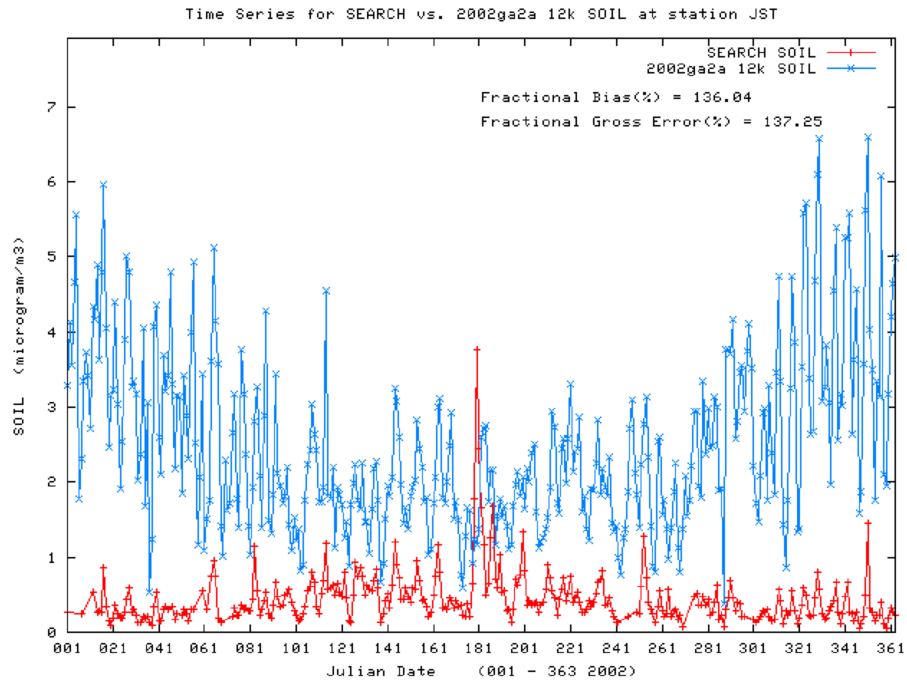


Figure B-13c. Time series of predicted and observed 24-hour ammonium (NH4, top) and total carbon mass (TCM, bottom) concentrations during 2002 at the SEARCH Jefferson Street (JST) Georgia site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



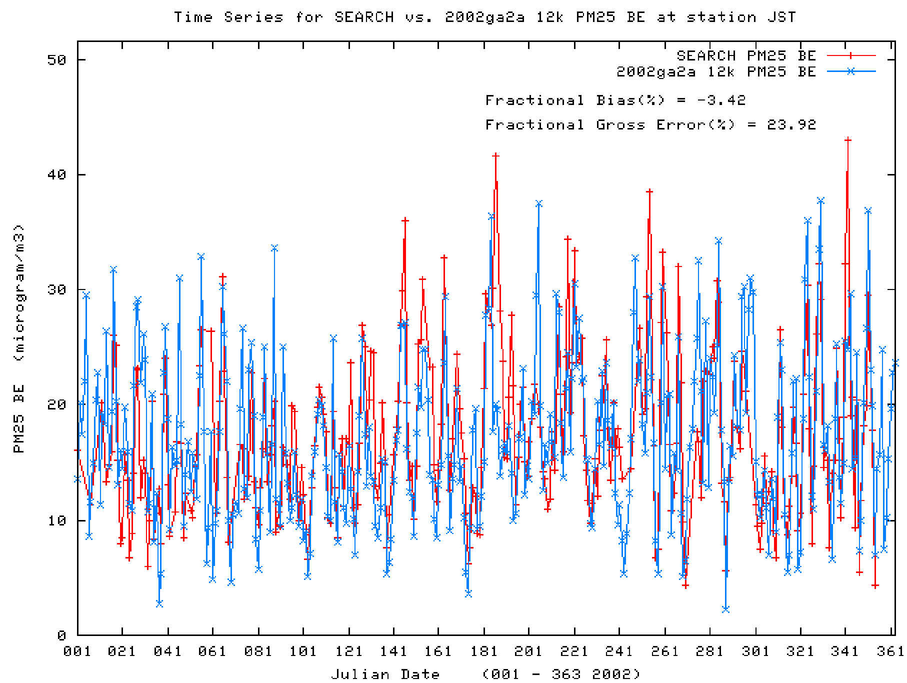


Figure B-13d. Time series of predicted and observed 24-hour other $PM_{2.5}$ (Soil, top) and total fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the SEARCH Jefferson Street (JST) Georgia site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

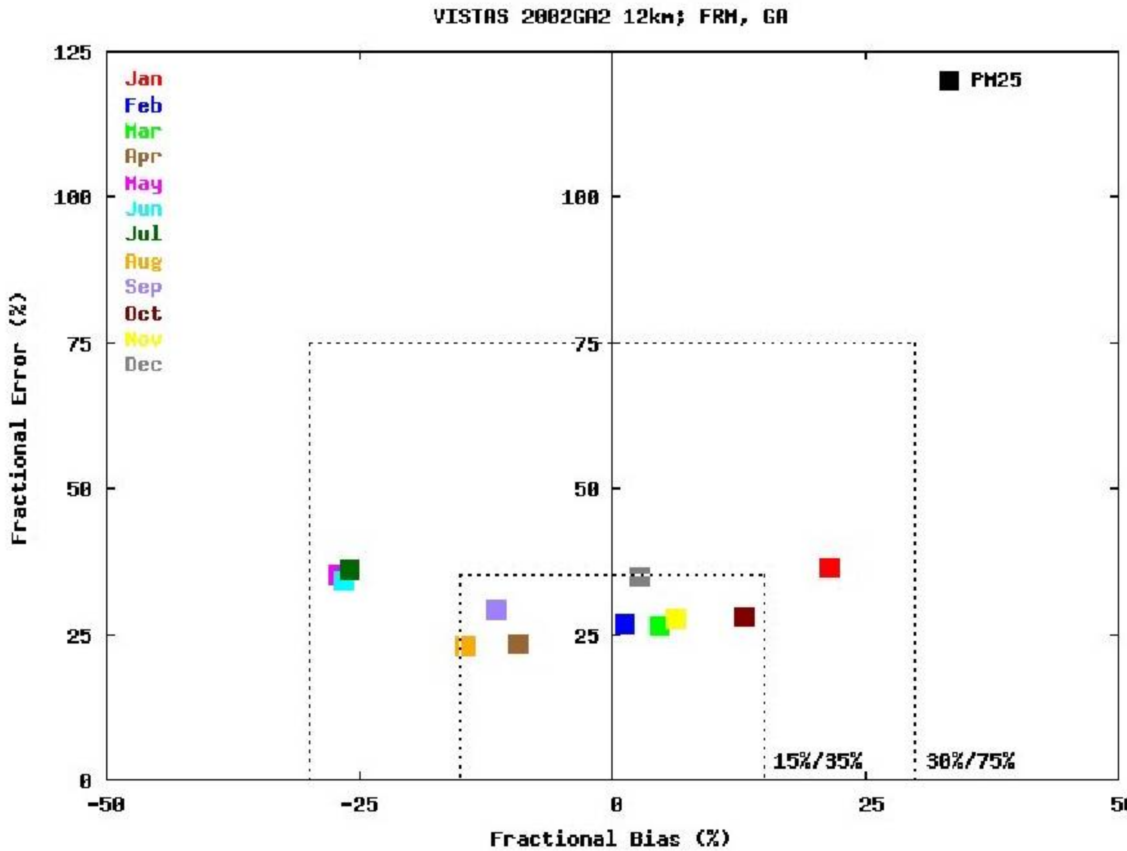


Figure B-14. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Georgia for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

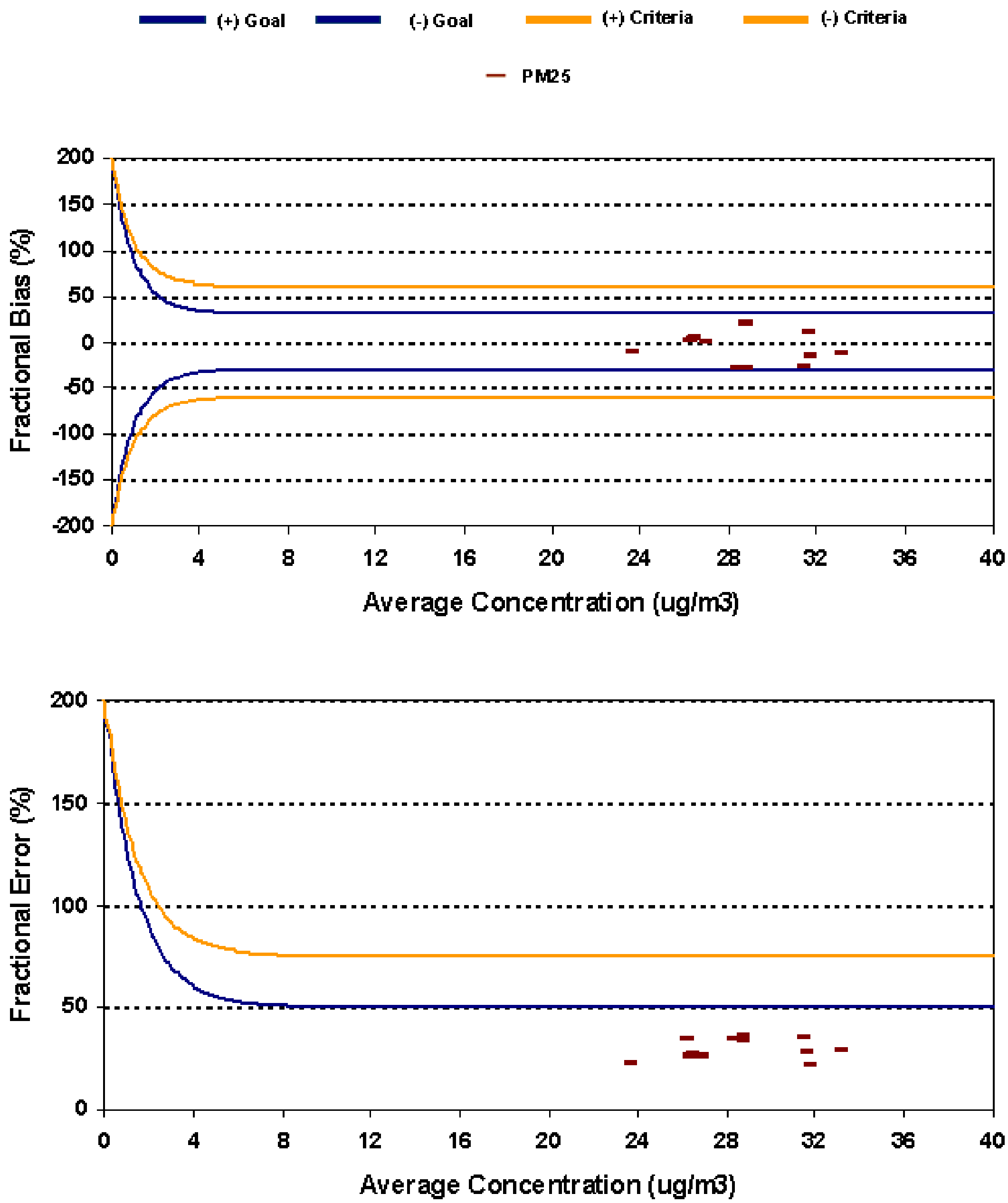


Figure B-15. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Georgia and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.4 Kentucky

The quarterly scatter plots and performance statistics for PM species and sites in Kentucky are shown in Figure B-16. The performance for SO4 in Q1 is mixed, with a group of points clustered around the 1:1 line and another further to the right resulting in a net underprediction bias of approximately -25%. An examination of the more detailed perform plots on the website reveals that this dichotomy in Q1 SO4 model performance in Kentucky is due to temporal rather than spatial differences in performance. The CMAQ 12 km SO4 performance in Q2 and Q3 achieve the most stringent ozone performance goal. Like Q1, Kentucky SO4 performance in Q4 has an underprediction bias of approximately -30% so is right at the PM performance goal.

As seen in the other states, NO3 performance in Kentucky is characterized by underprediction bias during the warmer months that is largest in Q2 (-98% to -105%) and Q3 (-115% and -125%) (Figure B-16b). During the cooler periods of the year, the NO3 fractional bias is low with values of -6% in Q2 and 8% in Q4, although the error is too large to achieve the ozone performance goal (~60%).

Like SO4, NH4 performance is fairly good albeit with an underprediction bias that is largest in Q2 and Q3 (-20% to -30%) (Figure B-16c). As seen for the other states, OCM in Kentucky is underpredicted with the bias ranging from -80% to -105% (Figure B-16d). The OCM errors are the opposite sign but the same magnitude as the bias suggesting that the OCM underprediction bias is almost systematic. The CMAQ 36 km and 12 km modeling results exhibit different EC performance in Kentucky. The CMAQ 12 km results have bias that is much closer to zero than the 36 km results, whose EC performance is characterized by an underprediction bias (Figure B-16e). In fact, the CMAQ 36 km EC fractional bias is approximately 30 percentage points lower than the CMAQ 12 km modeling results. This is likely due to the 36 km grid cells over dispersing the urban EC emissions. Both the CMAQ 36 km and 12 km results exhibit a lot of variability producing a lot of scatter and high error metrics.

The performance of total $PM_{2.5}$ mass concentrations in Kentucky is evaluated across 10 STN (Figure B-16f) and 23 FRM sites (Figure B-16g). Given the underprediction of most of the PM component species it is not surprising that total $PM_{2.5}$ mass is underpredicted across the STN sites by approximately -20%, -30%, -20% and 0% for Q1, Q2, Q3 and Q4. Across the FRM sites in Kentucky, however, the CMAQ model for $PM_{2.5}$ mass bias that is generally closer to zero with values of from approximately +10% to -20% for the four quarters of 2002. The FRM $PM_{2.5}$ mass performance always achieves the PM performance goal and sometimes even achieves the ozone model performance goal.

An example PM model performance for a single STN site in Lexington (Fayette County) Kentucky is shown in Figure B-17. The model reproduces the temporal variations in SO4 quite well (Figure B-17a, top) at this site resulting in low bias (-10%) and error (33%). Although the model shows some skill in reproducing the observed higher NO3 values in the winter, especially in the first part of the year, the near zero modeled NO3 during the summer results in a fractional bias value of -62% with 87% error, so does not achieve the PM performance goal (Figure B-17a, bottom).

OCM is underpredicted with fractional bias values of -52% and an error of 58% just at the PM performance goal (Figure B-17b, top). EC exhibits much better performance at the Lexington, Kentucky site with a bias near zero (-4%) and error of 36% so almost achieves the ozone performance goal.

The performance for NH4 and $PM_{2.5}$ mass is quite good, which is not surprising given the good SO4 performance and the strong link between SO4 and these two species in Kentucky. The fractional bias for NH4 and $PM_{2.5}$ are both approximately -10% with NH4 having an error of 36% and $PM_{2.5}$ an error of 28% thereby achieving the ozone performance goal.

Figure B-18 displays another example time series performance for PM components at an STN site in Kenton County, Kentucky that lies in the Cincinnati NAA. The performance at the Cincinnati NAA STN site is similar to that at Lexington STN site with very good SO4 performance that produces bias/error values of -12%/30% that achieves the ozone performance goal and NO3 with a net underestimation with bias/error of -47%/75% that is right at the PM performance criteria (Figure B-18a). OCM exhibits a large underprediction bias (-57%), whereas performance for EC is better with bias (14%) and error (36%) that is right at the ozone performance goal (Figure B-18b). NH4 (-4%/37%) and $PM_{2.5}$ (-7%/31%) also exhibit low bias/error and good performance, which again is not surprising given their relationship with SO4 (Figure B-18c).

Figure B-19 and B-20 summarized the Kentucky $PM_{2.5}$ mass model performance using Soccer and Bugle Plots of monthly bias and error. With the exception of July, whose fractional bias falls slightly below -30%, $PM_{2.5}$ performance in the other 11 months achieves the PM bias/error performance goal of <-30%/75%. In fact 5 months that occur mainly in the winter even achieve the more stringent ozone model performance goal.

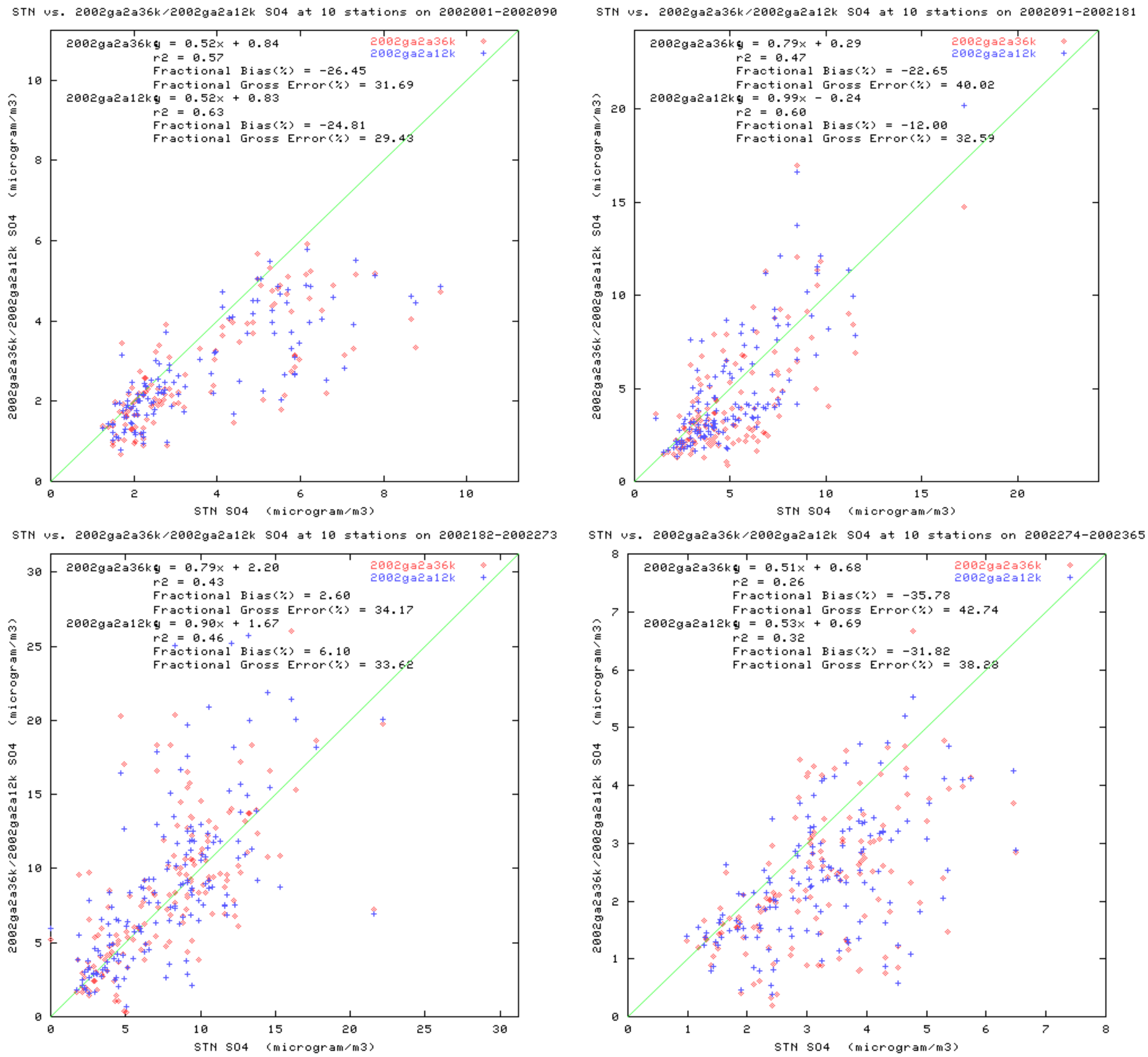


Figure B-16a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

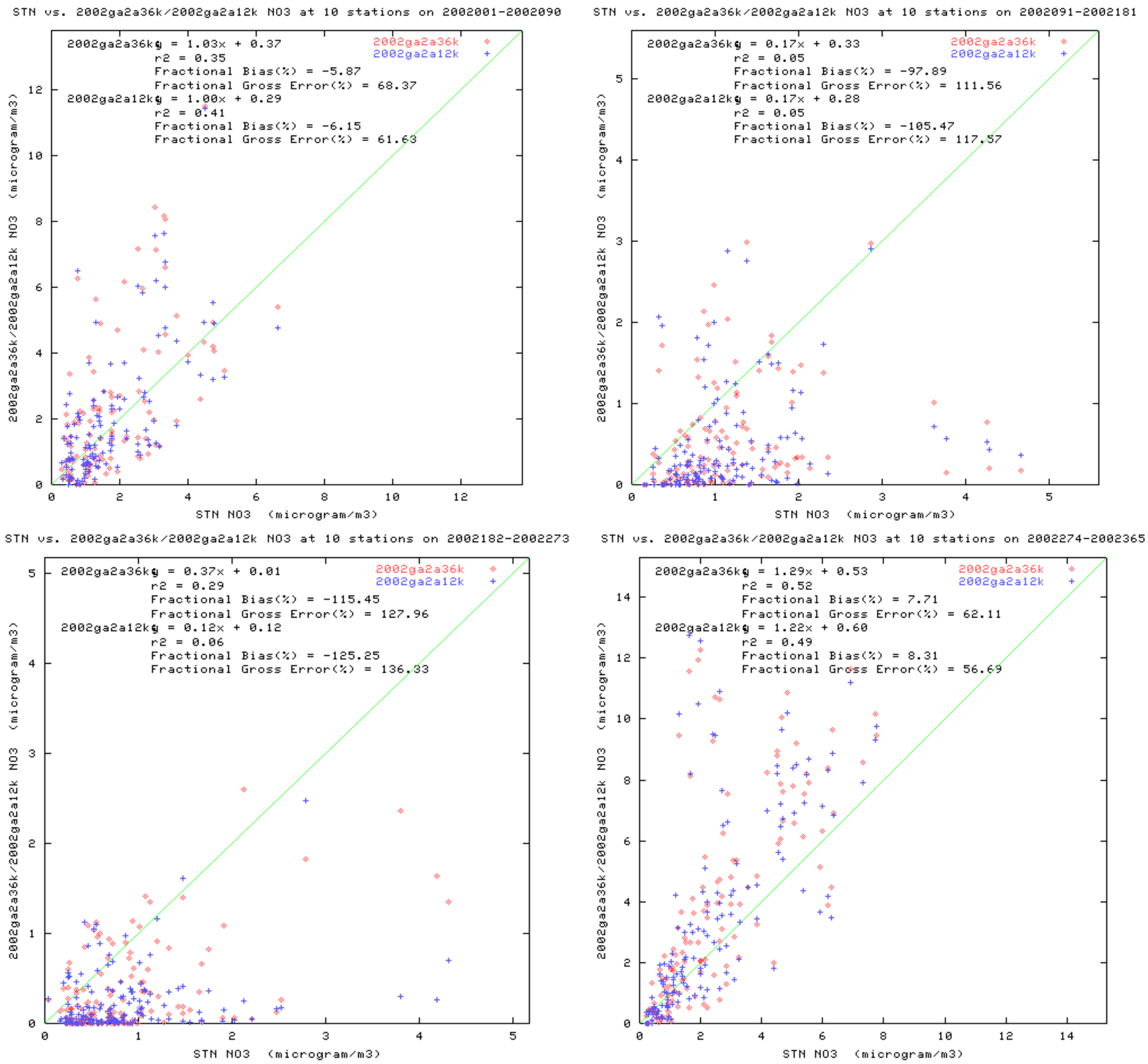


Figure B-16b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

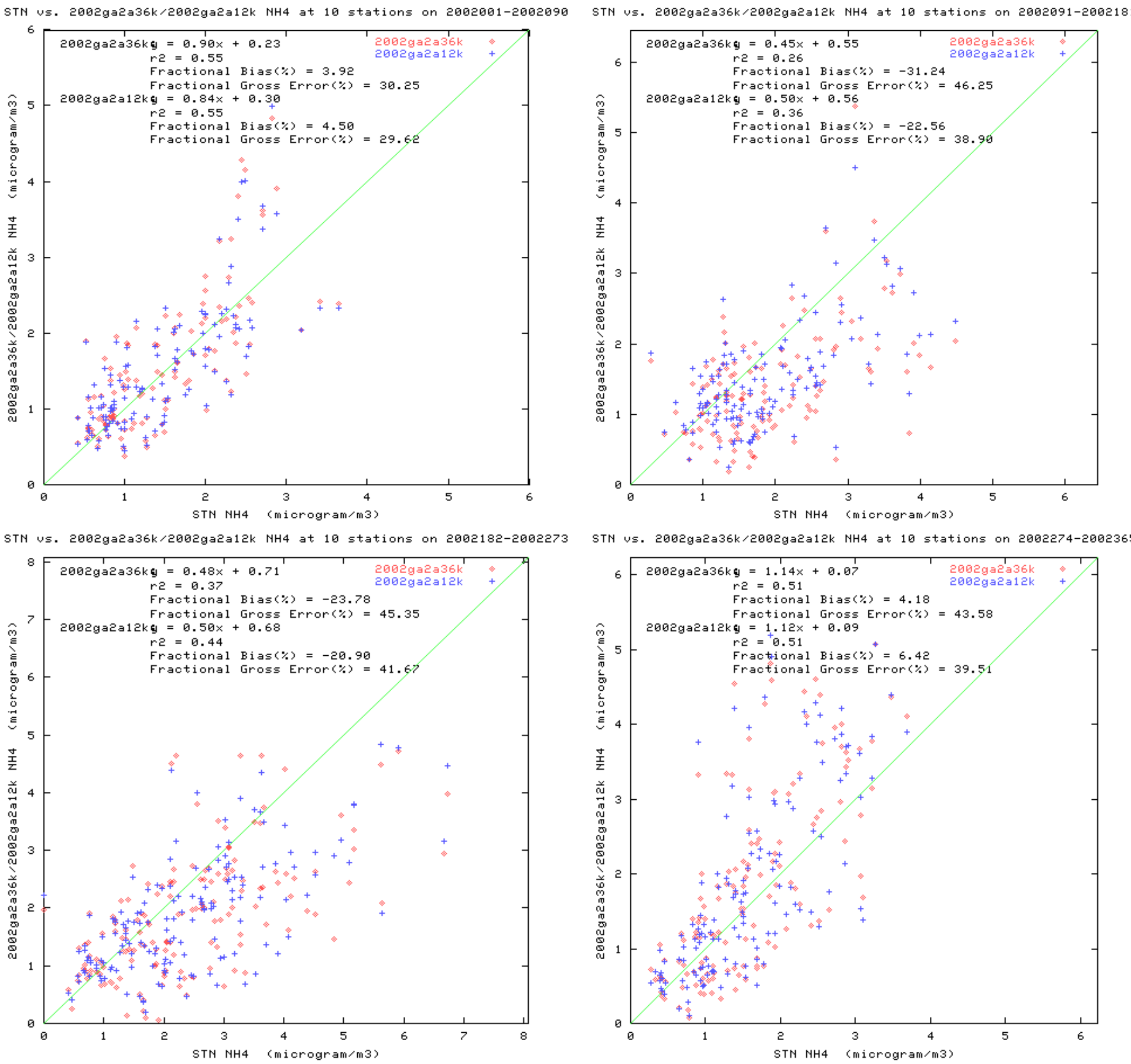


Figure B-16c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

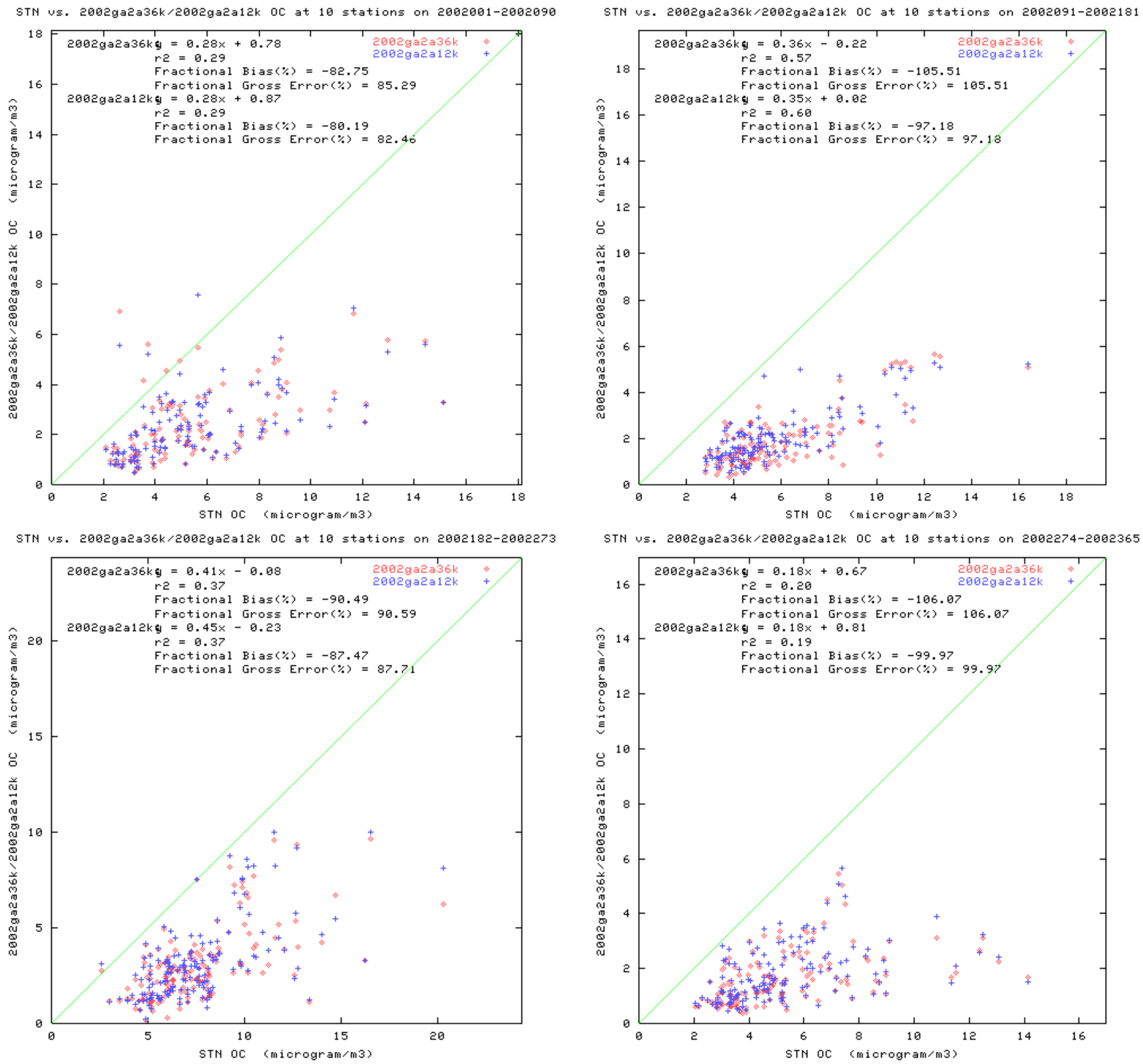


Figure B-16d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

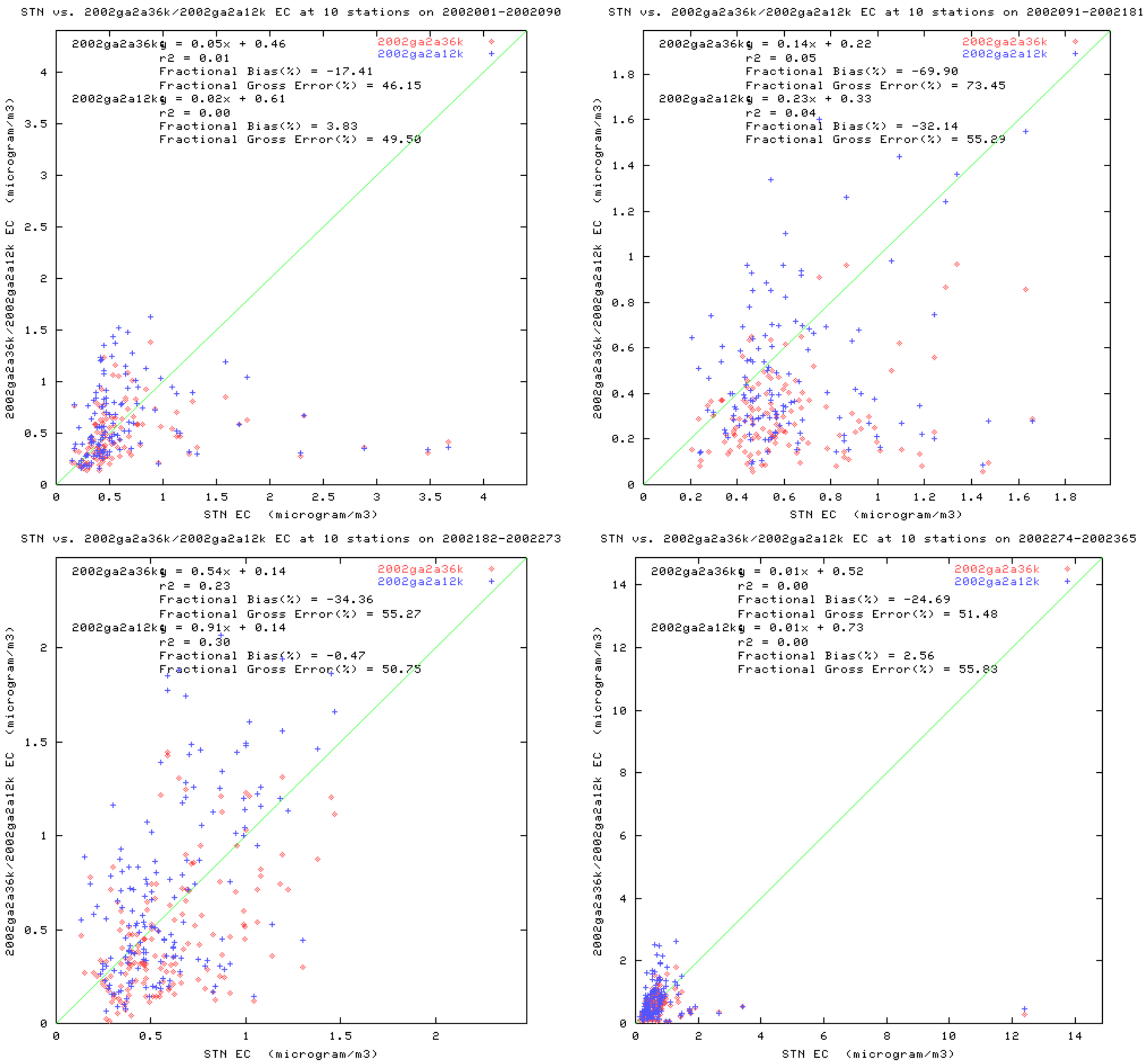


Figure B-16e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

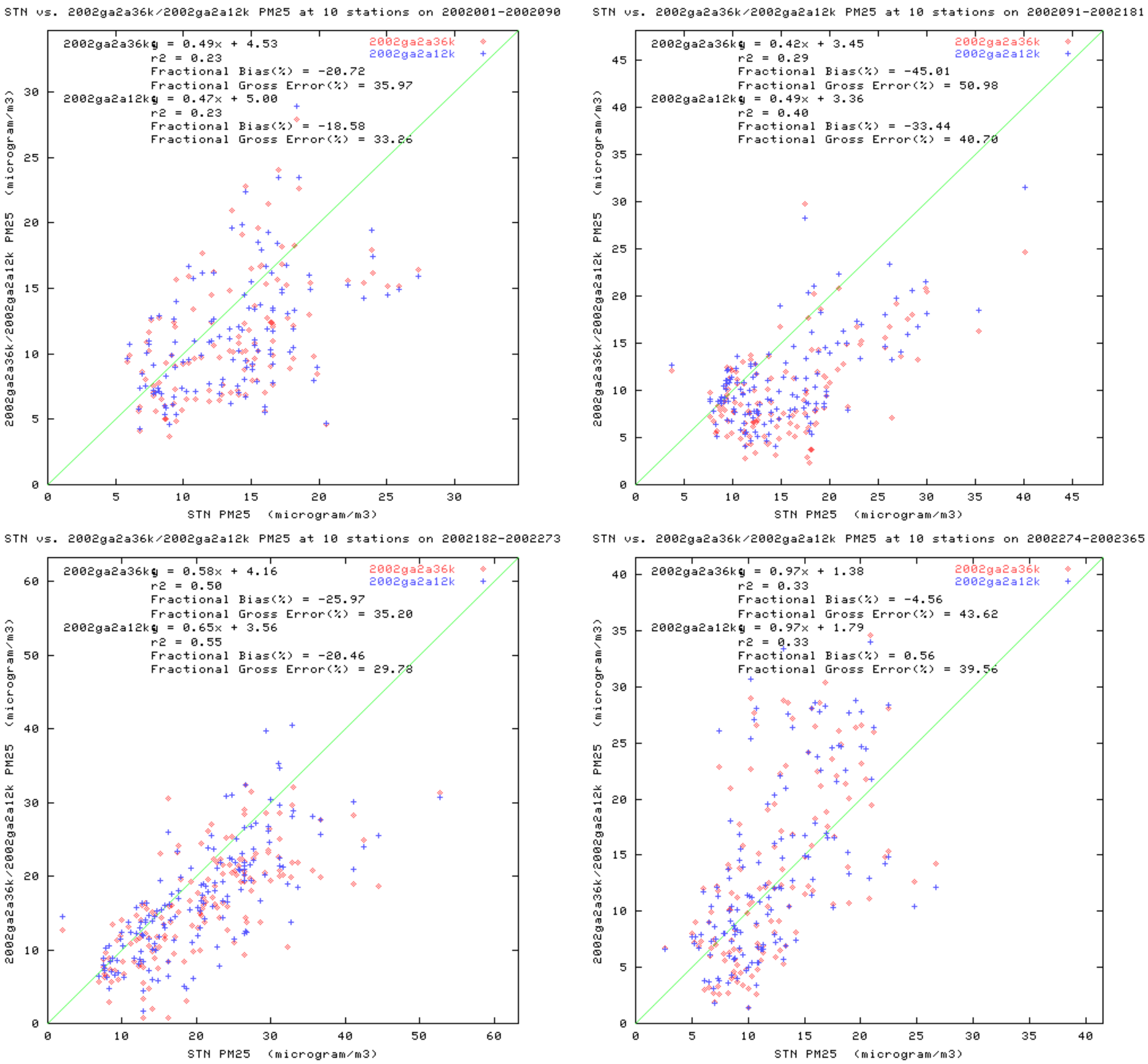


Figure B-16f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

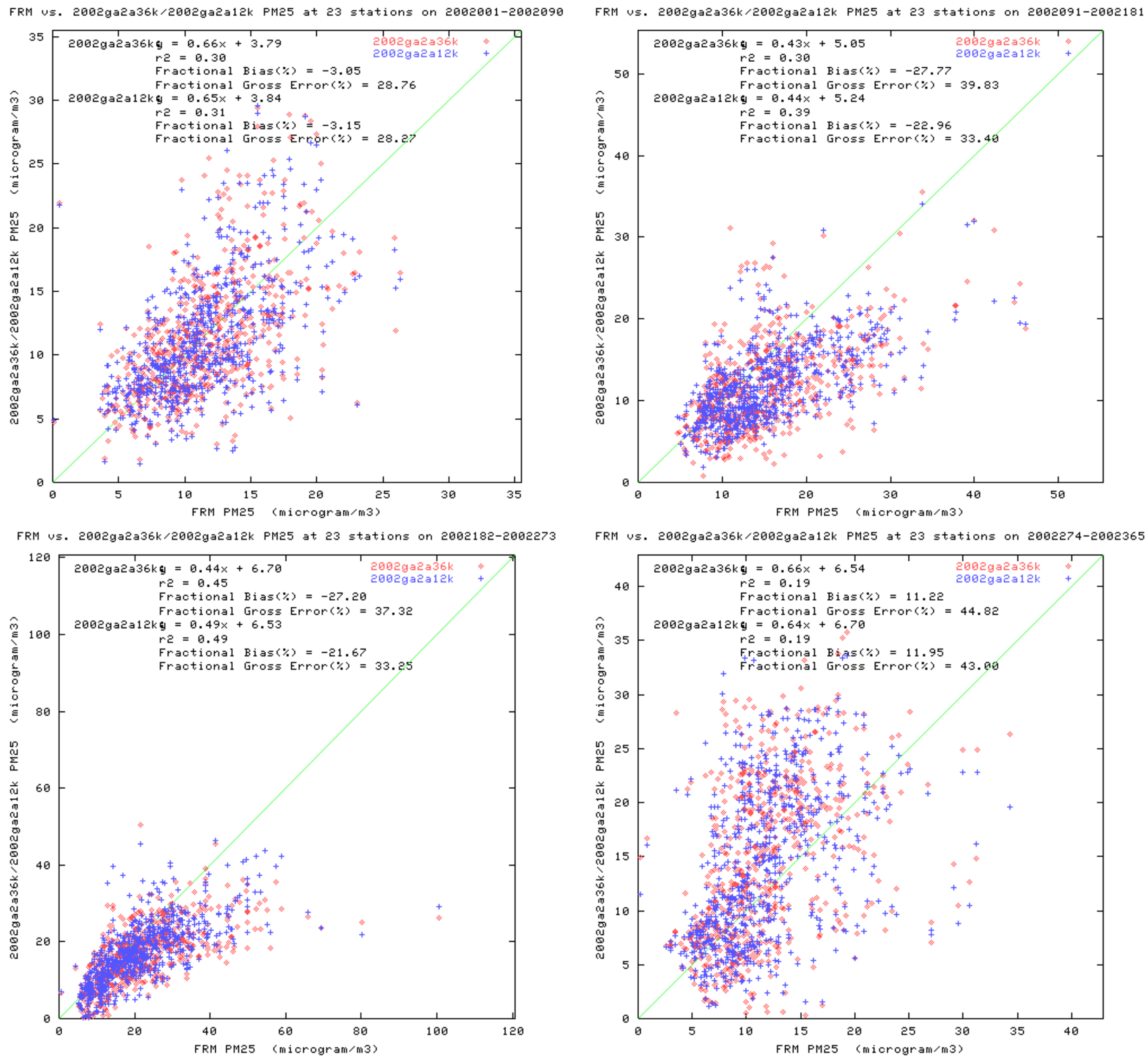


Figure B-16g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Kentucky and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

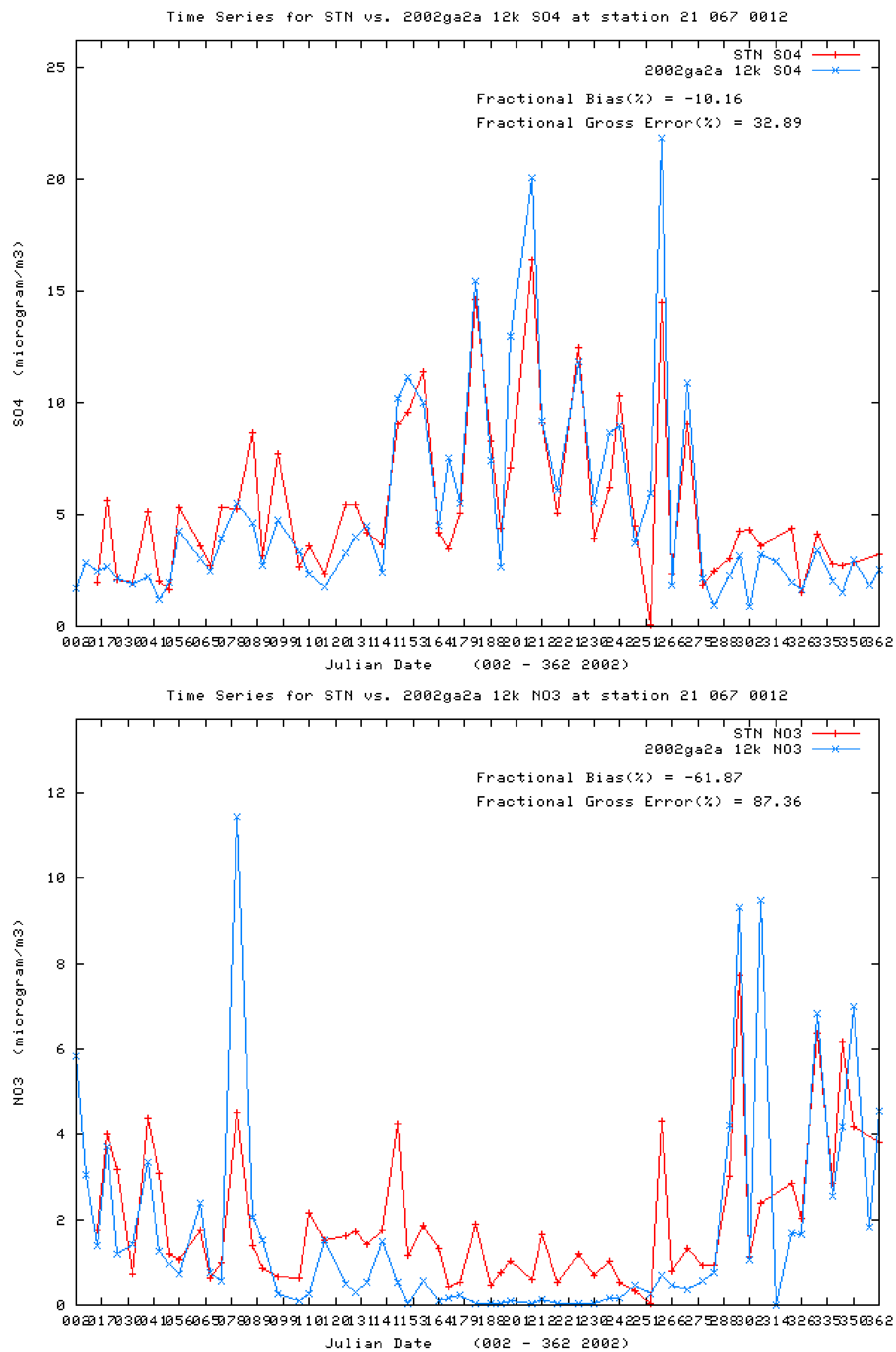


Figure B-17a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Fayette County, Kentucky Site No. 21-067-0012 (Lexington) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

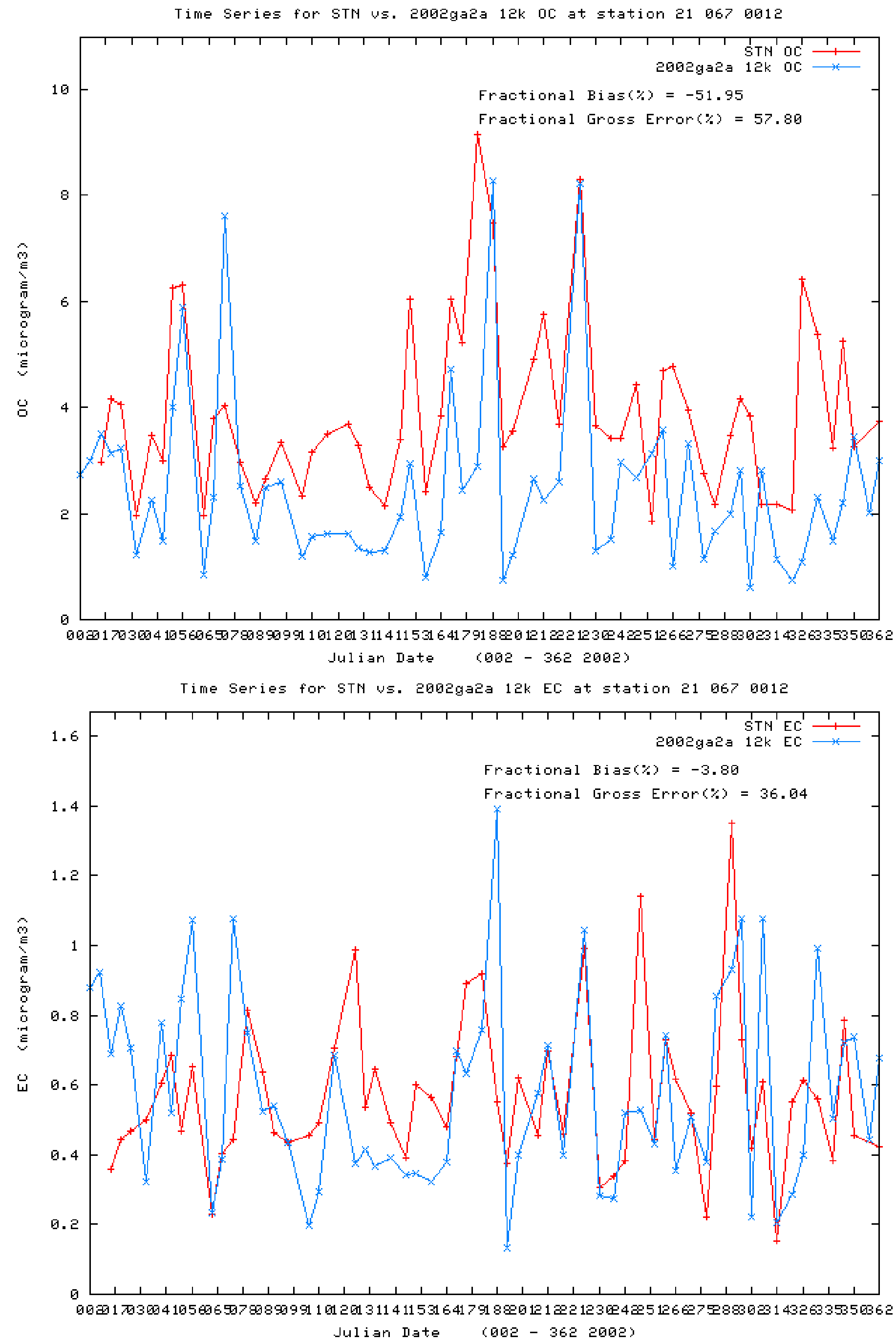
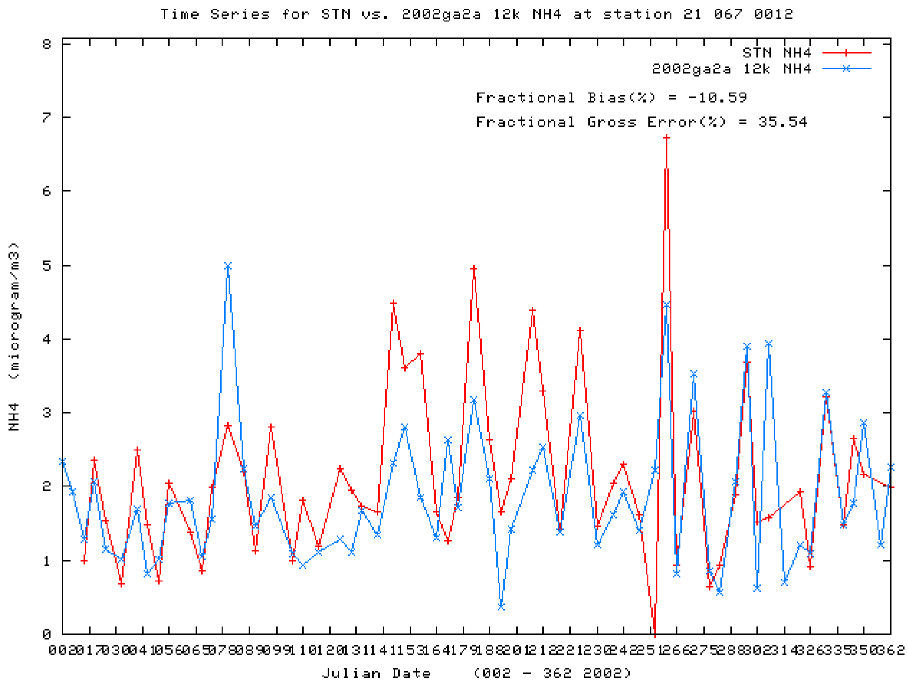


Figure B-17b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Fayette County, Kentucky Site No. 21-067-0012 (Lexington) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



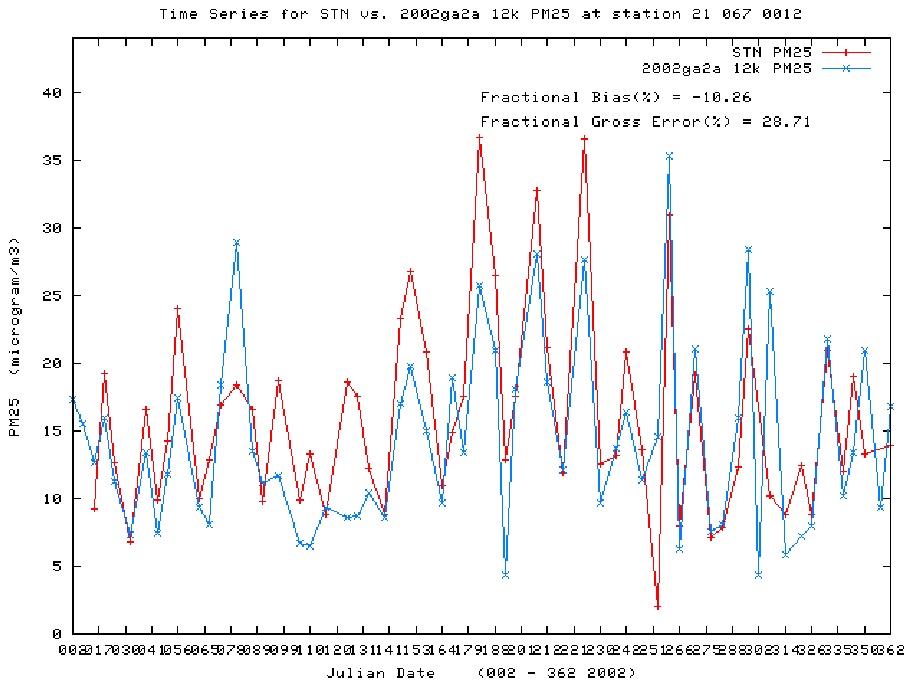


Figure B-17c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Fayette County, Kentucky Site No. 21-067-0012 (Lexington) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

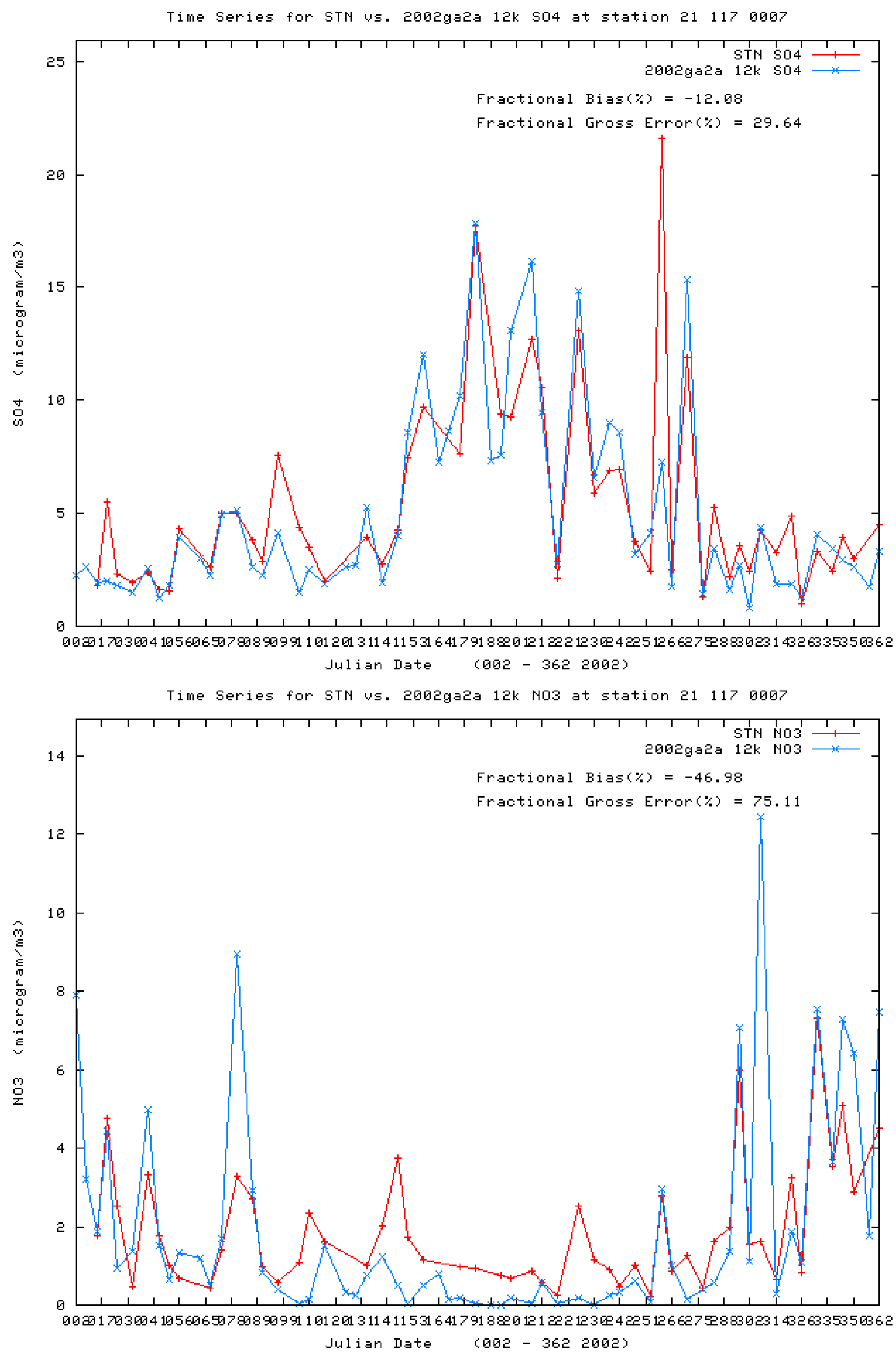
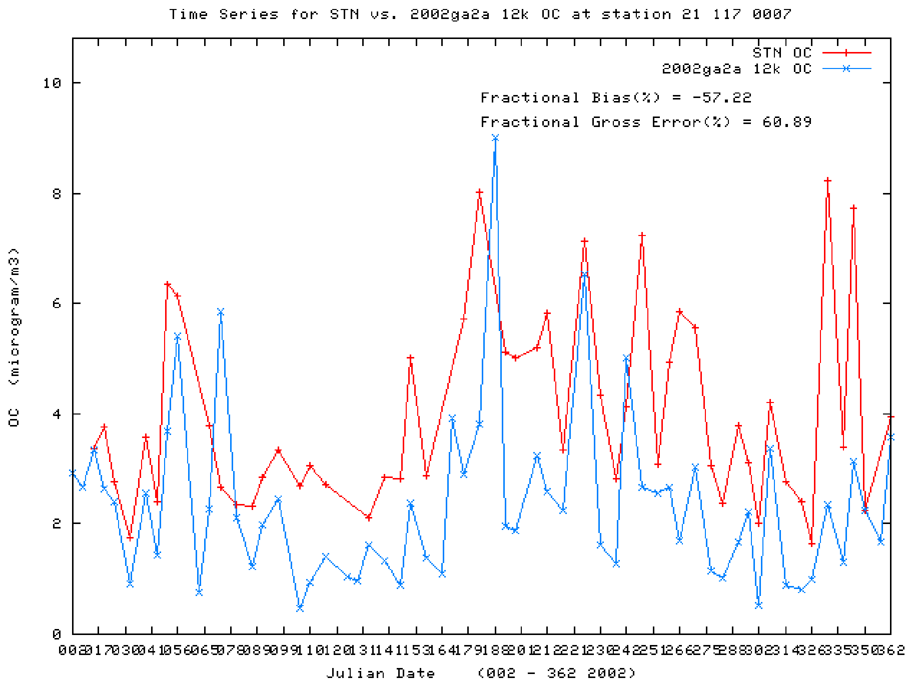


Figure B-18a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Kenton County, Kentucky Site No. 21-117-0007 (Cincinnati) site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



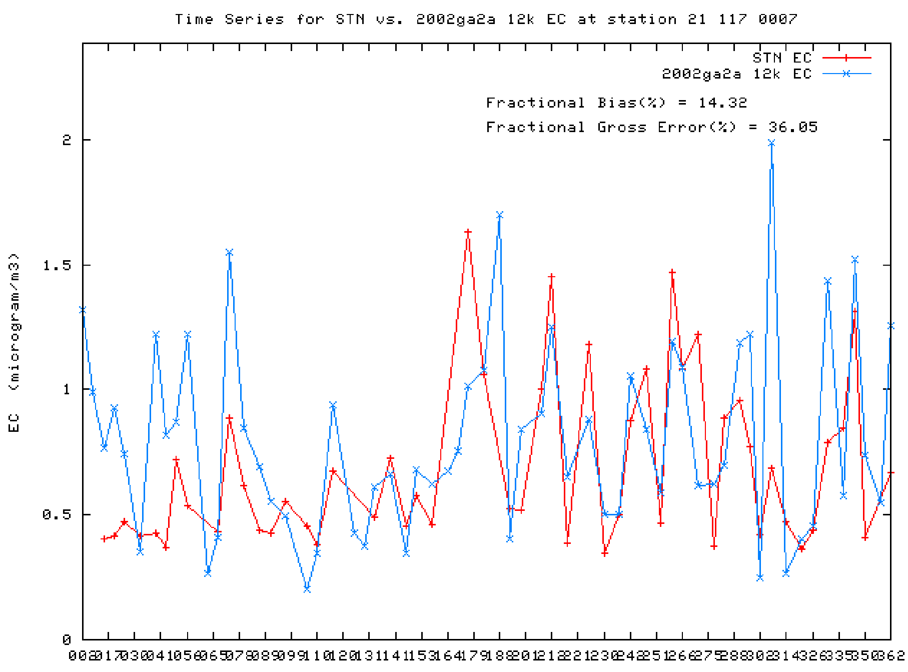
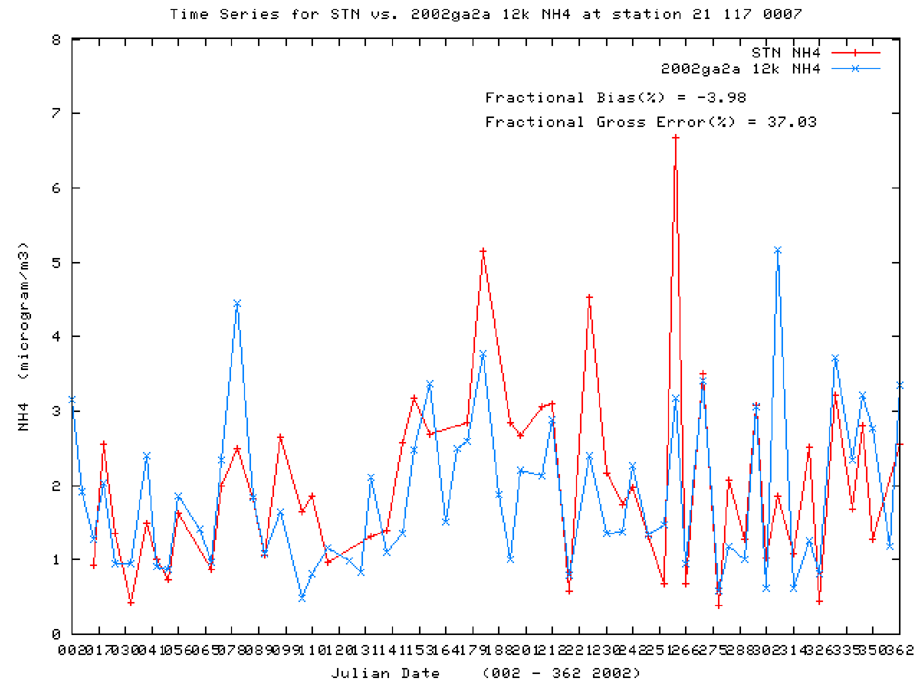


Figure B-18b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Kenton County, Kentucky Site No. 21-117-0007 (Cincinnati) site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



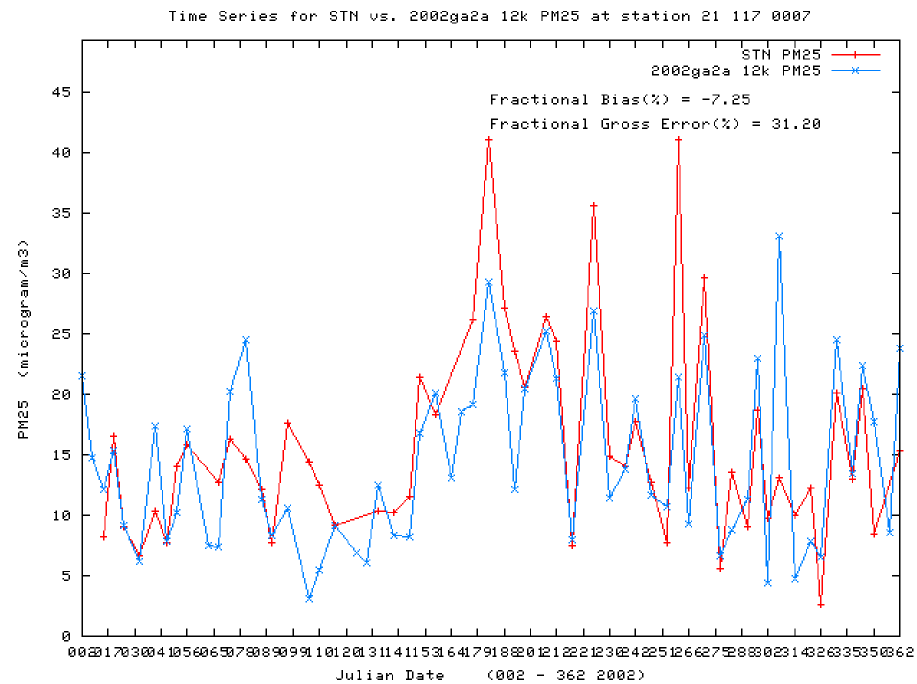


Figure B-18c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Kenton County, Kentucky Site No. 21-117-0007 (Cincinnati) site for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

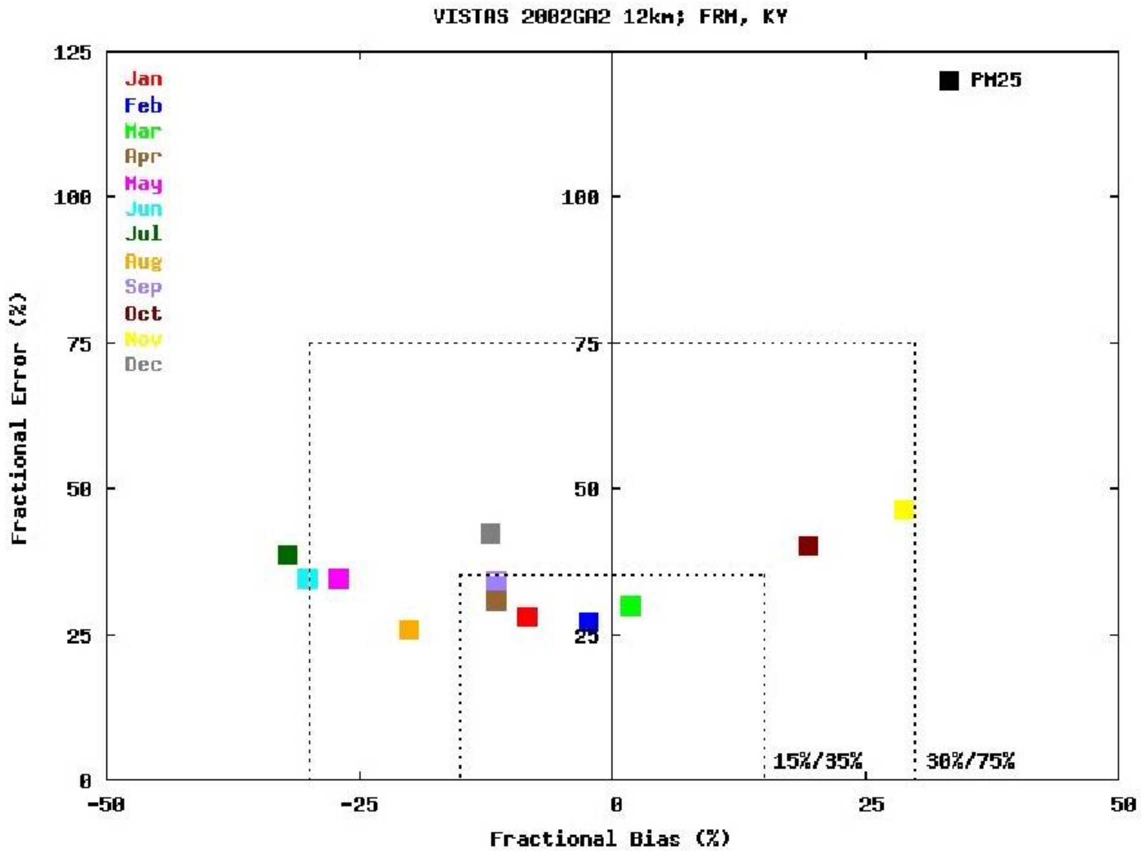


Figure B-19. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Kentucky for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

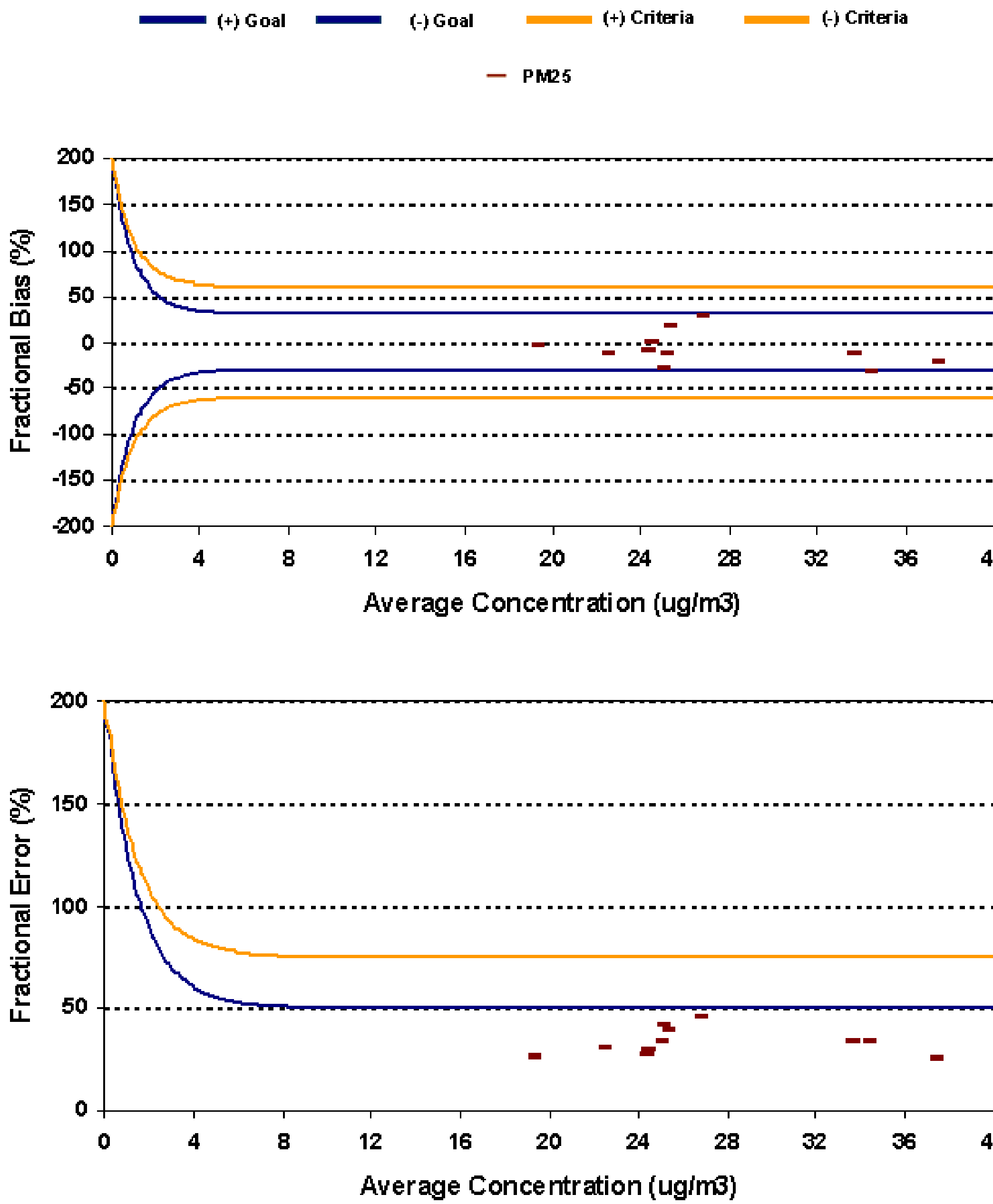


Figure B-20. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Kentucky and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.5 Mississippi

Performance of PM species across sites in Mississippi is shown in Figure B-21. SO4 is generally underpredicted with fractional bias values ranging from -18% to -41%. Although the PM performance goal is achieved in Q2 and Q3, because the underprediction bias in Q1 and Q4 exceeds -30% the PM performance goal is not achieved. NO3 performance metrics are poor with fractional bias values of -50% to -60% in Q1, -110% in Q2, -150% in Q3 and -14% to -28% in Q4.

NH4 performance is characterized by lots of scatter and little correlation so that even though the ozone bias performance goal is achieved in Q1, Q2 and Q4, the error goal is not (Figure B-21c). OCM is underpredicted at sites in Mississippi with fractional bias values of approximately -70% to -90% (Figure B-21d). Performance for EC is better, albeit still with an underprediction bias ranging from -10% to -60%. Again as seen for other states, the CMAQ 12 km modeling results produces much lower bias that is closer to zero than the 36 km modeling results (Figure B-21e).

$PM_{2.5}$ performance in Mississippi across the STN and FRM networks are shown in Figures B-21f and B-21g, respectively. Across the STN network, $PM_{2.5}$ is underestimated by approximately -20% in Q4 rising to -47% in Q3 with Q1 and Q2 in between. Across the FRM network, the $PM_{2.5}$ underprediction bias is lower, at -2% in Q4 and -30% for Q3 with again Q1 and Q2 being in between. The 12 km CMAQ modeling results for FRM $PM_{2.5}$ achieves the PM performance goal across all four quarters and even the ozone performance goal in Q4.

Figure B-22 displays an example model performance time series analysis at an STN site in Jones County in southeastern Mississippi (Hattiesburg). SO4 performance is worse than seen in the other ASIP states with a -36% fractional bias and 44% error. NO_3 performance exhibits similar characteristics as the other ASIP states with a summer underestimation bias that produces an annual fractional bias value of -40%. Like the other states, OCM is underestimated by -43% on average, but unlike the other states the underprediction fractional bias for EC exhibits an underprediction (-60%) that is even greater than seen for OCM. Performance statistics for NH4 are reasonable with a near zero bias and 42% error, the near zero bias is due to a few days of large overprediction compensated for a general underprediction. Given the fact that almost all of the PM components are underestimated, the underprediction of total $PM_{2.5}$ mass is not a surprise with a fractional bias value of -35%.

The Soccer Plot (Figure B-23) and Bugle Plot (Figure B-24) for $PM_{2.5}$ mass performance confirm that $PM_{2.5}$ performance in Mississippi is worse than seen for the other ASIP states. Only two months achieve the ozone model performance goal and only 8 months achieve the PM model performance goal. The underprediction bias in March through July 2002 produces fractional bias that do not achieve the $<\pm50\%$ PM performance goal.

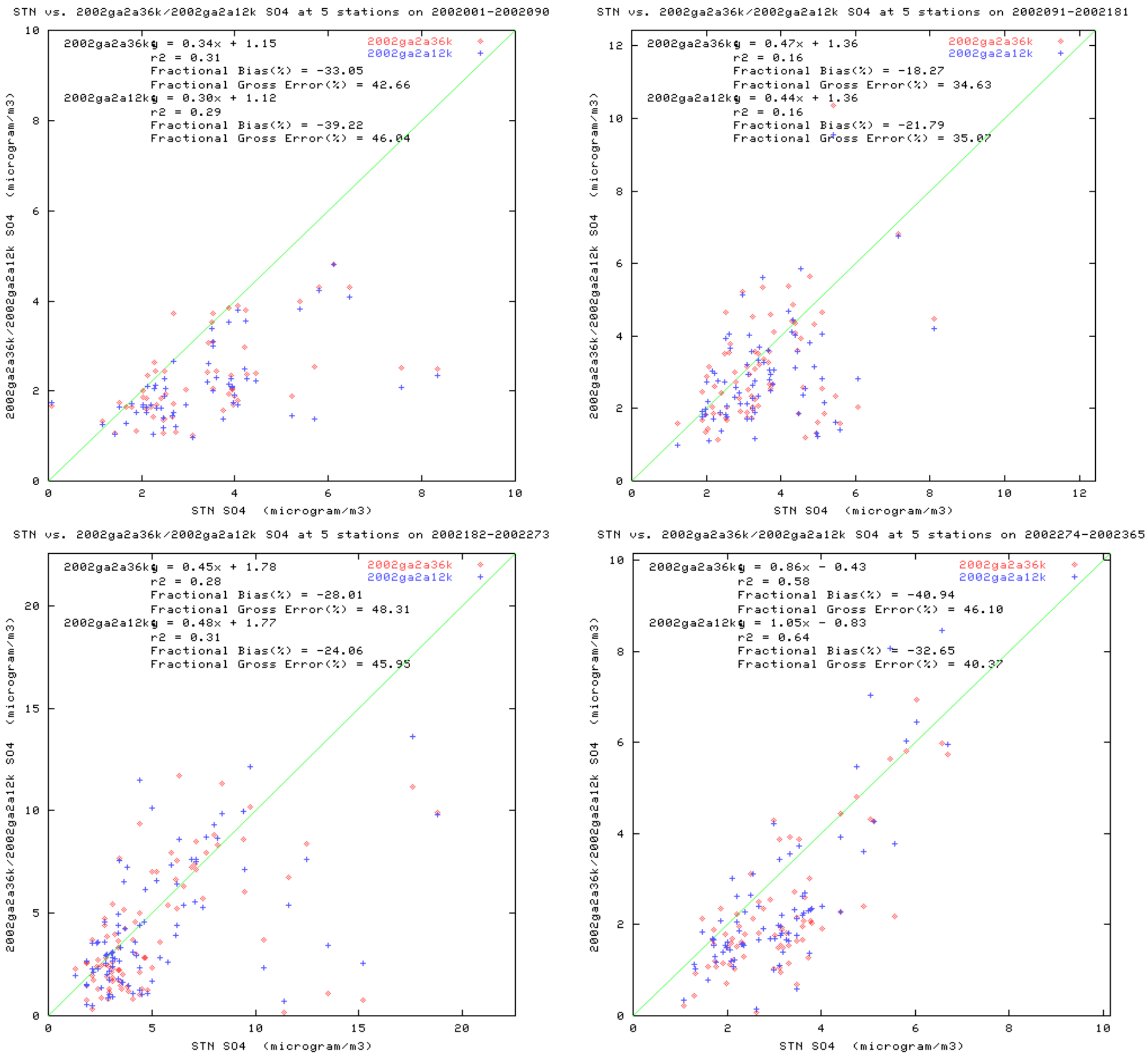


Figure B-21a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

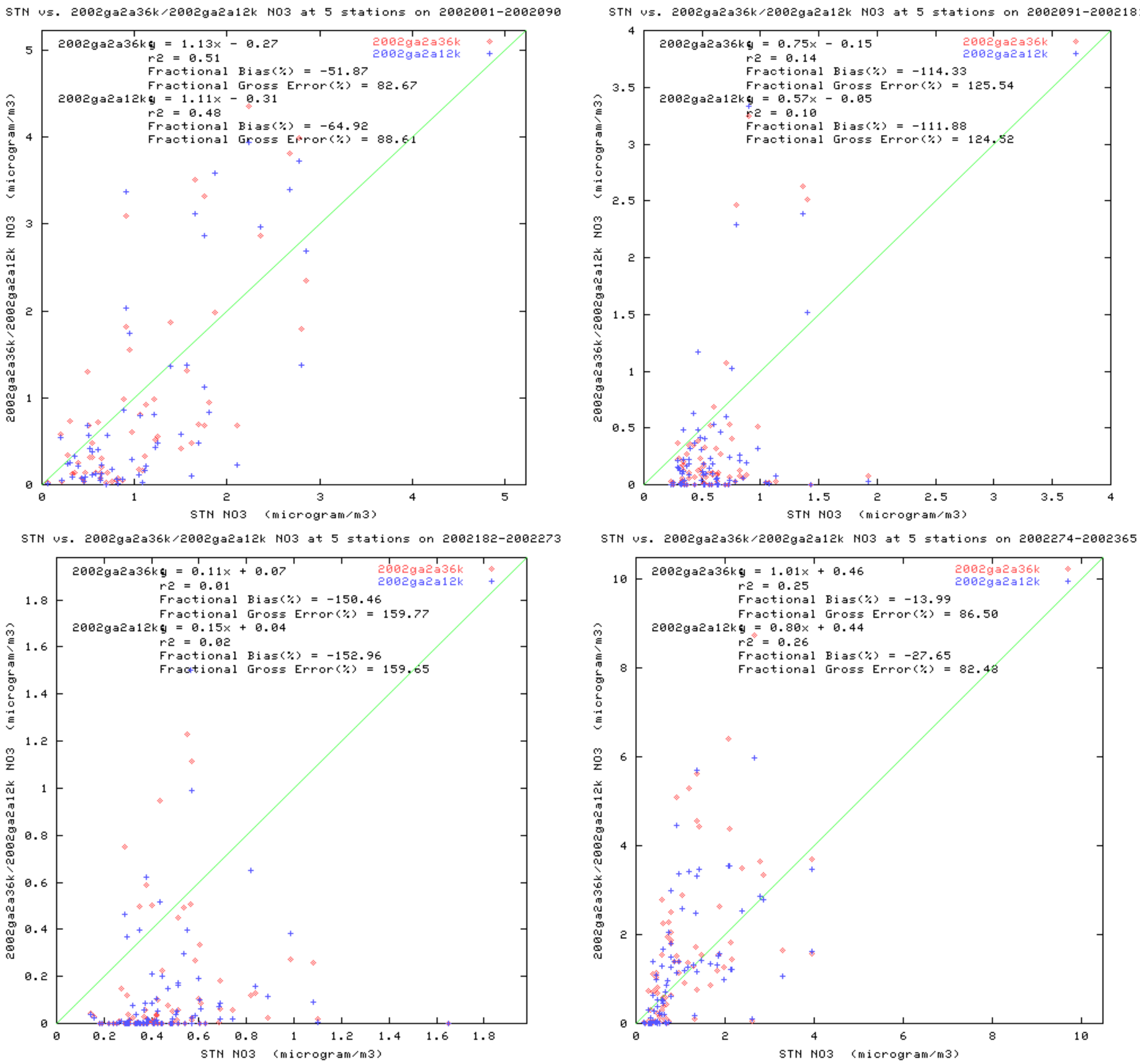


Figure B-21b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

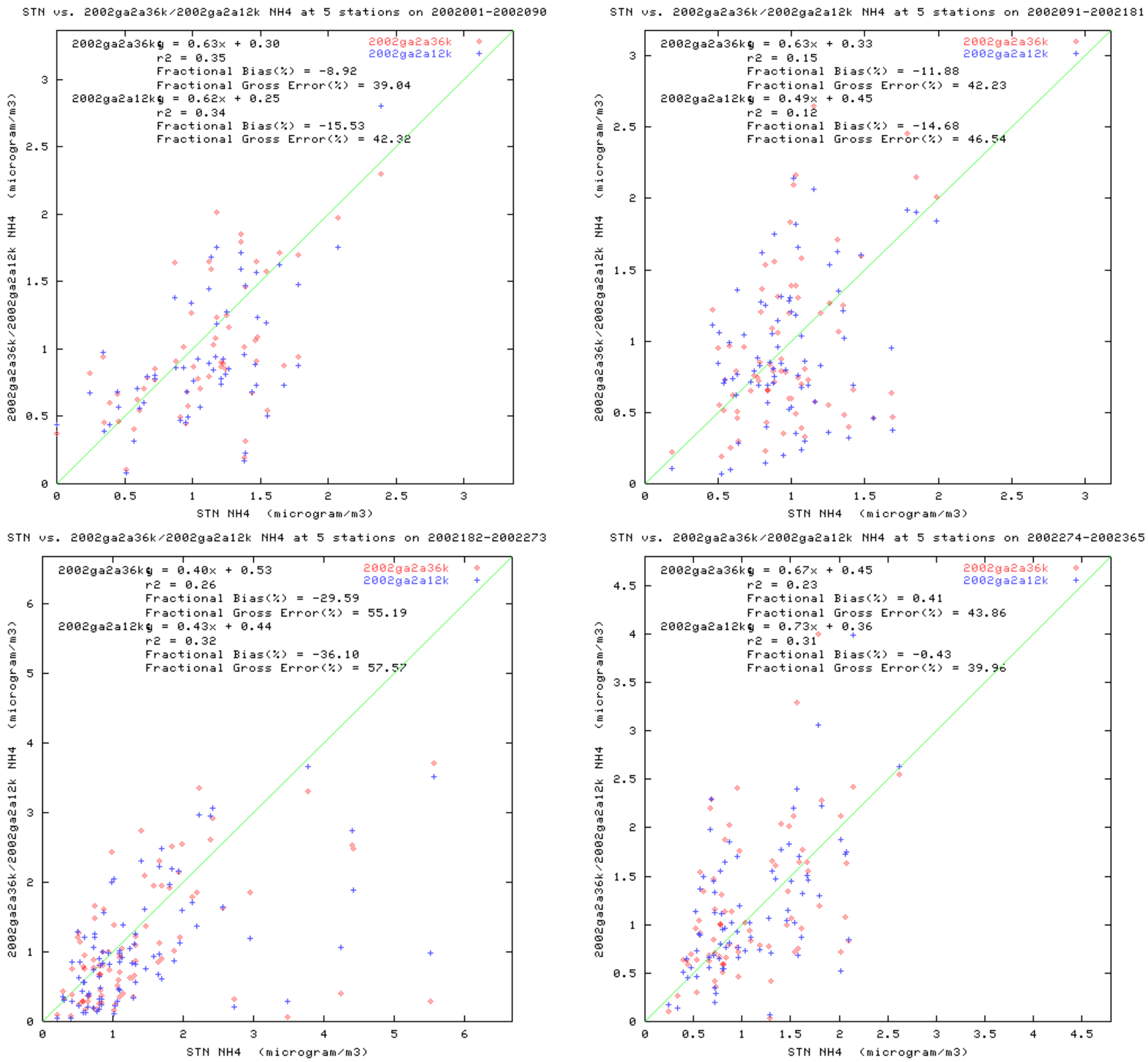


Figure B-21c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

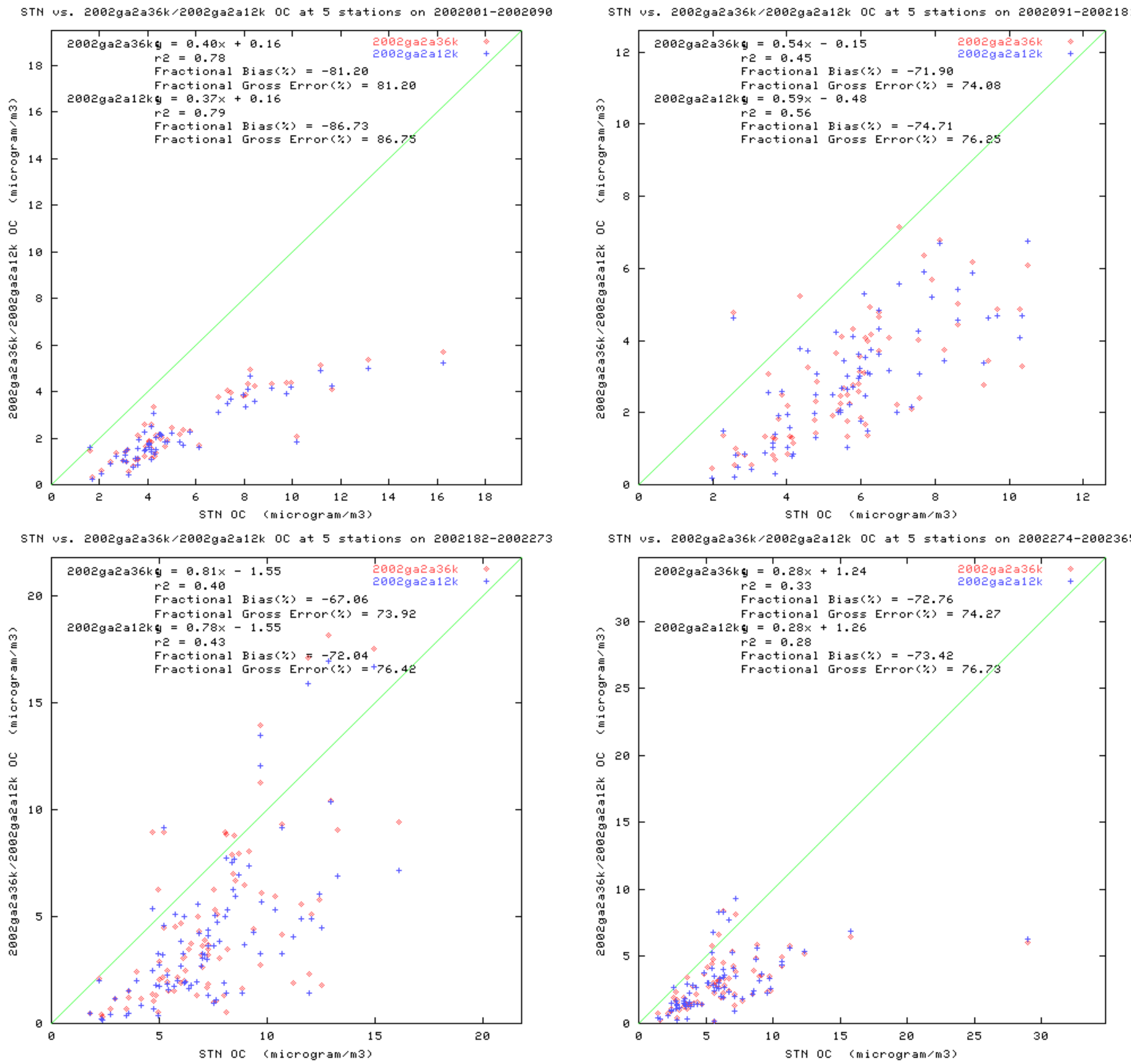


Figure B-21d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

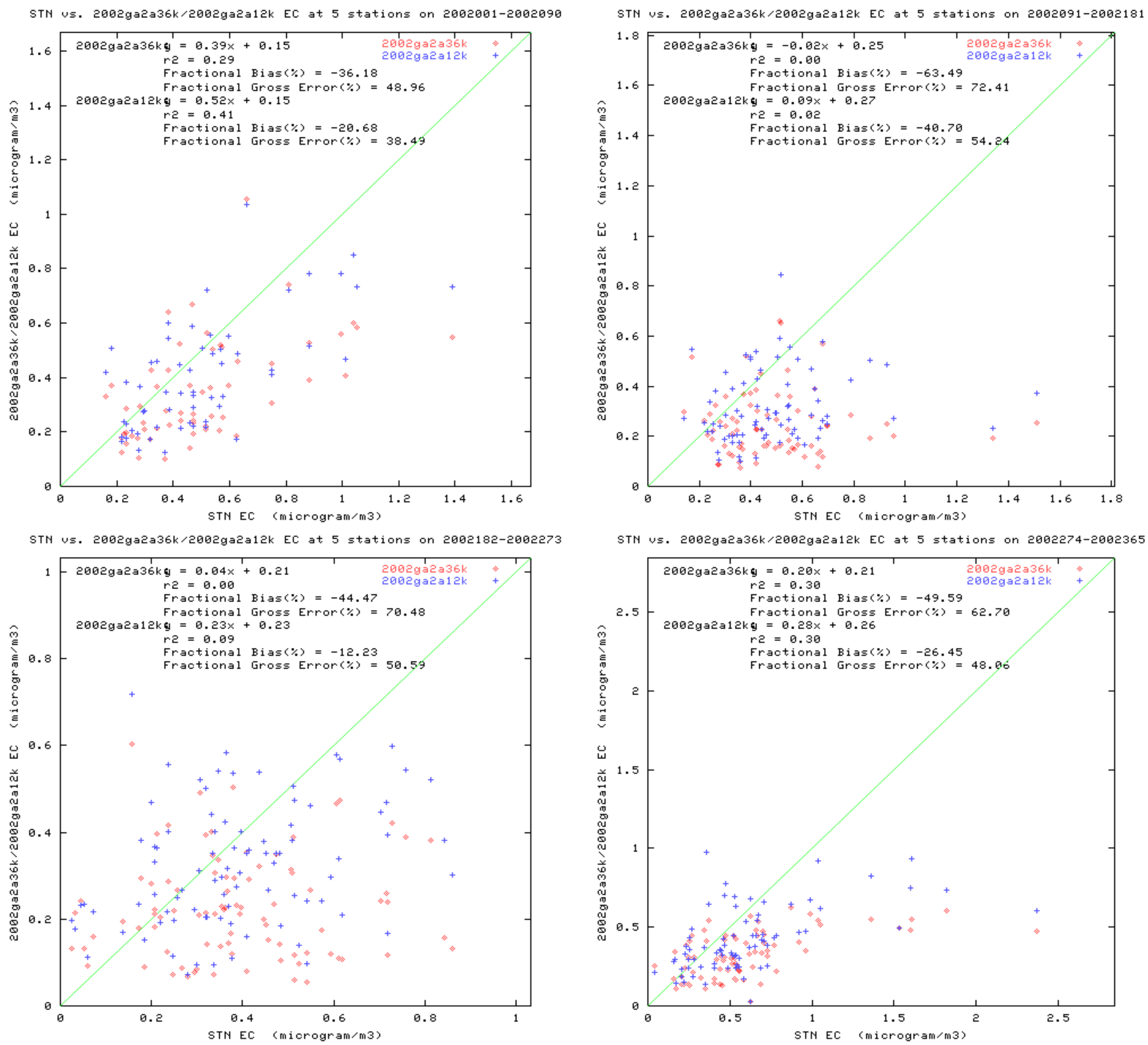


Figure B-21e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

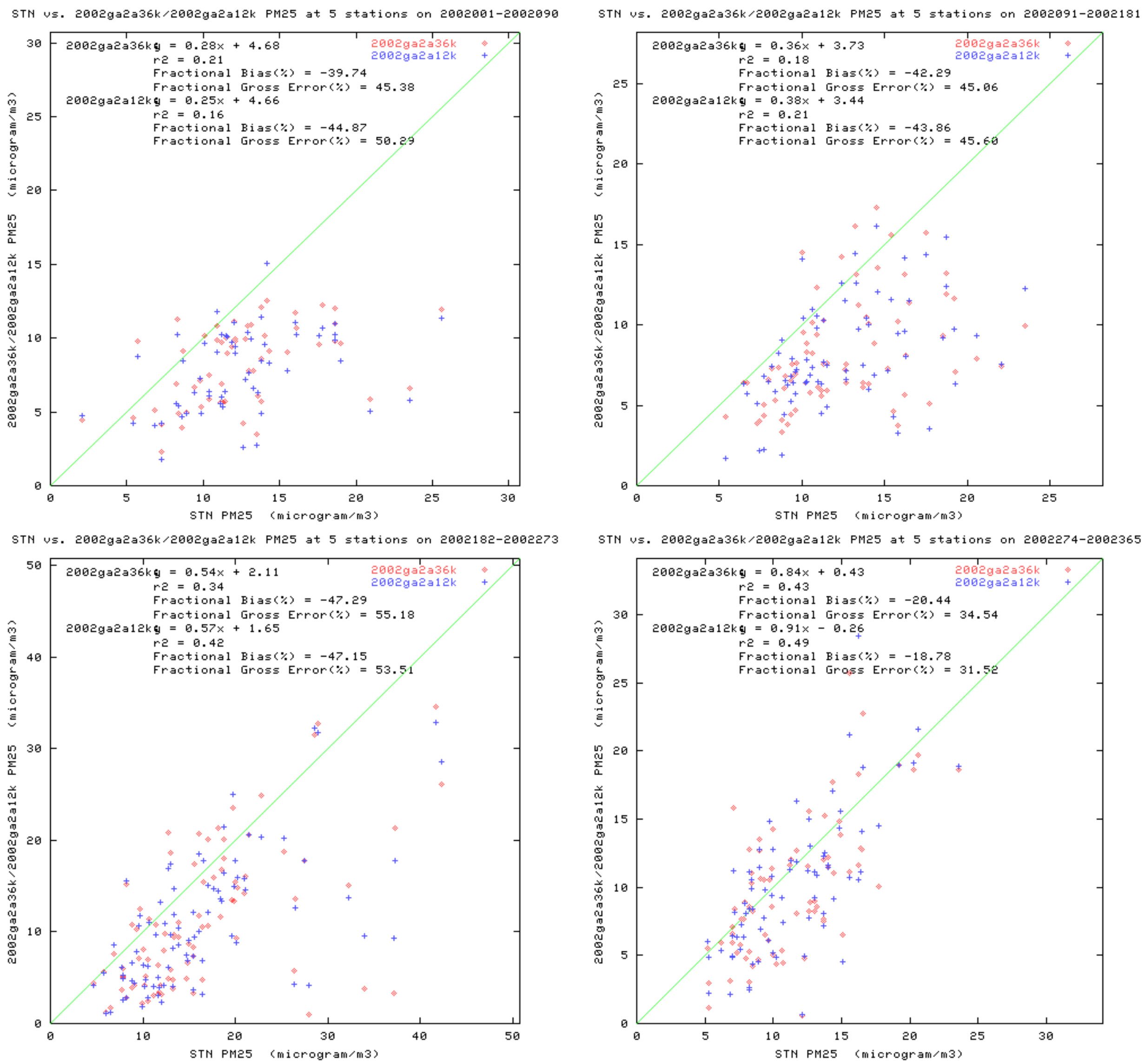


Figure B-21f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

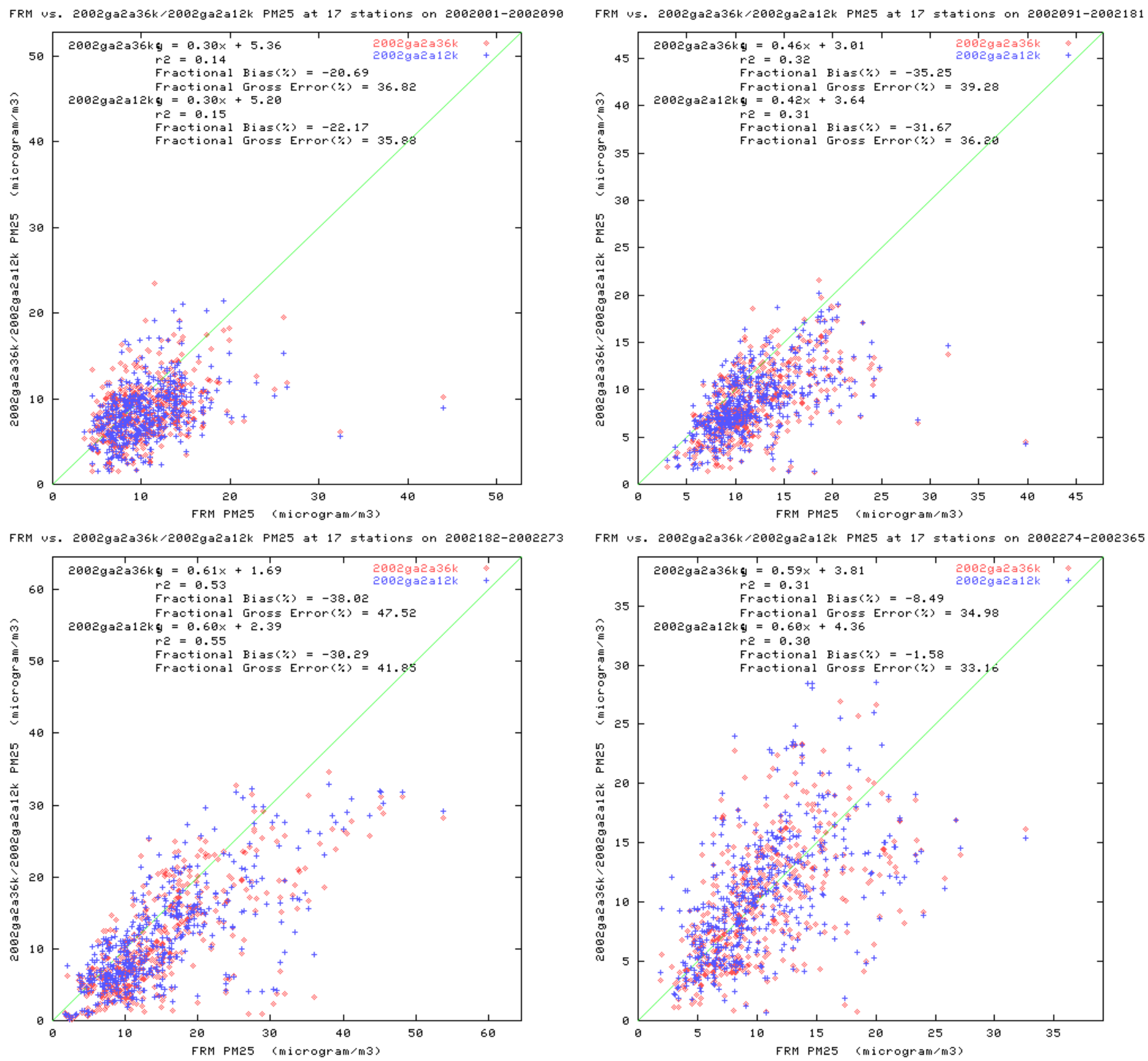
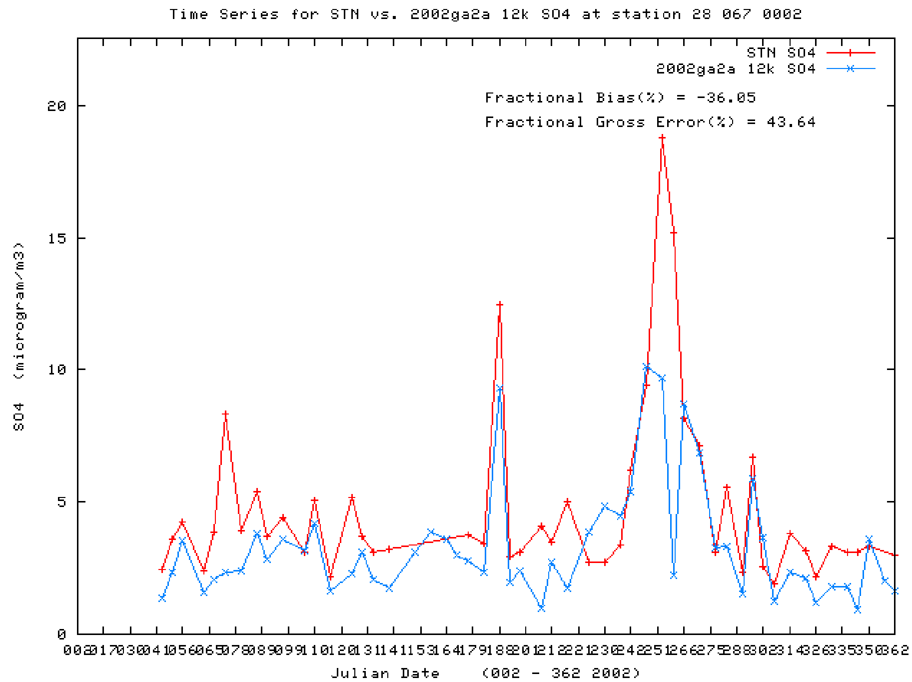


Figure B-21g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Mississippi and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.



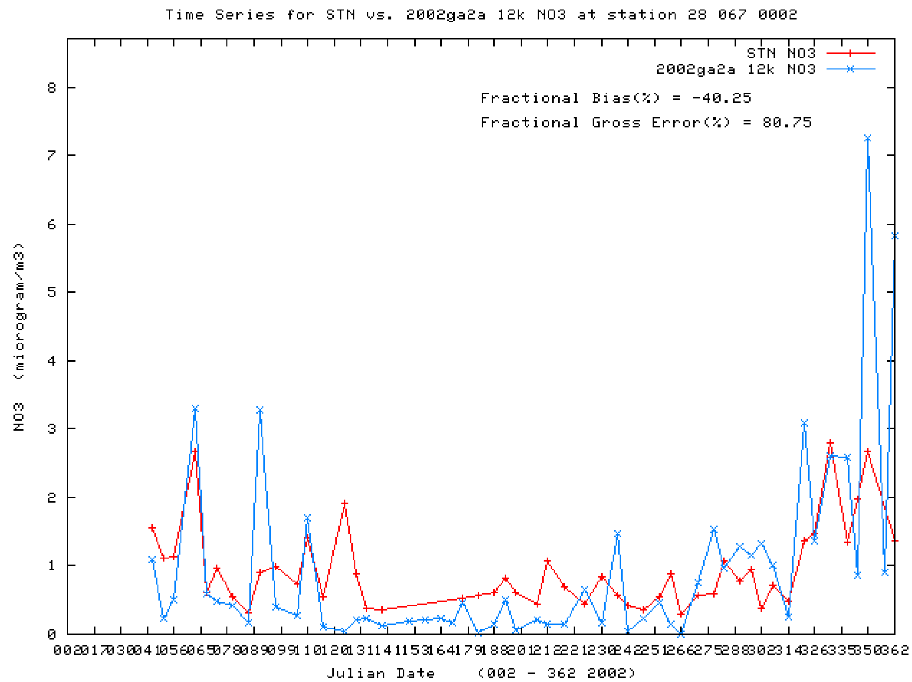


Figure B-22a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Jones County, Mississippi Site No. 28-067-0002 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

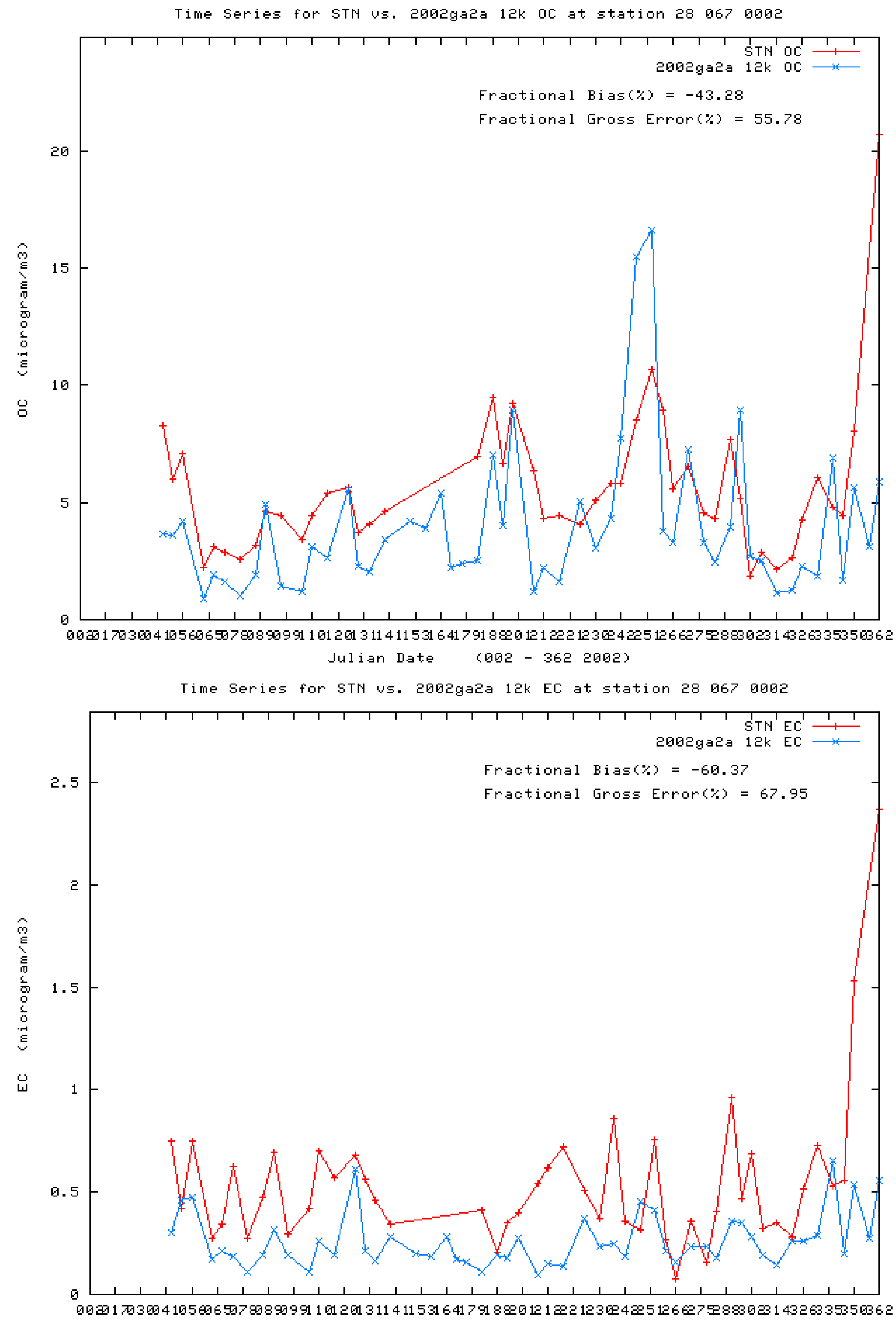


Figure B-22b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Jones County, Mississippi Site No. 28-067-0002 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

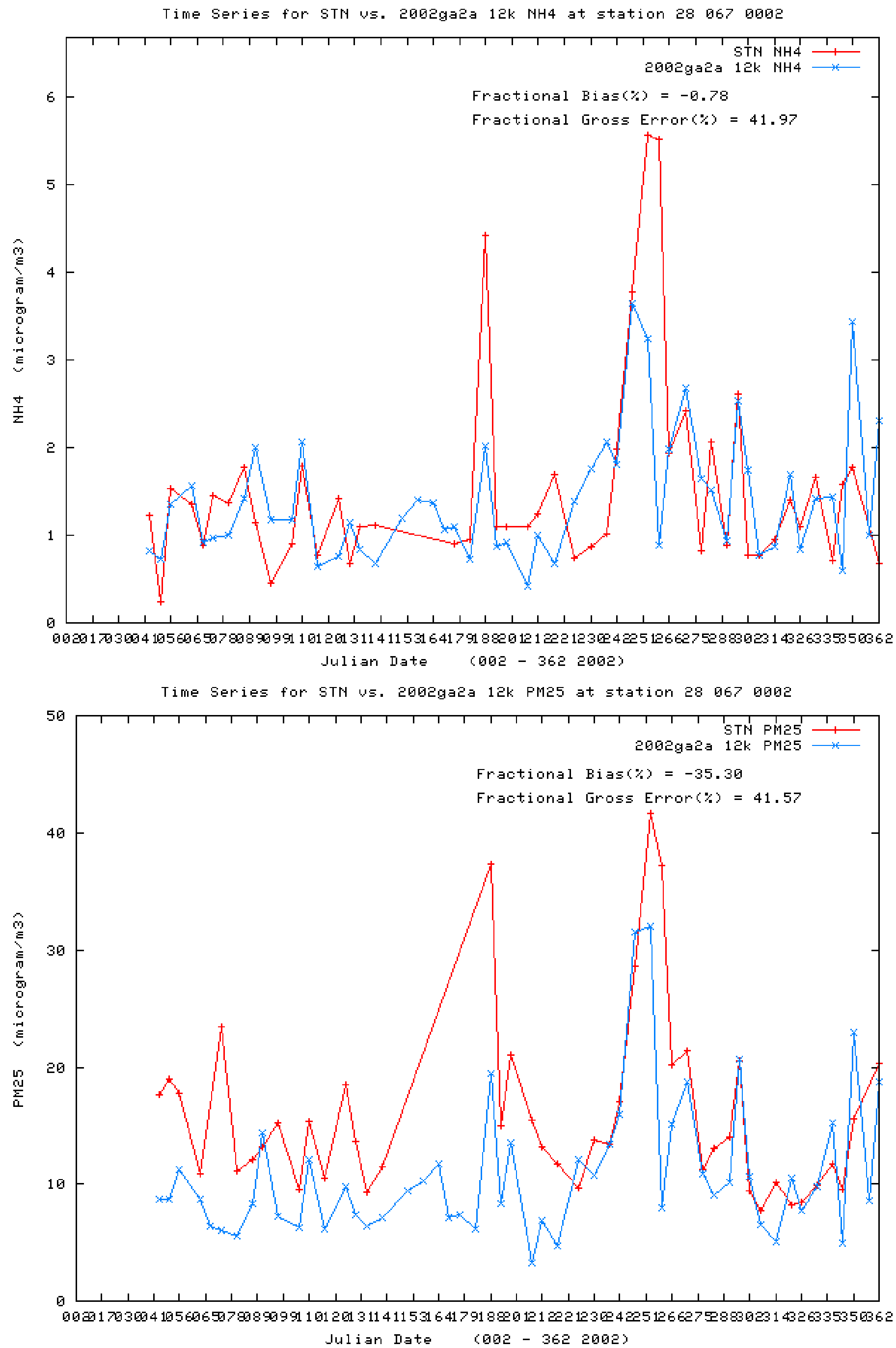


Figure B-22c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Jones County, Mississippi Site No. 28-067-0002 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

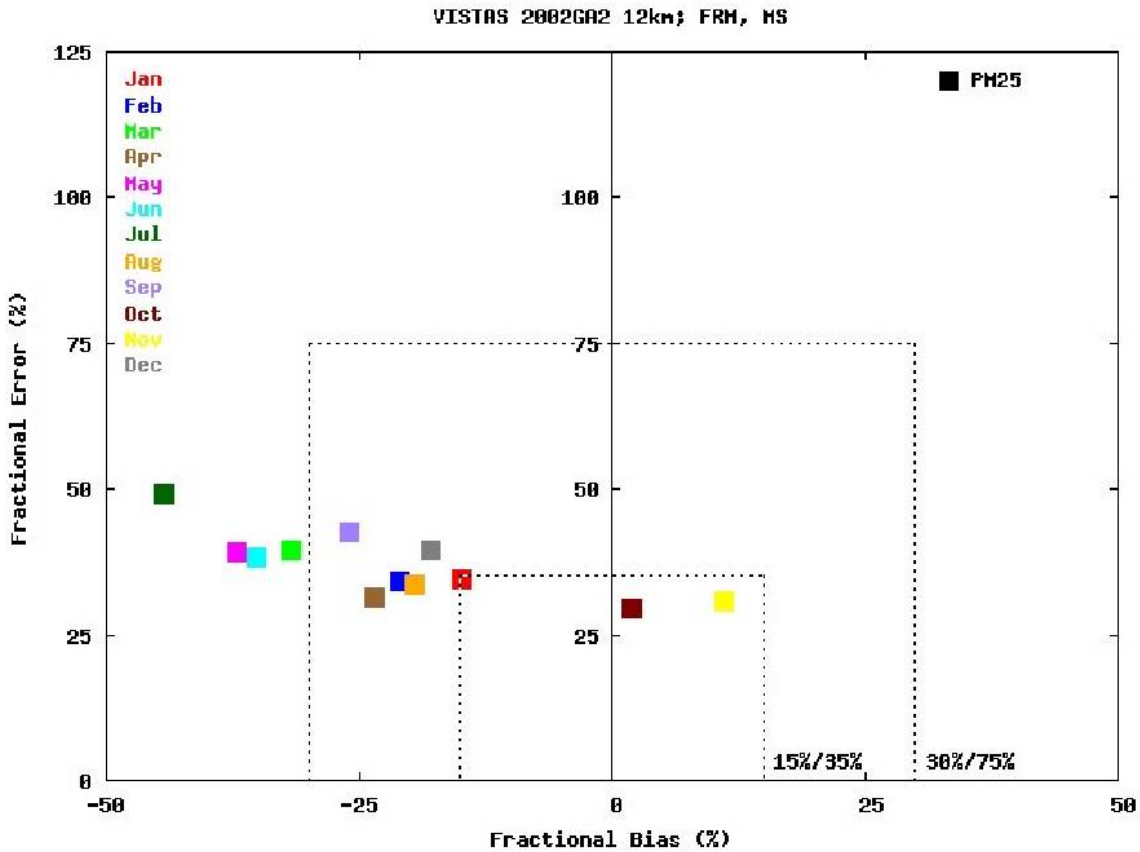


Figure B-23. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Mississippi for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

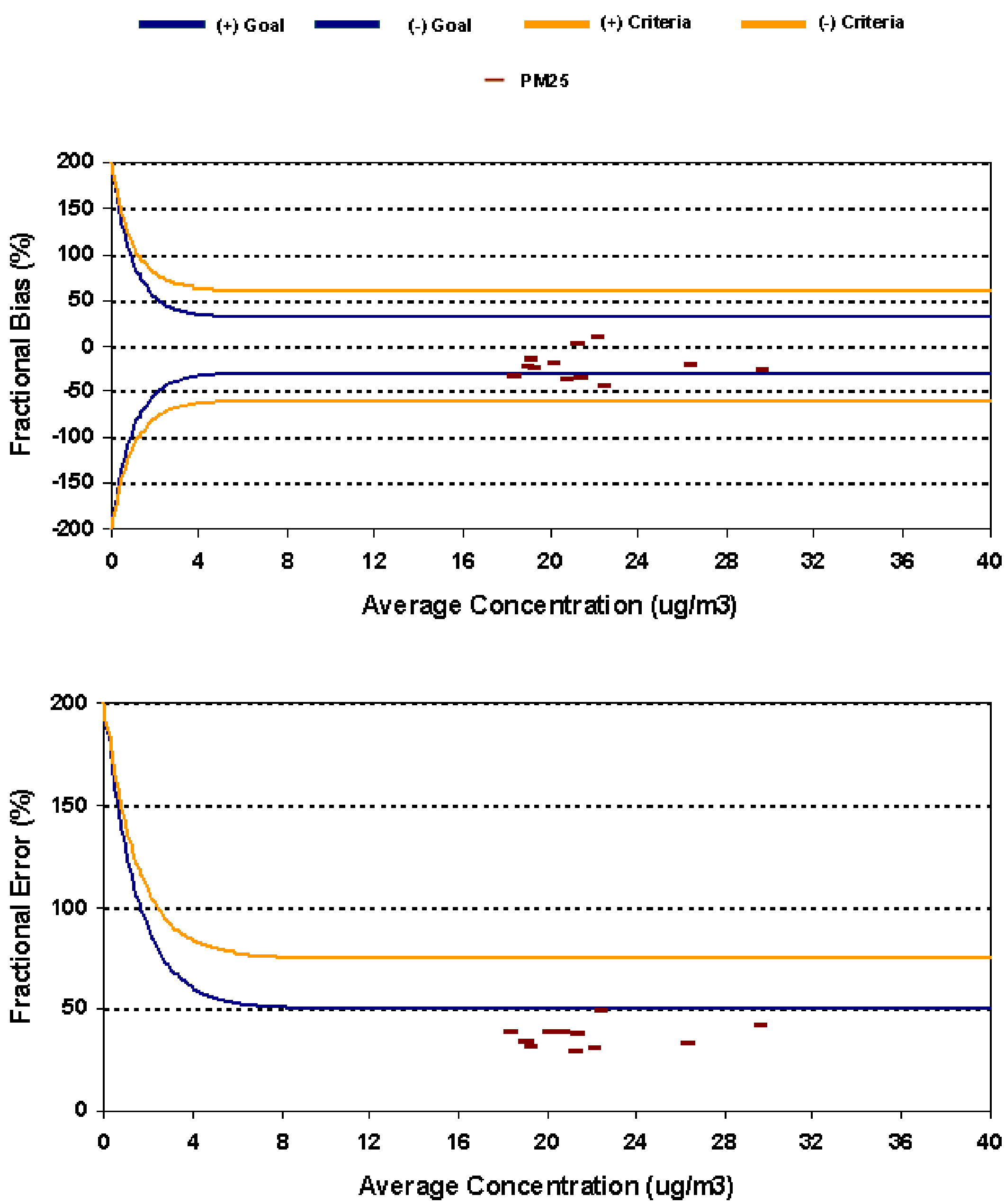


Figure B-24. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Mississippi and the CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.6 North Carolina

SO4 performance across 9 STN monitoring sites in North Carolina and four quarters from 2002 is shown in Figure B-25a. SO4 performance achieves the PM performance goal with fractional bias values that range from -13% to -30%. Although NO3 is still greatly underestimated in North Carolina during the summer (Q3 bias of -90% to -118%), during Q1 and Q4 NO3 exhibits a slight overestimation bias of 10% to 30% (Figure B-25b). This is likely due to overstated ammonia emissions during the winter and adjacent periods which is somewhat verified by the overstated ammonium during Q1 and Q4 that have fractional bias values in the +20% to +30% range (Figure B-25c)

OCM is characterized by an underprediction bias ranging from -70% to -90% failing to achieve even the PM performance criteria (Figure B-25d). EC, on the other hand, achieves the PM performance goal in Q1 and Q4 but has lots of scatter in the other two months exceeding the PM performance goal for bias in Q2 (-36% and -41%) and for error in Q3 (~62%).

$PM_{2.5}$ mass performance across the 9 STN sites in North Carolina exhibits an underprediction bias of -20% to -30% for Q1-Q3 that achieves the PM performance goal and near zero bias in Q4 that achieves the ozone performance goal (Figure B-25f). The model exhibits lower bias across the FRM $PM_{2.5}$ mass network in North Carolina that ranges from +10% to – 26% and achieves the PM performance goal throughout the year (Figure B-25g). FRM $PM_{2.5}$ is overpredicted in 4 (10% to 18%) and underpredicted in Q2 (-21% and -26%) and Q3 (-21% to -22%). The STN $PM_{2.5}$ performance is similar except because the STN measurements tend to be higher the underprediction bias is greater and the overprediction bias is less.

Figures B-26 and B-27 displays time series performance analysis at two STN sites in North Carolina, one on Charlotte (Mecklenburg County) and the other in Raleigh (Wake County). So4 performance is good at both sites, albeit with an underprediction bias of -14% for Charlotte and -19% for Raleigh with both sites having low error (31% and 32%). Although both sites have a net annual NO3 underprediction bias (-19% and -38%) due to the summer underprediction tendency discussed previously, during the winter there are some days when the CMAQ model overpredicts the observed NO3 by a factor of 2-3. OCM is underpredicted by a far margin at the two sites (-34% and -50%). At the Charlotte site EC is overpredicted by 45% which occurs year round, whereas at the Raleigh site EC is predicted well with a zero bias and 34% error. NH4 is predicted reasonably well with bias/error values that achieve or nearly achieve the ozone performance goal. $PM_{2.5}$ is predicted well at the Charlotte site with low bias (-8%) and error (29%), but underestimated at the Raleigh site with a bias of -28%.

The Soccer and Bugle Plots summary of FRM $PM_{2.5}$ mass model performance in North Carolina are shown in Figures B-28 and B-29. With the exception of the large summer underprediction bias in June and July, the other 10 months $PM_{2.5}$ performance achieves the <±30%/50% PM performance goal and four of the months even achieve the more stringent ozone performance with four additional months right at the ozone goal.

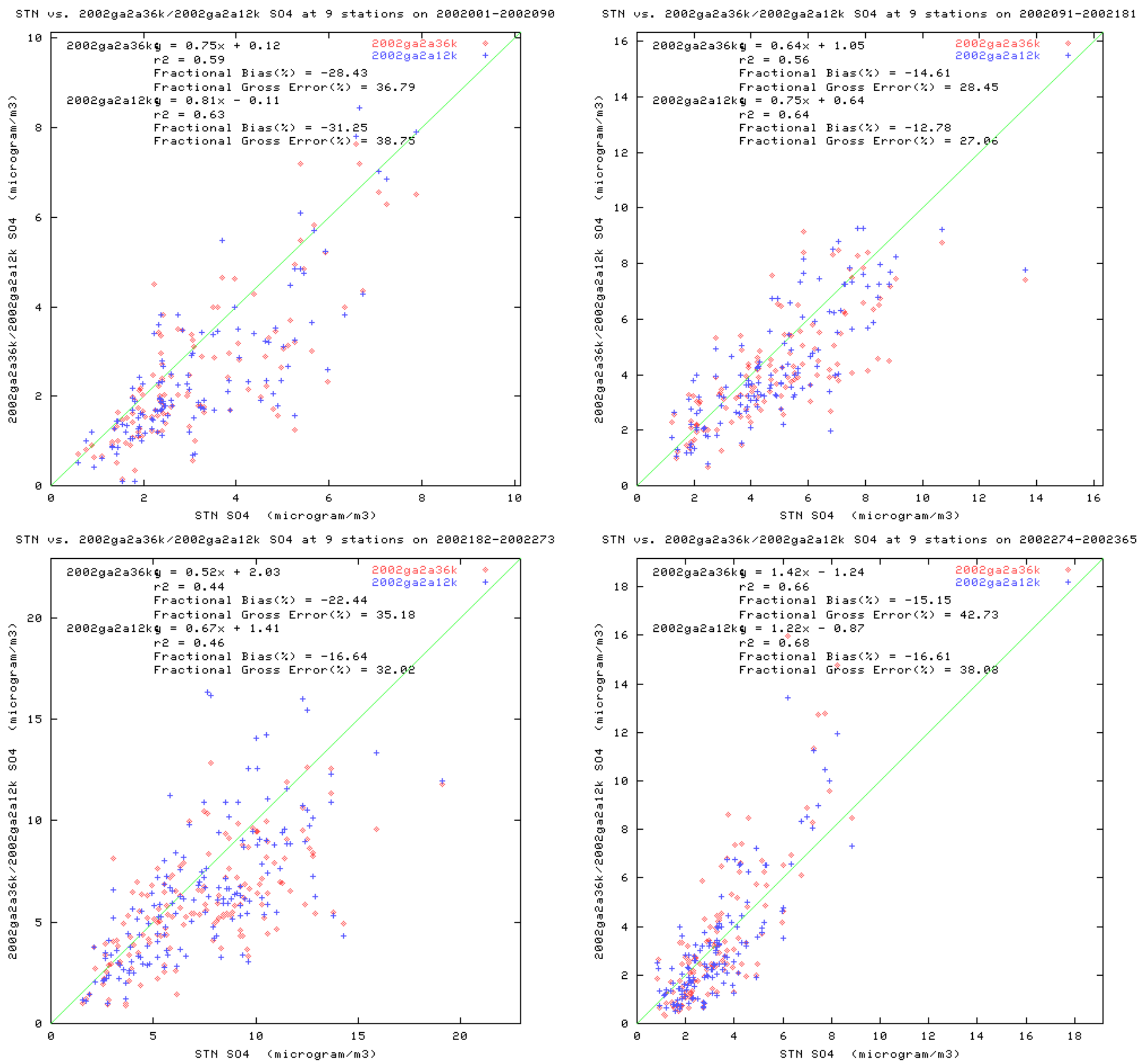


Figure B-25a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

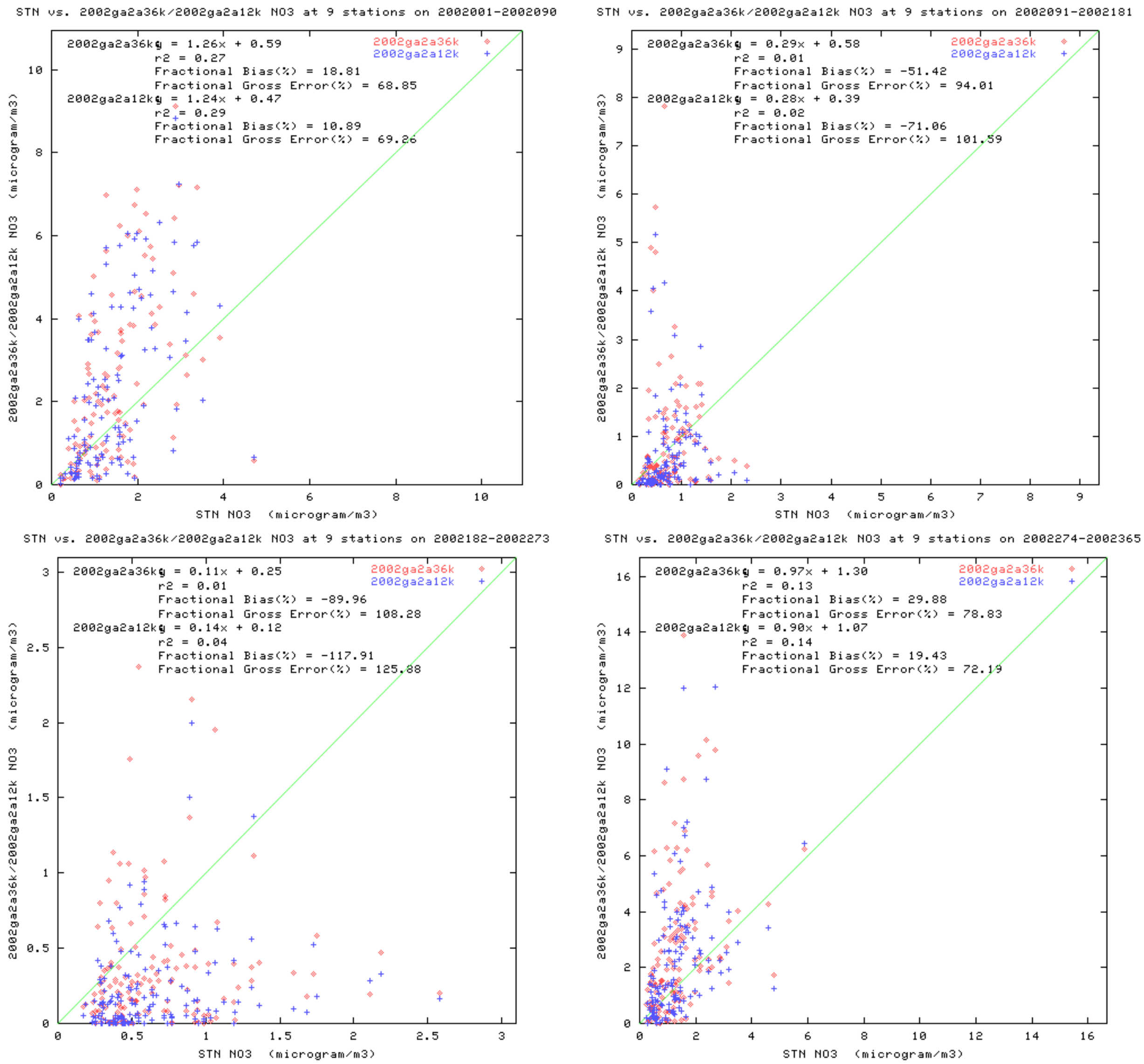


Figure B-25b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

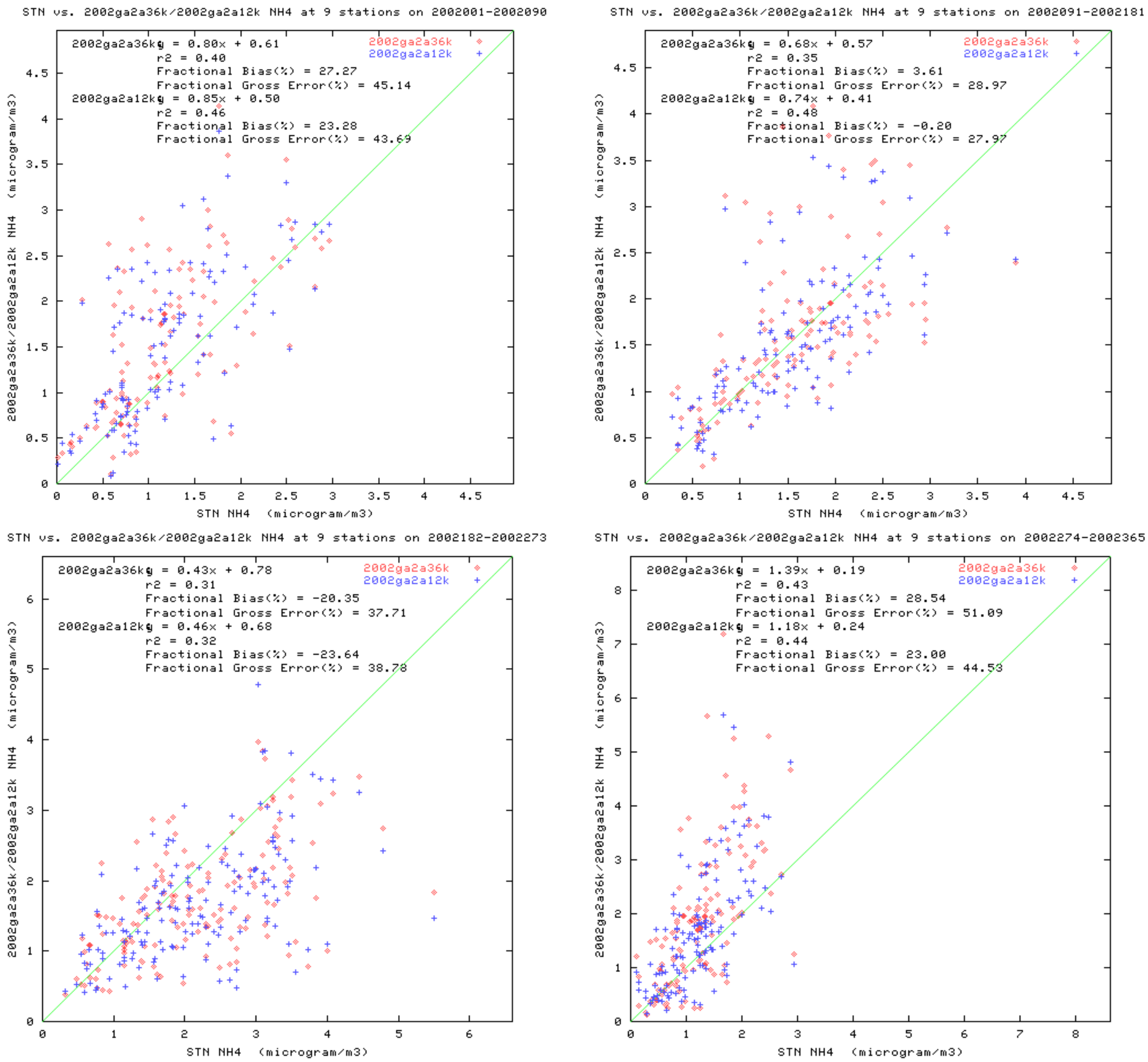


Figure B-25c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

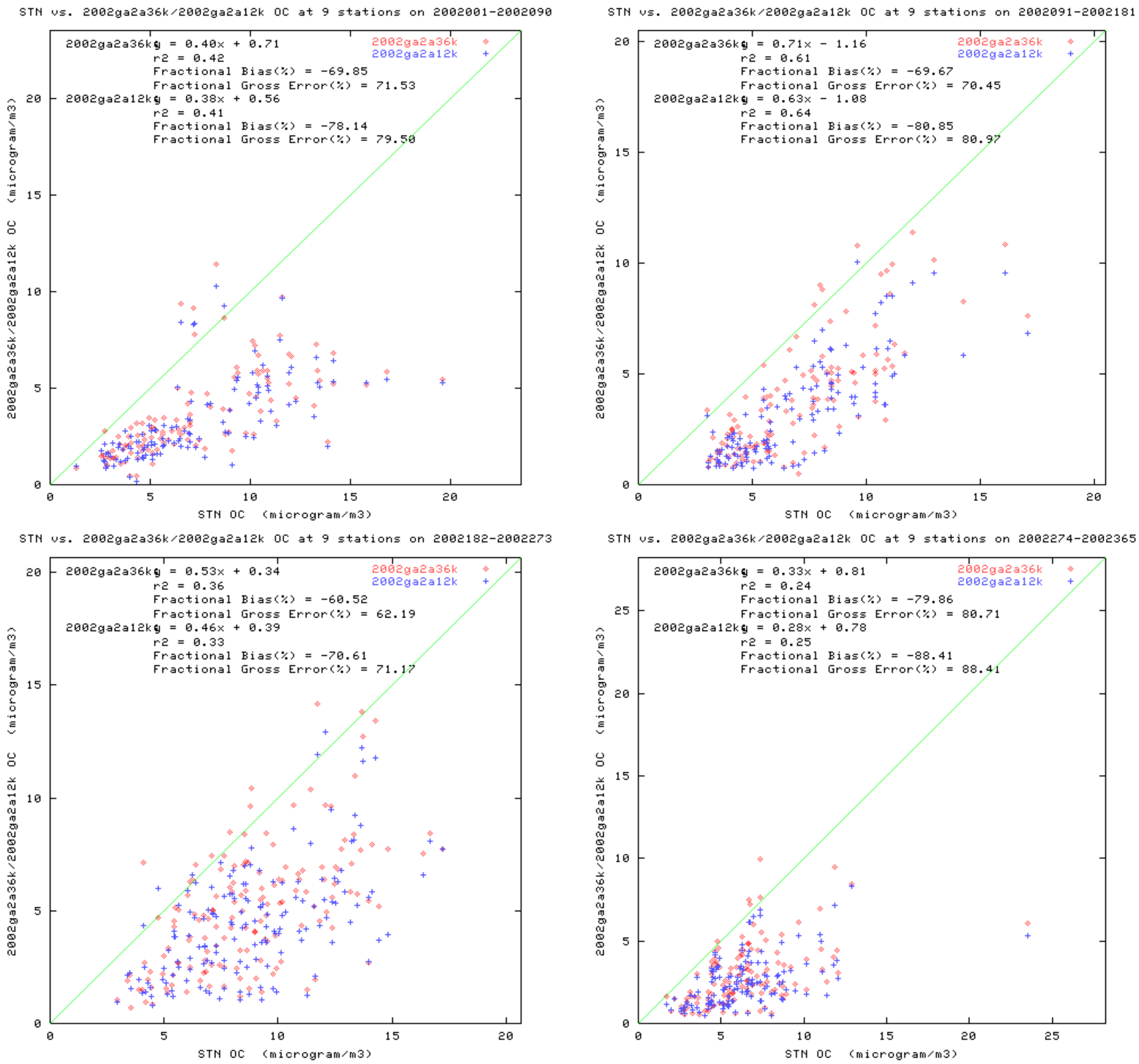


Figure B-25d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

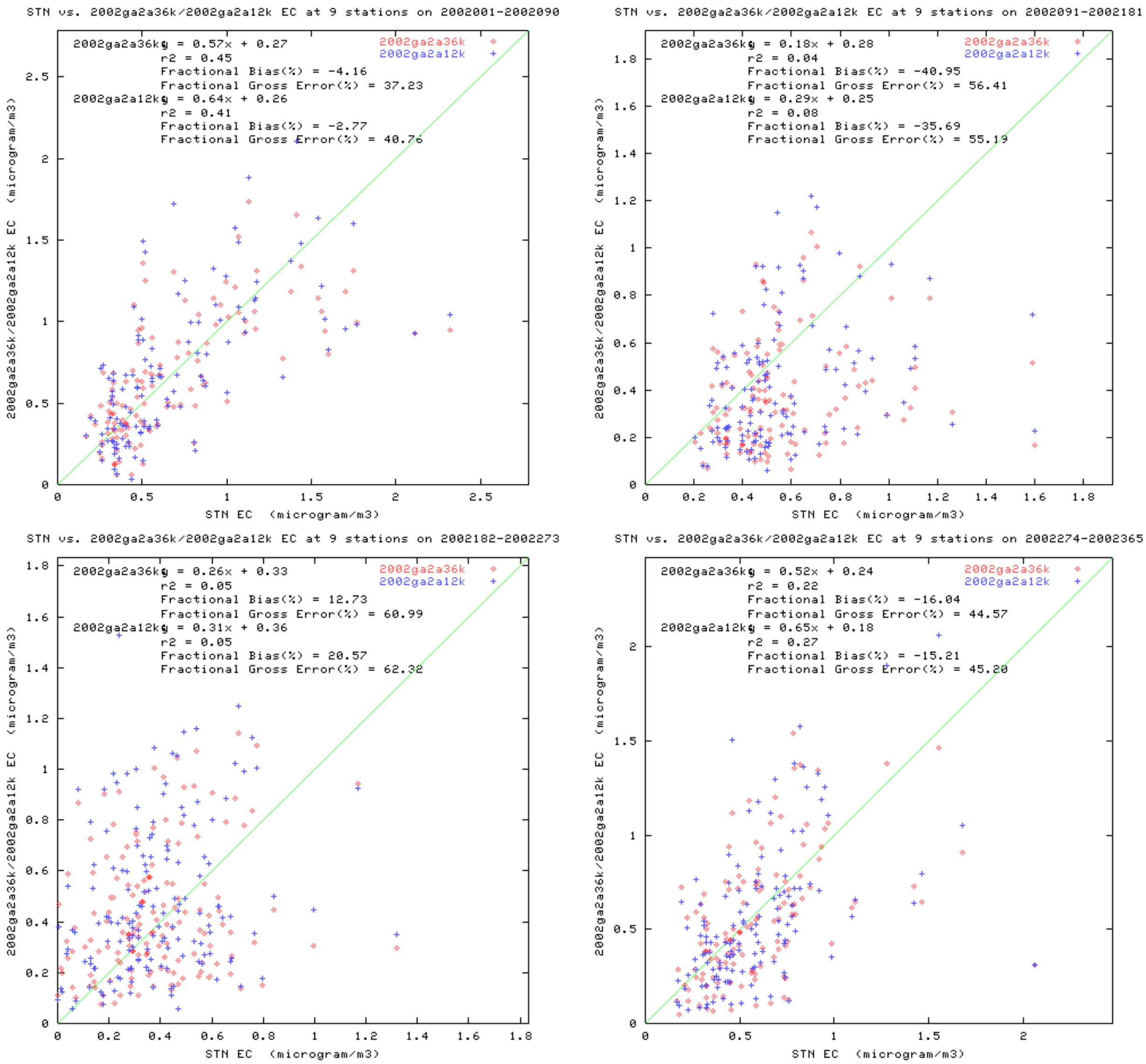


Figure B-25e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

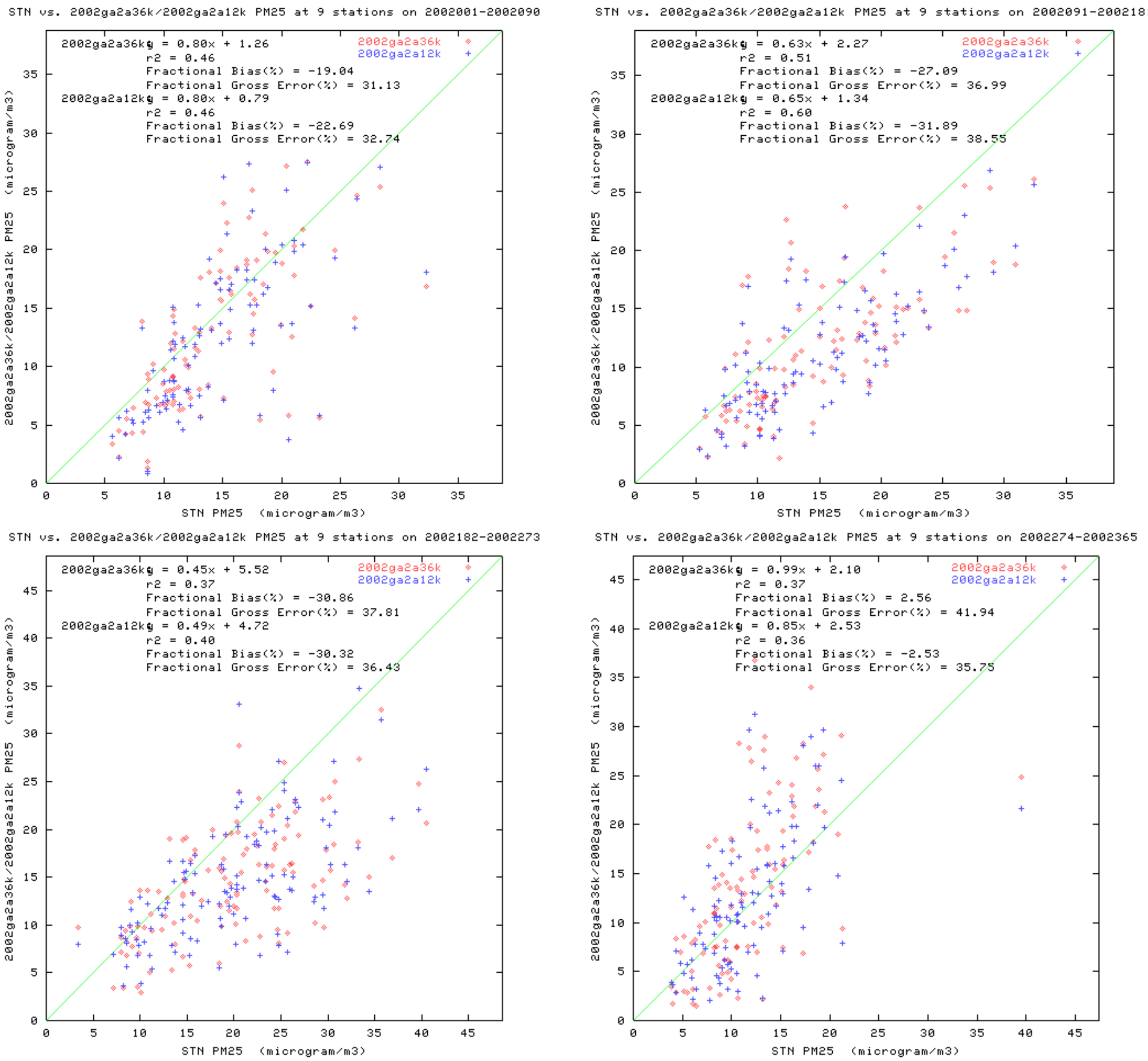


Figure B-25f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

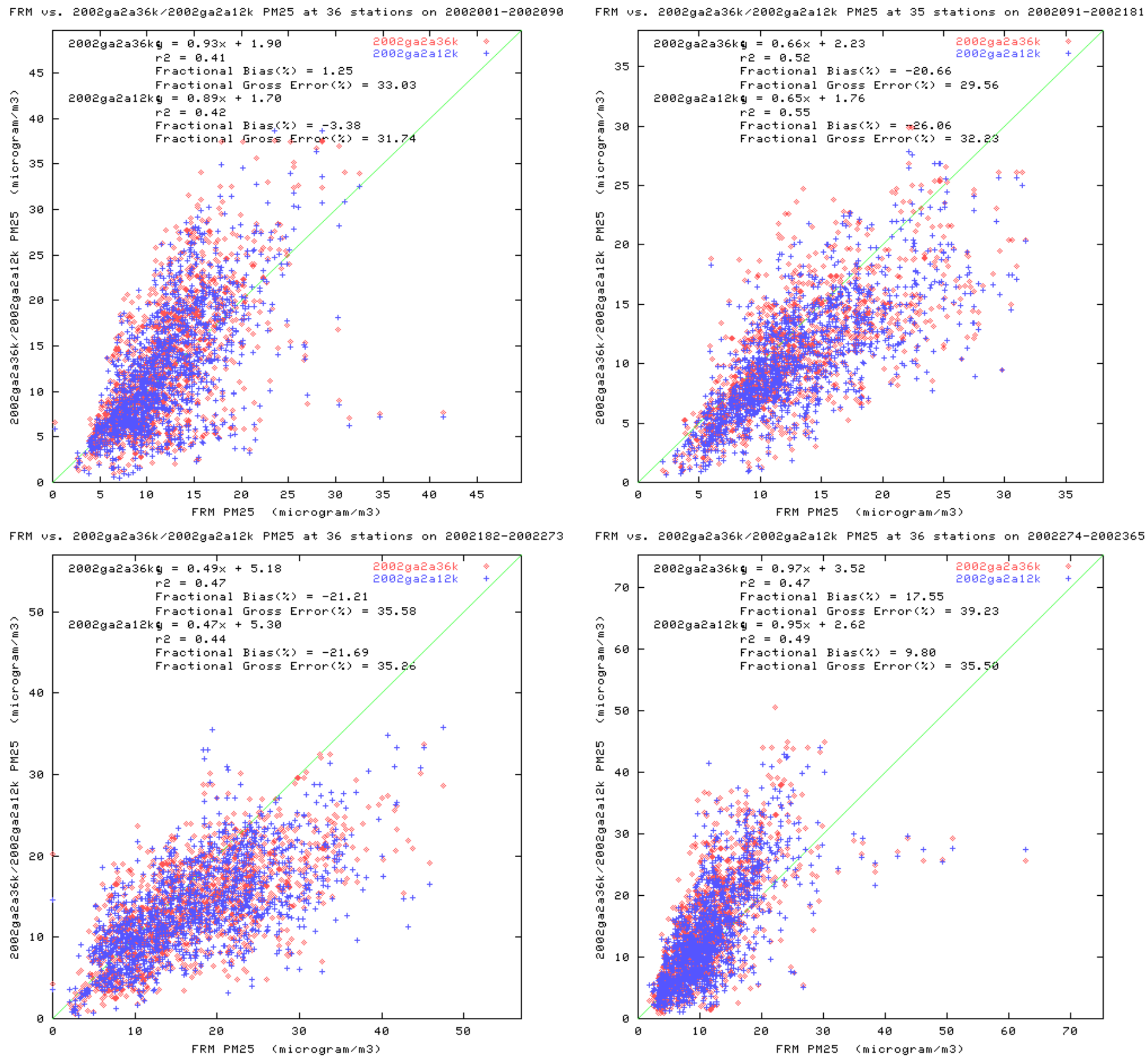
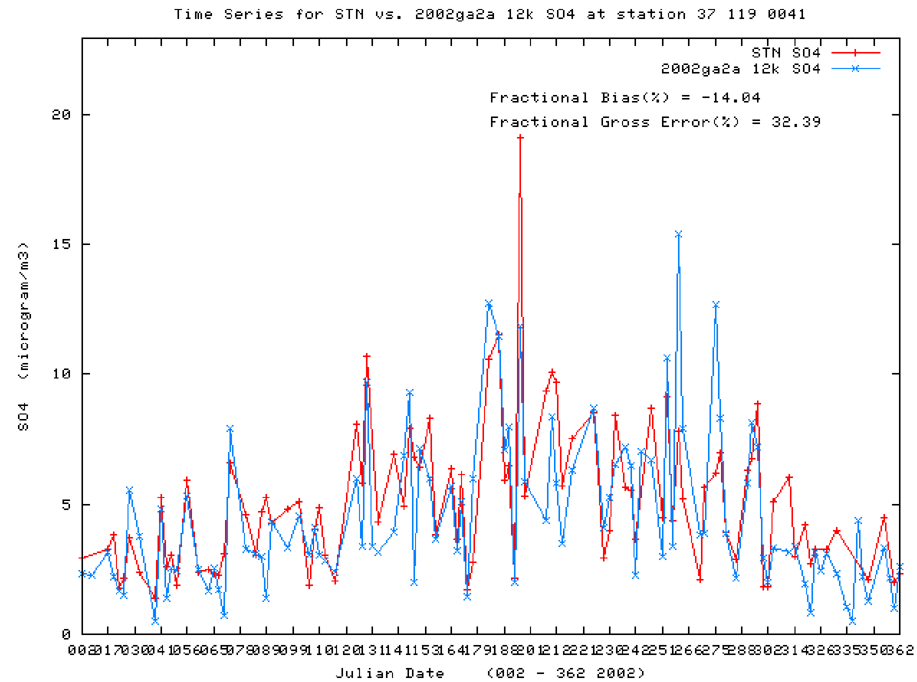


Figure B-25g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in North Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.



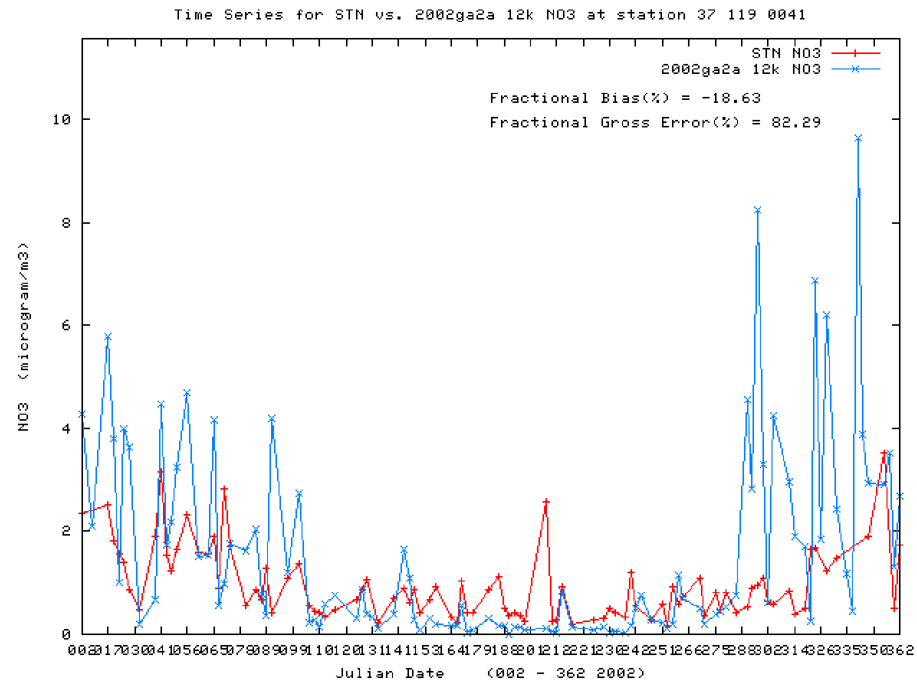
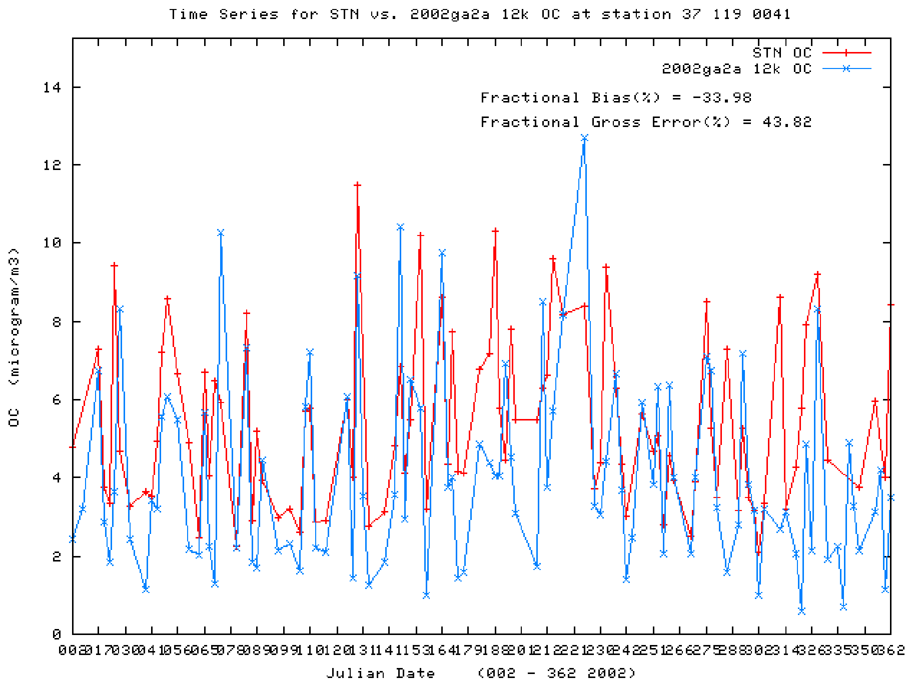


Figure B-26a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Mecklenburg County, North Carolina Site No. 37-119-0041 (Charlotte) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



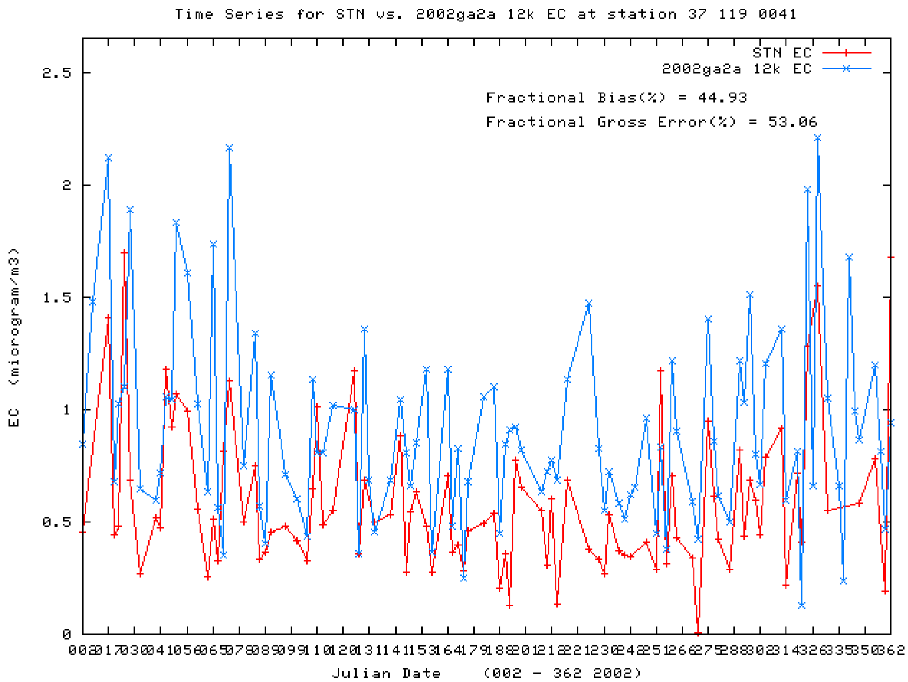
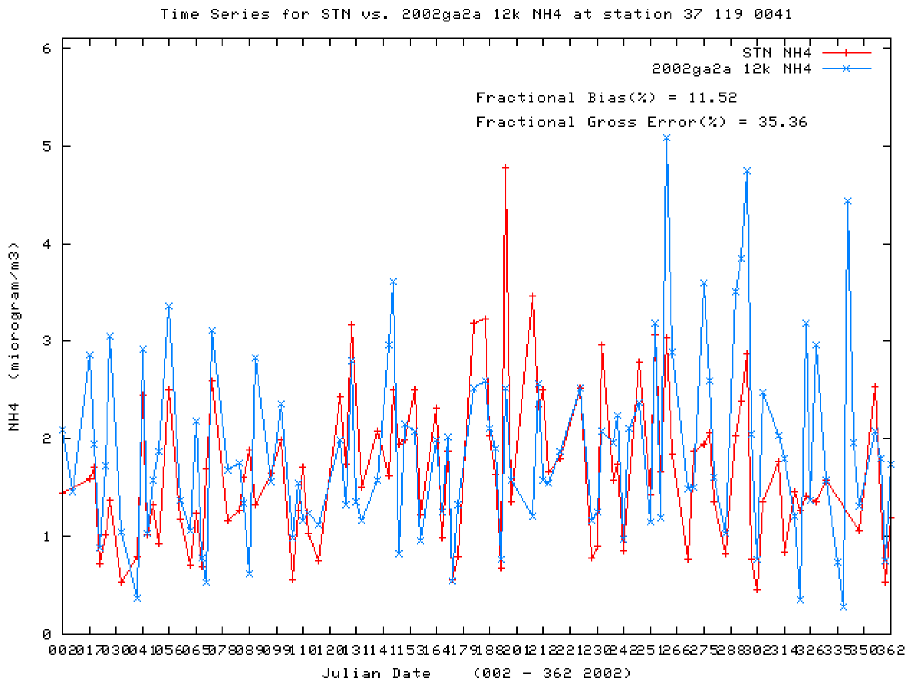


Figure B-26b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Mecklenburg County, North Carolina Site No. 37-119-0041 (Charlotte) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



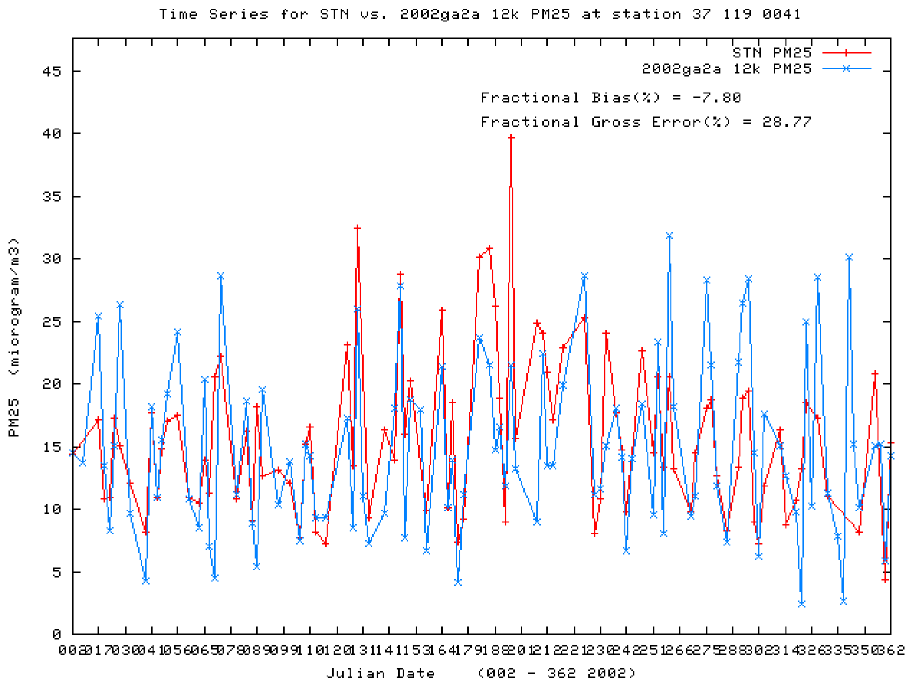


Figure B-26c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Mecklenburg County, North Carolina Site No. 37-119-0041 (Charlotte) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

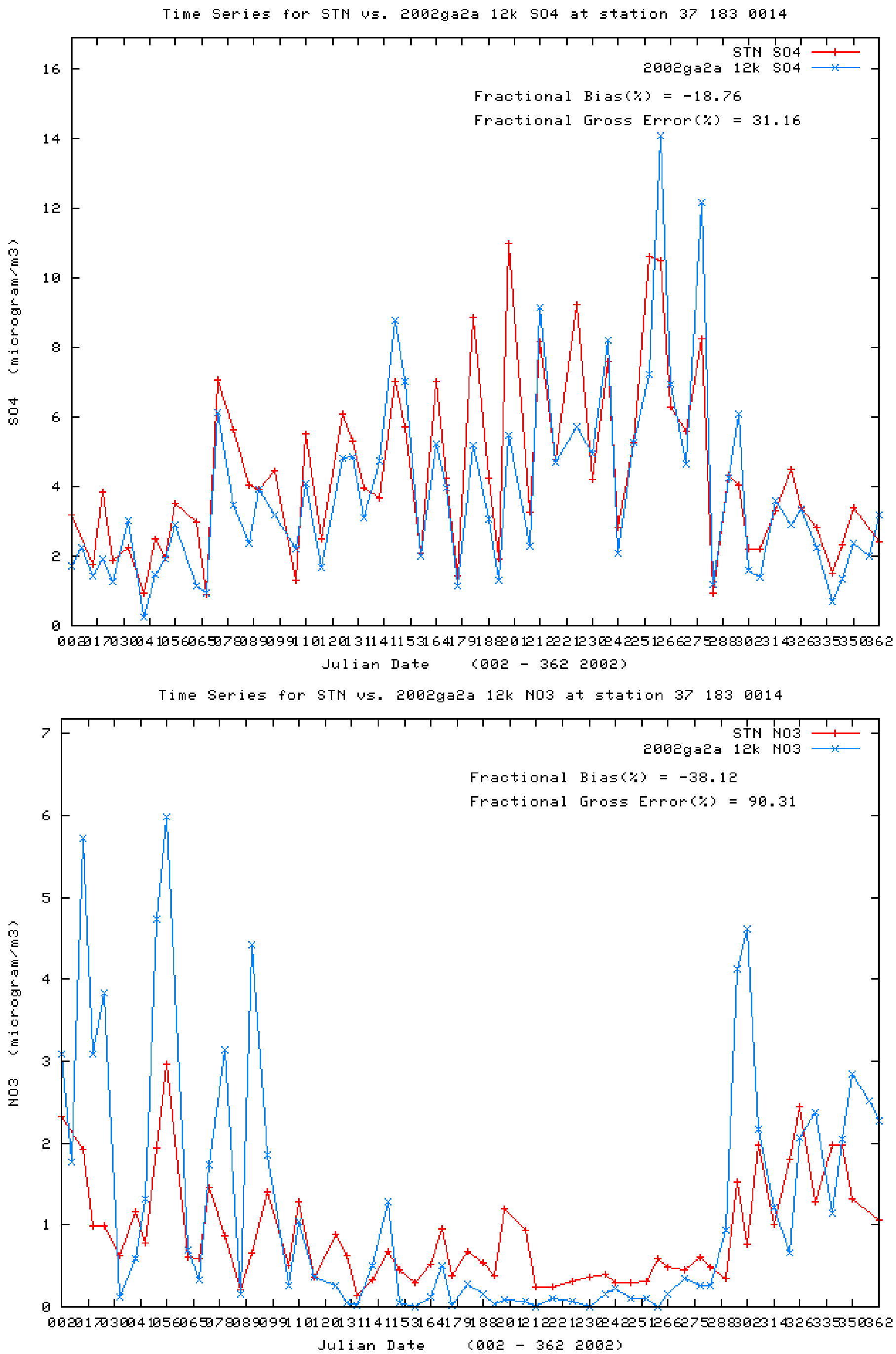


Figure B-27a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Wake County, North Carolina Site No. 37-183-0014 (Raleigh) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

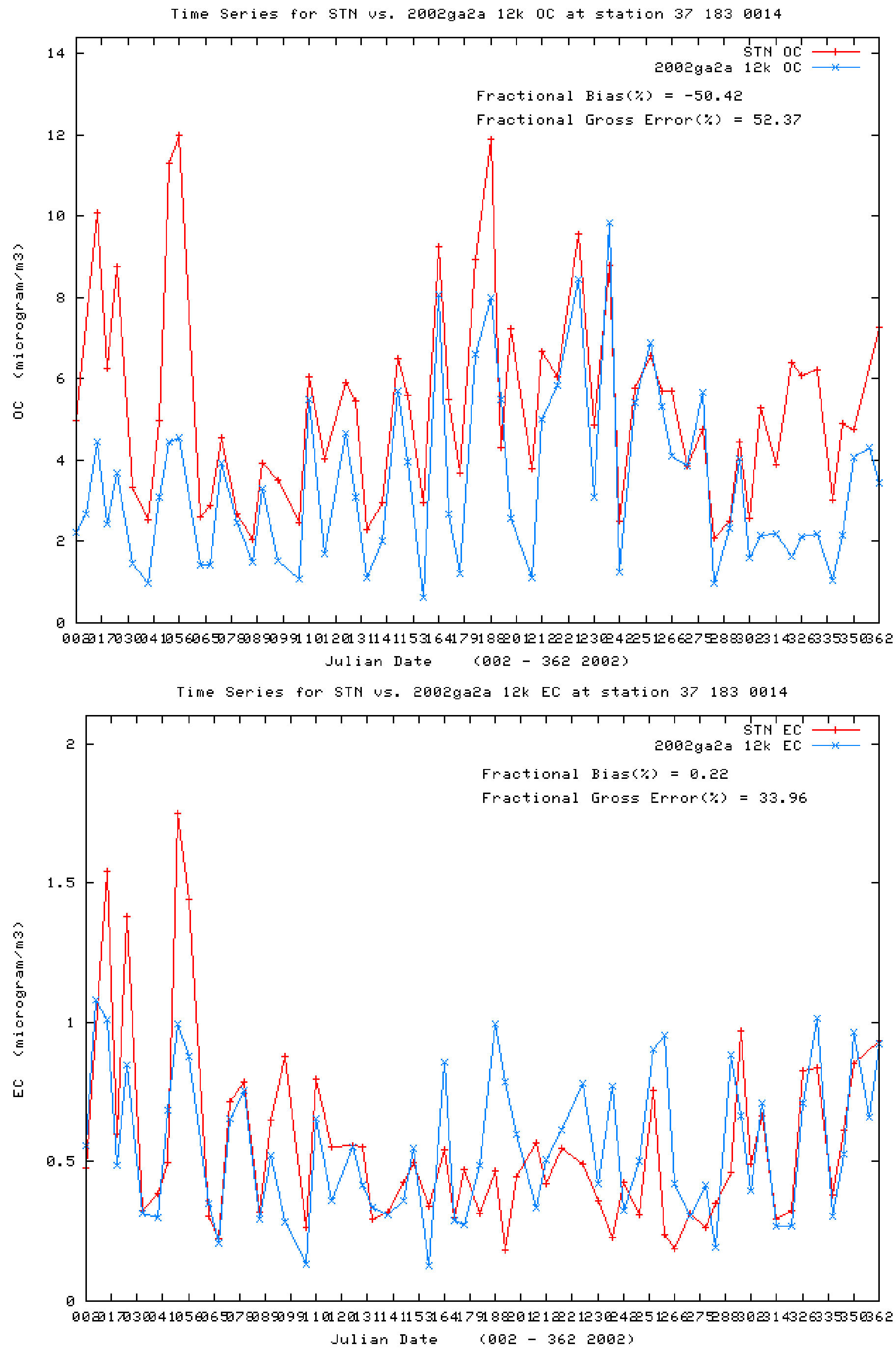
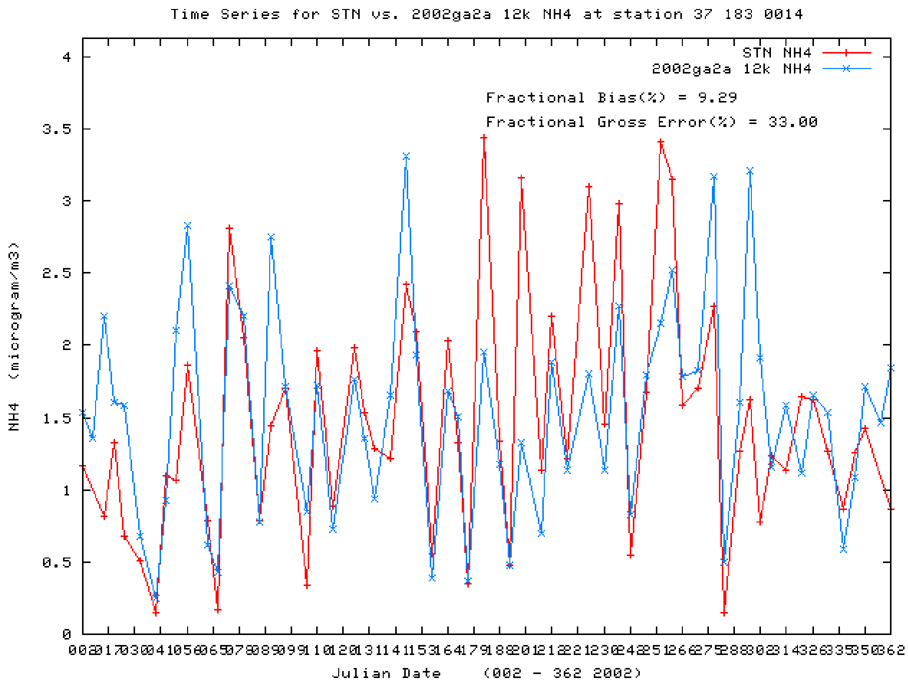


Figure B-27b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Wake County, North Carolina Site No. 37-183-0014 (Raleigh) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



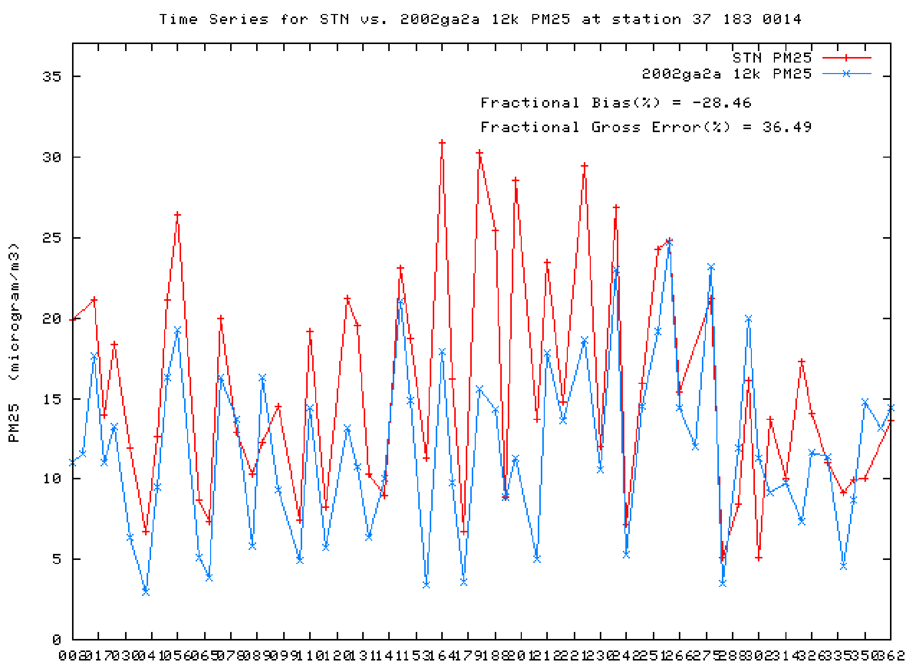


Figure B-27c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Wake County, North Carolina Site No. 37-183-0014 (Raleigh) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

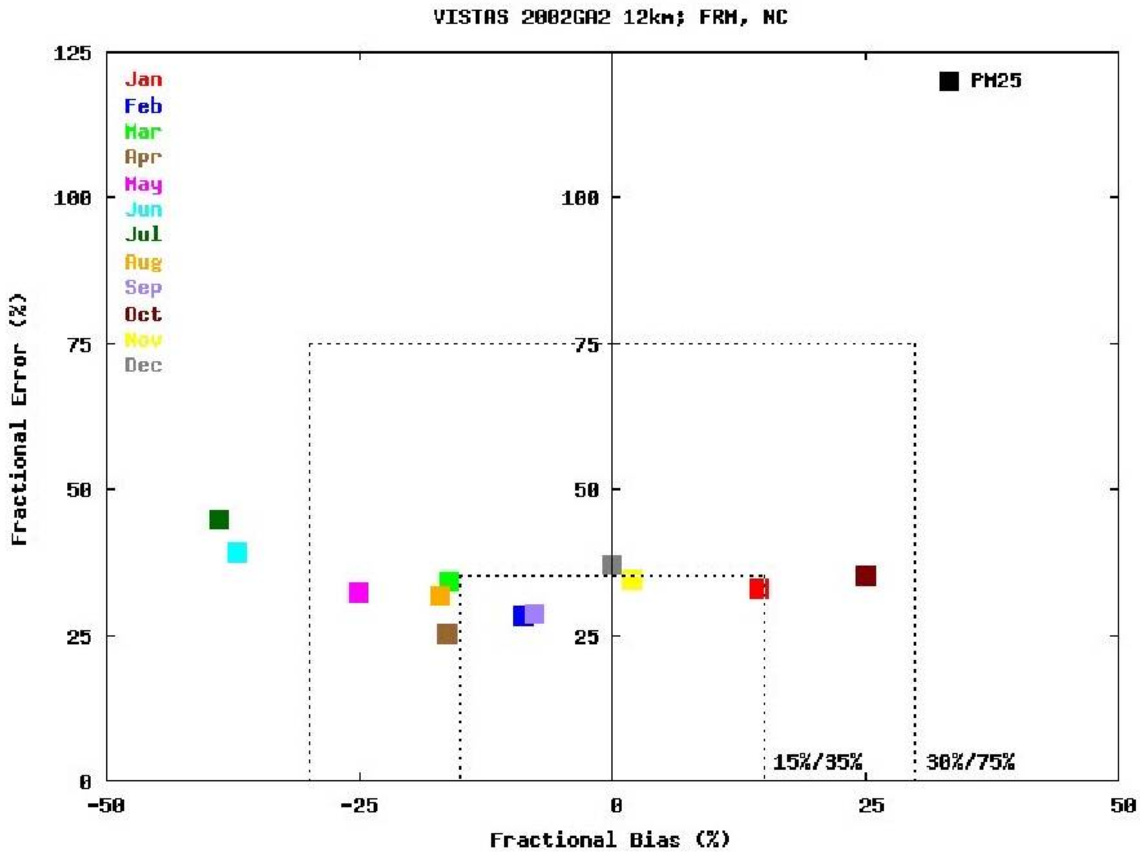


Figure B-28. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in North Carolina for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

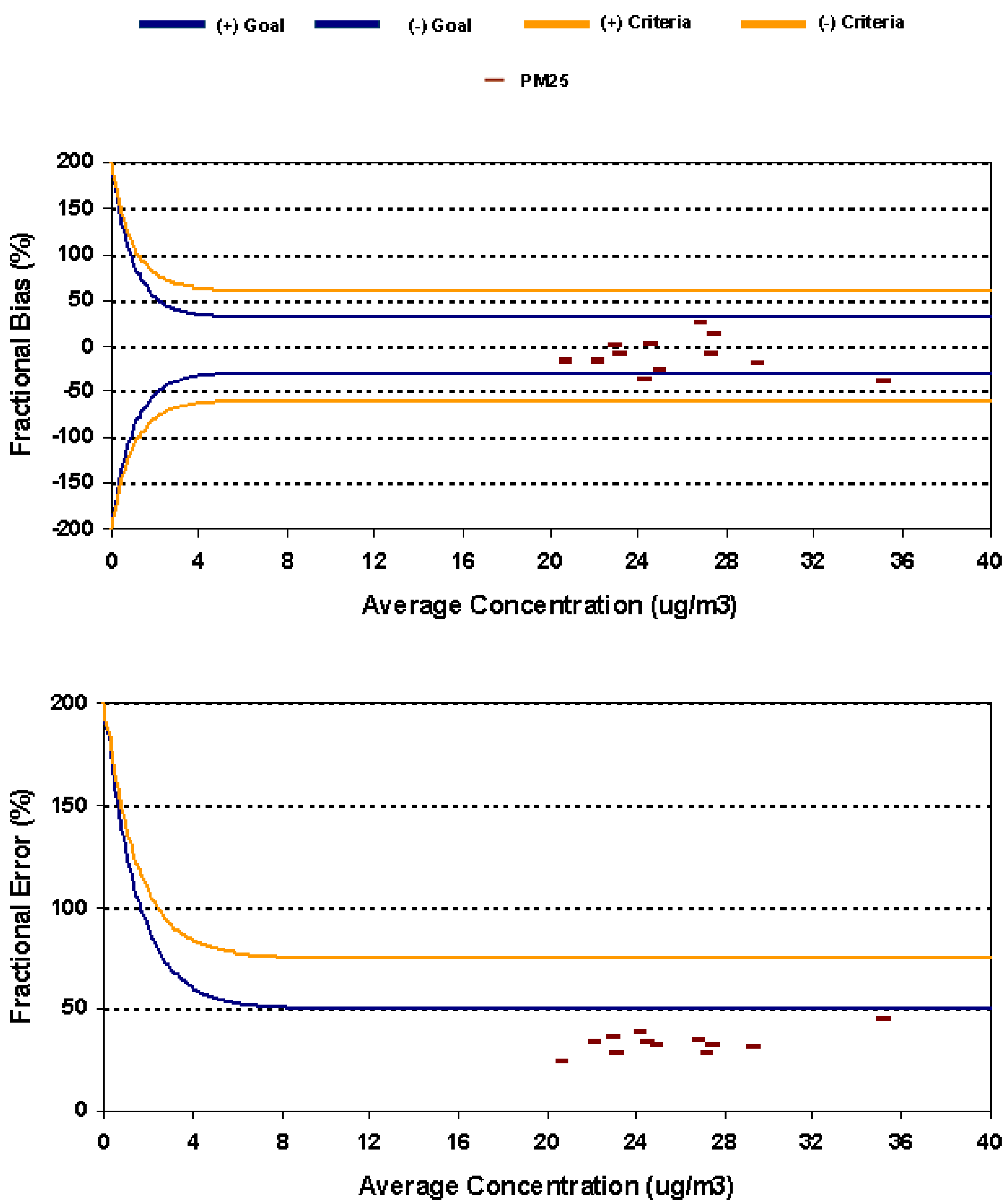


Figure B-29. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in North Carolina and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.7 South Carolina

The CMAQ performance for SO4 across the 4 STN sites in South Carolina generally has an underprediction bias but is reasonably good always achieving the PM performance goal (Figure B-30a). NO3 performance is poor with an underprediction bias generally from -23% to -166% that is largest in the summer (Q3) when NO3 is lowest and not an important component of the $PM_{2.5}$ (Figure B-30b). NH4 performance is variable frequently achieving the PM performance goal with the worst performance in the summer with a large underprediction tendency. OCM is underestimated with bias of -76% to -87%. EC performance also has an underestimation tendency, although not is bad as seen for OCM. The CMAQ 12 km results also exhibits much better EC performance than the CMAQ 36 km modeling results with the 12 km EC model performance almost always achieving the PM performance goal, whereas the CMAQ 36 km EC results never achieves the PM performance goal although Q1 is right at the PM performance goal (Figure B-30e).

$PM_{2.5}$ model performance across STN and FRM networks in South Carolina are shown in Figures B-30f and B-30g, respectively. $PM_{2.5}$ mass is usually underpredicted across both networks, with the fractional bias across the STN network is worse and approximately 20 percentage points worse underprediction than the FRM network. In fact, the bias and error for $PM_{2.5}$ across the FRM network achieves or almost achieves the PM performance goal for all four quarters and even the ozone performance goal for Q1 and Q4.

An example time series of predicted and observed PM concentrations and model performance metrics at the Greenville, South Carolina STN site is given in Figure B-31. All PM components are underestimated on average with fractional bias values for SO4, NO3, NH4, OCM, EC and $PM_{2.5}$ of, respectively, -23%, -97%, -19%, -46%, -11% and -30%. Although the model does show some skill in reproducing the temporal and seasonal variability in the observed PM concentrations.

The summary fractional bias and gross error Soccer and Bugle Plots for total $PM_{2.5}$ mass across the FRM network in South Carolina are shown in Figures B-32 and B-33. During the fall and winter months of Aug, Sep, Nov, Dec, Jan and Feb the monthly bias and error statistics achieve the ozone model performance goal. The three additional months of Mar, Apr and Oct achieve the PM performance goal. Whereas the summer months of May, Jun and Jul fail to achieve the PM performance goal due to large underprediction bias that is due to the underprediction of each of the PM component species.

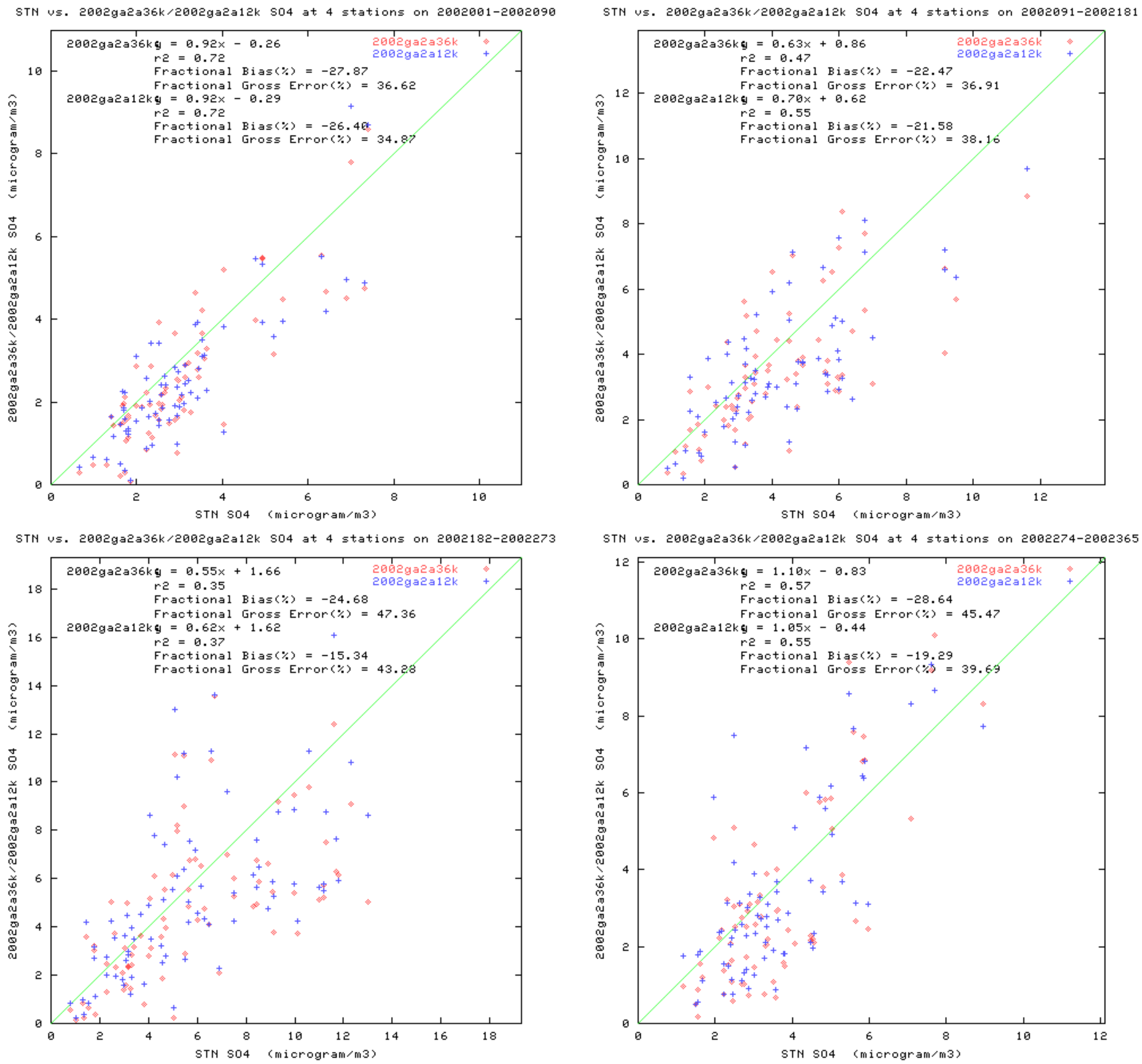


Figure B-30a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

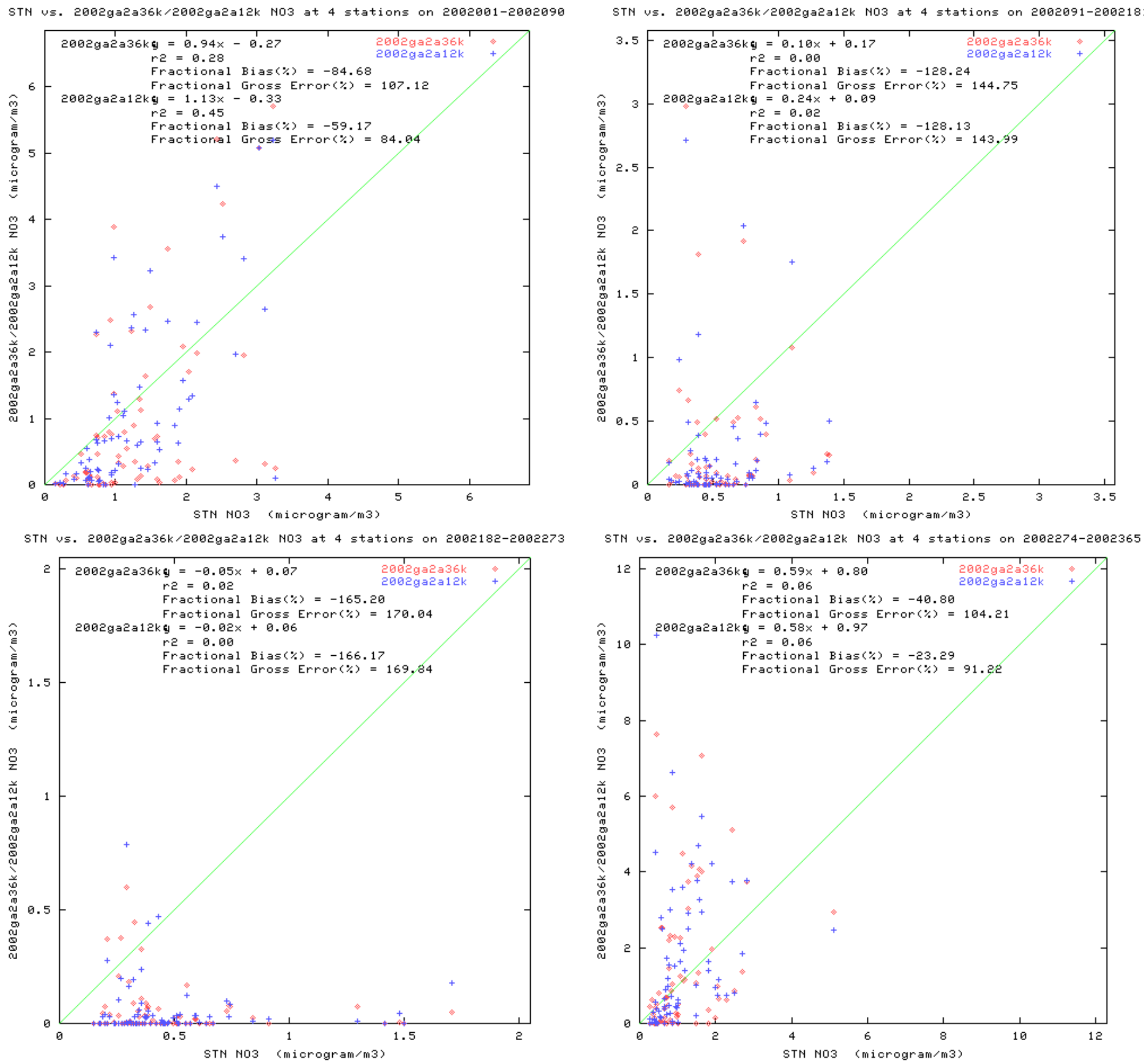


Figure B-30b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

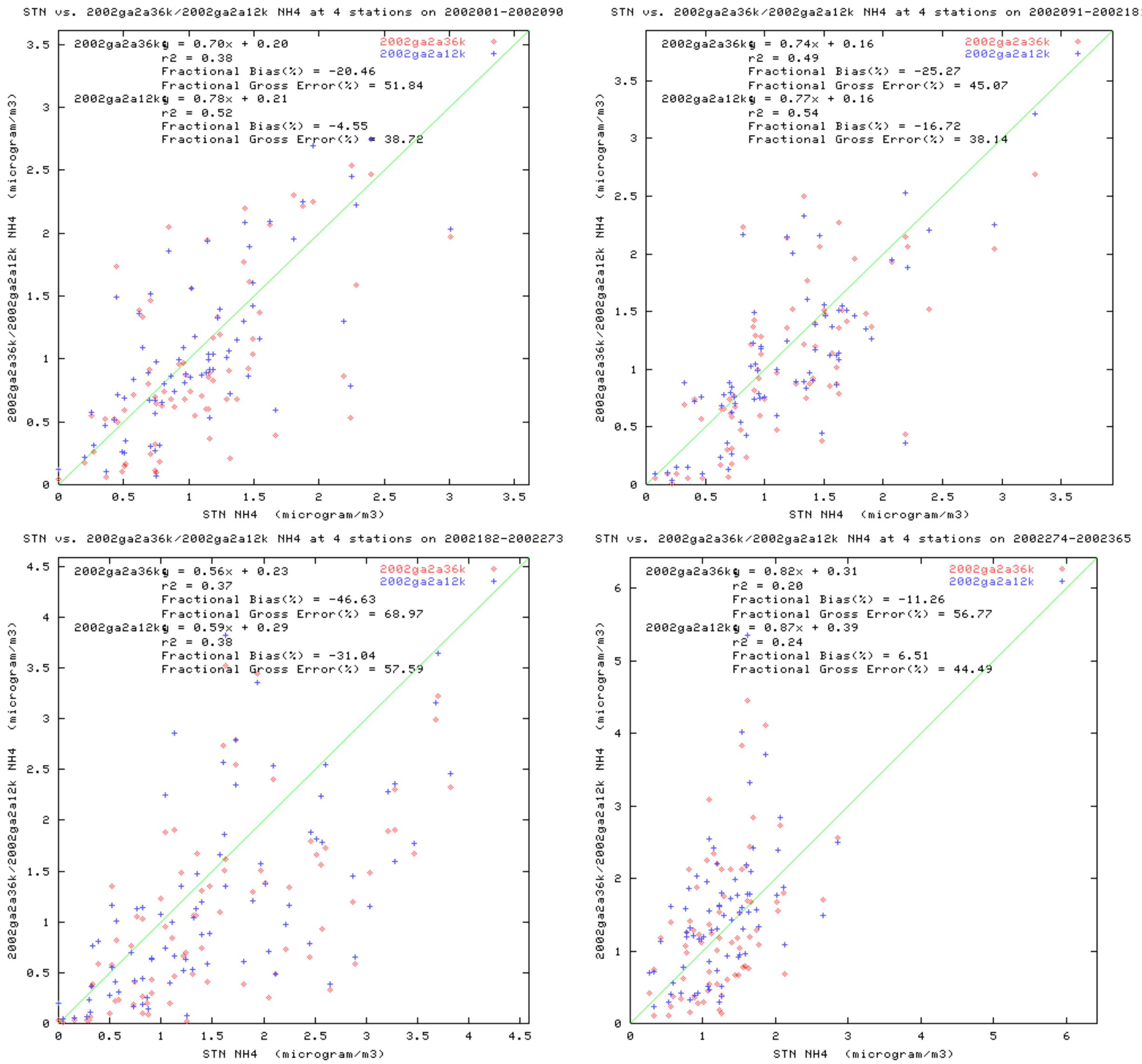


Figure B-30c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

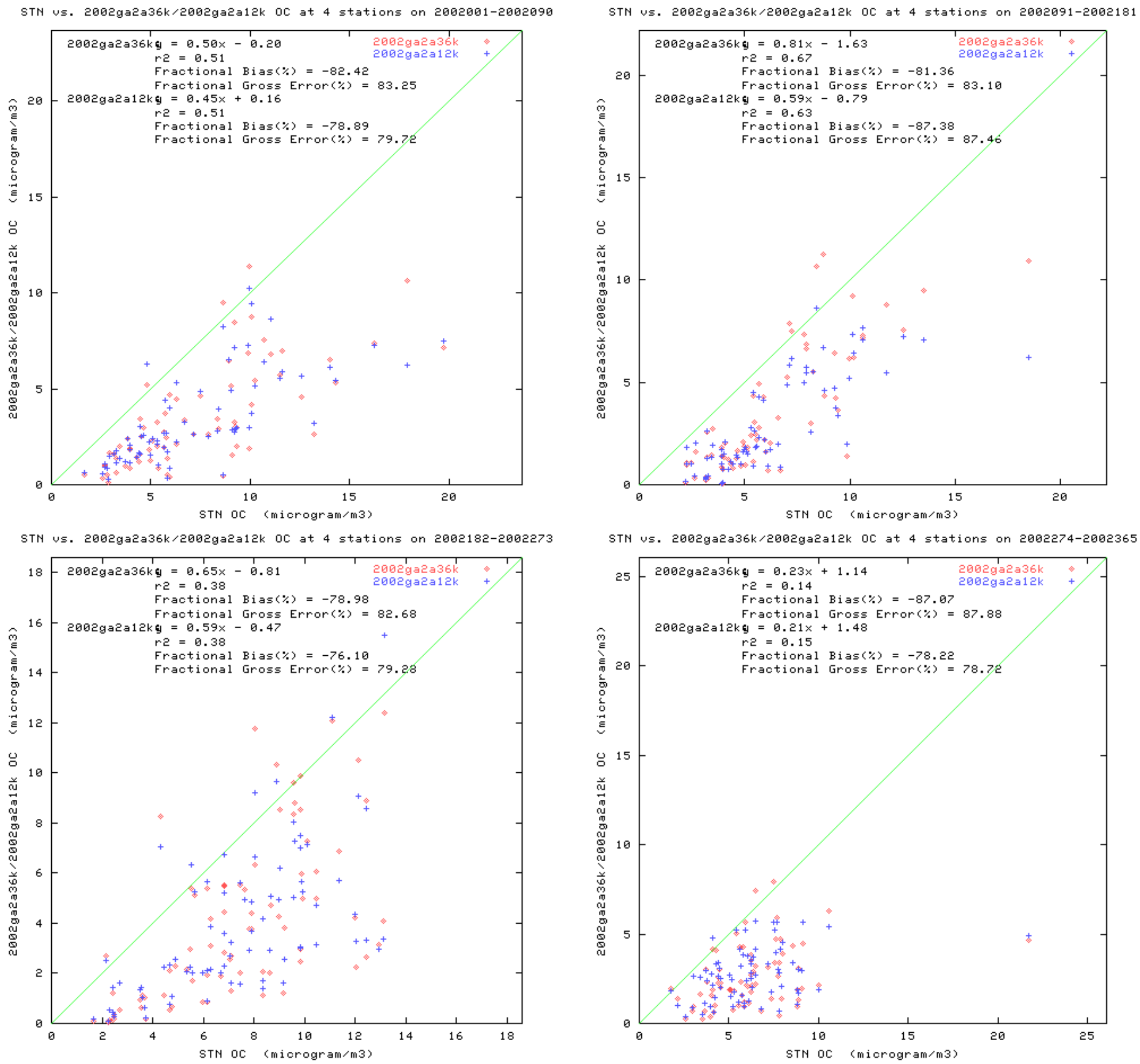


Figure B-30d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

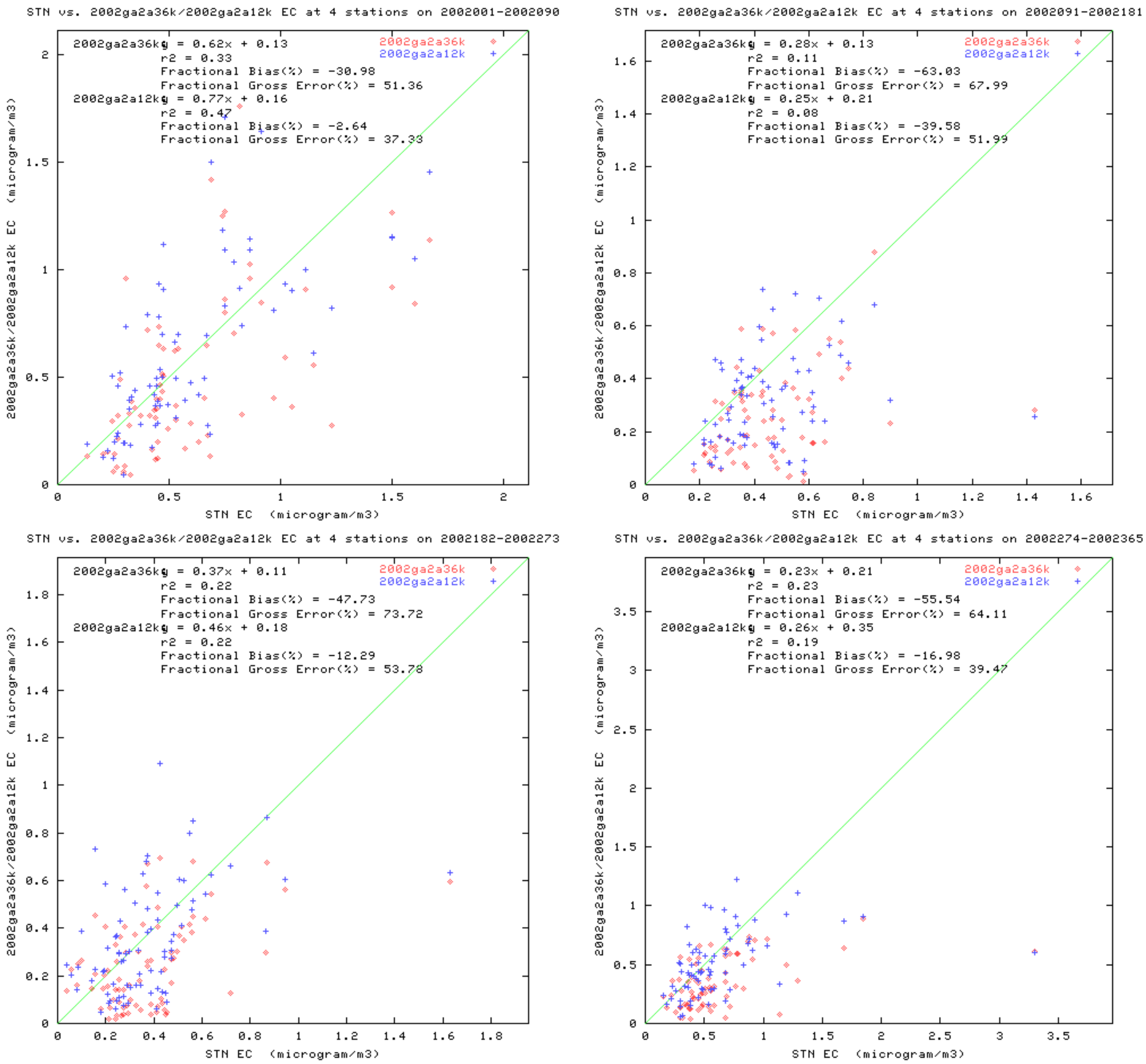


Figure B-30e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

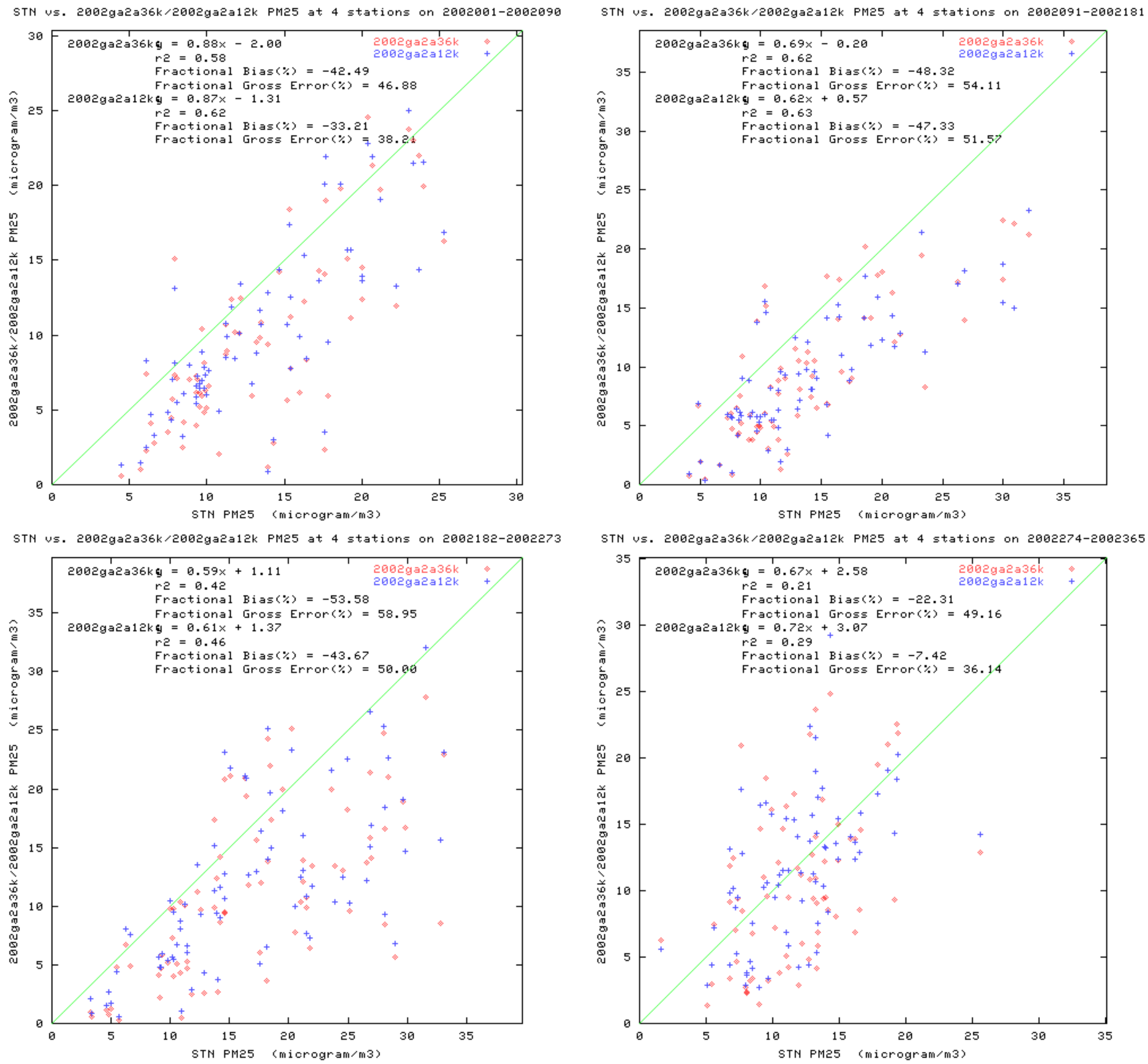


Figure B-30f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

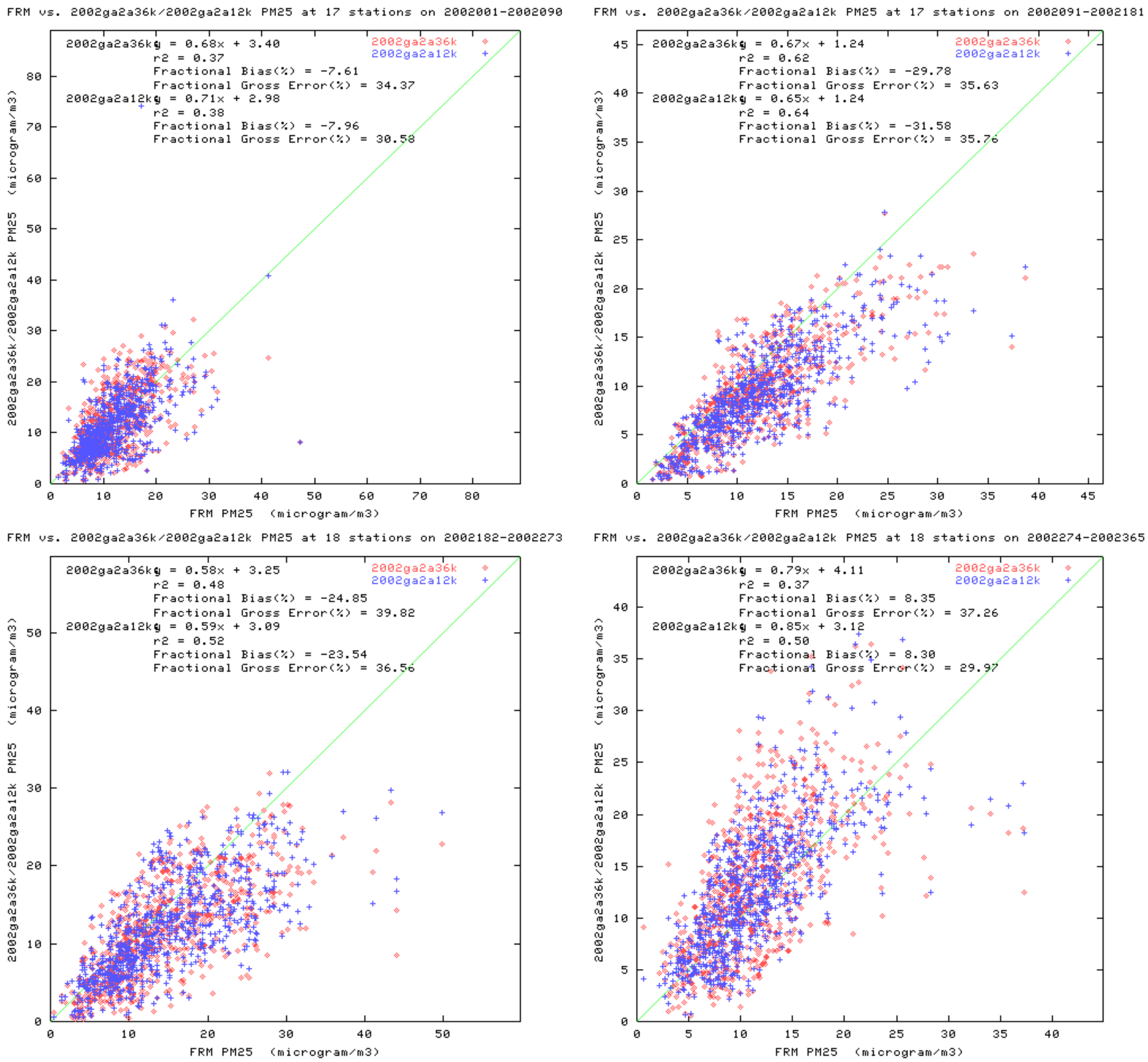


Figure B-30g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in South Carolina and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

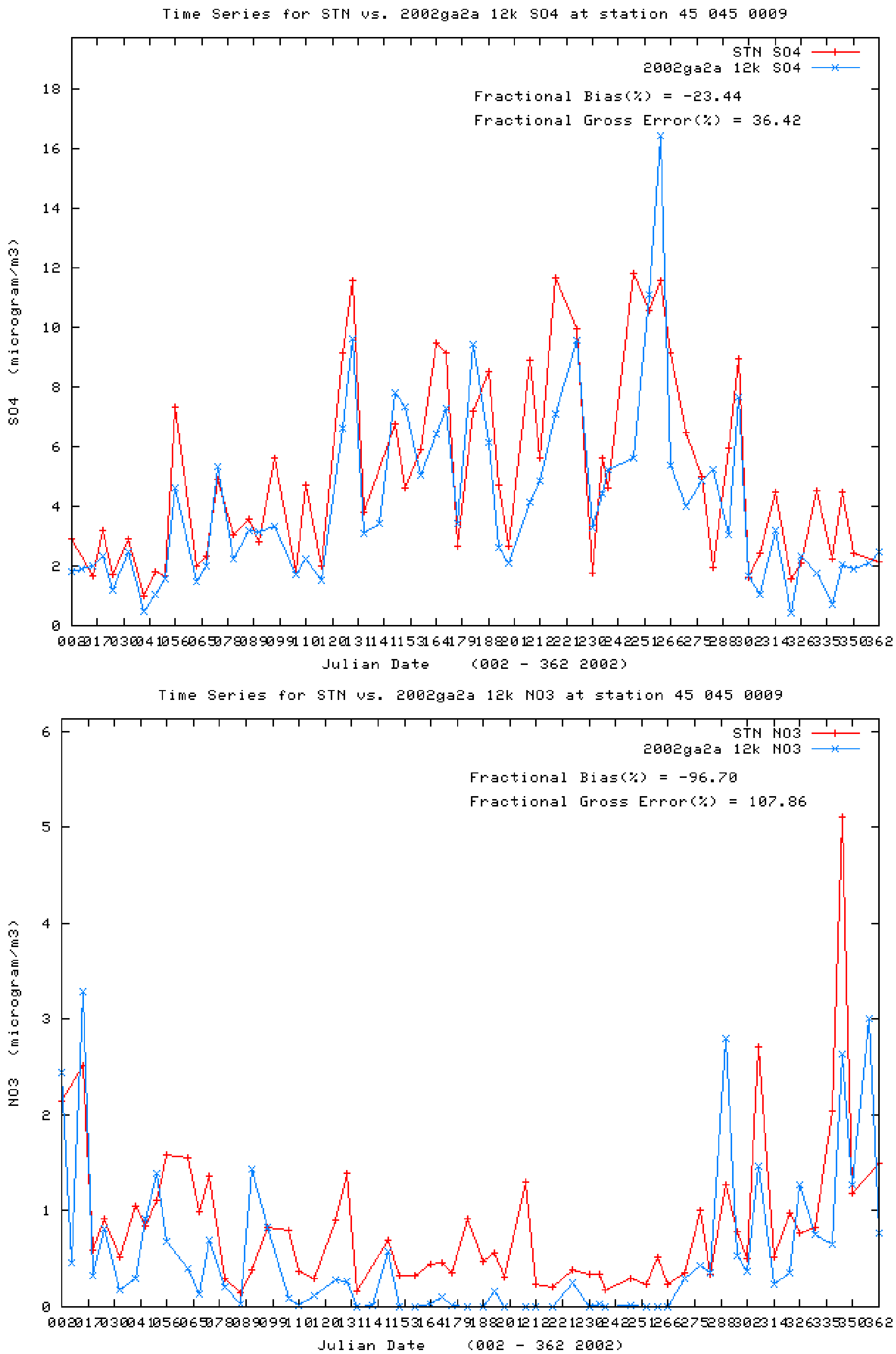
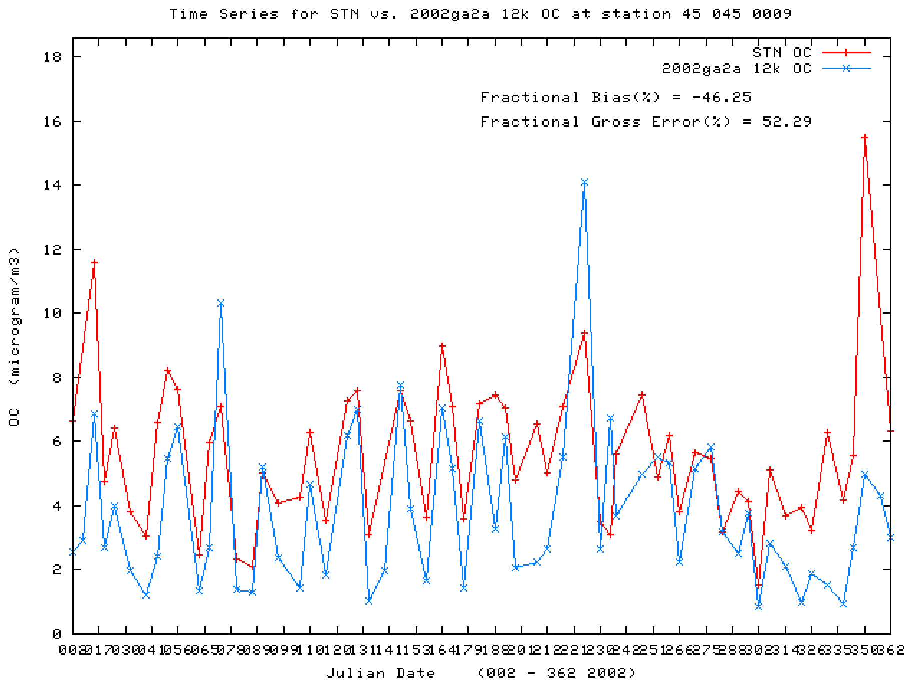


Figure B-31a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Greenville County, South Carolina Site No. 45-045-0009 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



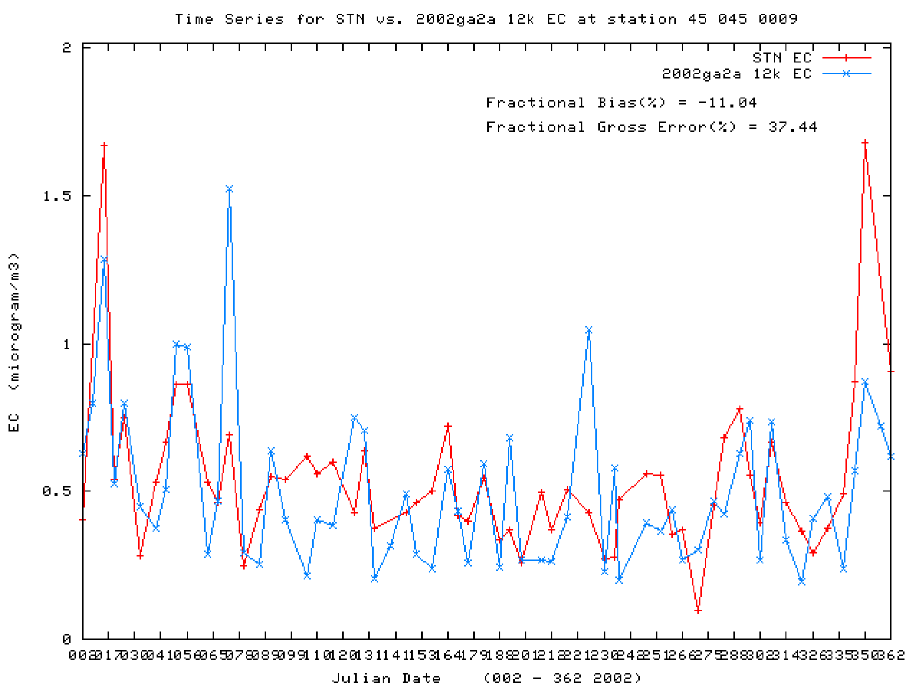
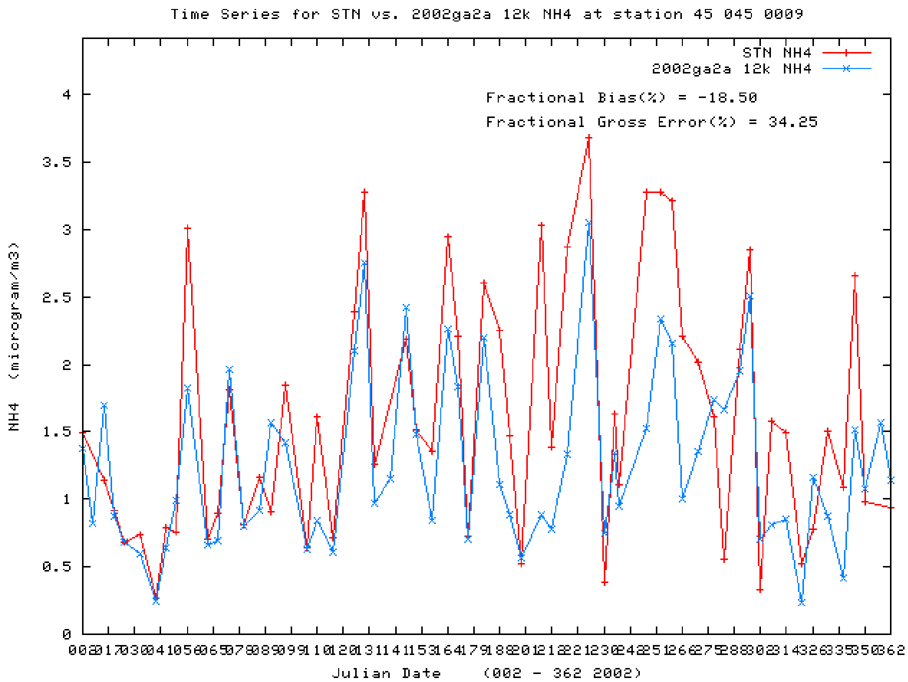


Figure B-31b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Greenville County, South Carolina Site No. 45-045-0009 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



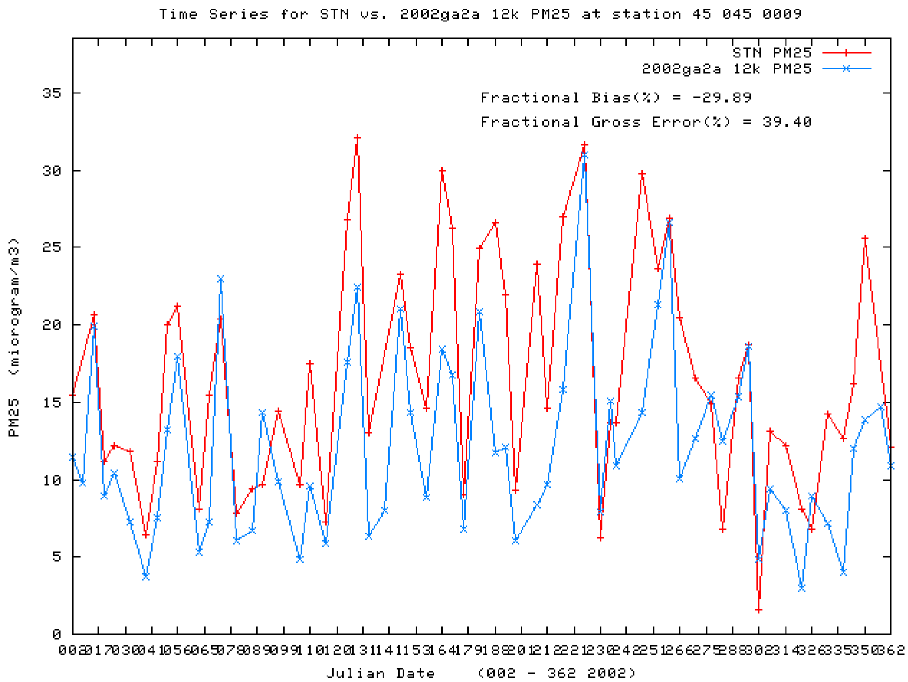


Figure B-31c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Greenville County, South Carolina Site No. 45-045-0009 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

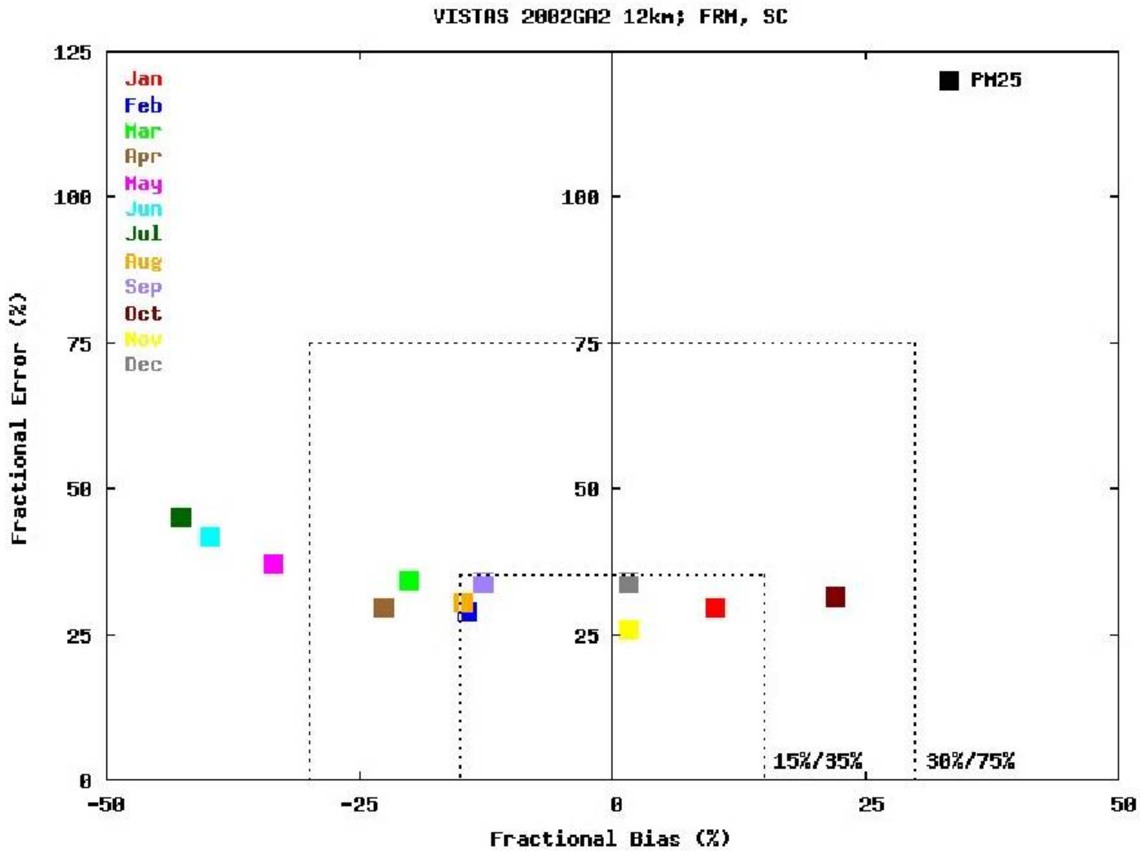


Figure B-32. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in South Carolina for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

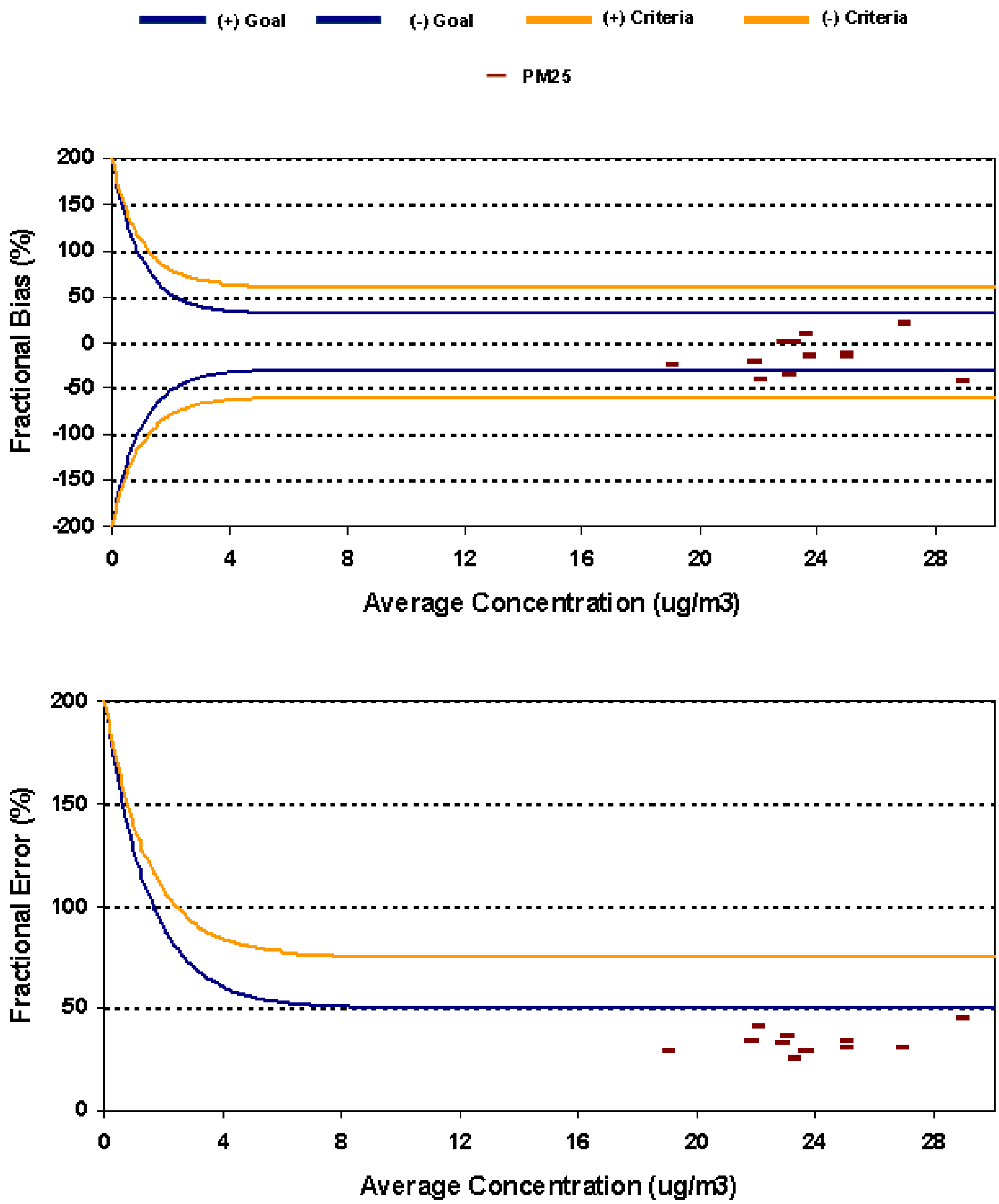


Figure B-33. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in South Carolina and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.8 Tennessee

The CMAQ does a good job predicting the observed SO4 concentrations in Tennessee with bias and error values that either achieve the most stringent ozone performance goal (Q2 and Q3) or falls slightly out of the ozone goal (Figure B-34a). The CMAQ 12 km results are slightly better than the 36 km predictions and, unlike the other states, where Q3 had the largest underprediction bias in Tennessee the SO4 performance in Q3 is quite good with the 12 km results producing a 8% bias and 36% error.

The model exhibits little skill in its NO3 predictions (Figure B-34b) with the usual large underprediction bias in the summer (e.g., -150% in Q3). Although the bias is low in Q1 and Q4 (<±10%), the error is large (60% to 80%). NH4 performance is generally reasonably good with low bias and error in Q1 and Q2l, but a slight underprediction bias in Q3 (-7% and -18%) and an overprediction bias in Q4 (15%).

As seen in the other states, OCM exhibits a large underprediction bias that generally ranges from -65% to -90% (Figure B-34d). EC performance is fairly good with the 12 km results always achieving the PM performance goal (Figure B-34f).

Tennessee $PM_{2.5}$ mass performance across the STN and FRM networks are shown in Figures B-34f and B-34g. Across the STN networks performance for $PM_{2.5}$ achieves the ozone goal in Q1 and almost in Q4, but exhibits an underprediction bias in Q2 and Q3 with the 12 km modeling results achieving the PM performance goal. Across the FRM network the model performs better for $PM_{2.5}$ achieving the ozone performance goal in Q1 and Q4, but with an underprediction bias in Q2 (-17%) and Q3 (-18%) that just barely falls out of the ozone performance goal.

Example time series comparisons and annual model statistics are presented for two sites in Tennessee, one in Chattanooga, Hamilton County (Figure B-35) and one in Knoxville, Knox County (Figure B-36). The model reproduces the daily variations in the SO4 at these two sites fairly well with an annual underprediction bias of -17% and -9%. NO3 is underpredicted in the summer resulting in an annual underprediction bias in Chattanooga and Knoxville of -86% and -74%, respectively. OCM is underpredicted at both sites with bias values of -56% and -44%. EC is underestimated on average in Chattanooga (-23%) and overestimated in Knoxville (21%). The underprediction of the two main PM components at the two sites (SO4 and OCM) results in a net underprediction bias of $PM_{2.5}$ mass of -51% and -22%.

The monthly fractional bias and error Soccer and Bugle Plots for FRM $PM_{2.5}$ performance in Tennessee show that all months of the year achieve the PM model performance goal and that 5 of the months even achieve or are right at the ozone model performance goal. The months that do not achieve the ozone performance goal are due to a summer underprediction bias for May-July and a fall/winter overprediction bias for October and November and a too high error for December.

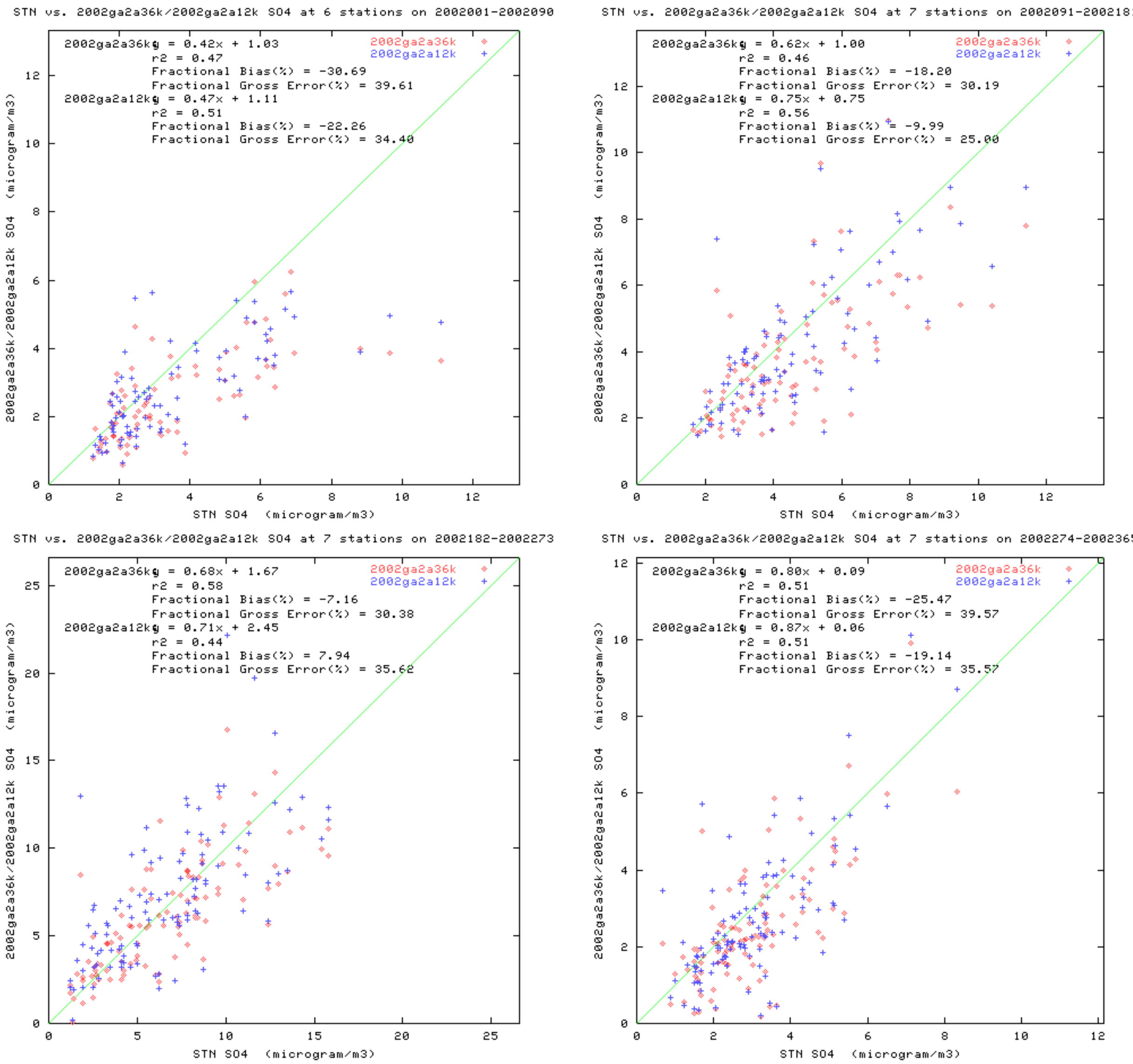


Figure B-34a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

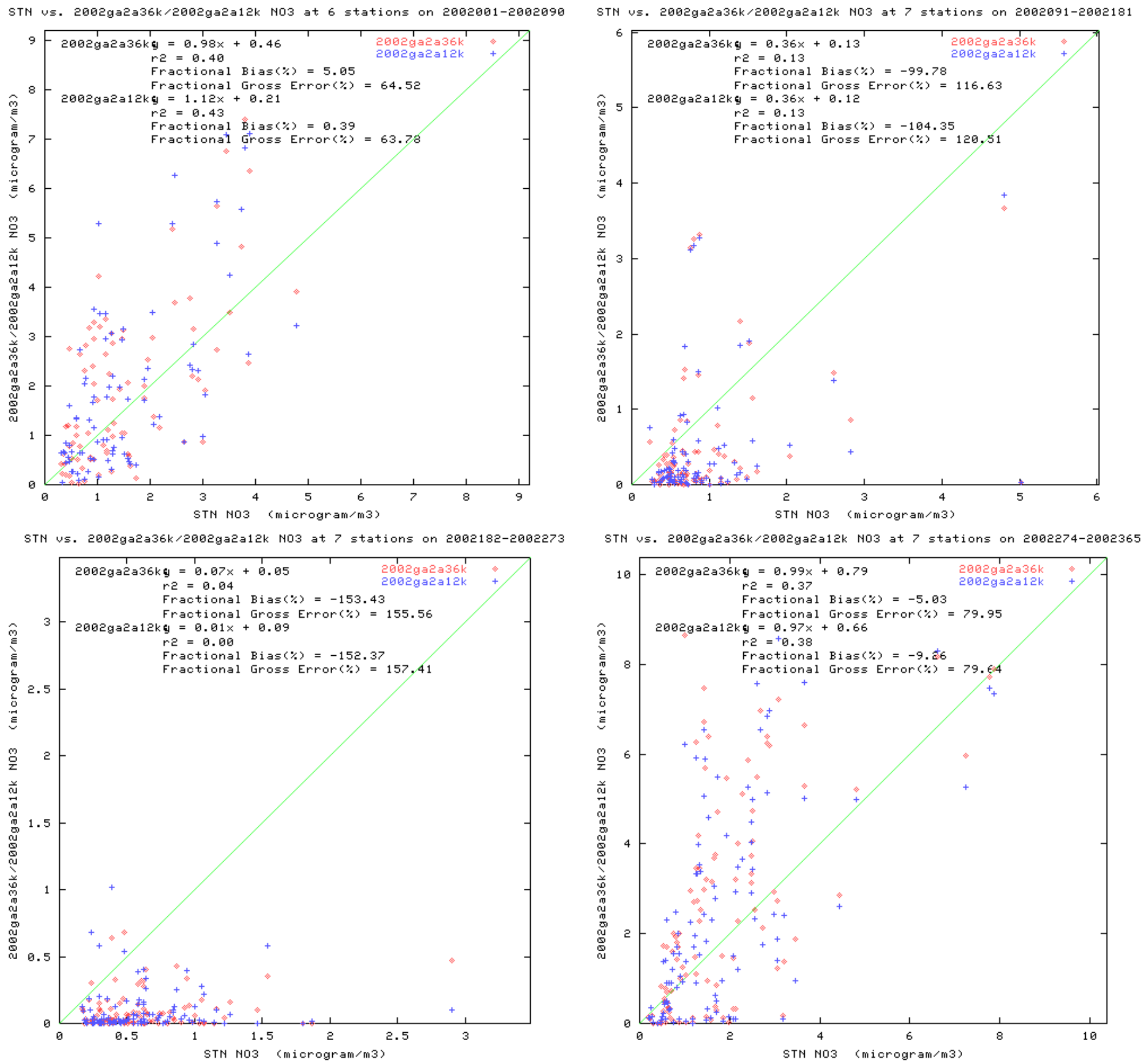


Figure B-34b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

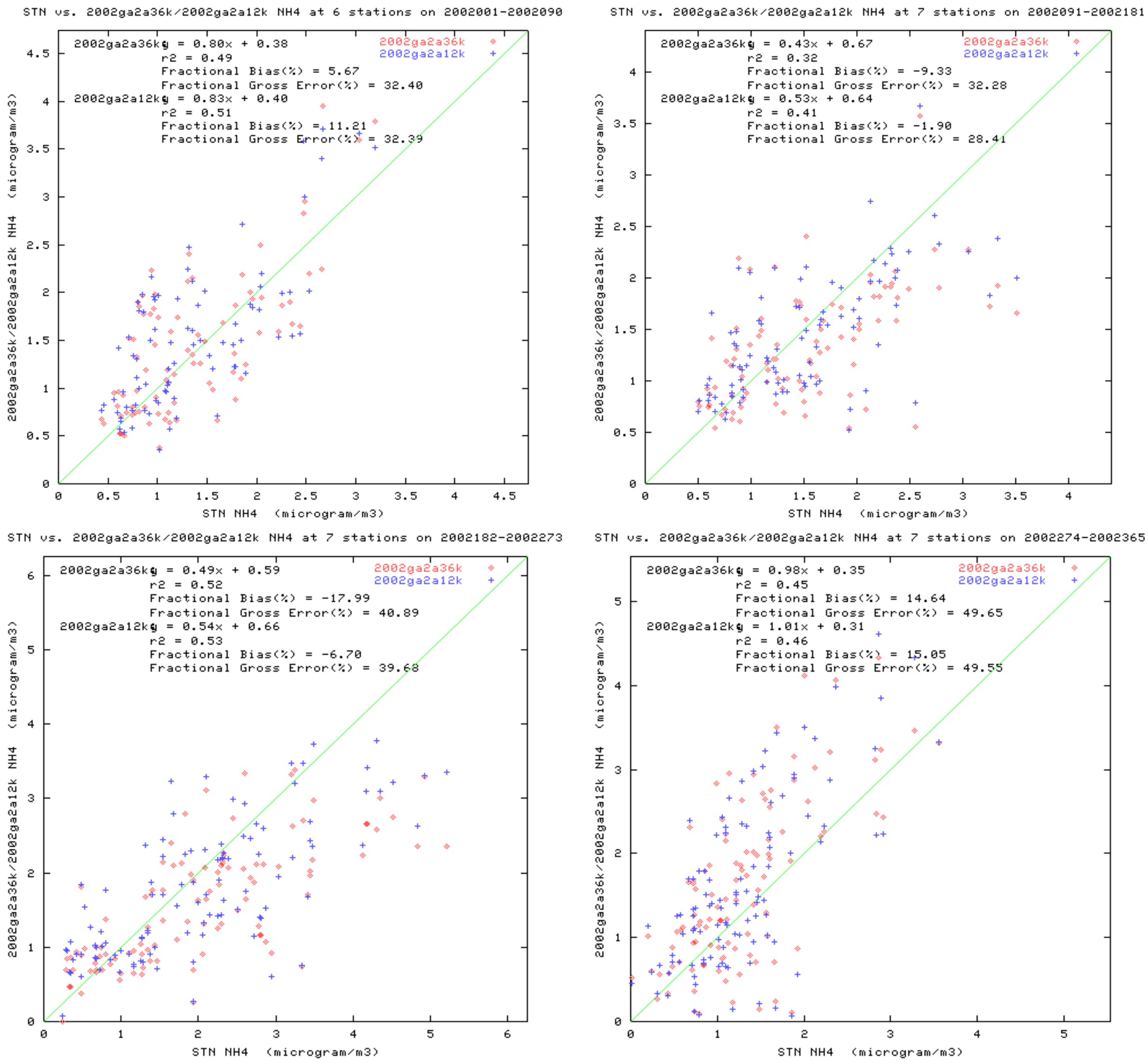


Figure B-34c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

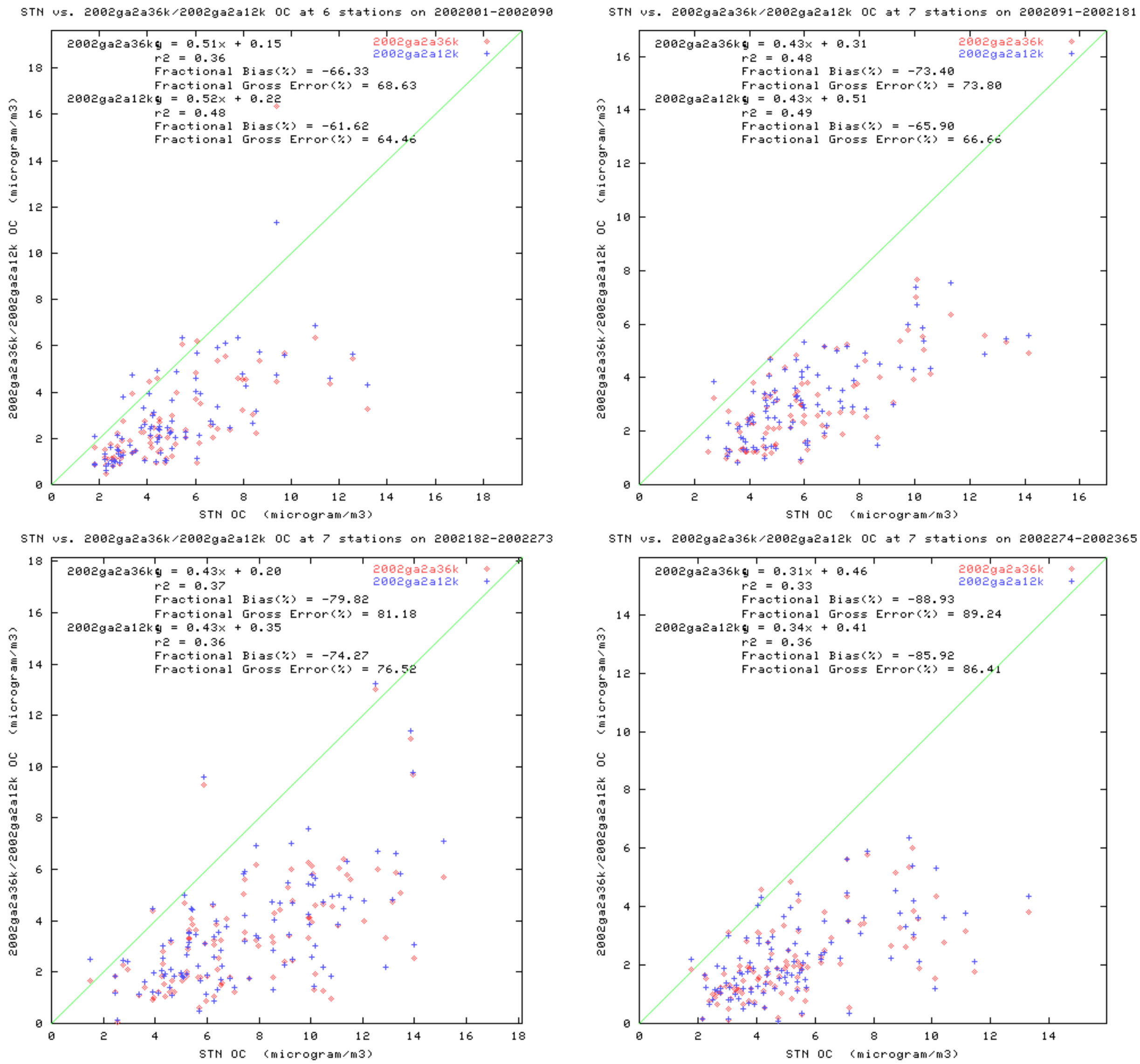


Figure B-34d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

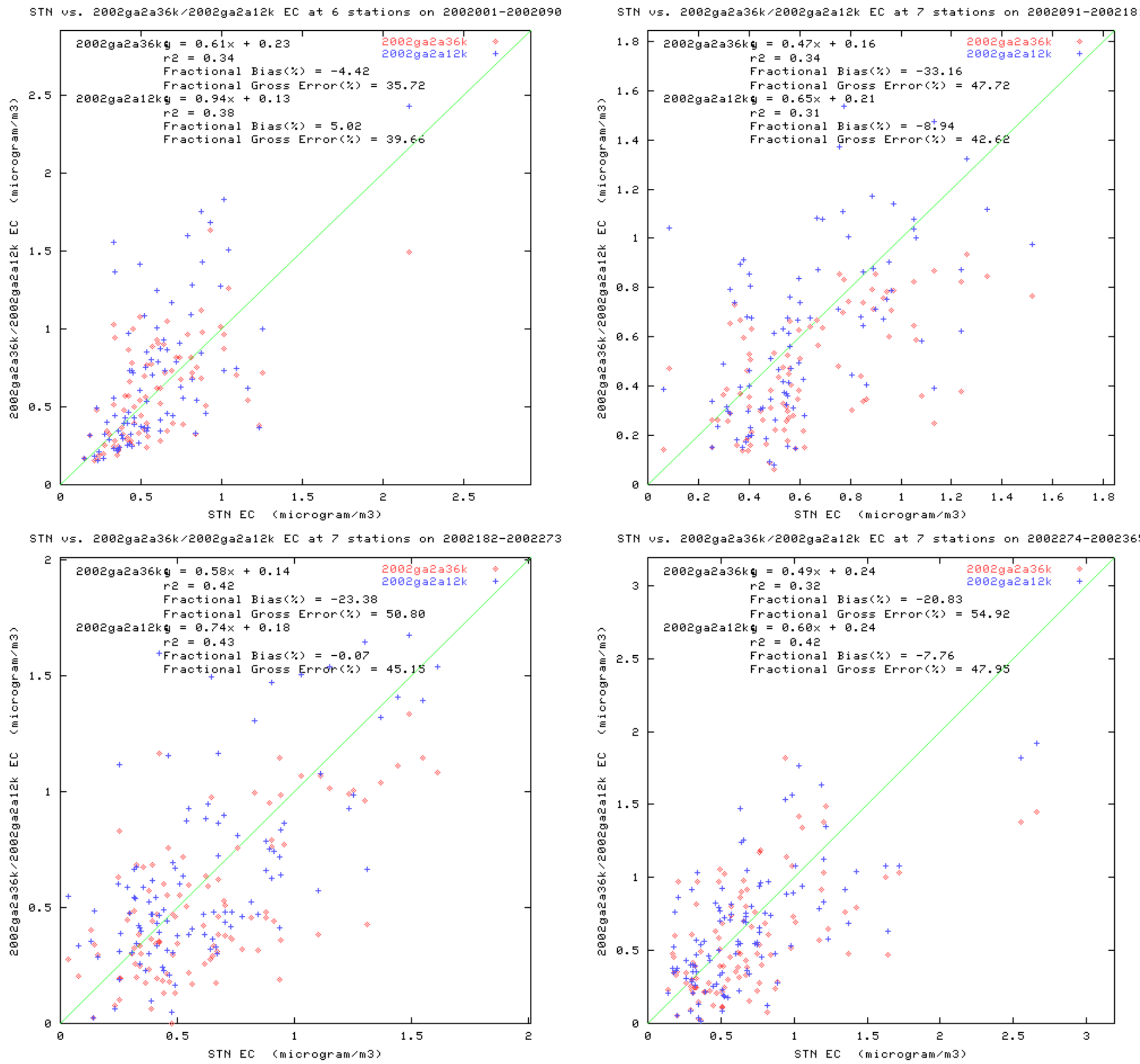


Figure B-34e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

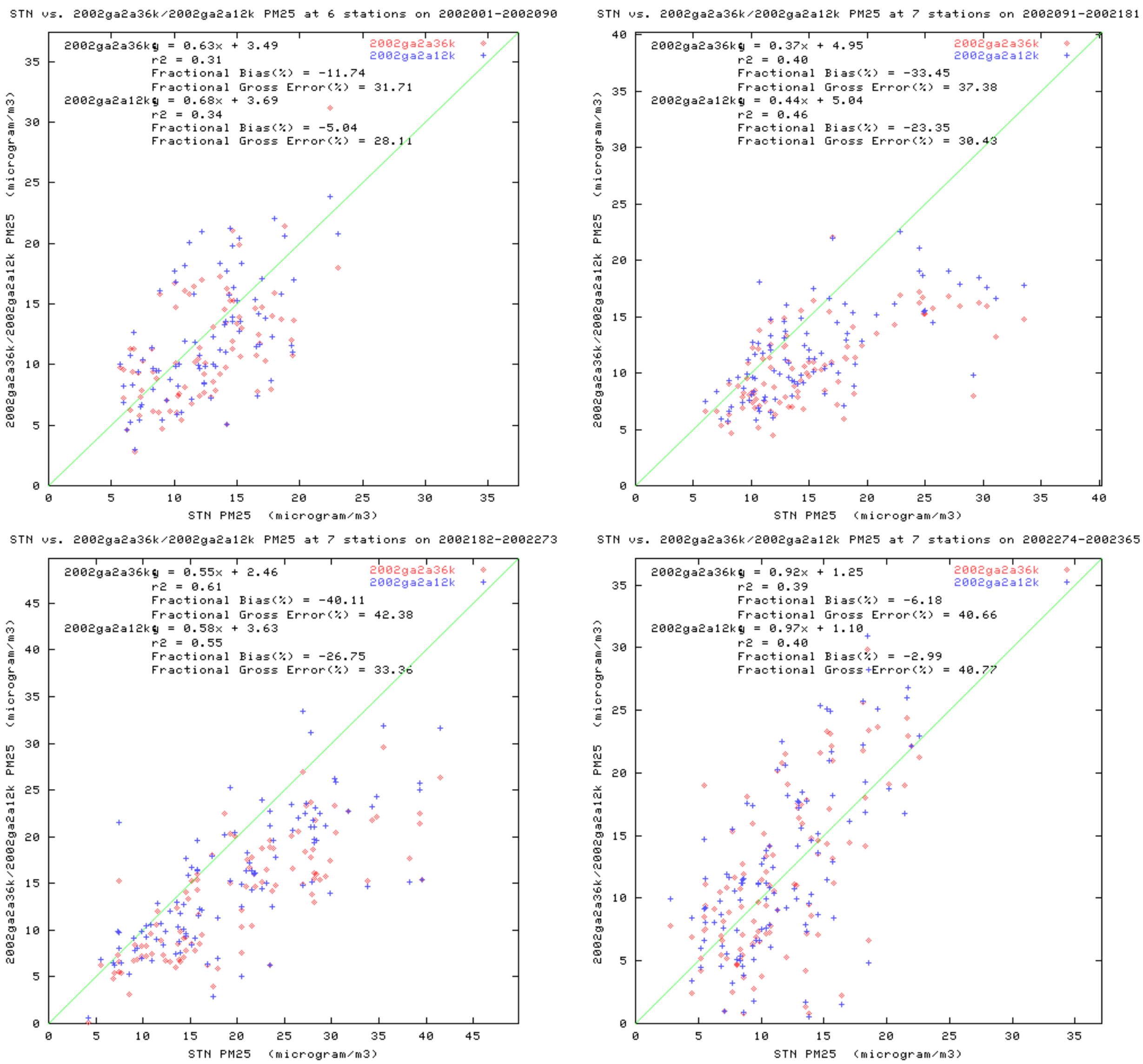


Figure B-34f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

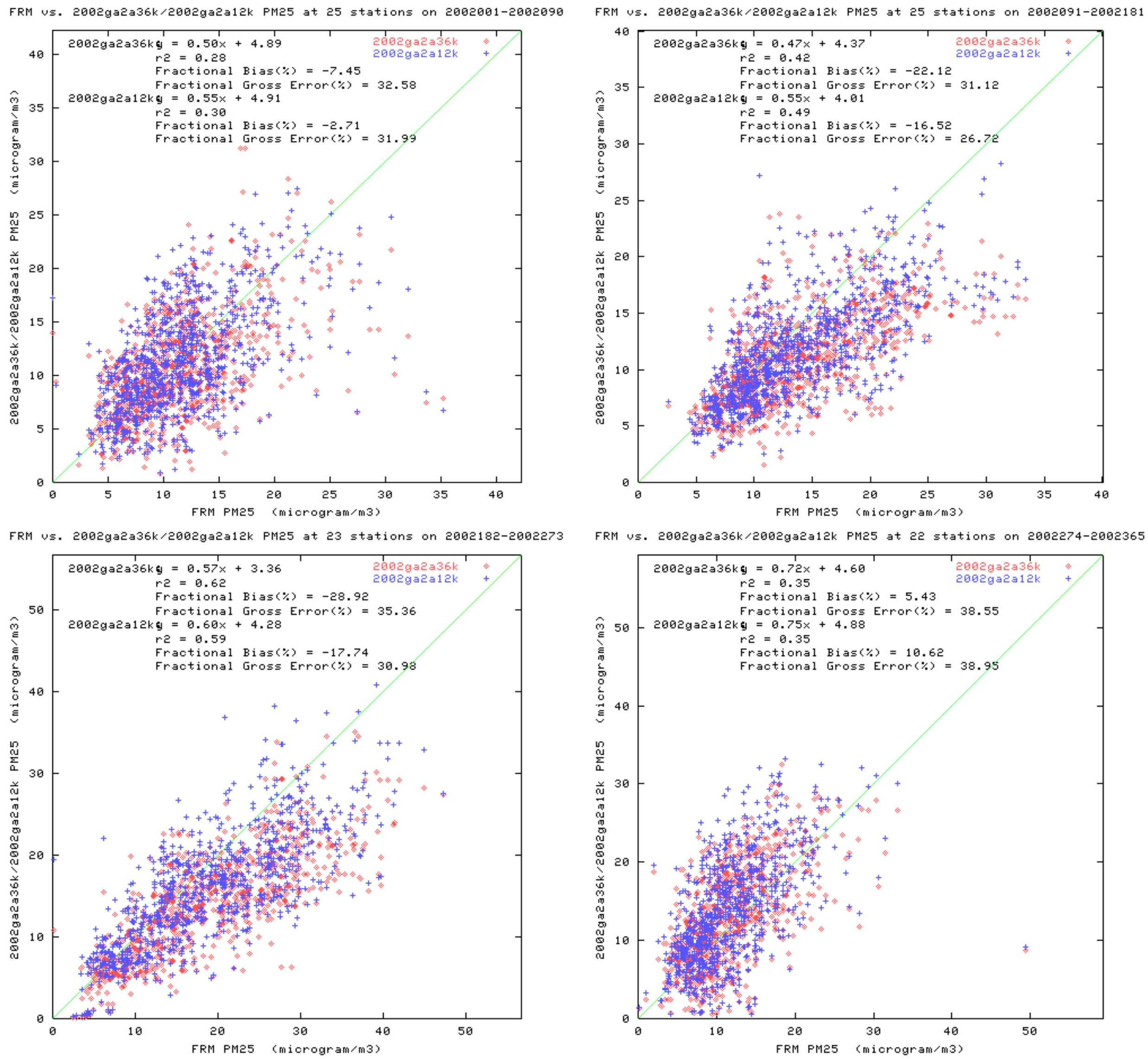


Figure B-34g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Tennessee and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

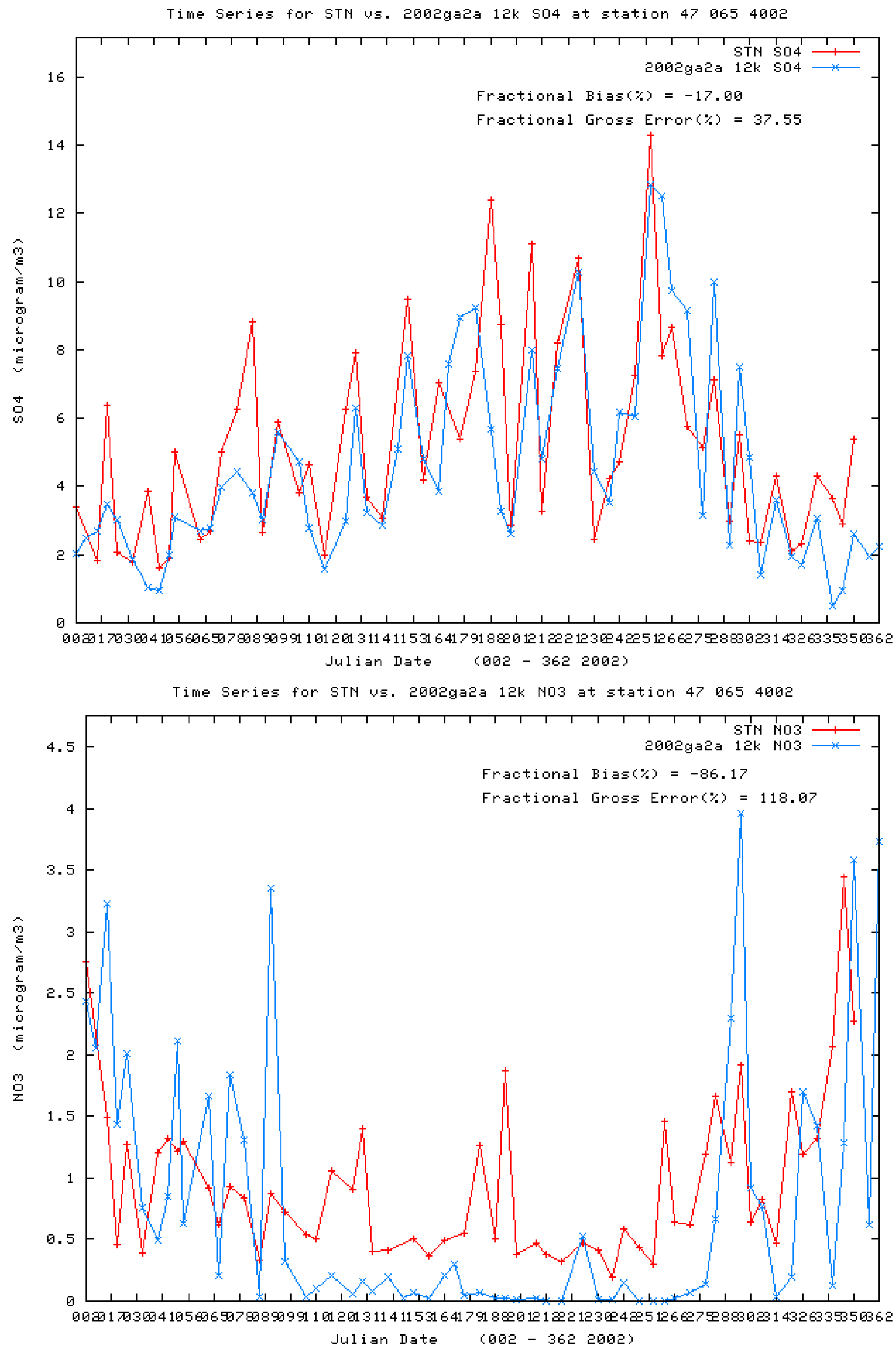


Figure B-35a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Hamilton County, Tennessee Site No. 47-065-4002 (Chattanooga) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

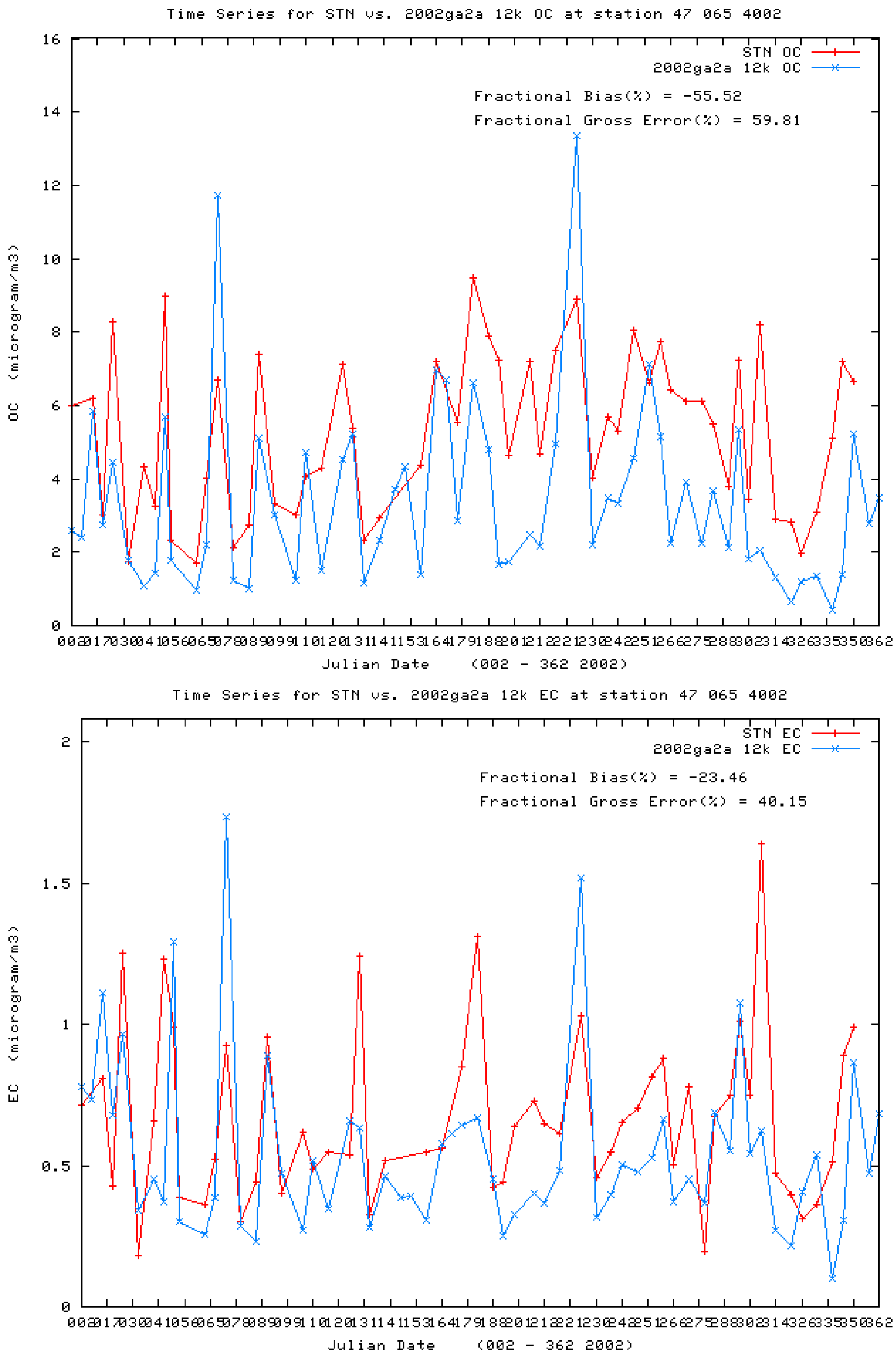


Figure B-35b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Hamilton County, Tennessee Site No. 47-065-4002 (Chattanooga) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

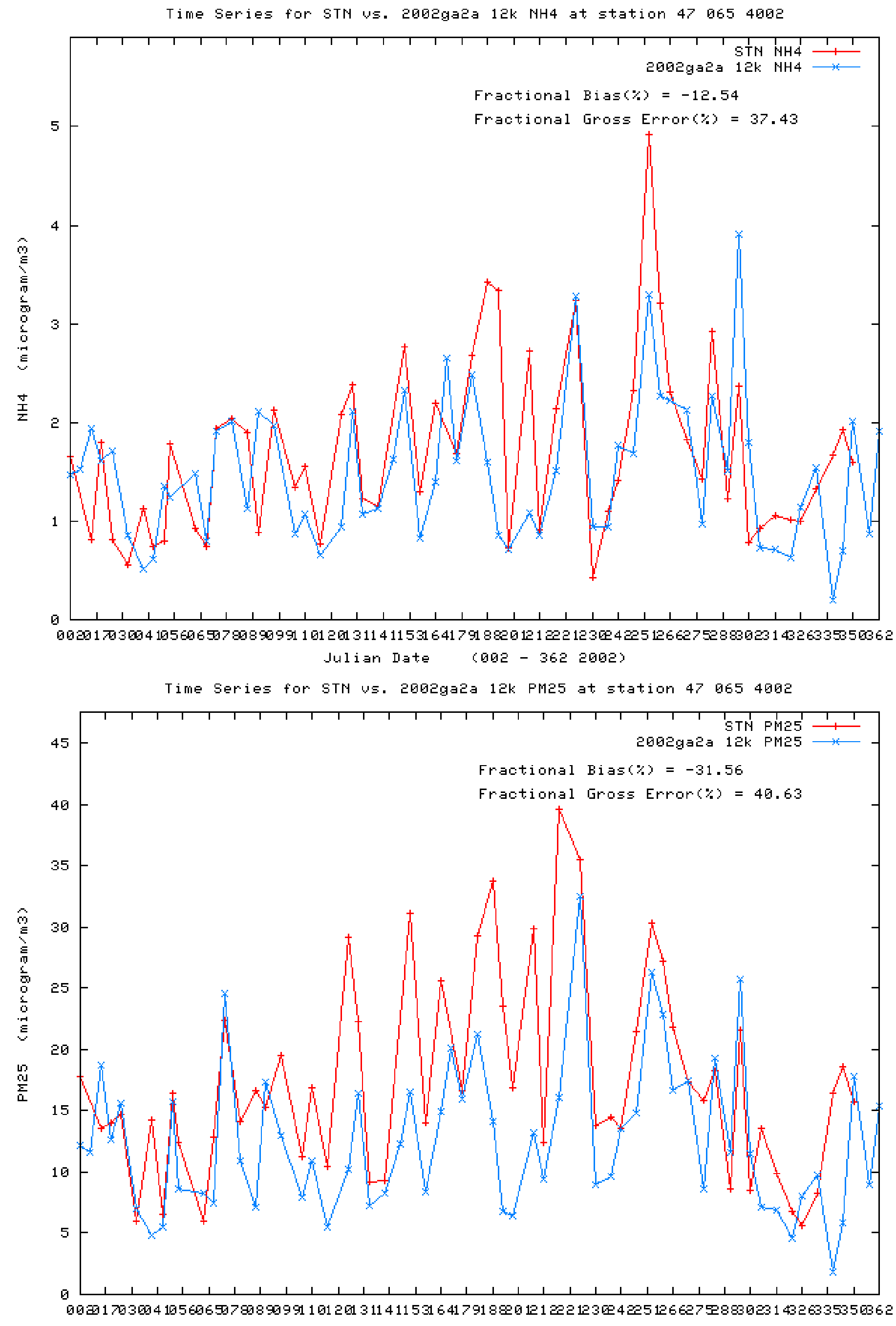


Figure B-35c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Hamilton County, Tennessee Site No. 47-065-4002 (Chattanooga) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

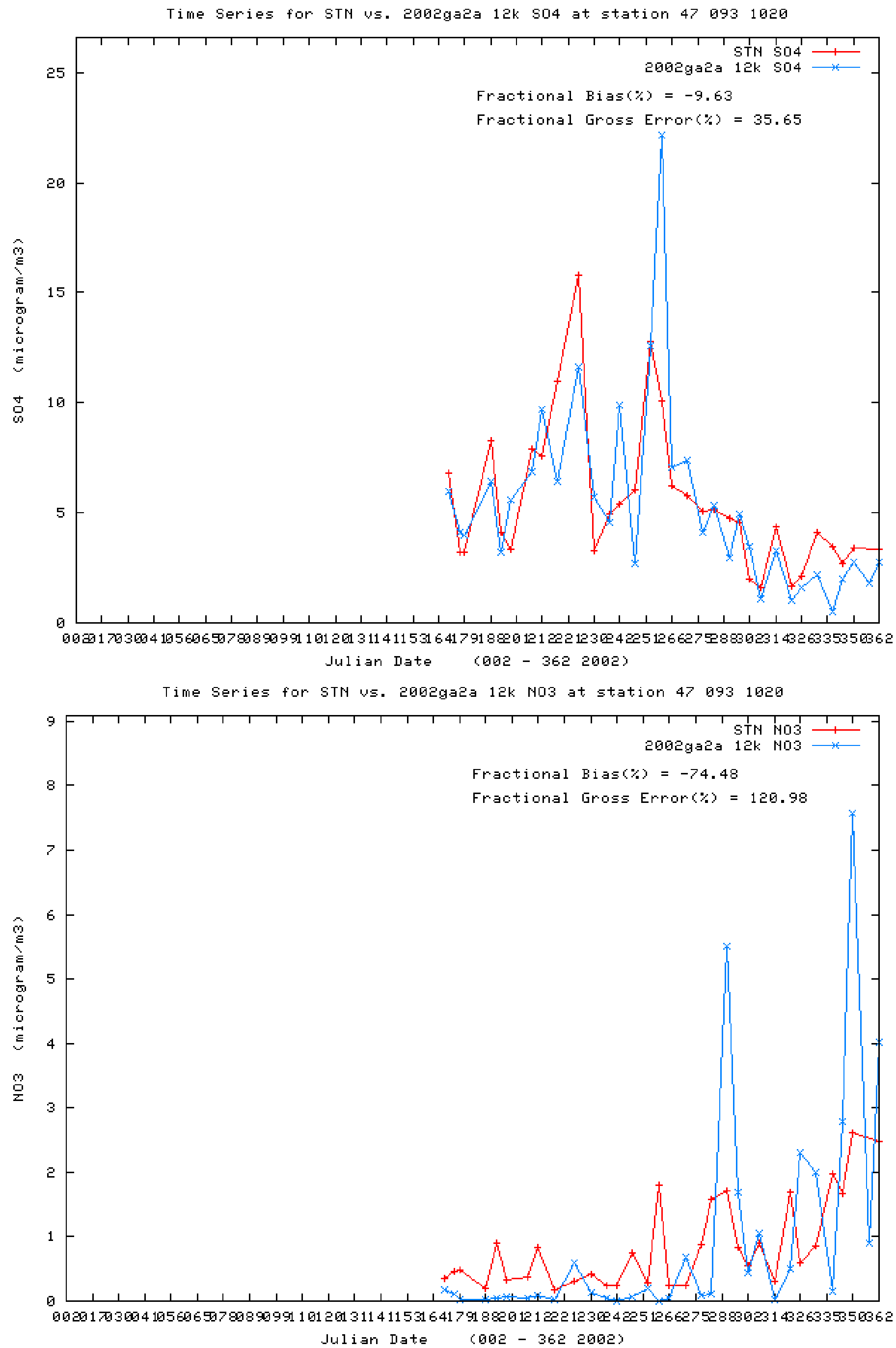


Figure B-36a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Knox County, Tennessee Site No. 47-093-1020 (Knoxville) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

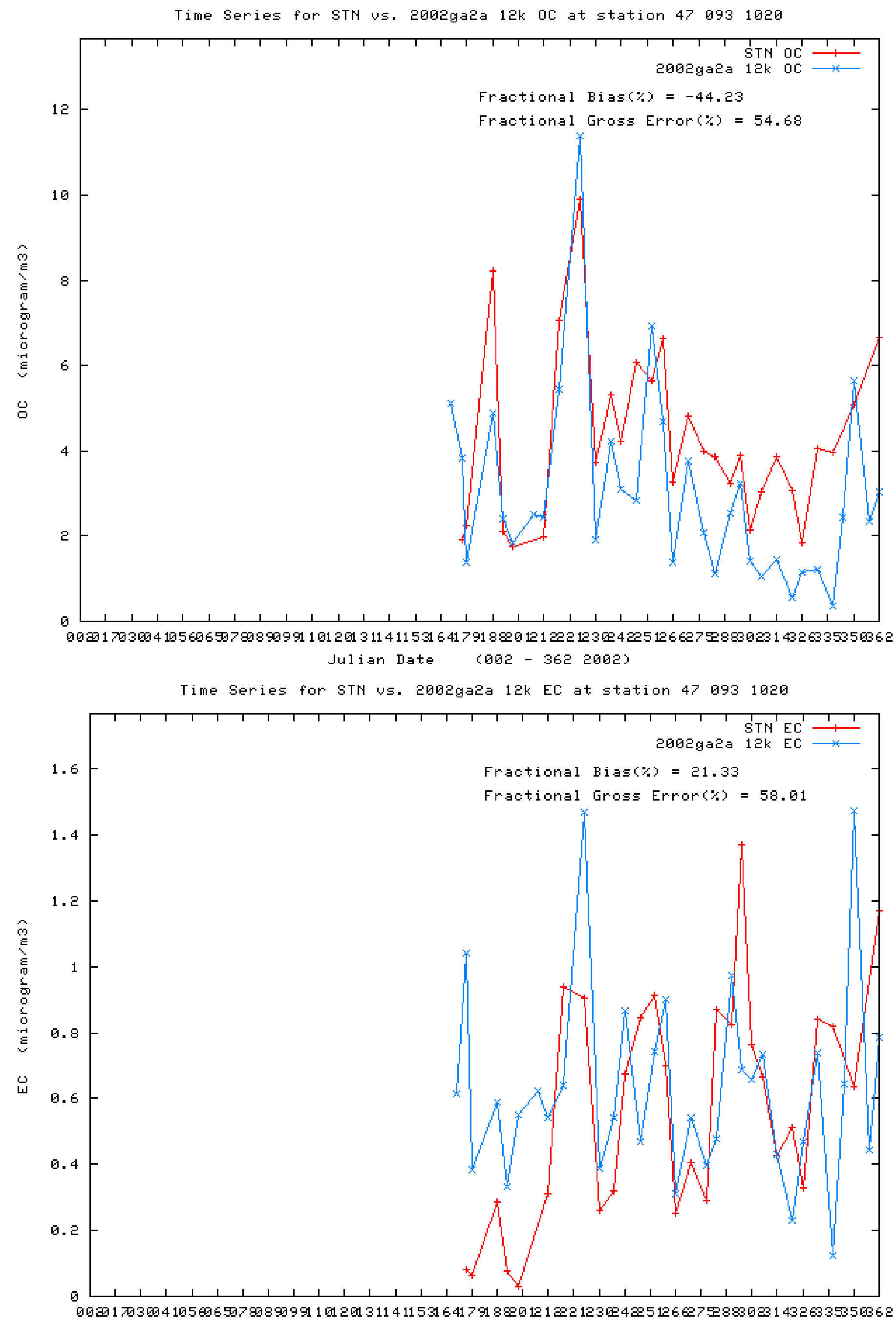


Figure B-36b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Knox County, Tennessee Site No. 47-093-1020 (Knoxville) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

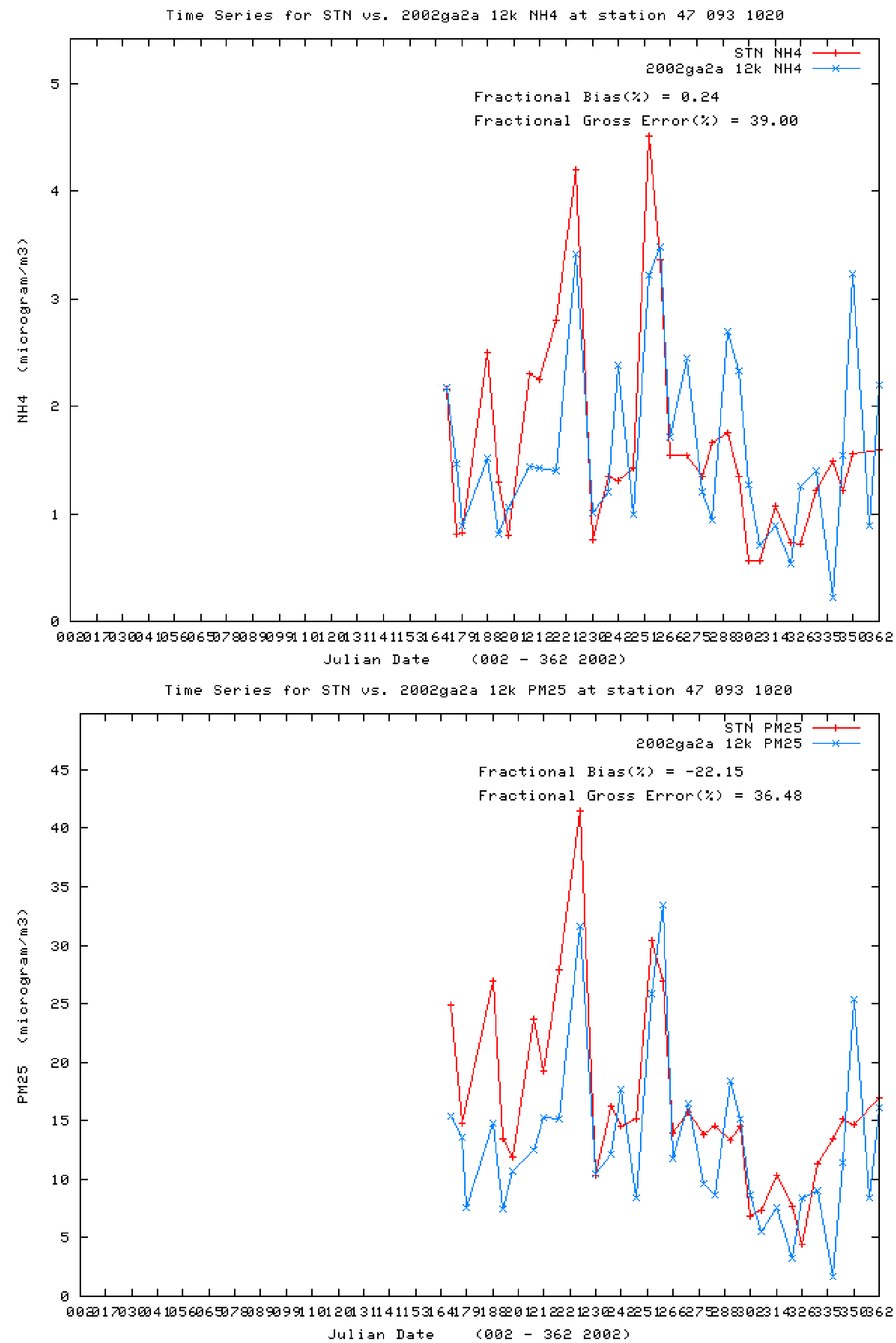


Figure B-36c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Knox County, Tennessee Site No. 47-093-1020 (Knoxville) for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

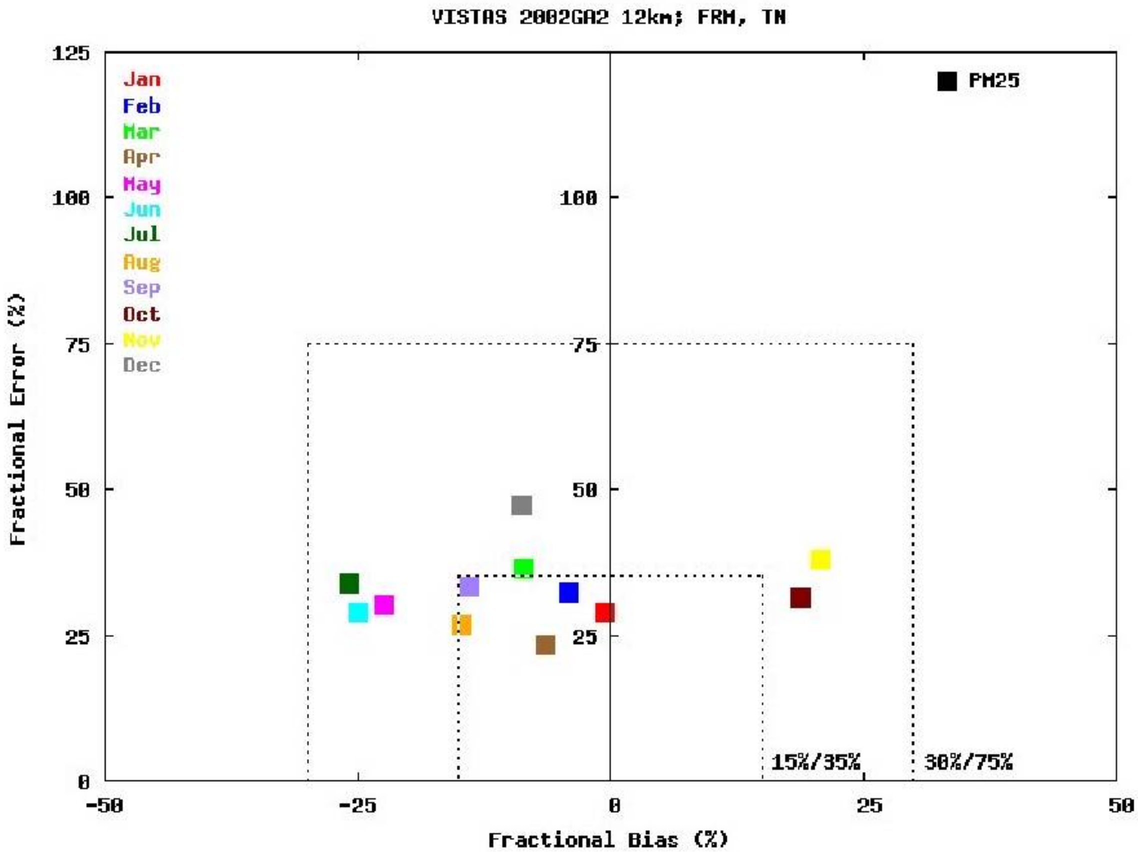
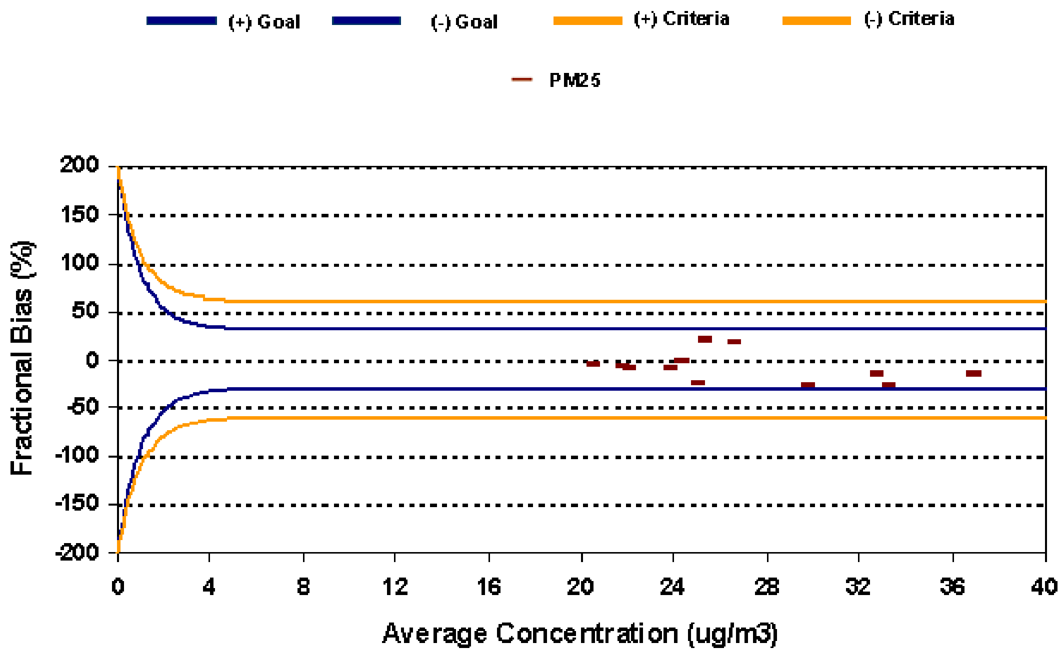


Figure B-37. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Tennessee for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



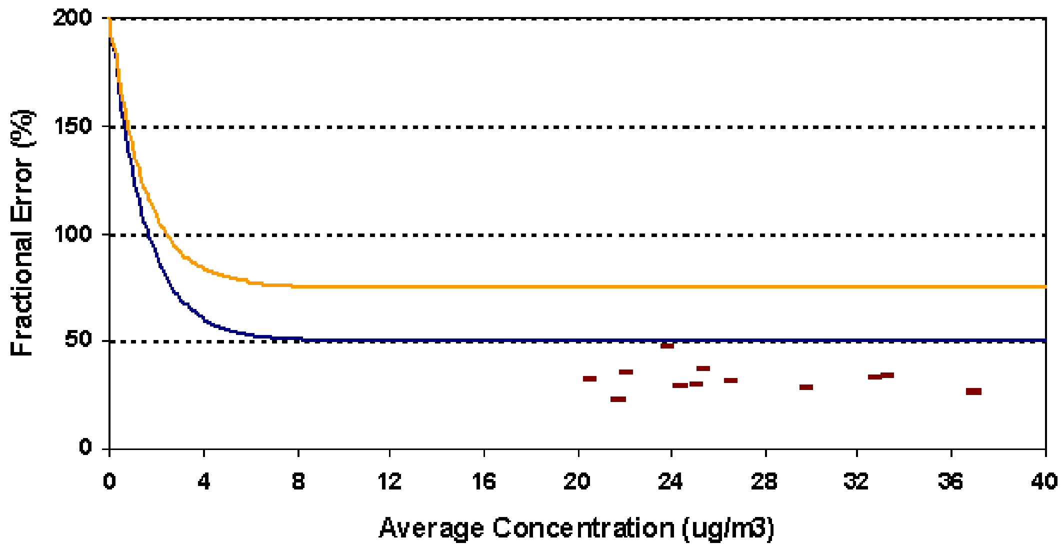


Figure B-38. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Tennessee and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.9 Virginia

SO4 performance is fairly good in Virginia with low bias and error in Q2 and Q3 that achieves the <±15%/35% ozone bias/error performance goal (Figure B-39a). Although SO4 performance in Q1 and Q4 exhibit a -17% to -21% underprediction bias, it still achieves the PM performance goal. As seen for the other states, NO3 performance is poor and characterized by an underprediction bias that is greatest in the summer (-150%) when CMAQ estimates near zero NO3 predictions. NH4 performance achieves the ozone performance goal in Q1 and Q2 and PM performance goal the other two quarters (Figure B-39c).

OCM performance is characterized by an underprediction bias of from -65% to -91% with error of opposite sign and similar magnitude (Figure B-39d). The fractional bias for EC is about 20-30 percentage points higher using CMAQ with a 12 km grid than 36 km grid resulting in the 12 km results always achieving the PM performance goal but the 36 km results underprediction bias in Q2 and Q4 is approximately -40% range so does not achieve the PM performance goal, but does achieve the PM performance criteria.

The $PM_{2.5}$ mass performance across the FRM sites is fairly good achieving (Q1, Q3 and Q4) or nearly achieving (Q2) the ozone performance goal (Figure B-39g). Across the STN sites, the PM performance goal is also achieved for all four quarters by the CMAQ 12 km modeling.

Figure B-40 displays an example annual time series model performance evaluation for a site in Richmond County, Virginia. SO4 performance at this Richmond County STN site is extremely good as the model follows the day-to-day variations quite well resulting in low annual fractional bias (-11%) and gross error (30%). NO3 performance, on the other hand, is characterized by a winter overprediction and summer underprediction bias with an annual bias and gross error of -46% and 91%, respectively. OCM at the Richmond site has an underprediction bias that occurs throughout the year resulting in an annual fractional bias of -46%. Better performance is seen for EC with bias (24%) and error (42%) that achieves the PM performance goal. $PM_{2.5}$ performance is also fairly good with bias (-10%) and error (28%) that achieves the most stringent ozone performance goal.

Another example time series model performance analysis is given in Figure B-41 for a site in Roanoke County, Virginia. Similarly good SO4 and poor NO3 performance is seen at the Roanoke County site. OCM is almost systematically underpredicted through the year with a -50% bias and 51% error. Whereas better performance is seen for EC that achieves the ozone performance goal. $PM_{2.5}$ performance is generally characterized by an underestimation tendency resulting in a -33% fractional bias.

Figures B-42 and B-43 summarize the $PM_{2.5}$ model performance across 19 FRM sites in Virginia using, respectively, Soccer and Bugle Plots. Monthly fractional bias and gross error for $PM_{2.5}$ mass achieves the PM performance goal for every month in 2002, with six of the months achieving the ozone performance goal and another two just at the ozone goal. As seen in the other states, the three summer months of May, June and July have an underprediction bias that exceeds the ozone performance goal, but still meets the PM performance goal.

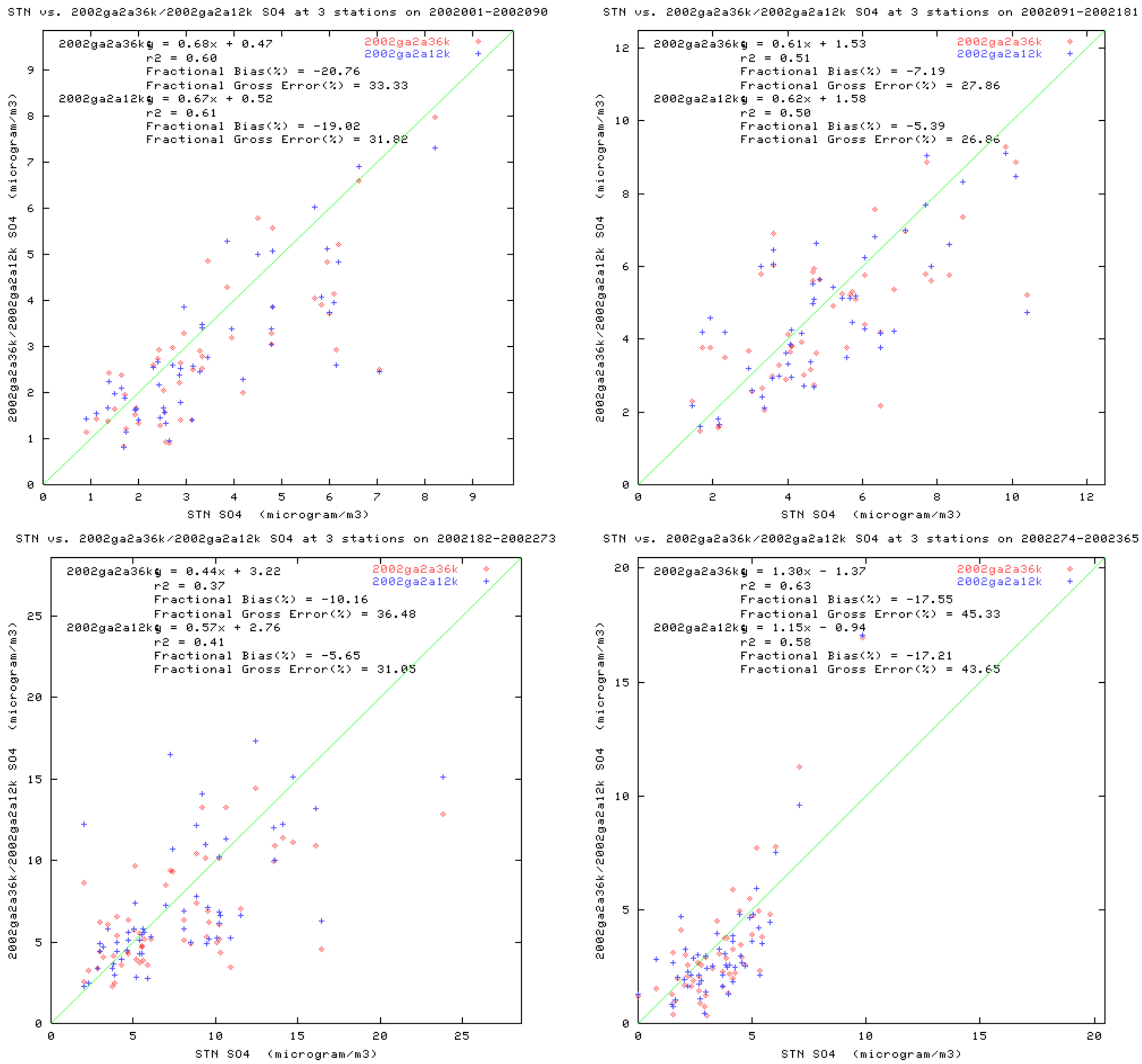


Figure B-39a. Scatter plots of predicted and observed sulfate (SO4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

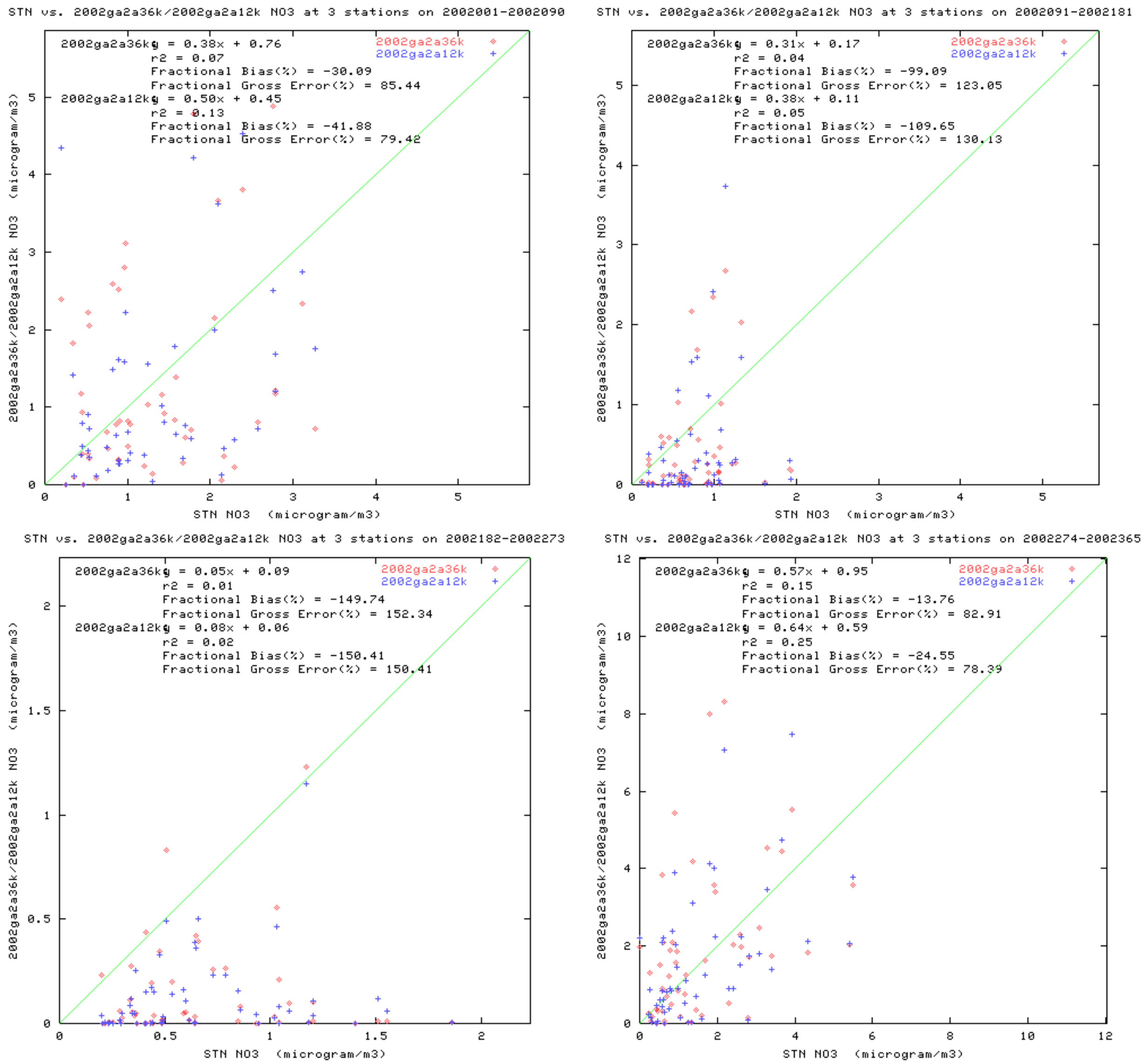


Figure B-39b. Scatter plots of predicted and observed nitrate (NO3) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

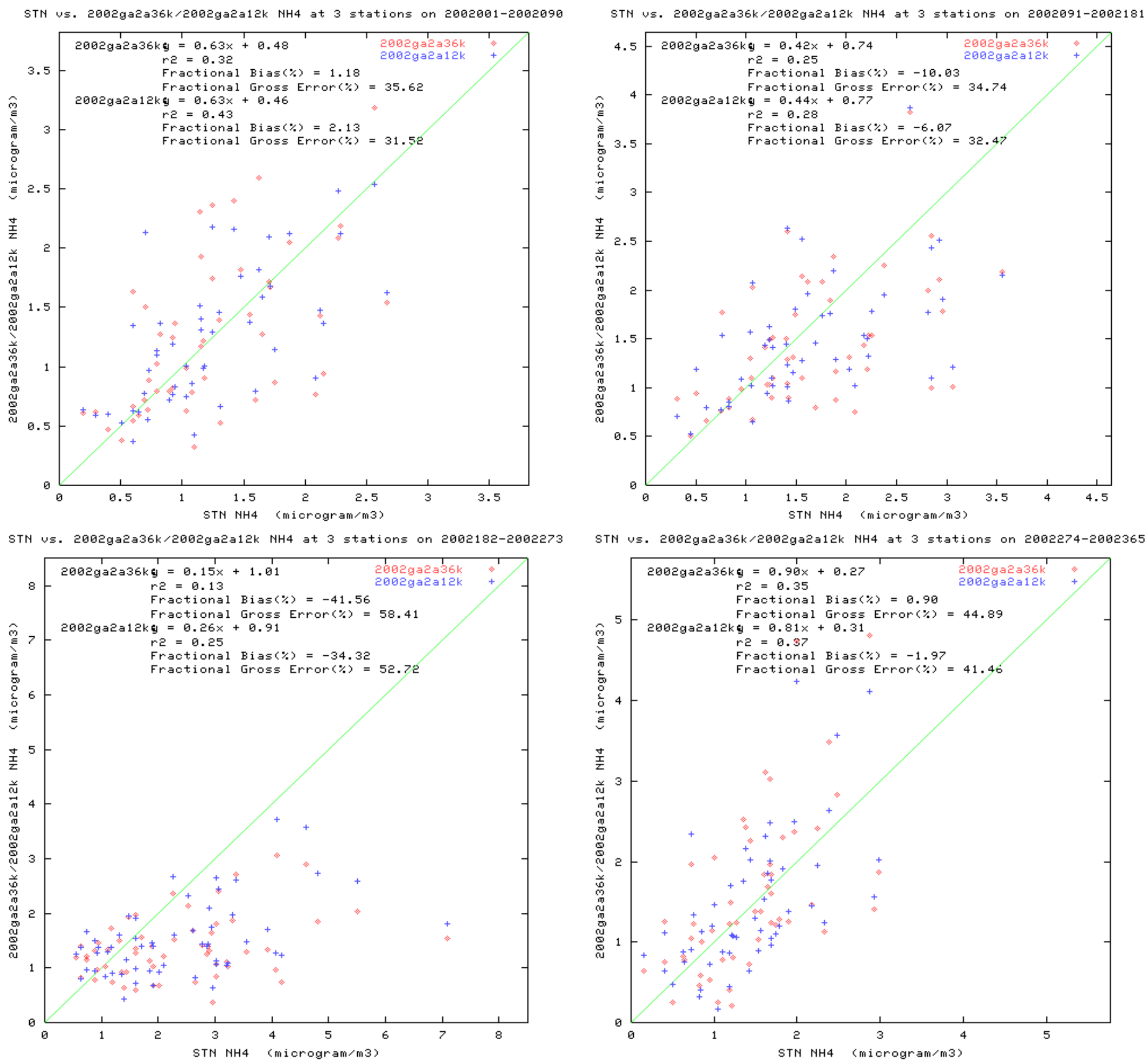


Figure B-39c. Scatter plots of predicted and observed ammonium (NH4) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

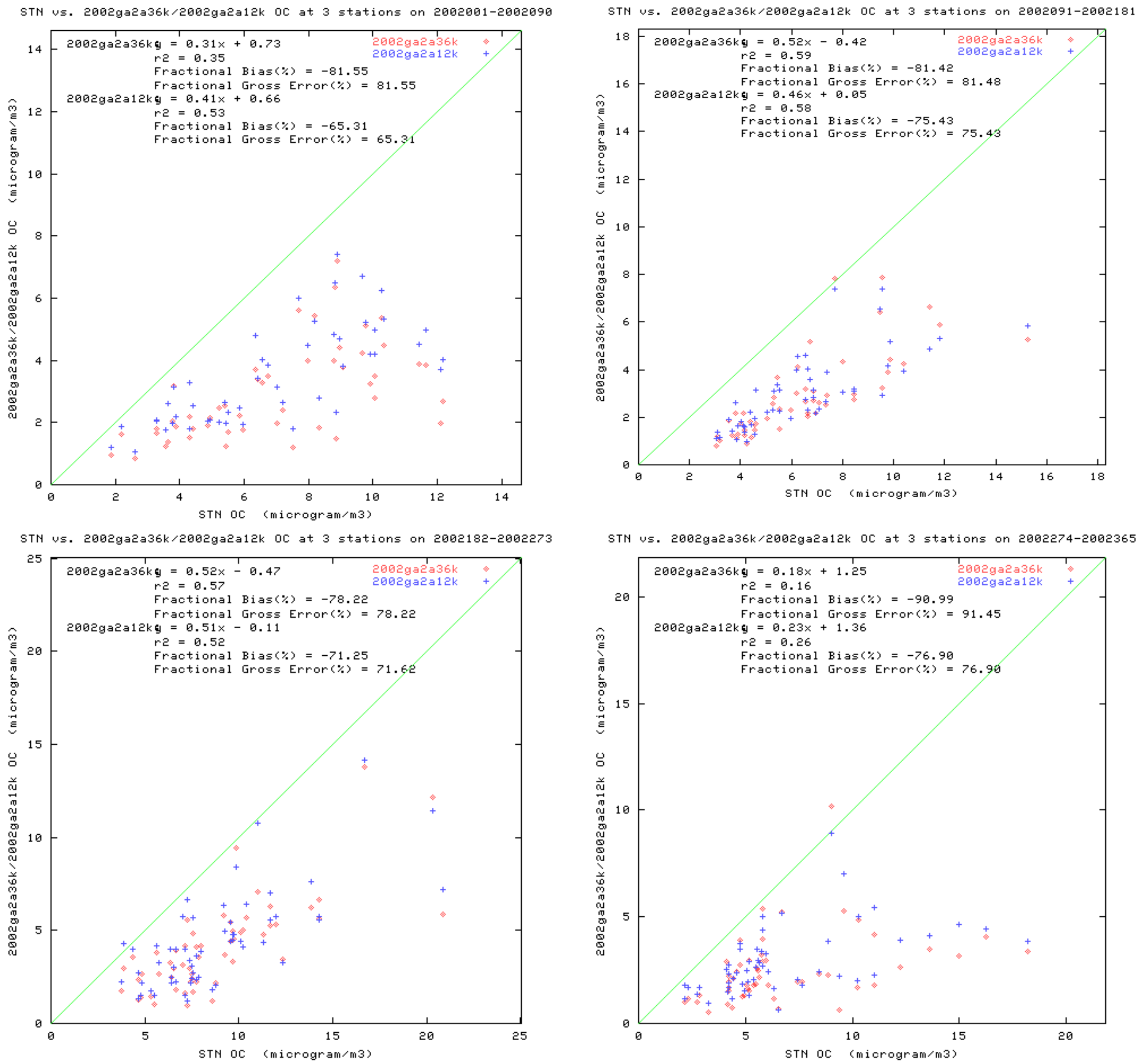


Figure B-39d. Scatter plots of predicted and observed organic matter carbon (OCM) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

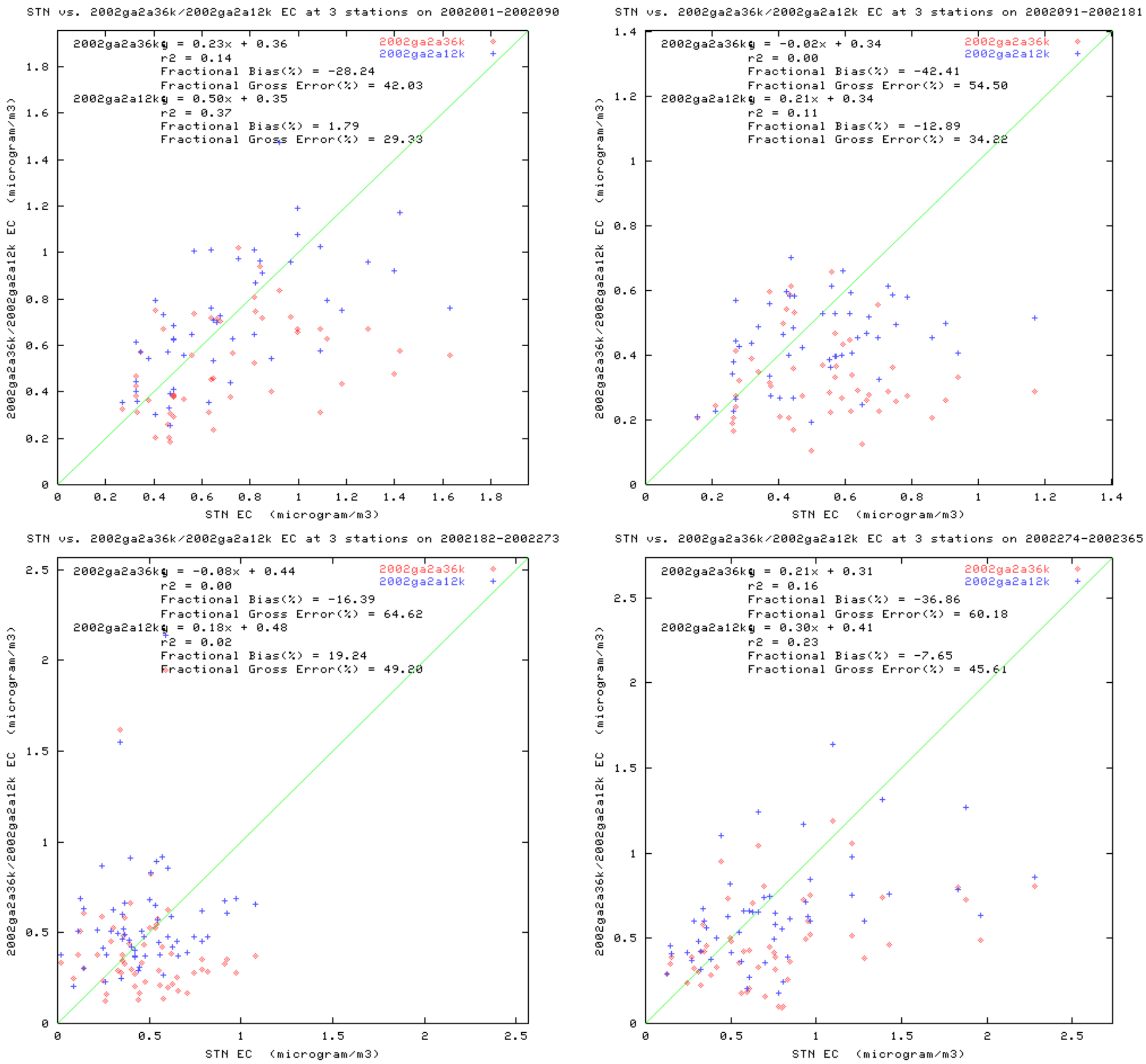


Figure B-39e. Scatter plots of predicted and observed elemental carbon (EC) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

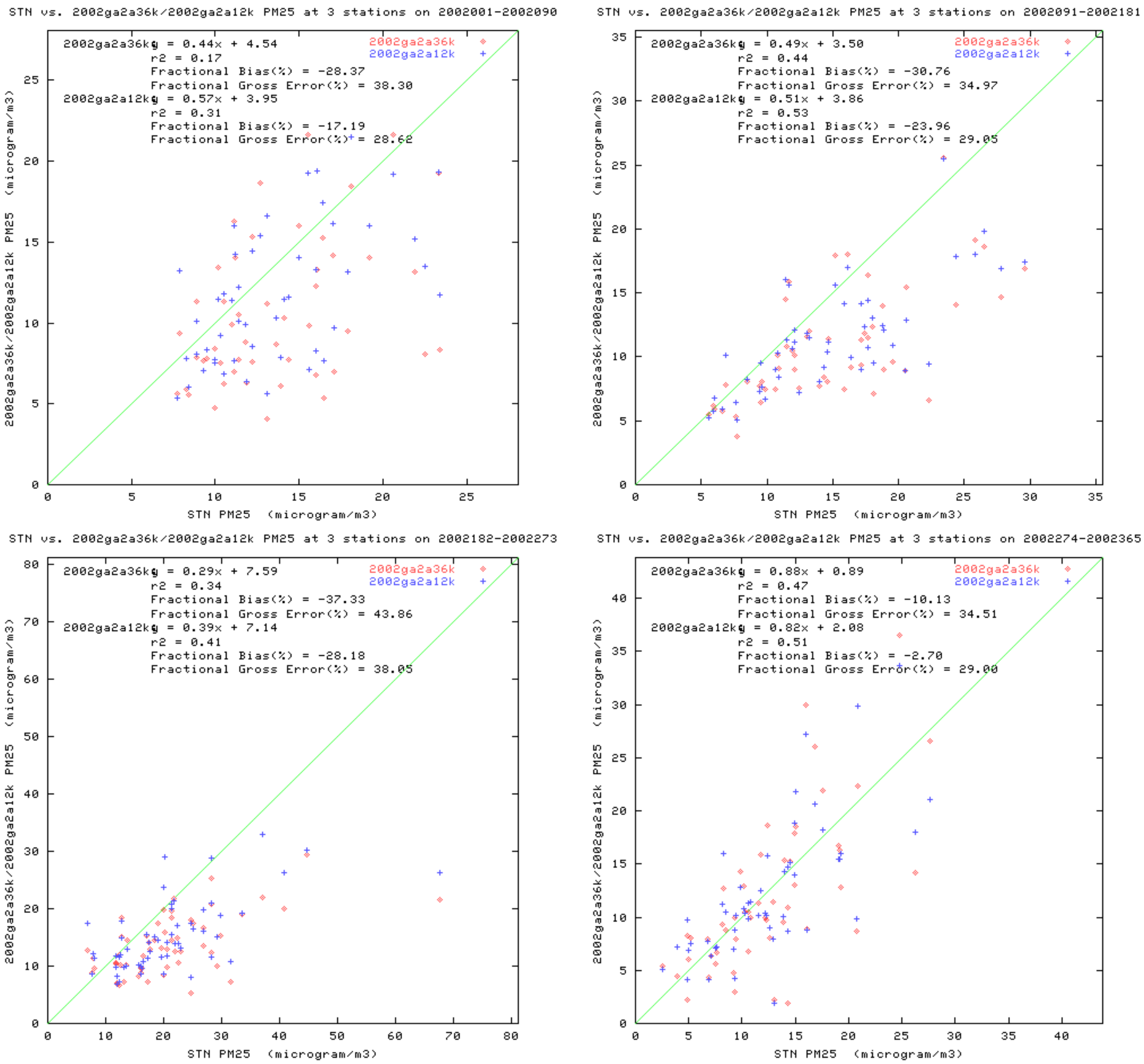


Figure B-39f. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, STN sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

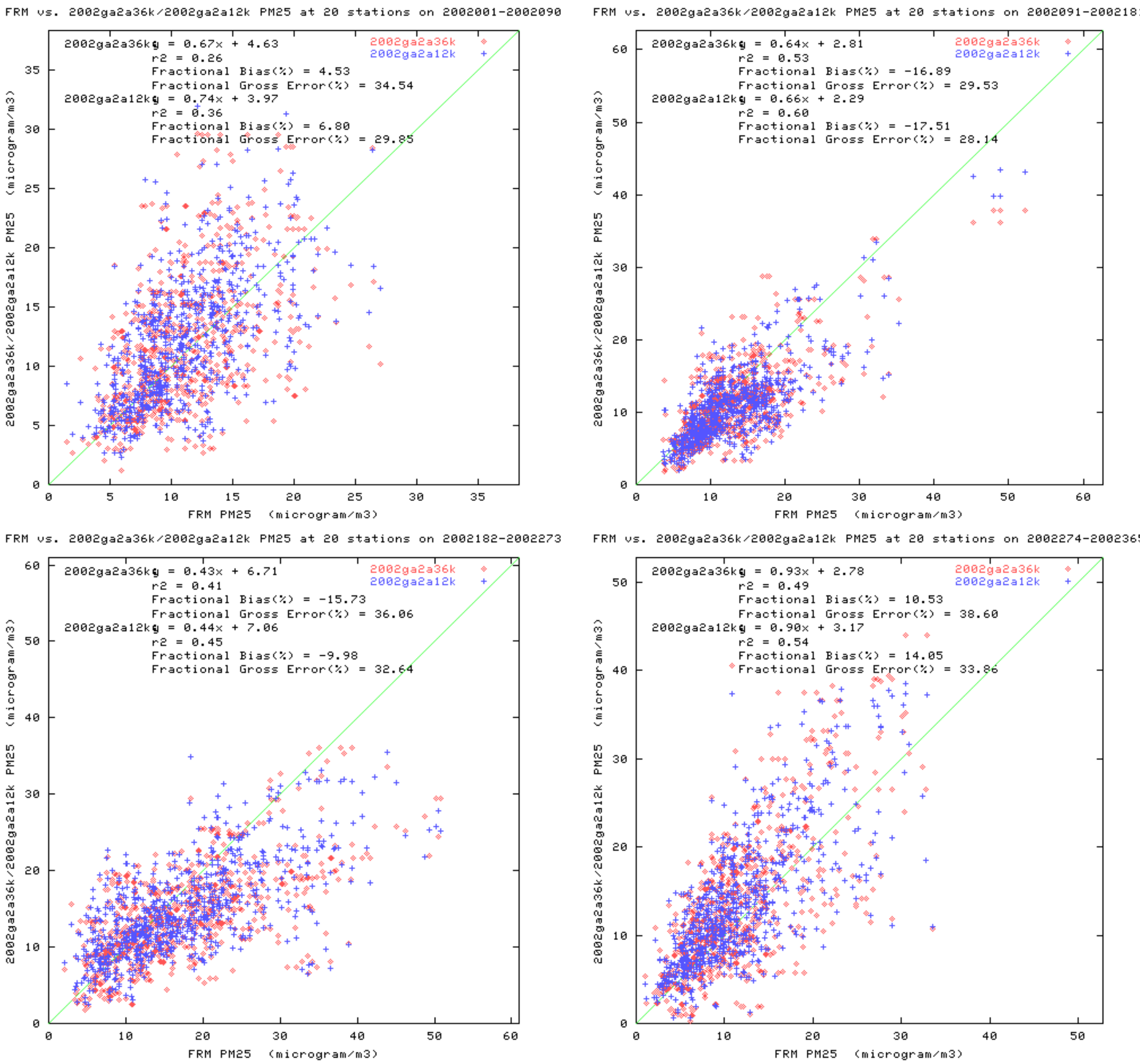


Figure B-39g. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

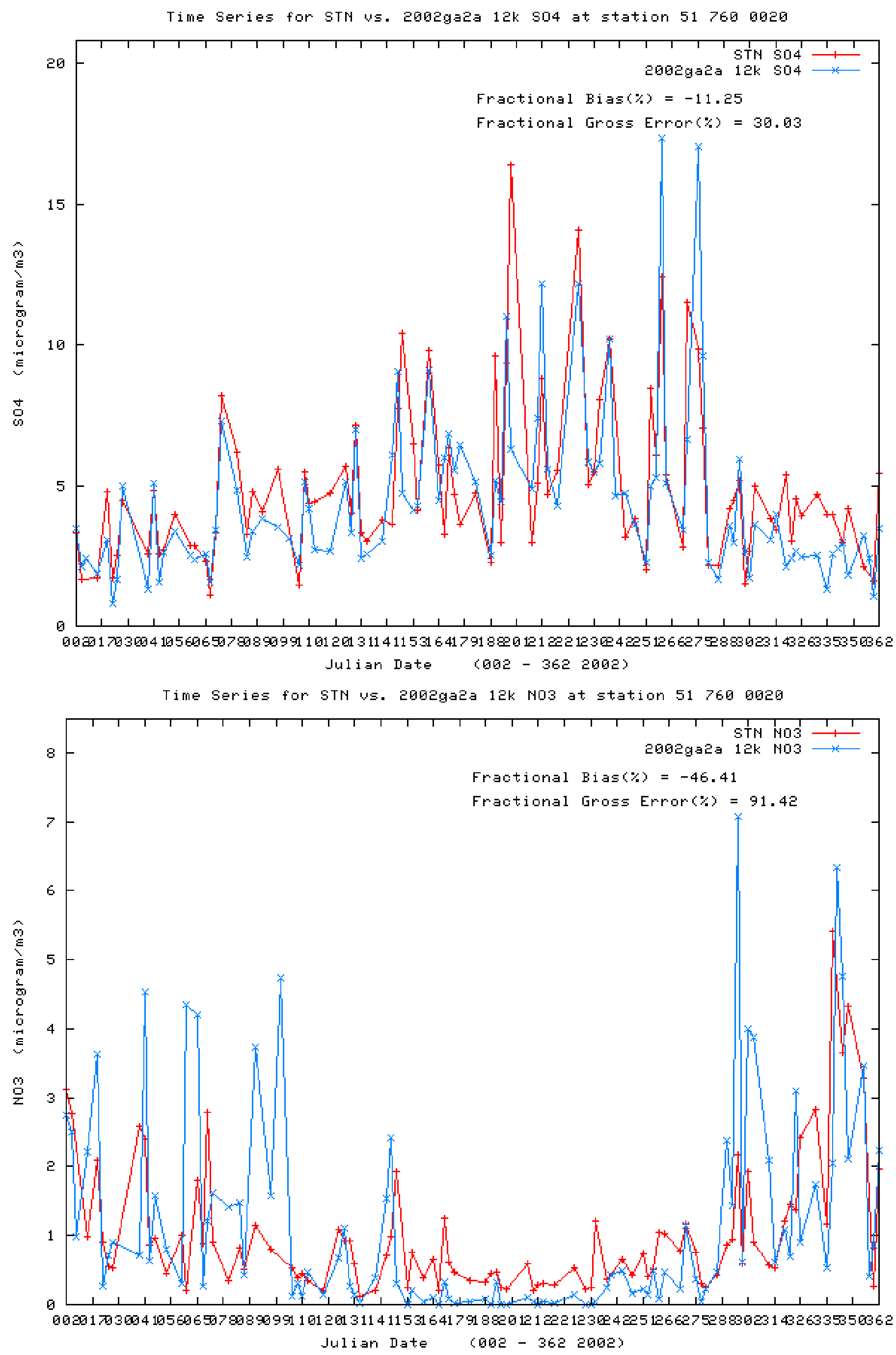


Figure B-40a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Richmond County, Virginia Site No. 51-760-0020 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

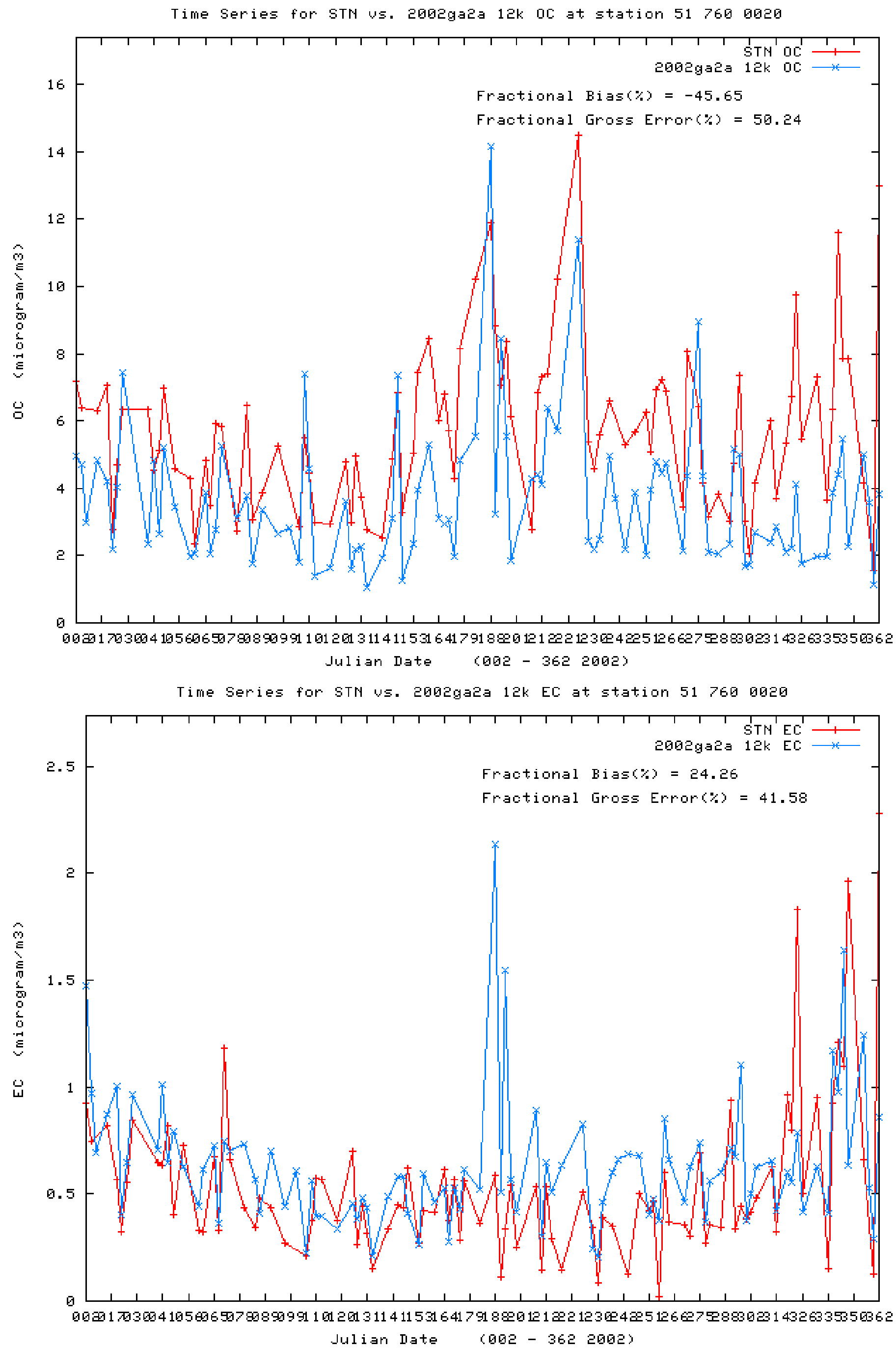
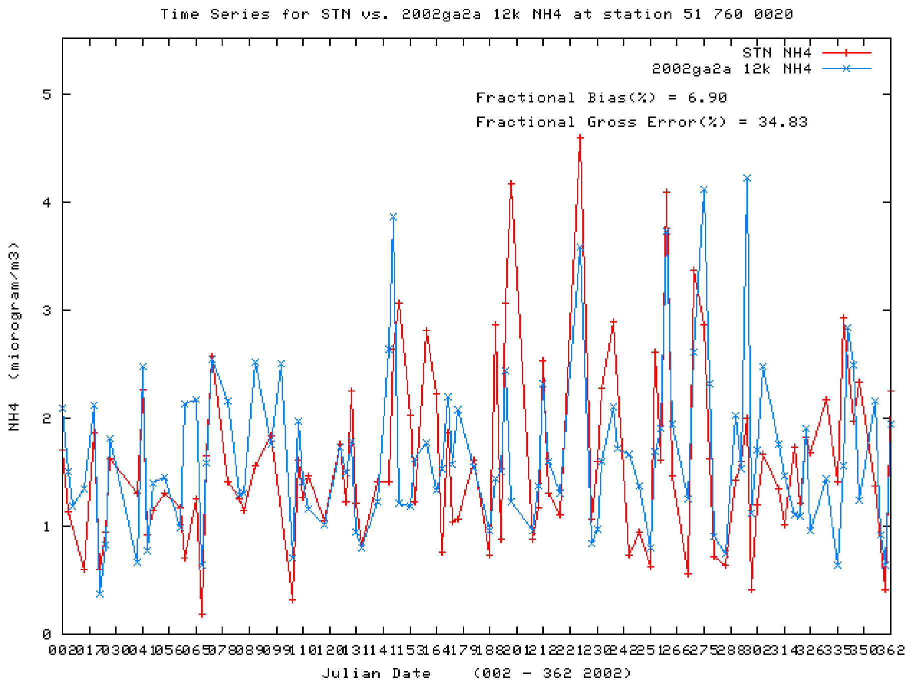


Figure B-40b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Richmond County, Virginia Site No. 51-760-0020 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



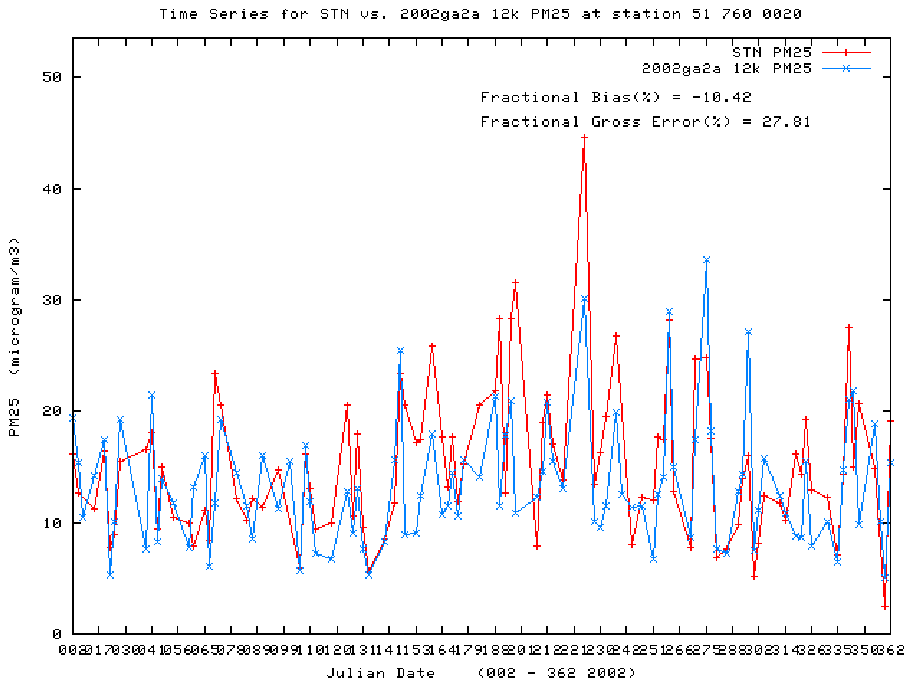


Figure B-40c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Richmond County, Virginia Site No. 51-760-0020 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

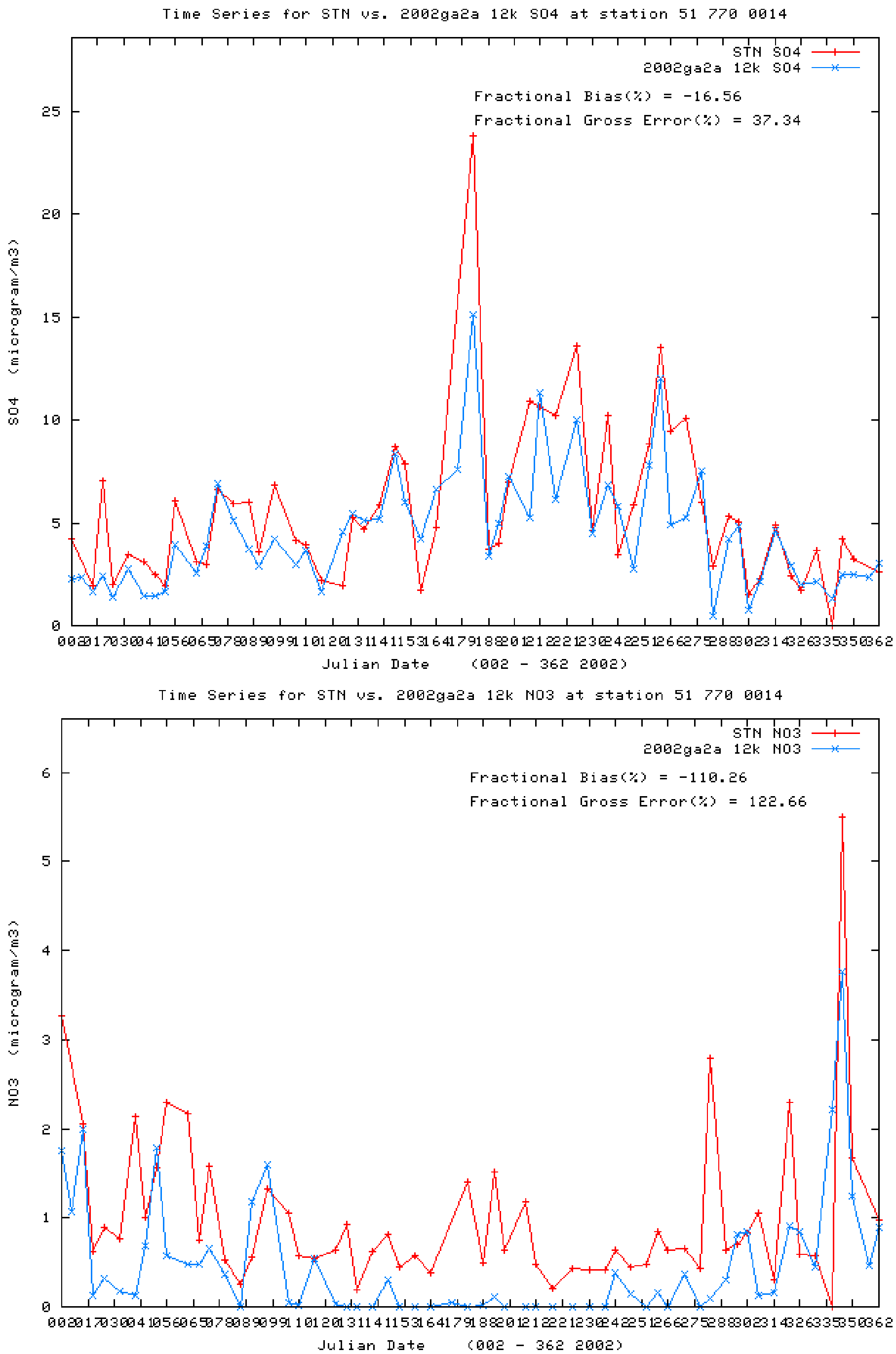
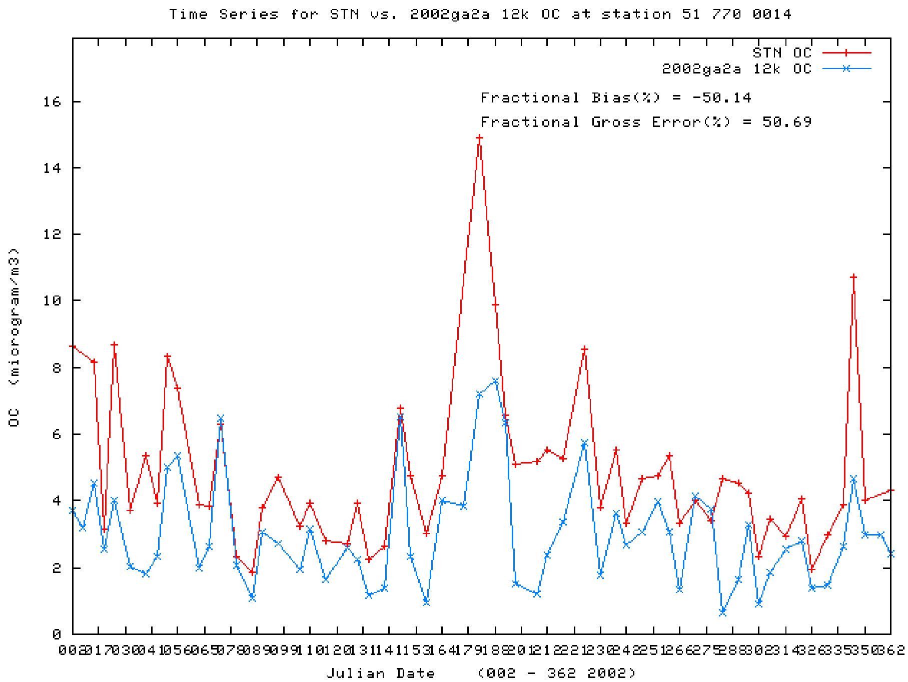


Figure B-41a. Time series of predicted and observed 24-hour sulfate (SO4, top) and nitrate (NO3, bottom) concentrations during 2002 at the STN Roanoke County, Virginia Site No. 51-770-0014 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.



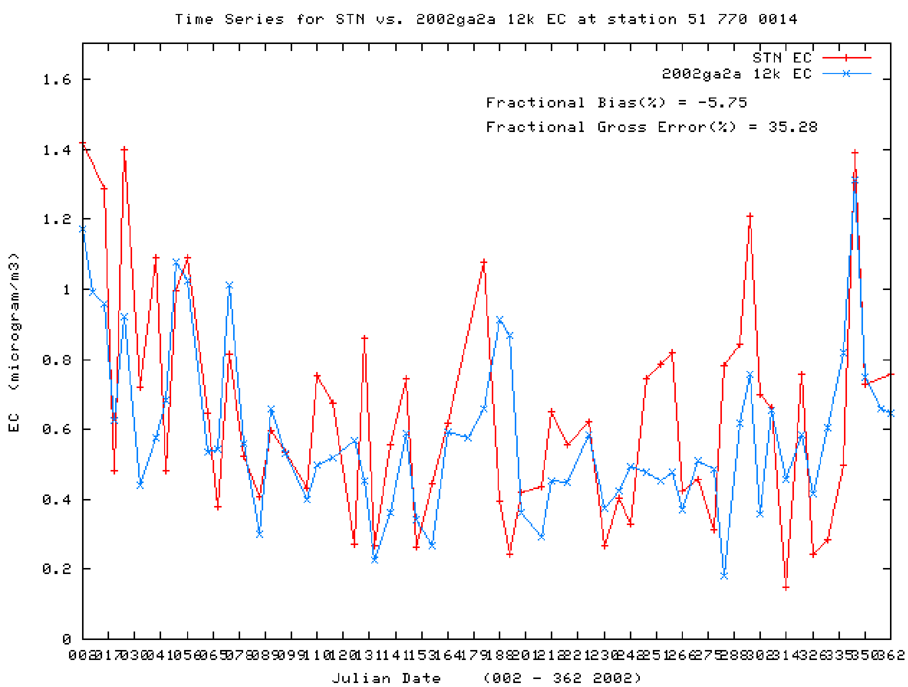


Figure B-41b. Time series of predicted and observed 24-hour organic mass carbon (OCM, top) and elemental carbon (EC, bottom) concentrations during 2002 at the STN Roanoke County, Virginia Site No. 51-770-0014 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

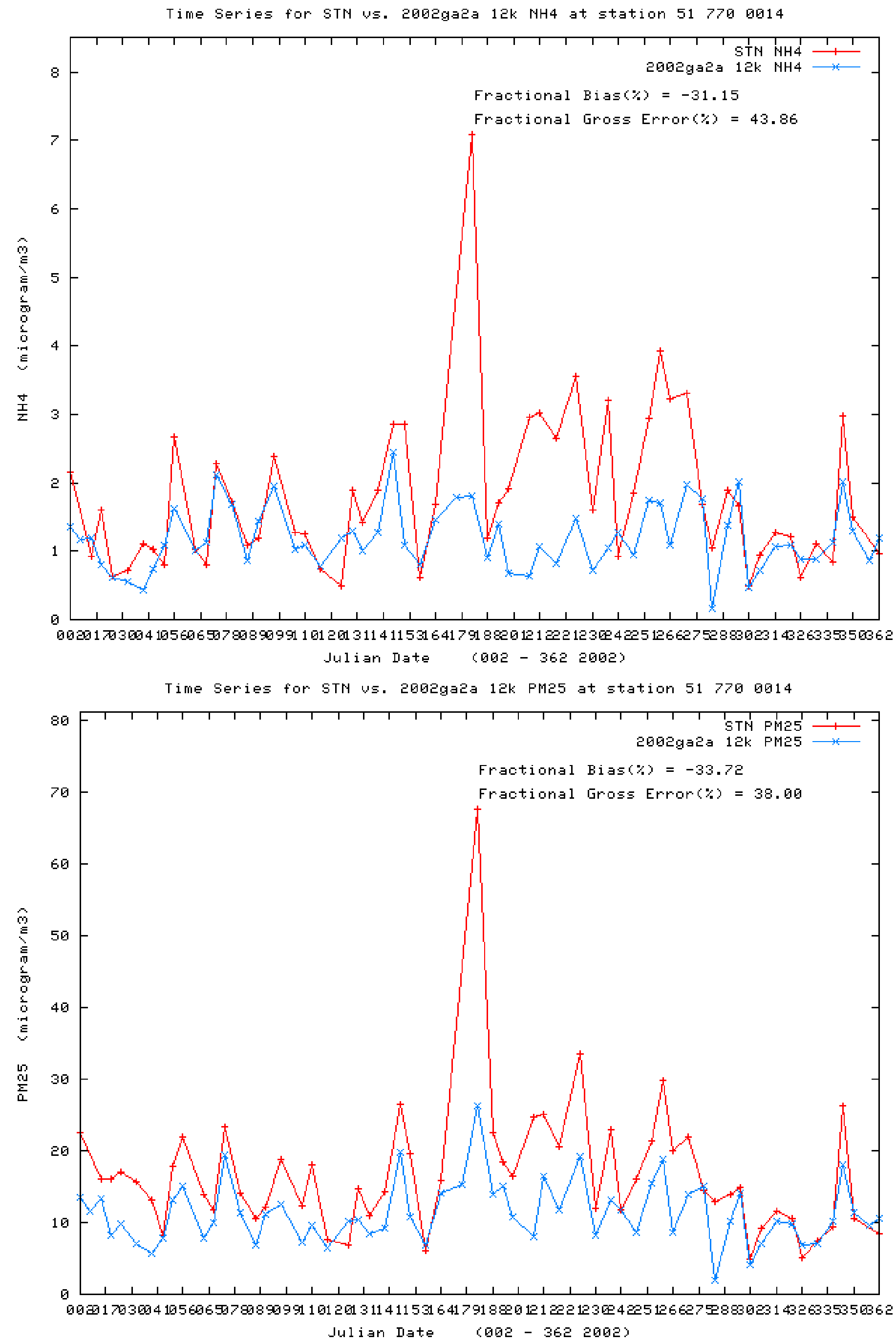


Figure B-41c. Time series of predicted and observed 24-hour ammonium (NH4, top) and fine particulate mass ($PM_{2.5}$, bottom) concentrations during 2002 at the STN Roanoke County, Virginia Site No. 51-770-0014 for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

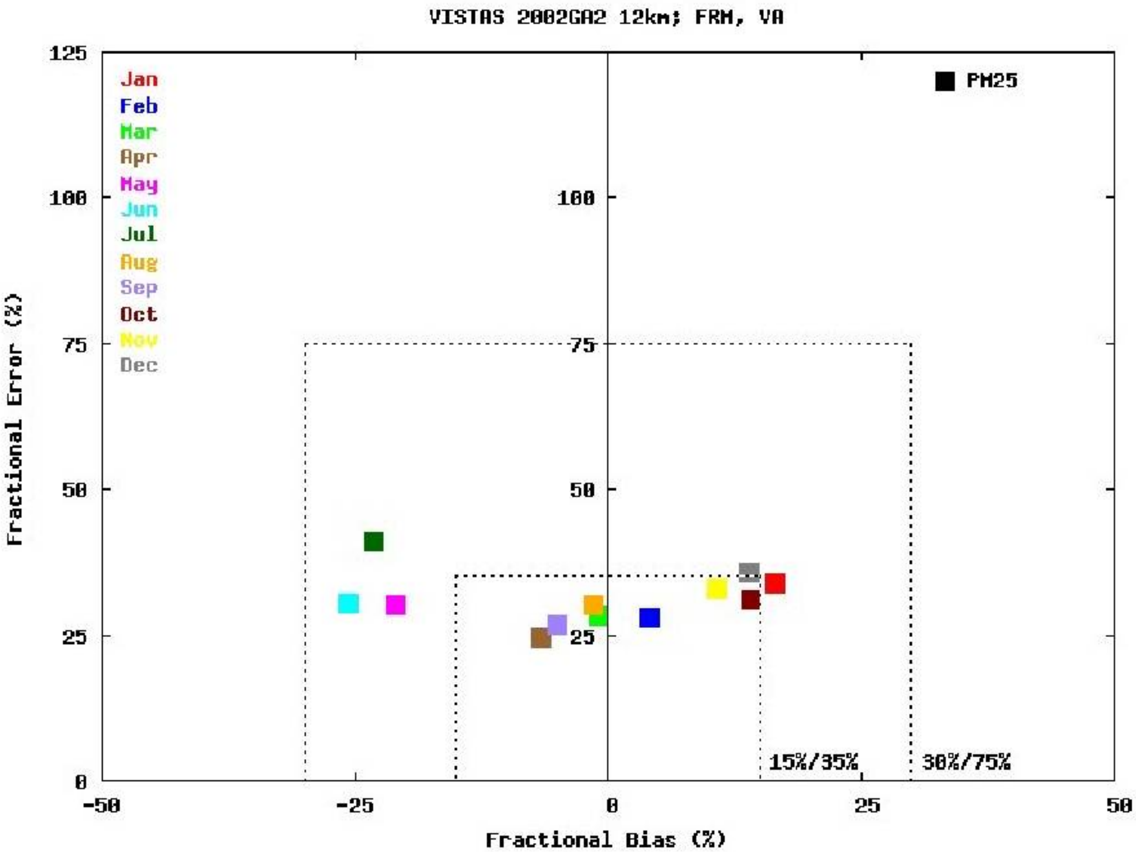


Figure B-42. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in Virginia for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

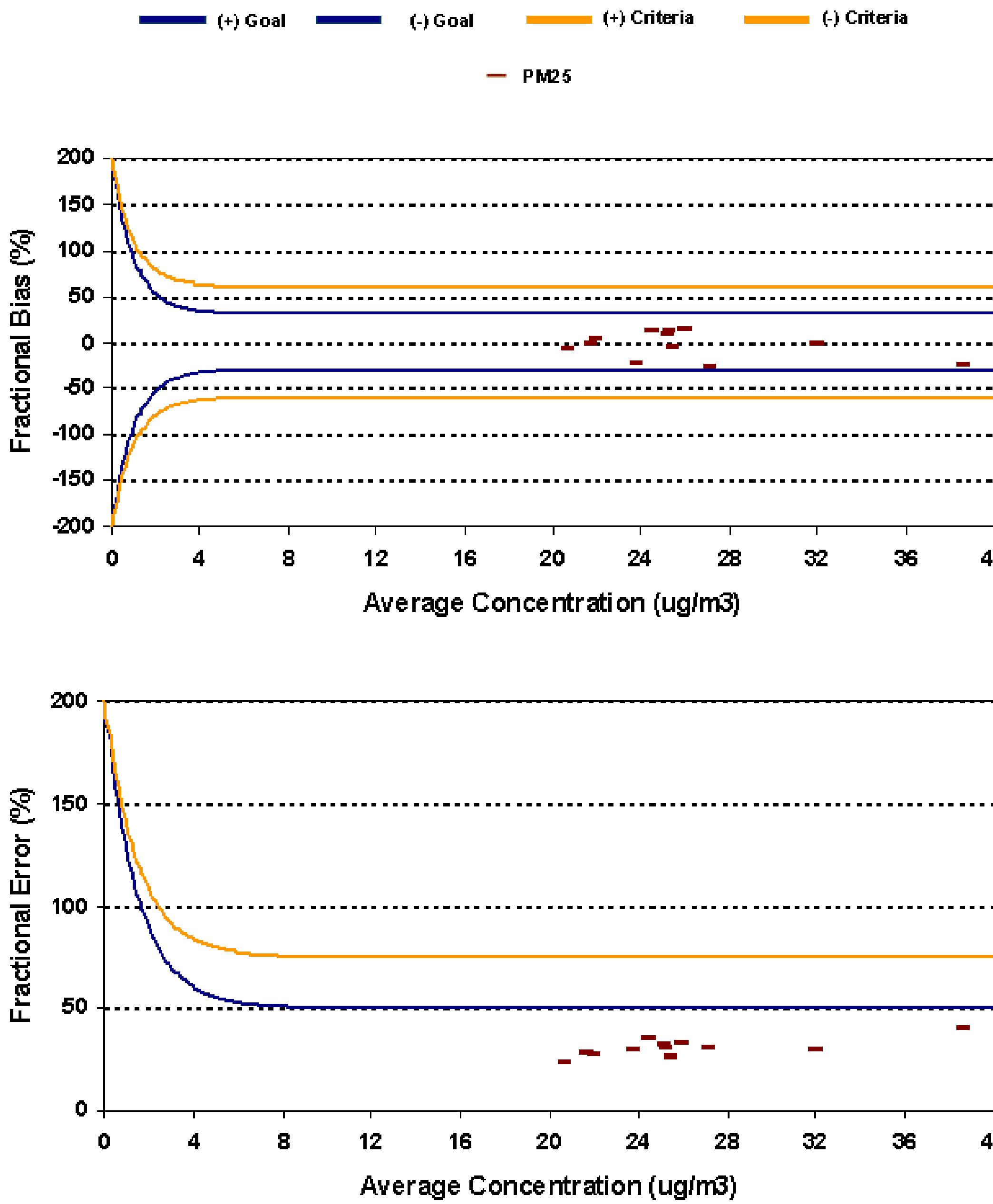


Figure B-43. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in Virginia and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.4.10 West Virginia

There were no speciated $PM_{2.5}$ STN monitoring sites within West Virginia during the 2002 modeling year, so the $PM_{2.5}$ model evaluation is limited to the 16 FRM $PM_{2.5}$ mass monitoring sites. In Q1, Q2 and Q3, CMAQ underestimates $PM_{2.5}$ mass across the FRM sites in West Virginia by approximately -23%, -37% and -27%, respectively, and achieves the PM performance goal in (Figure B-44). In Q4 the model has near zero bias and 32% error so achieves the ozone model performance goal. The Soccer and Bugle Plots in Figures B-45 and B-46 summarizes the FRM $PM_{2.5}$ mass performance in West Virginia in each month. Nine of the months achieve the PM performance goal with the winter months even achieving or nearly achieving the ozone model performance goal. As seen for the other states, the underprediction bias during the May-July summer months results in the bias falling outside of the PM performance goal, but within the PM performance criteria.

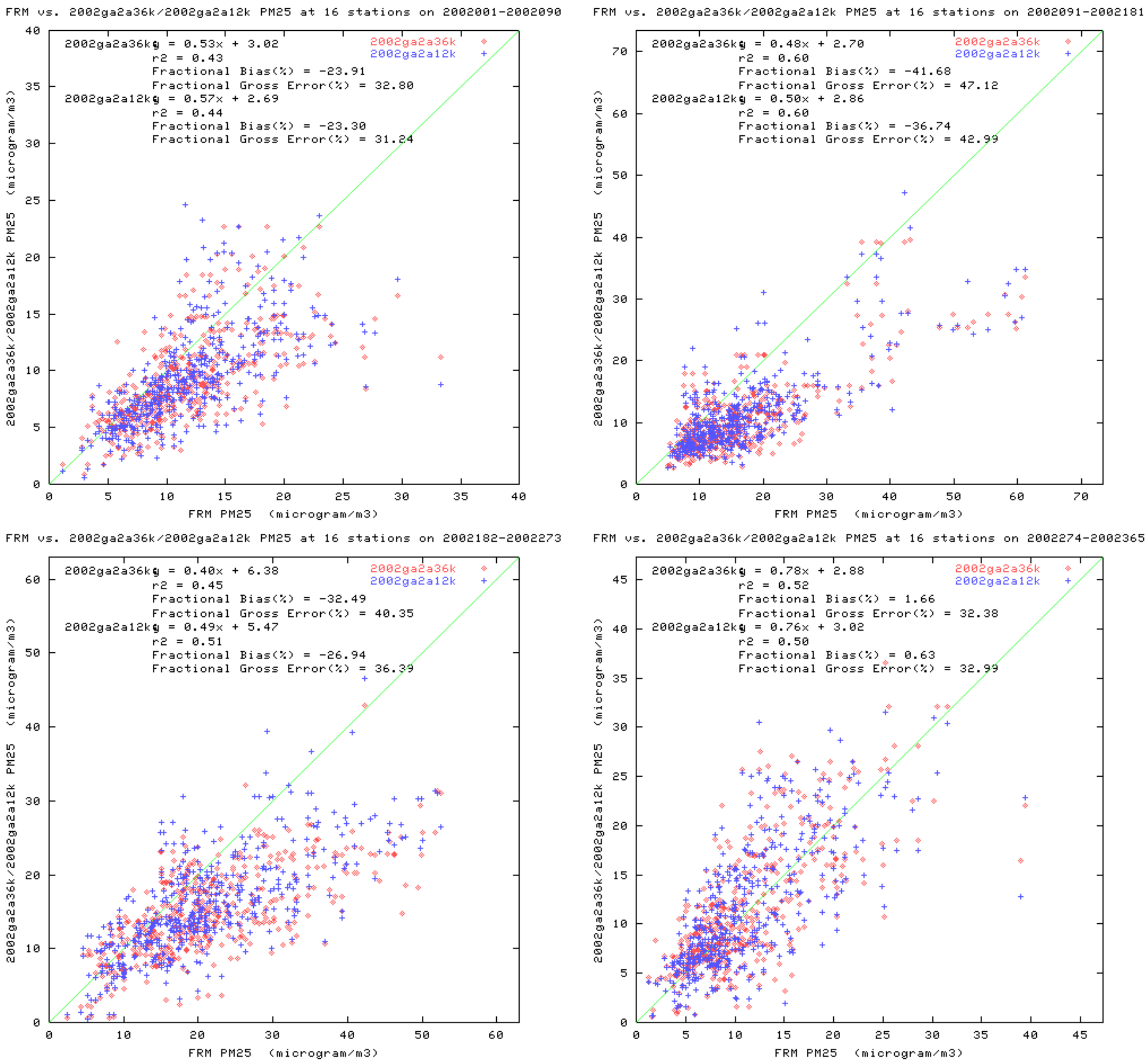


Figure B-44. Scatter plots of predicted and observed fine particulate mass ($PM_{2.5}$) concentrations for Q1, Q2, Q3 and Q4 2002, FRM sites in West Virginia and the CMAQ 2002 36 and 12 km Base G2 Actual base case simulation.

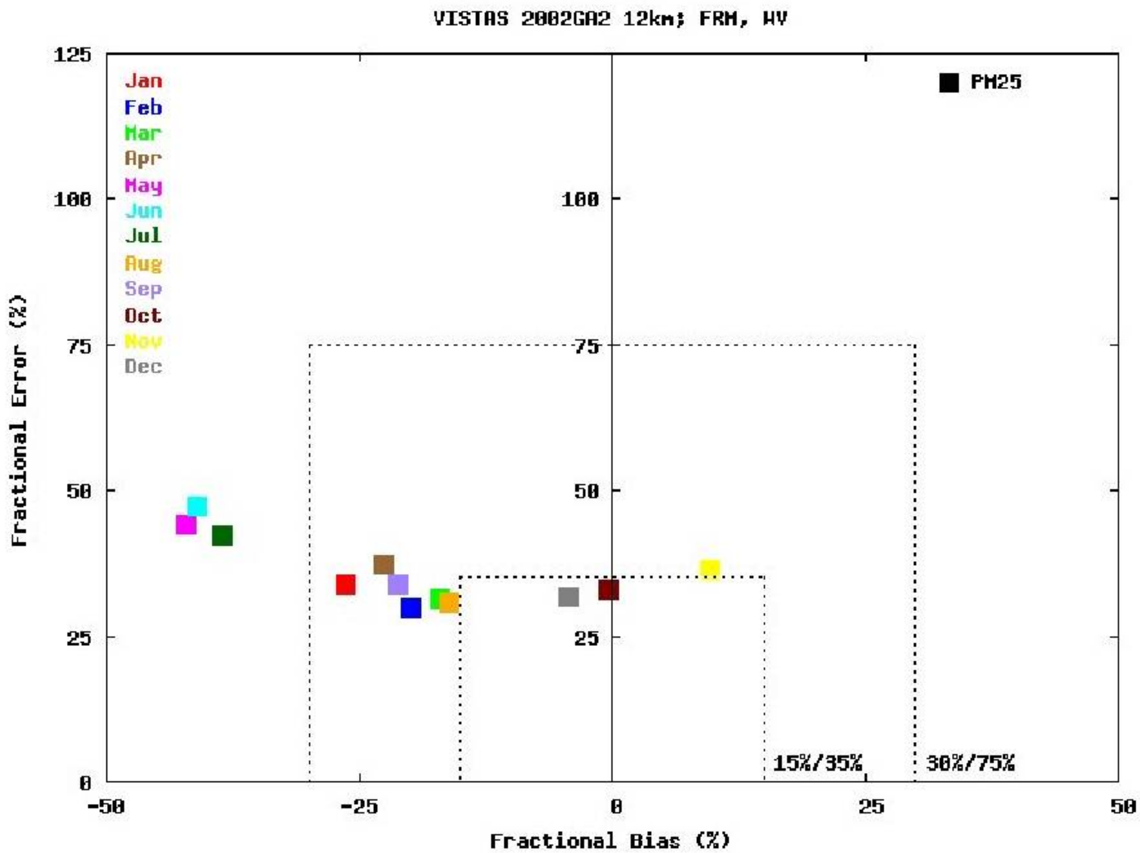


Figure B-45. Soccer plot of monthly fractional bias versus fractional gross error for $PM_{2.5}$ mass at FRM monitors in West Virginia for the CMAQ 12 km 2002 Base G2 Actual base case simulation.

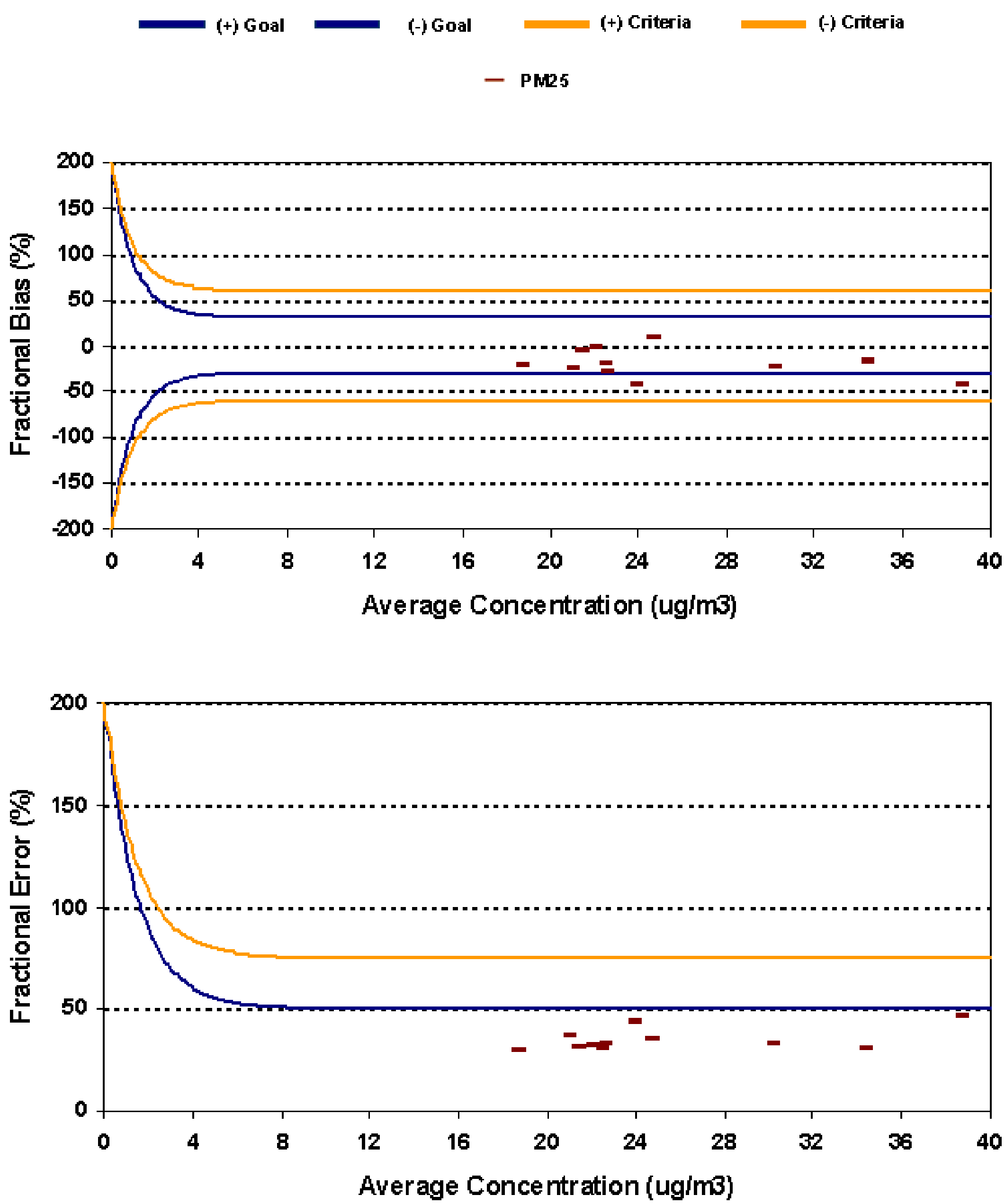


Figure B-46. Bugle plots of monthly fractional bias (top) and gross error (bottom) for FRM sites in West Virginia and thee CMAQ 12 km 2002 Base G2 Actual base case simulation.

B.5 CONCLUSIONS STATE-BY-STATE MODEL EVALUATION

The state-by-state model performance evaluation for P.$M_{2.5}$ mass and component species reveals several model performance tendencies of the CMAQ 2002 Base G2 actual base case. SO_4 performance is by far constantly the best performing PM species frequently achieving the most stringent ozone performance goal. Although the SO_4 performance in some of the most southern states degraded some (e.g., Florida and Mississippi). NO_3 performance, on the other hand, was consistently poor with a large summer underprediction bias. OCM was routinely underpredicted, with the underprediction bias most severe in the summer months (May – July). EC performance is usually fairly good frequently achieving the most stringent ozone model performance goal with the CMAQ 12 km modeling results exhibiting much superior EC performance to the 36 km modeling results. Performance for NH4 and total $PM_{2.5}$ mass is also good most of the time. This is not surprising since the SO_4 performance is usually quite good and SO_4 dominates the $PM_{2.5}$ mass and drives the NH4 performance in the Southeast U.S.

APPENDIX C

Spatial Maps of Quarterly Average $PM_{2.5}$ Components and Total Mass Concentrations with Superimposed Observations for the CMAQ 2002 12 km Base G2 Actual Base Case Simulation

C.1 OVERVIEW OF SPATIAL MODEL PERFORMANCE

The discussion in this appendix provides a general qualitative overview of the 2002 Base G2 Actual base case model performance of the Community Multiscale Air Quality (CMAQ) modeling system Version 4.5 with SOAmods enhancement across the ASIP 12 km domain, with emphasis on temporal (seasonal) and spatial patterns within the domain. The evaluation is carried out for each of the major $PM_{2.5}$ components separately (sulfate, nitrate, ammonium, organic carbon material, elemental carbon, soil $PM_{2.5}$, sea-salt $PM_{2.5}$), as well as for total $PM_{2.5}$ mass. For each species, two sets of figures are provided, one comparing model predictions to observations at the STN sites, the other to observations at the IMPROVE network sites (soil and sea-salt are available at the IMPROVE network only). Total $PM_{2.5}$ mass estimates are also compared to observations at the FRM network, in addition to the STN and IMPROVE networks. Four figures are provided for each set corresponding to the average concentrations during the four quarters of the year (Q1: Jan-Mar; Q2: Apr-Jun; Q3: Jul-Sep; Q4: Oct-Dec).

This evaluation allows for a general understanding of model performance and key issues. A more detailed and quantitative performance evaluation at key VISTAS states sites is provided in Appendix B and summarized in Chapter 3.

The observed quarterly average $PM_{2.5}$ mass and $PM_{2.5}$ species concentrations were obtained by averaging all 24-hour measurements at a site that occurred during each three month quarter. The modeled quarterly average spatial maps were obtained by averaging the daily average concentrations for each day in the three month quarter and each grid cell. No attempt was made to match the modeled daily average concentrations with the 1:3 day sampling frequency used by the monitoring networks. In fact, obtaining modeled quarterly average concentrations trying to match the measurement days is problematic since not all sites collect valid samples on every 1:3 day sampling day. In the case of the STN network, this results in a bias in the Q1 quarterly average predicted and observed comparisons since many of the STN sites started up in 2002 and have samples near the end of Q1 but not during the beginning. For species like SO4 that has a strong seasonal trend, basing observed Q1 averages on samples in March and modeled values averaged across January-February-March introduces a seemingly underprediction bias that is artificial and an artifact of the network sampling periods. We know this is occurring at some STN sites, for example see discussion for Georgia in Section 3.5.3.

C.2 SPATIAL MODEL PERFORMANCE EVALUATION

C.2.1 Sulfate (SO4)

Modeled sulfate concentrations show a very strong seasonal pattern (Figures C-1a,b), with peak concentrations occurring during summer months (Quarters 2 and 3), when photochemistry is highest. A spatial pattern is also evident, with higher concentrations in the northeast, Ohio River valley, and southeast, compared to the upper Midwest and Florida, caused mainly by the higher and denser SO_2 emissions in those regions compared to the latter two. In Florida, the impacts of individual major sources of SO_2 are evident (such as in the Tampa and Jacksonville areas), as their emissions remain relatively unmixed with emissions from other regions, being surrounded by ocean. However, in most of the domain, a "regional" sulfate field is observed as a result of mixing of emissions from various regions, especially for the long averaging time presented here (three months).

Overall, the model seems to accurately simulate sulfate levels over the domain, and captures both the temporal and spatial patterns exhibited in the observations, both from the STN (Figure C-1a) and IMPROVE (Figure C-1b) networks. The exception is Quarter 1 for the STN network, in which the observed concentrations seem higher than the modeled ones, and there is not much agreement in the spatial pattern between the two. This is mainly due to an artifact in the way the observations are presented here discussed above. Since some of the STN sites were not in operation during the first few months of 2002, observed Quarter 1 averages might in fact be driven by observations during the latter (and warmer) part of Quarter 1 (e.g., March samples), and therefore are biased high.

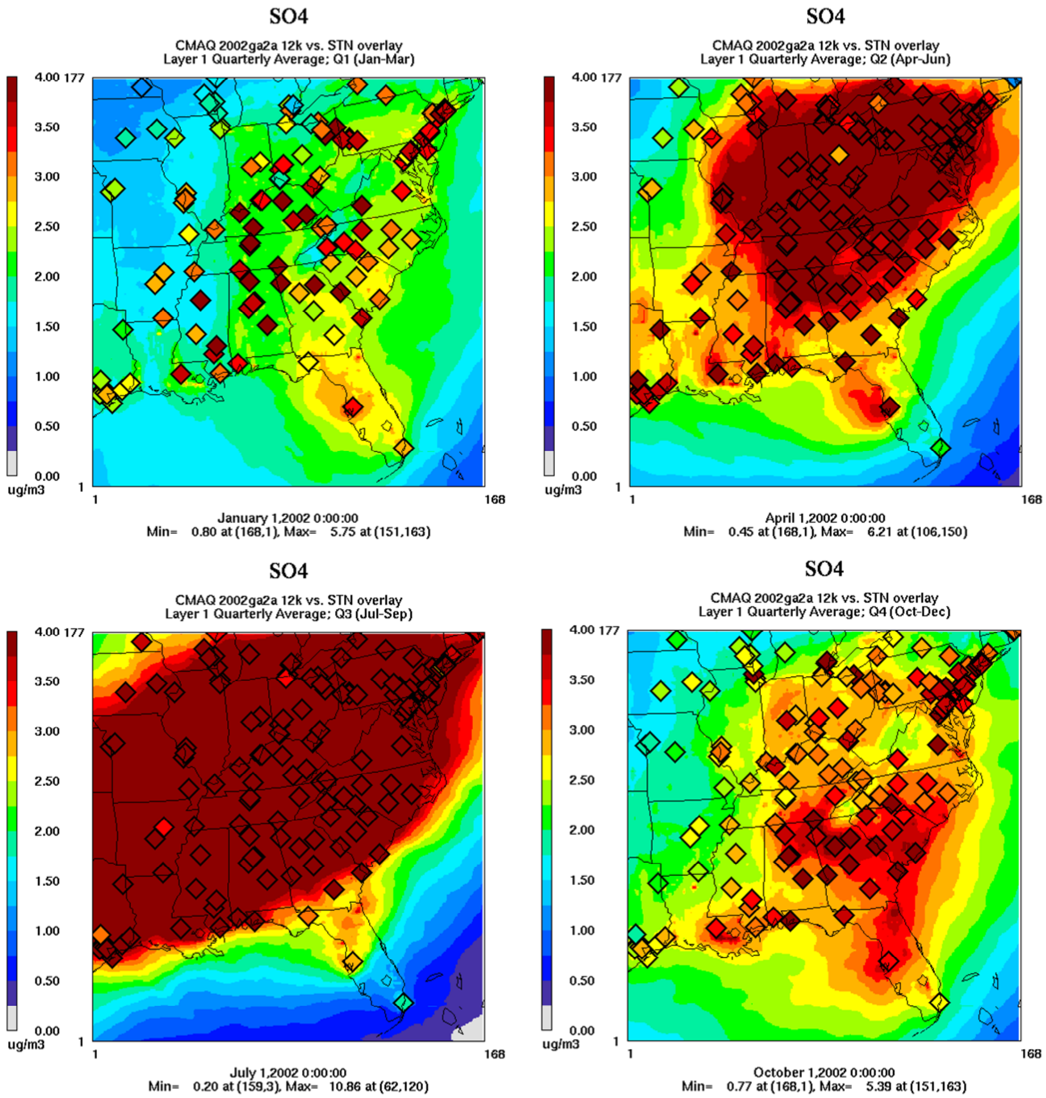


Figure C-1a. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) sulfate (SO4) concentrations over the VISTAS 12 km domain.

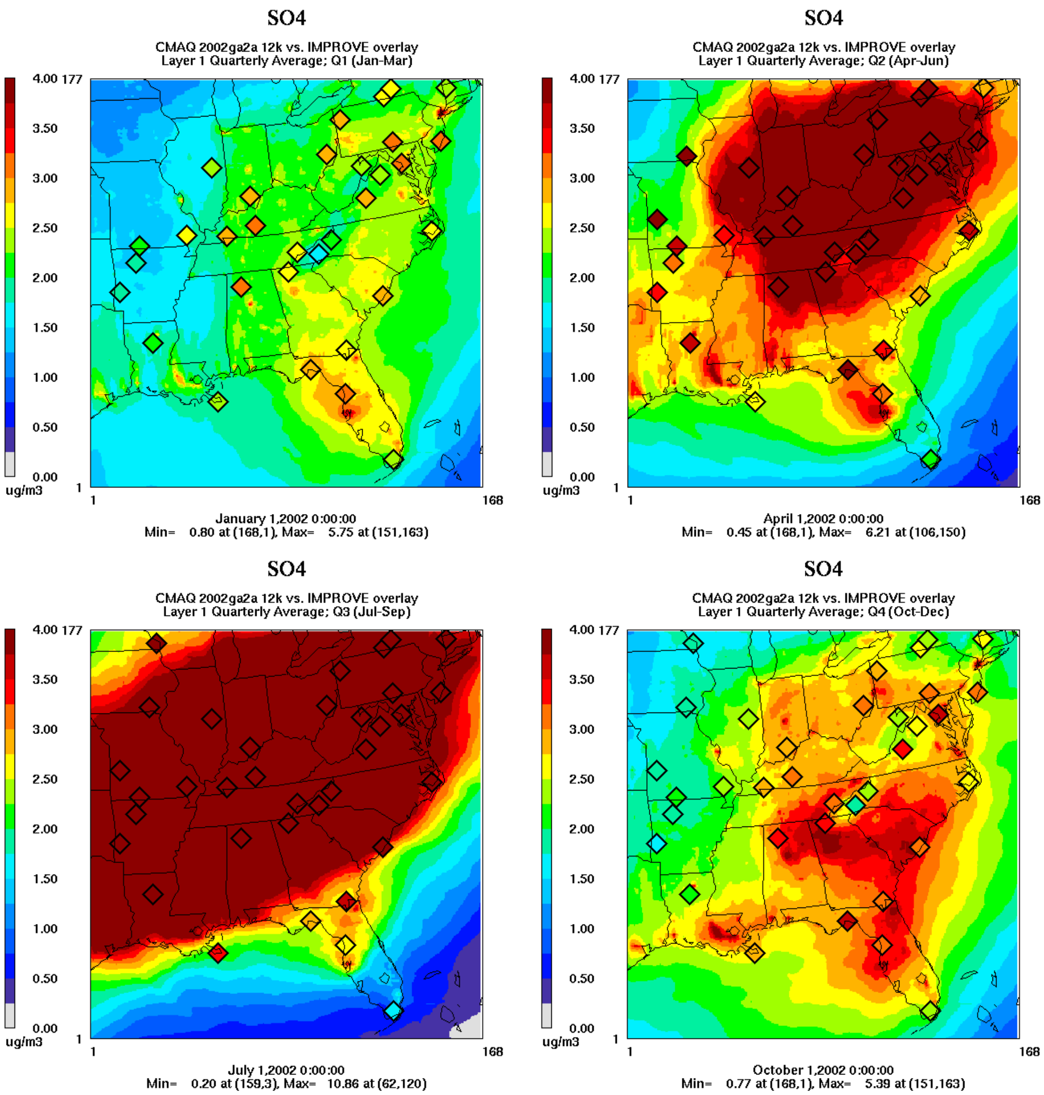


Figure C-1b. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) sulfate (SO4) concentrations over the VISTAS 12 km domain.

C.2.2 Nitrate (NO3)

Nitrate is in many ways the "mirror" image of sulfate, with peak concentrations occurring during wintertime, when the cooler temperatures are favorable for particulate nitrate formation and sulfate concentrations are lower making more ammonia available to bond with nitrate. The need for nitrate to be neutralized by a basic compound in order to be in the particulate state results in peak particulate nitrate concentrations occurring in areas of the domain where ammonia emissions are highest, such as the Midwest.

While overall the model does capture the seasonal and spatial variability in particulate nitrate concentrations (Figures C-2a,b), it does seem to overestimate concentrations during wintertime, especially over urban centers, such as in part of the Northeast and over Atlanta and Birmingham. Winter overestimations are also evident over much of North Carolina. While it is impossible to infer from these data alone on the cause for these overpredictions, they are related to either one or a combination of the model nitrate partitioning between gaseous and particulate phase, and the availability of gaseous ammonia, as reflected by the emissions inventory. The latter can be the common denominator between the overpredictions over the urban centers and over North Carolina, as ammonia emissions in these areas, though originating from different sources (mobile sources in the urban centers; agricultural ammonia emissions in North-Carolina), might be overestimated, making more ammonia available for particulate formation compared to the observations.

In the summer, the model estimates near zero (< 0.25 $\mu g/m^3$) particulate nitrate concentrations, whereas the observed values are typically in the 0.25-0.75 $\mu g/m^3$ range. In any event, both the modeled and observed summer NO3 values suggest that it is not an important component of the total $PM_{2.5}$ mass concentrations in the southeastern U.S. during the summer.

Fairly similar trends are observed when comparing the model to either the STN (Figure C-2a) or the IMPROVE (Figure C-2b) networks, however a more detailed analysis is provided based on the STN, given its size and density.

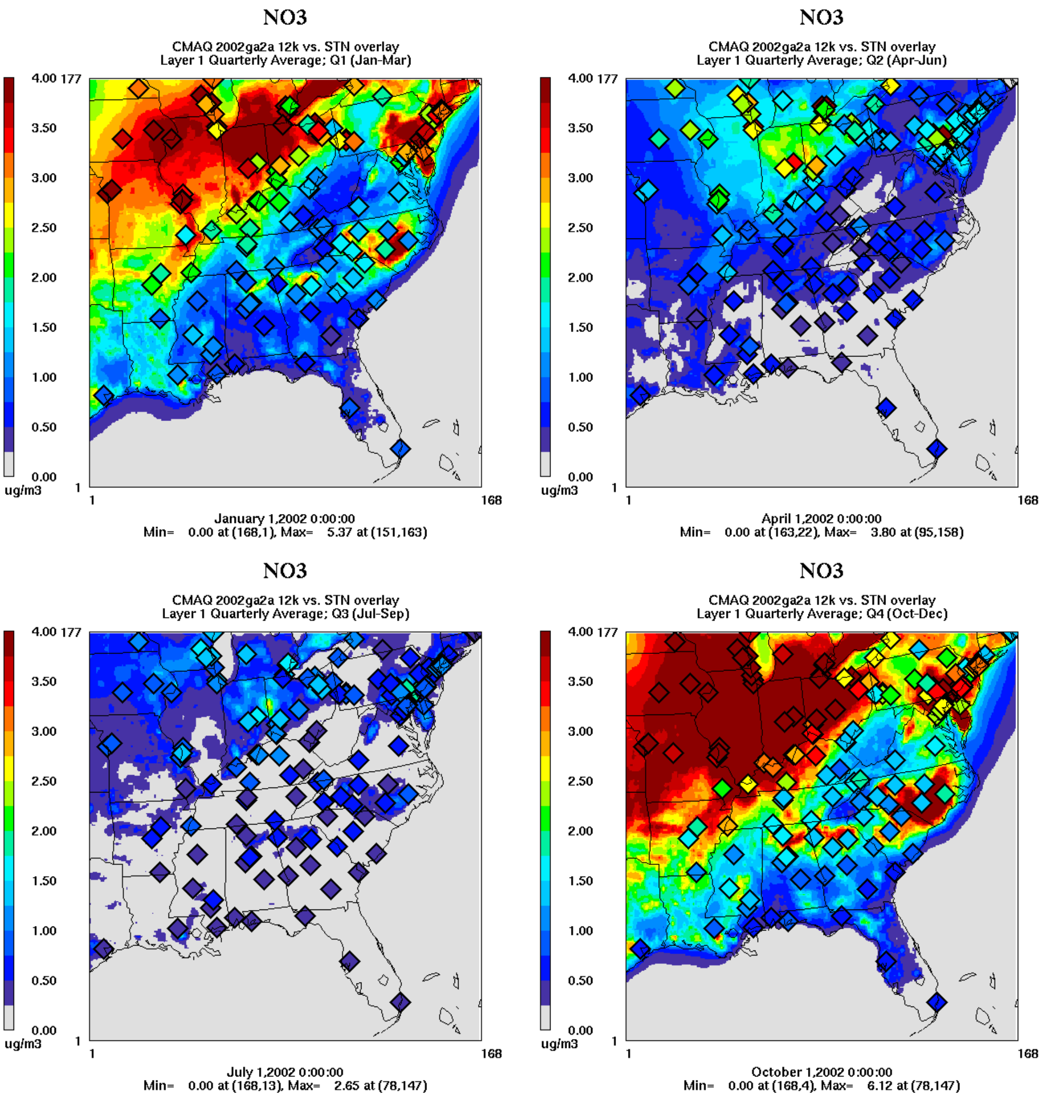


Figure C-2a. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) nitrate (NO3) concentrations over the VISTAS 12 km domain.

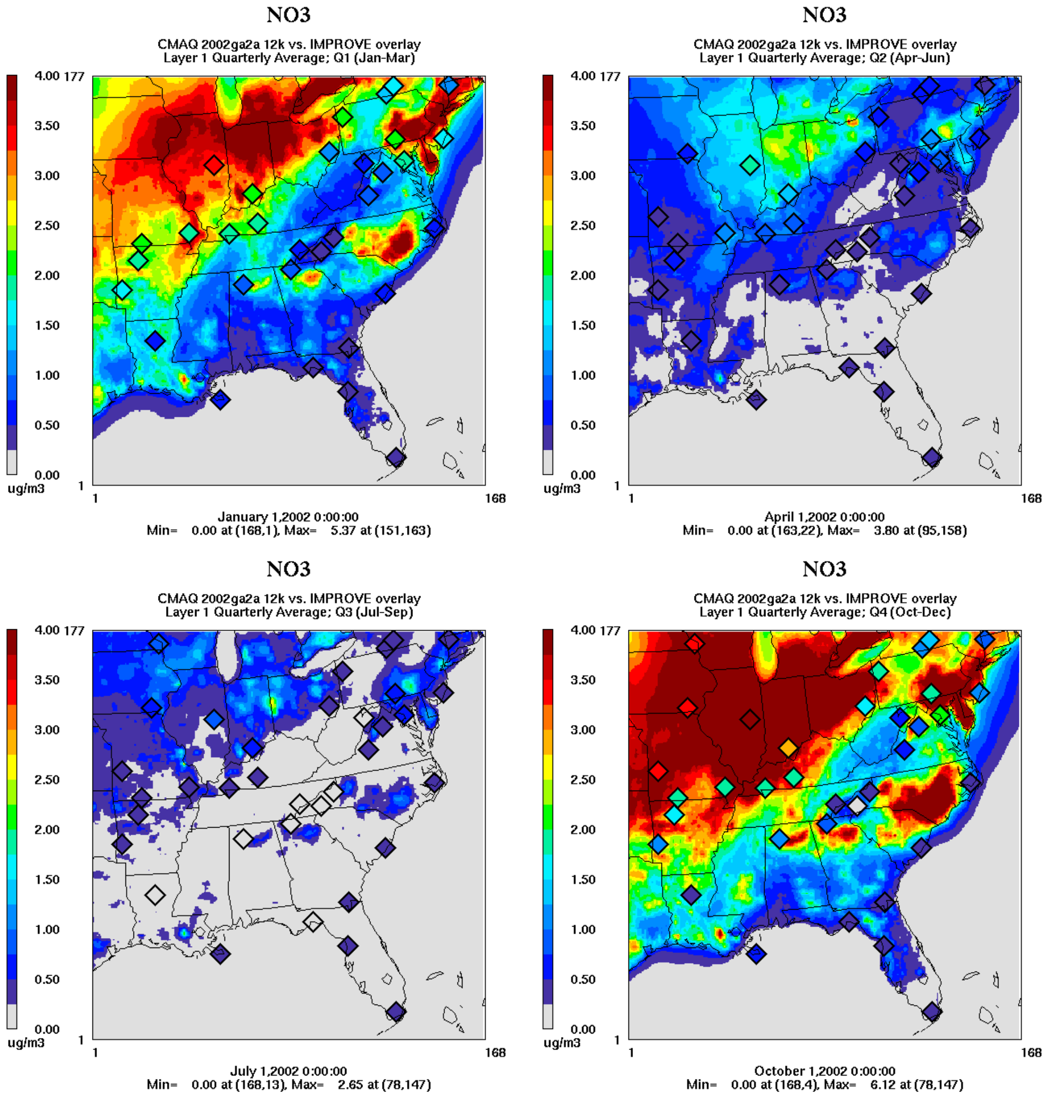


Figure C-2b. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) nitrate (NO3) concentrations over the VISTAS 12 km domain.

C.2.3 Ammonium (NH4)

Ammonium concentrations depend, to a large degree, on the availability of sulfate and nitrate. Therefore, ammonium levels do not exhibit as strong seasonal pattern, due to the seasonal tradeoff between sulfate and nitrate, to which it bonds.

Model performance, when compared to the STN data (Figure C-3a), seems to be better during summertime (Quarters 2 and 3), when the ammonium is mainly associated with sulfate. During wintertime (Quarters 1 and 4), most of the issues observed with nitrate overpredictions are also evident in the ammonium plots, especially over North-Carolina and the urban centers of the Southeast.

Ammonium is not directly measured by IMPROVE, rather it is derived by assuming it completely neutralizes the measured sulfate and nitrate. Assuming that nitrate is completely neutralized by ammonium is most of the time a valid assumption, however the same may not be true for sulfate, especially in the summer months. Hence the observed ammonium comparison in the IMPROVE case (Figure C-3b) is likely overstated during the summer months when sulfate is less likely to be fully neutralized and the seemingly underpredicted observed ammonium concentrations across the Appalachian Mountain IMPROVE monitoring sites in Quarter 3 in Figure C-3b are in part due to using derived observed ammonium.

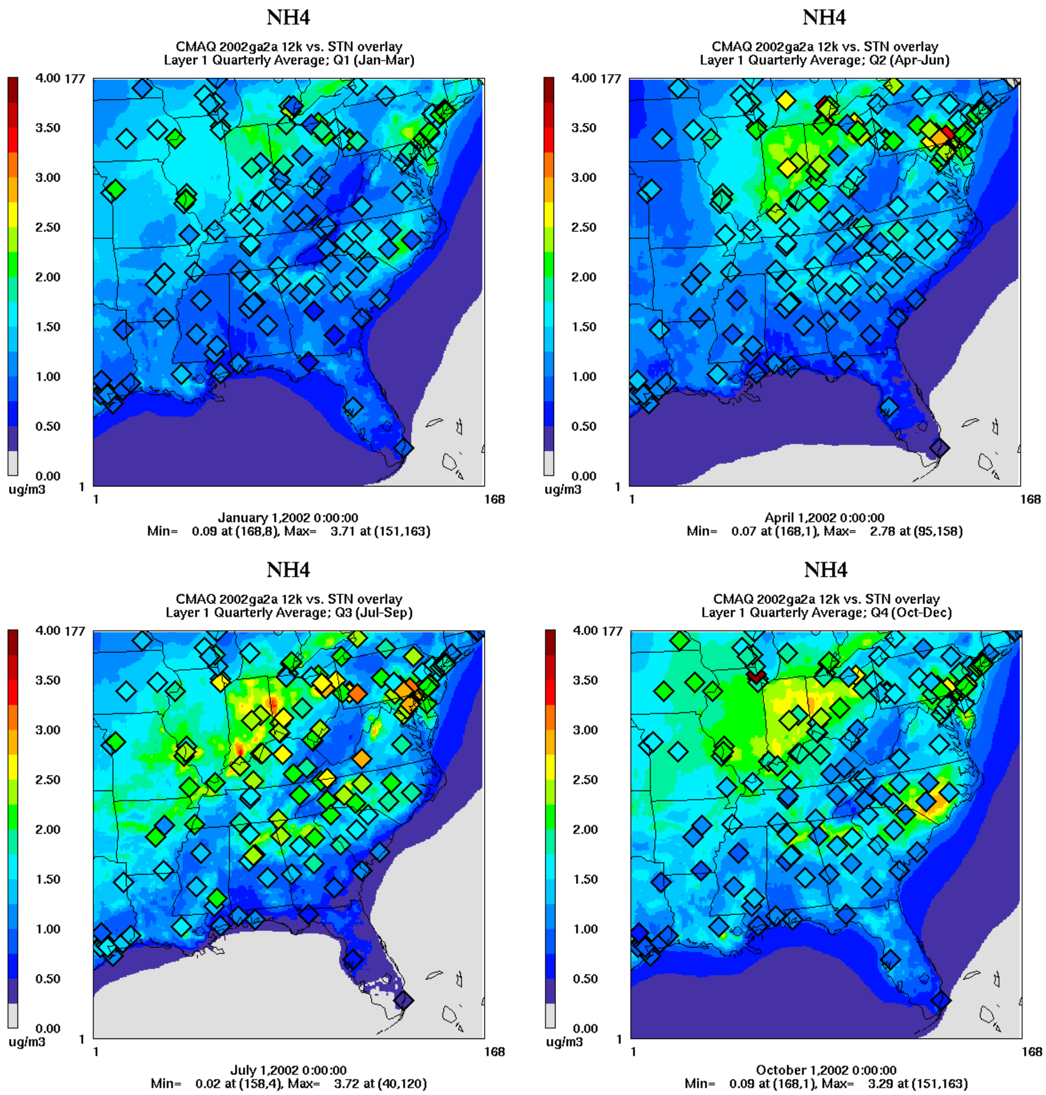


Figure C-3a. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) ammonium (NH4) concentrations over the VISTAS 12 km domain.

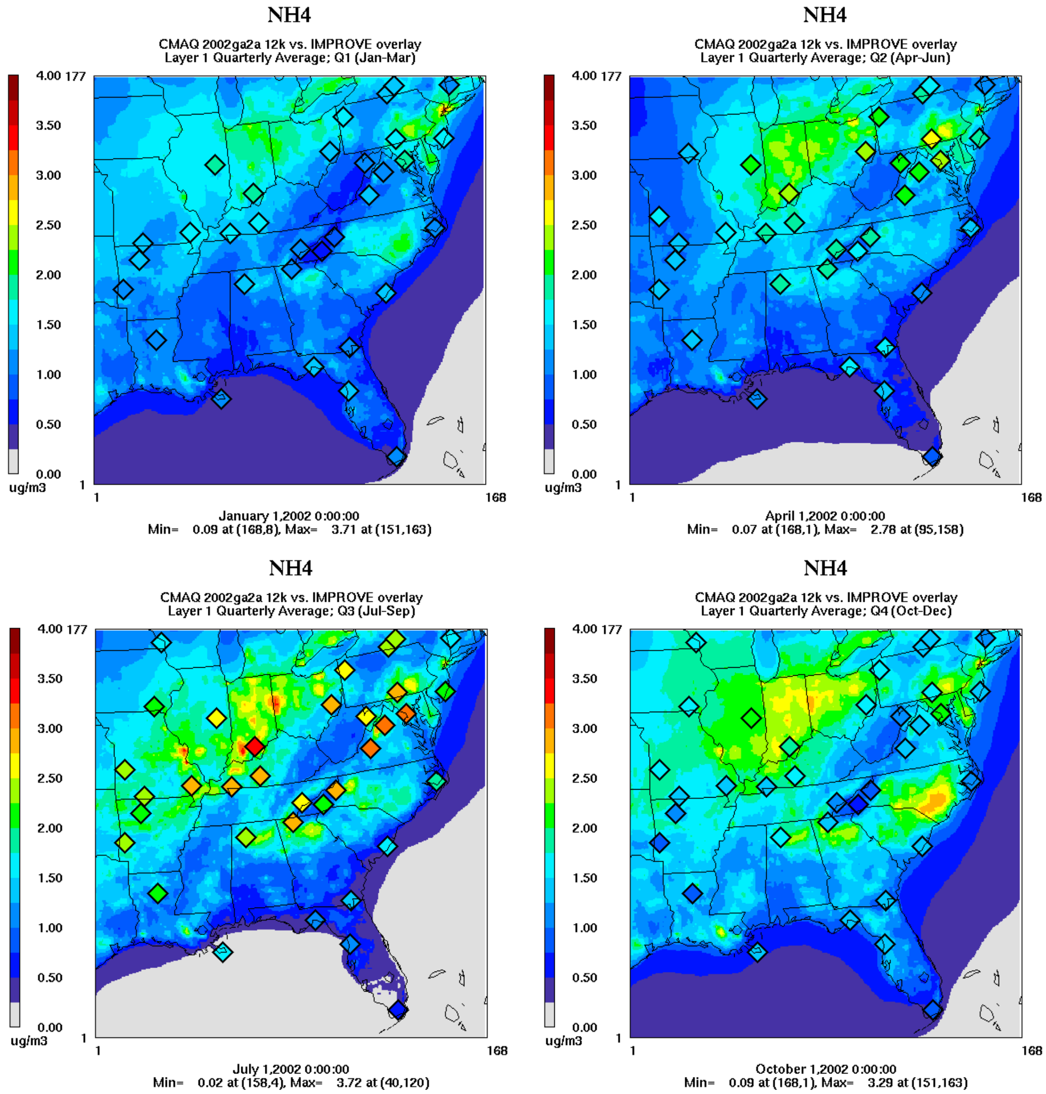


Figure C-3b. 2002 Quarterly averages of CMAQ simulated and IMPROVE derived (diamonds) ammonium (NH4) concentrations over the VISTAS 12 km domain.

C.2.4 Organic Carbon Material (OCM)

Evaluating model performance for OCM is complicated due to its dual primary/secondary nature and anthropogenic/biogenic precursor sources. As a result, the evaluation is dependant on a combination of very different emissions and formation processes. In addition, there is a fair amount of uncertainty associated with OC measurements, with a major limitation being the inability to directly measure OCM. Instead, only OC is measured, and OCM is estimated (and compared to model results) by multiplying OC by an OCM/OC ratio factor. Such OCM/OC ratio factors typically range from 1.2 to 2.2 depending on whether the OCM is fresh or aged, where we have used an OCM/OC factor of 1.4. In addition, different analysis methods are used in the STN (NIOSH) and IMPROVE networks that introduce additional measurement artifacts.

The seasonal pattern of OCM concentrations would depend on the relative contributions from secondary OCM (peak concentrations during summertime) and primary OCM. The seasonal pattern of primary OCM would depend on the seasonality of activity and emissions from sources such as biomass burning and transportation. Given a flat activity/emissions profile, primary OCM is would typically be higher in wintertime, due to reduced atmospheric mixing.

Comparing model OCM predictions to STN observations (Figure C-4a), both exhibit a fairly flat seasonal pattern. Overall, the modeled concentrations are lower compared to observations. The model seems to exhibit a much stronger spatial pattern, with peak concentrations occurring in the Southeast. This is likely associated with biomass burning in the winter months, and biogenic secondary OCM formation in the summer months. The increased modeled-concentrations of secondary OCM are evident in Quarter 3, especially over the Northeast. When comparing simulated concentrations to IMPROVE observations (Figure C-4b), better agreement is observed. Given that most IMPROVE sites are located in rural areas, this may be an indication that OCM is underpredicted mainly at urban sites (STN, Figure C-4a), possibly due to local spatial gradients and the comparison of diffused 12 km grid-cell volume average concentrations to point measurements at urban sites. It is also partly due to measurement artifacts where the STN OC observations are not "blank corrected" so are biased high.

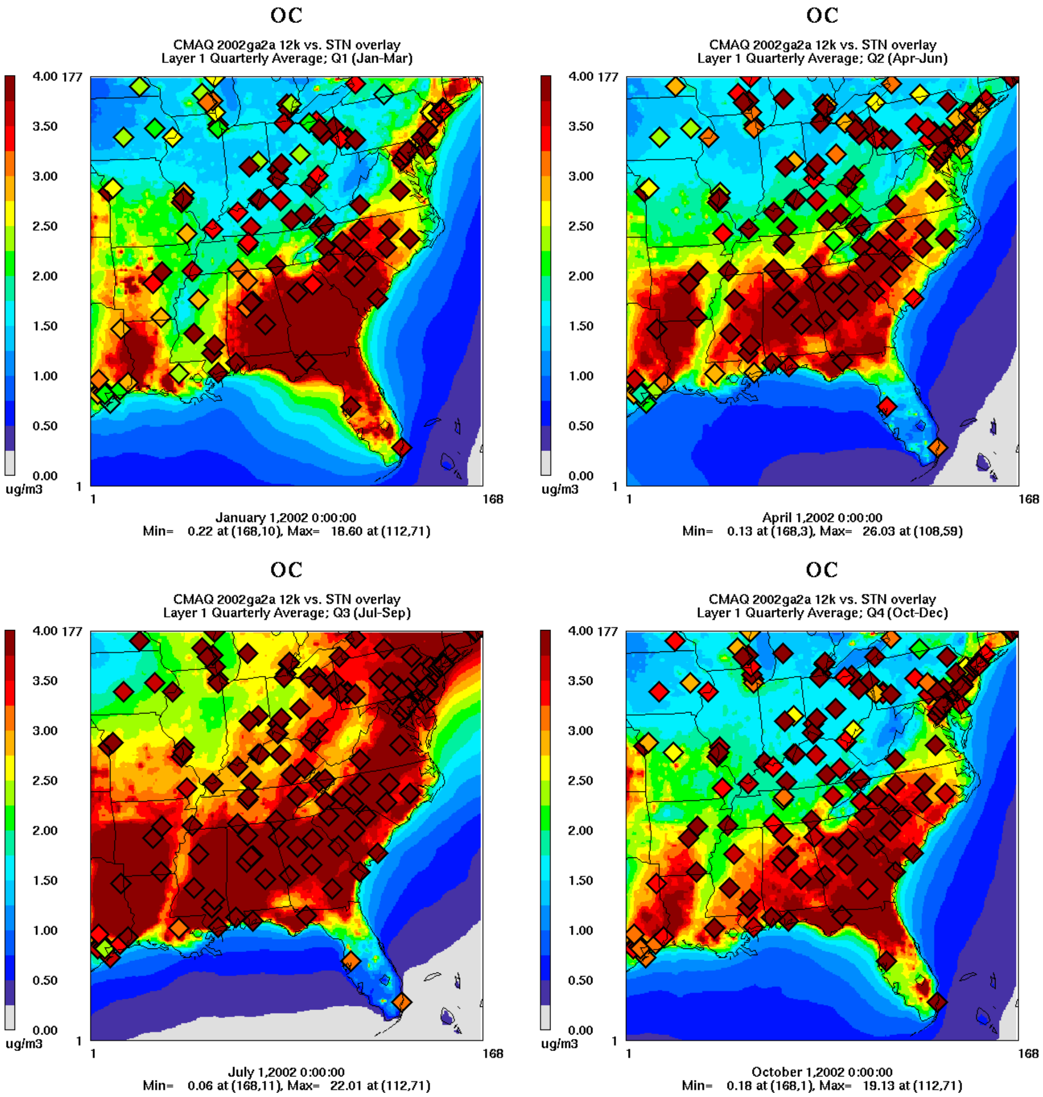


Figure C-4a. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) organic carbon material (OCM) concentrations over the VISTAS 12 km domain.

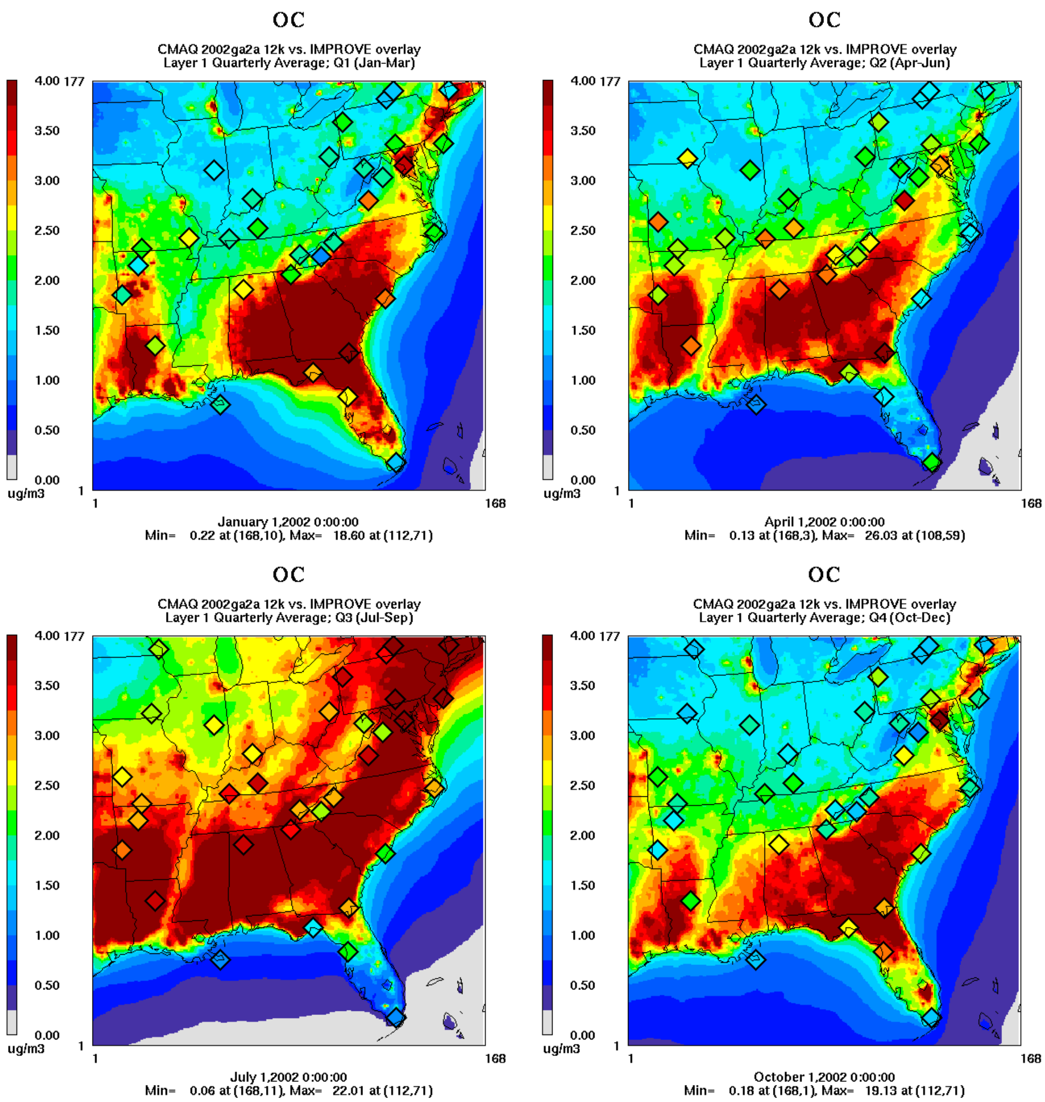


Figure C-4b. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) organic carbon material (OCM) concentrations over the VISTAS 12 km domain.

C.2.5 Elemental Carbon (EC)

Evaluating model performance for EC, the model tends to underpredict concentrations when compared to the STN network (Figure C-5a), while better agreement is observed with the IMPROVE network (Figure C-5b). This follows the same conclusion as for OCM and may be reflecting the differences between grid-cell volume average concentrations and point measurements. These differences are expected to be more pronounced at urban sites (STN) compared to rural ones (IMPROVE), as at urban locations there are likely stronger local spatial gradients in EC concentrations. The STN and IMPROVE networks also use different methods for measuring EC that may also be contributing to the differences in EC model performance using the two networks. In Chapter 3 and Appendix B we noted that the CMAQ 12 km modeling results exhibited superior EC model performance to the CMAQ 36 km modeling results across the urban STN network so the dilution of the urban EC emissions across the coarse 12 km grid cell is surely contributing to the EC underprediction tendency.

Both the modeled values and observations (at both networks) exhibit higher concentrations in wintertime (Quarters 1 and 4) that is likely due to reduced atmospheric mixing compared to summertime. However, the seasonal pattern is much stronger in the model results compared to the observations.

Another interesting finding has to do with relatively high modeled EC concentrations in the western part of the Georgia-Florida border, especially in Quarter 1. This is due to modeled emissions from biomass burning activities. However, nearby measurements at both the STN and IMPROVE networks do not exhibit the same trend.

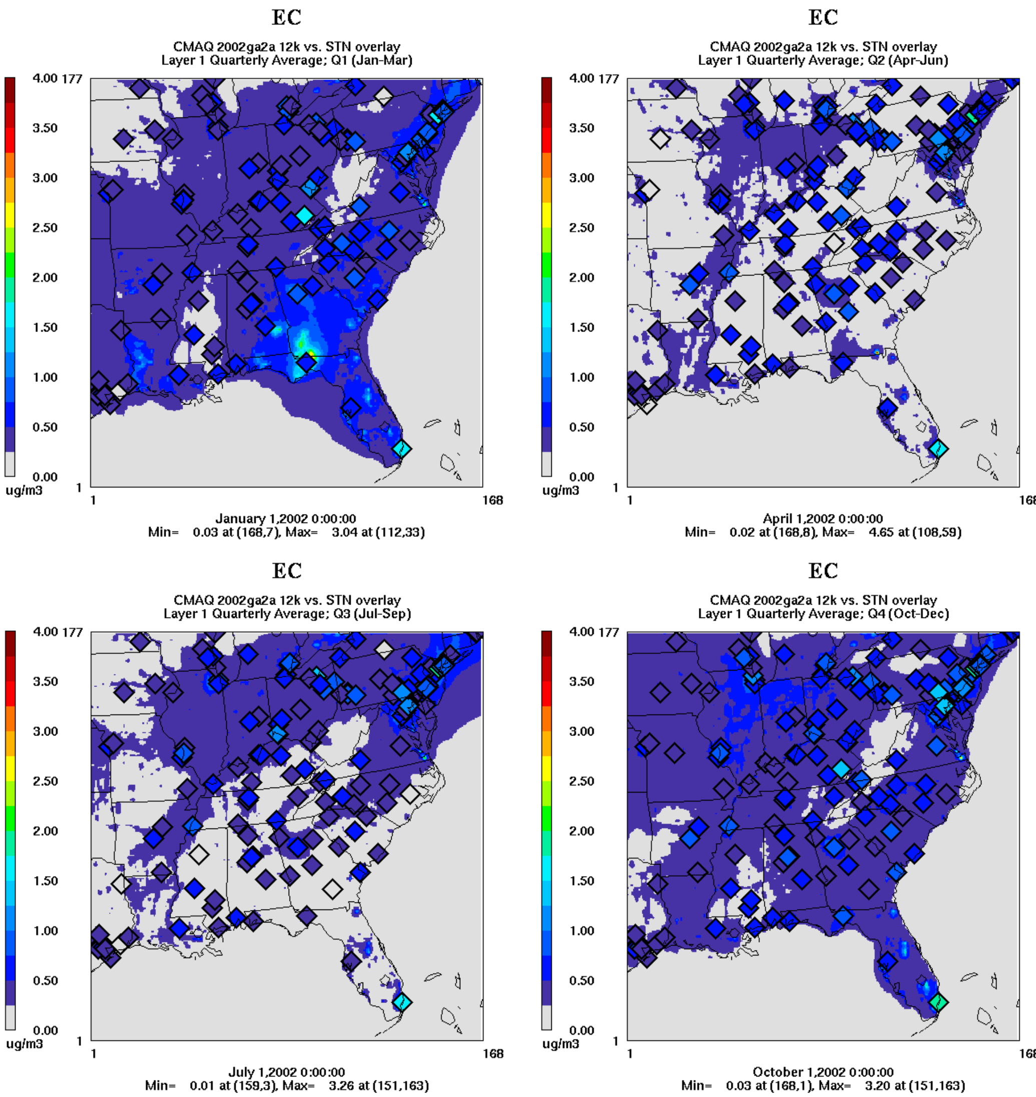


Figure C-5a. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) elemental carbon (EC) concentrations over the VISTAS 12 km domain.

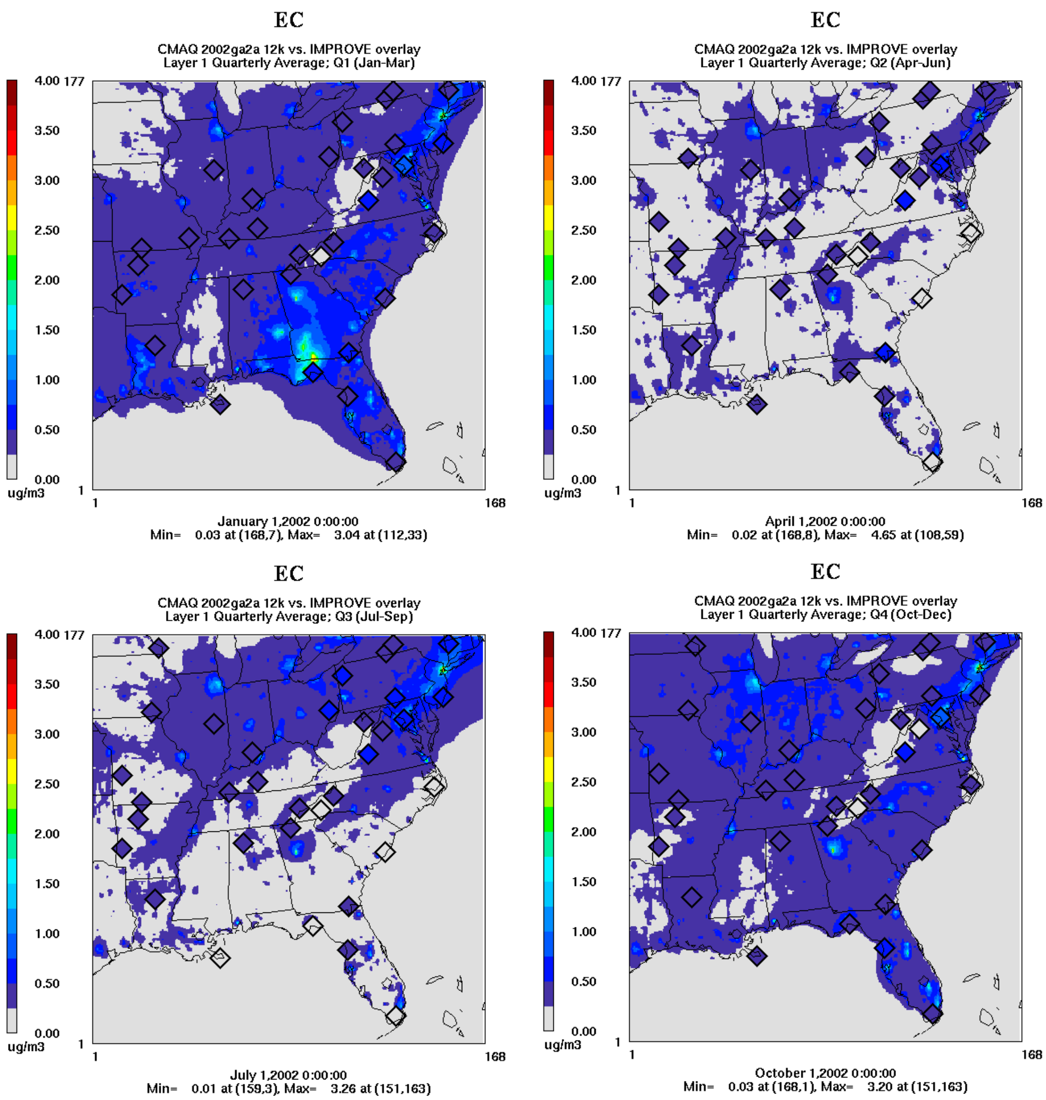


Figure C-5b. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) elemental carbon (EC) concentrations over the VISTAS 12 km domain.

C.2.6 Soil $PM_{2.5}$ (SOIL)

Soil $PM_{2.5}$ is measured/calculated/derived at the IMPROVE sites only (Figure C-6). In general, soil $PM_{2.5}$ is overpredicted compared to the observations. This is a common issue in grid-based models, where resuspended fugitive dust is assumed to be mixed uniformly in the first layer of the model, whereas in practice most of it is removed locally by impaction onto surfaces such as cars, buildings and vegetation. Higher concentrations are especially evident in urban centers, due to the way the model calculates the emission and dispersion of resuspended road dust. However, this is not very evident in this comparison, since most IMPROVE sites are located in rural areas. The ASIP/VISTAS modeling did apply fugitive dust transport factors (FDTF) to fugitive dust emission source categories to account for dust that is deposited locally and not transported.

Another issues associated with the Soil evaluation is the mismatch between how Soil is defined in the measured versus modeled values. The measured Soil values are derived by building it up from the elements, whereas the modeled values are obtained from the emission speciation profiles that assign all $PM_{2.5}$ that is not explicitly speciated as SO4, NO3, EC or OCM to the other $PM_{2.5}$ category that is interpreted as Soil in the model performance evaluation.

Also evident in the figures are the higher modeled concentrations in the western side of the domain. This could be originating for various reasons, such as possibly higher emissions in that region, transport into the domain from the west, or differences in methodologies used to calculate crustal emissions between the various Regional Planning Organizations (RPOs). The latter is likely the case, since a sharp spatial gradient is observed between the Midwest RPO states (and west of Mississippi, in the portions of the CENRAP states) and the MANE-VU (northeast) and VISTAS (southeast) states (see Figure 1-1 for definition of the RPO states).

Regardless of actual model performance, in the context of $PM_{2.5}$ State Implementation Plan (SIP) development and future attainment tests, modeled levels of soil components are of relatively little importance, since they are normalized according to observations, and little to no controls are being applied to fugitive dust sources (so the Relative Reduction Factor would be equal or close to unity).

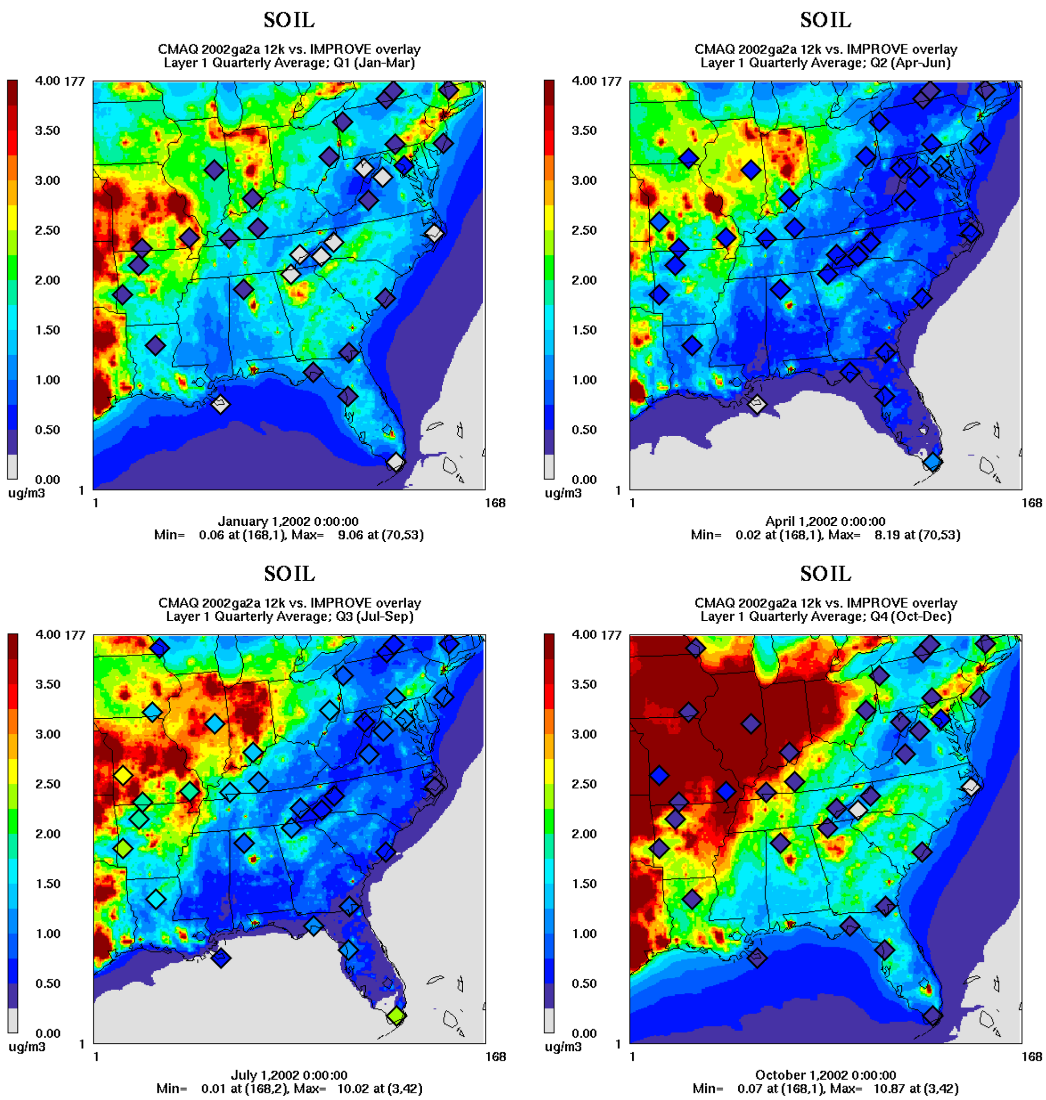


Figure C-6. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) soil $PM_{2.5}$ (SOIL) concentrations over the VISTAS 12 km domain.

C.2.7 Sea-Salt $PM_{2.5}$ (SeaSalt)

Sea-salt $PM_{2.5}$ is measured/calculated at some of the IMPROVE sites only (Figure C-7). As expected, higher concentrations are measured at sites along the coastline. This spatial pattern is captured by the model as well; however, concentrations along the coastline are underpredicted compared to the measurements.

Since sea-salt $PM_{2.5}$ is not used for future attainment tests as part of the SIP development process, model performance in this case is of relatively little importance.

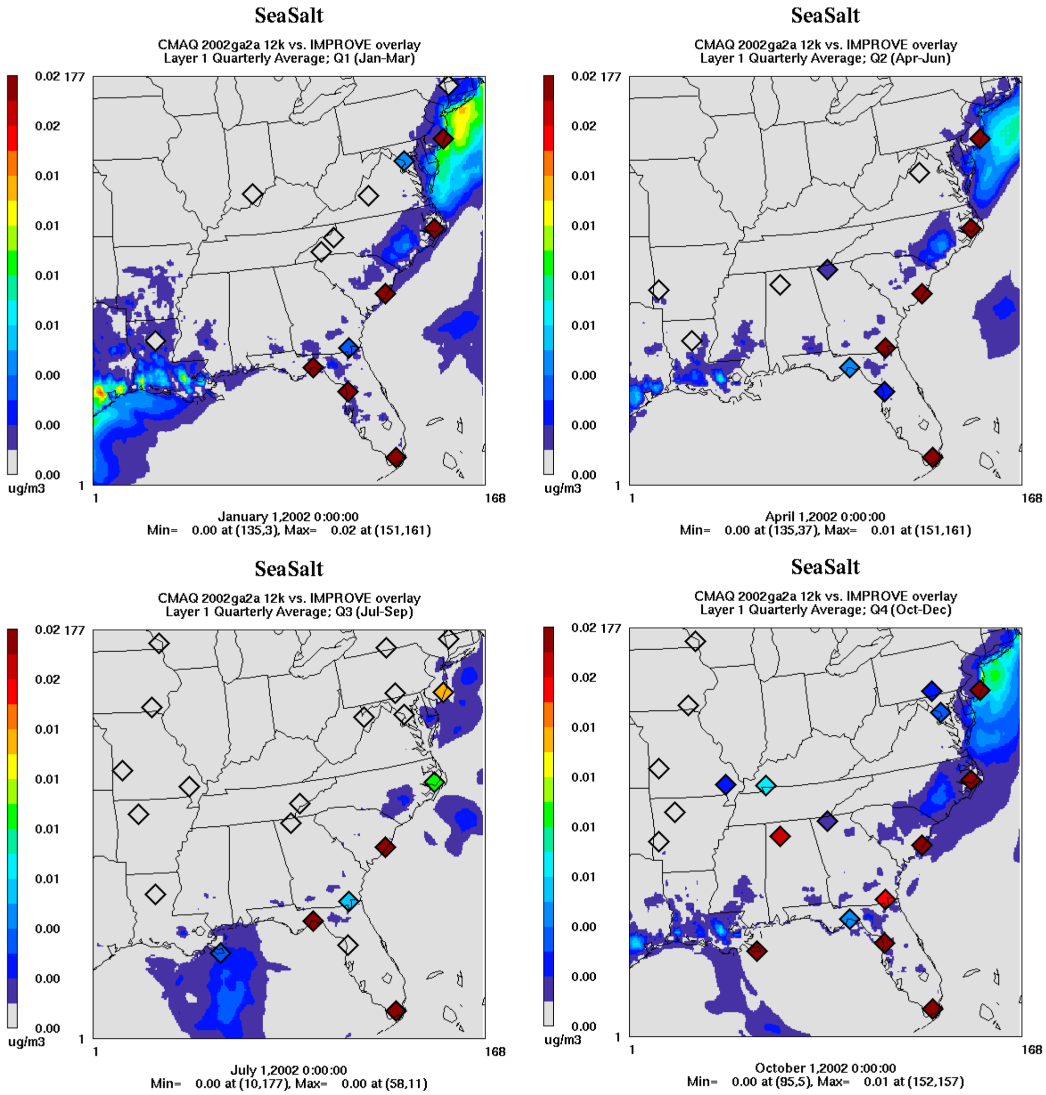


Figure C-7. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) sea-salt $PM_{2.5}$ (SeaSalt) concentrations over the VISTAS 12 km domain.

C.2.8 Total $PM_{2.5}$ Mass ($PM_{2.5}$)

A comparison of the modeled spatial distribution of quarterly average total $PM_{2.5}$ mass concentrations with observations from the FRM, STN and IMPROVE network are provided in Figure C-8. The conclusions on the model performance for total $PM_{2.5}$ mass vary by which network is examined. For Q1, there are elevated PM $_{2.5}$ concentrations in the major urban areas (e.g., Chicago-Gary, St. Louis, Atlanta, Northeast Corridor, etc.) and the western part of the Georgia-Florida border, the latter is due to biomass burning. The mainly rural IMPROVE monitors fail to capture any of these elevated areas, but does confirm the relative clean conditions in the Appalachian Mountains (Figure C-8c, top left). The IMPROVE St. Marks measured $PM_{2.5}$ levels appears to refute the elevated $PM_{2.5}$ in Q1 along the western Florida-Georgia border. However, the STN (Figure C-8b) and FRM (Figure C-8a) spatial plots confirm that elevated $PM_{2.5}$ levels occur in this area during Q1; the lack of elevated $PM_{2.5}$ at St. Marks is likely due to its coastal location.

During Q2 the model predicts elevated total $PM_{2.5}$ mass levels from St. Louis across the Midwest into Ohio with highest values centered on Indianapolis, in southeastern Pennsylvania and up the Northeast Corridor, and in the Birmingham and Atlanta urban areas in the southeast. The IMPROVE monitors suggest that the model is capturing the rural aspect of the spatial distribution of the total $PM_{2.5}$ mass patterns, albeit with an underprediction bias (Figure C-8c, top right). However, the FRM (Figures 3-26 and C-8a) and STN (Figure C-8b) plots indicates that the model is underestimating the spatial coverage of the elevated total $PM_{2.5}$ mass levels.

The highest seasonal $PM_{2.5}$ levels occur in the Q3 summer period when SO4 is the highest. The observations indicate that the entire interior portion of the ASIP/VISTAS 12 km grid domain is covered by elevated $PM_{2.5}$ levels, which is reproduced reasonably well by the model. However, the model is estimating slight lower values and relatively cleaner areas over the Appalachian Mountains that are not supported by the observations. In addition, the observed $PM_{2.5}$ concentration gradient from high to low occurs further south than predicted by the model. However, in general the model is doing a good job in reproducing the spatial distribution of $PM_{2.5}$ in Q3.

In Q3 the model estimates elevated PM levels across the upper Midwest (MO-IL-OH) and southwest (Northern AL and GA, SC and NC) that is split by the Appalachian Mountains and elevated levels in the Northeast Corridor. The IMPROVE network plots confirm the relative cleaner area in the Appalachian Mountains (Figure C-8c) and the STN network plot confirms the three areas of high $PM_{2.5}$ (Figure C-8b).

Model performance evaluation for total $PM_{2.5}$ mass depends heavily on the performance for the individual components. As such, it is less meaningful than the performance evaluation for the individual components. In addition, modeled total $PM_{2.5}$ is not used for future attainment tests as part of the SIP development process that uses the Speciated Modeled Attainment Test (SMAT) that is based on the modeled $PM_{2.5}$ component species. The FRM network spatial map (Figure 3-26 and C-8a) confirms the three areas of elevated $PM_{2.5}$ concentrations, but suggests the southeast area is not as high as the others and that the $PM_{2.5}$ distribution should be spottier.

In conclusion, the model appears to do a good job in reproducing the spatial and temporal variations in $PM_{2.5}$ concentrations across the ASIP/VISTAS 12 km grid, albeit with an underprediction bias. The spatial distribution of the modeled $PM_{2.5}$ concentrations is smoother and less spotty than the observed distributions, which is due in part to the coarse 12 km grid spacing used in the modeling.

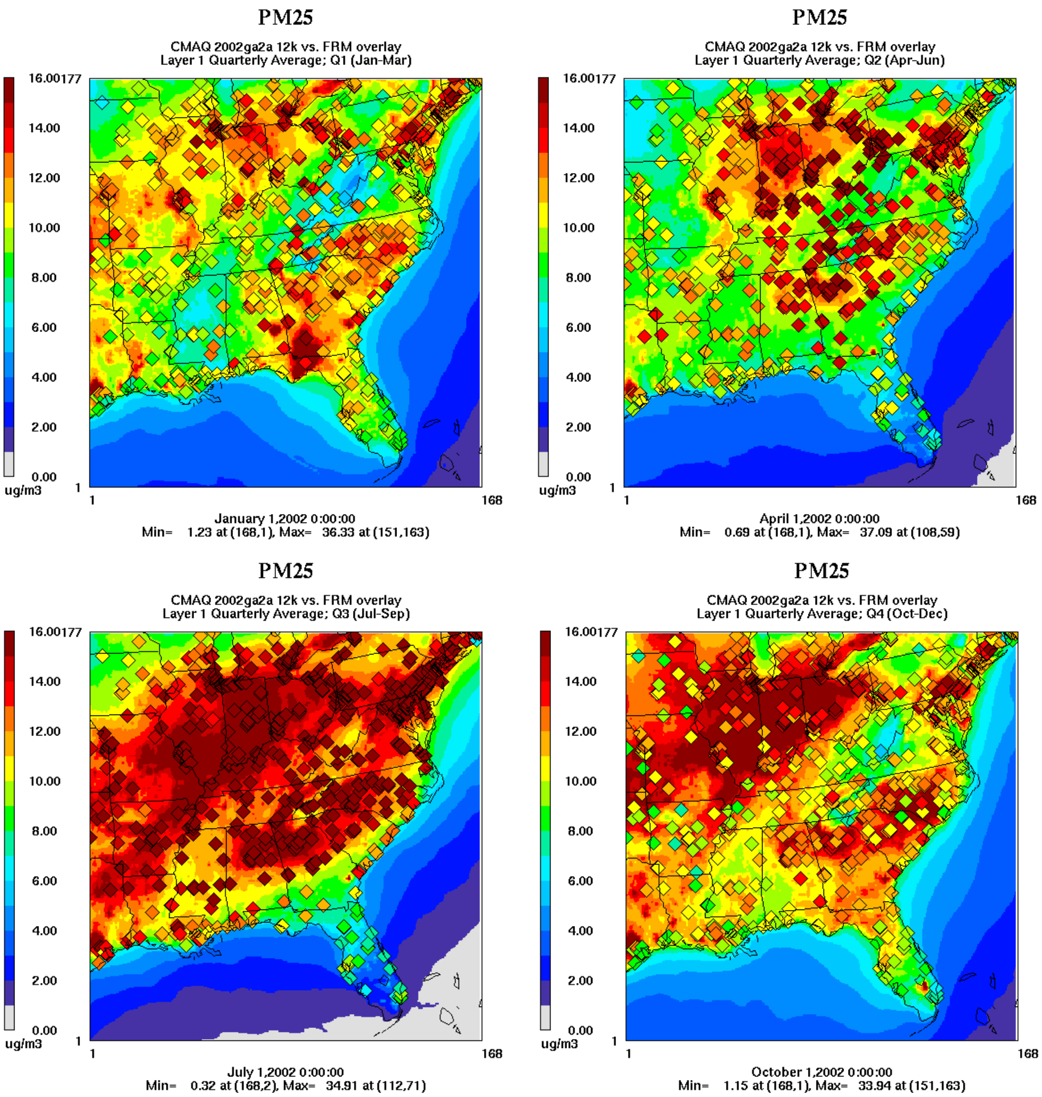


Figure C-8a. 2002 Quarterly averages of CMAQ simulated and FRM observed (diamonds) total $PM_{2.5}$ mass concentrations over the VISTAS 12 km domain.

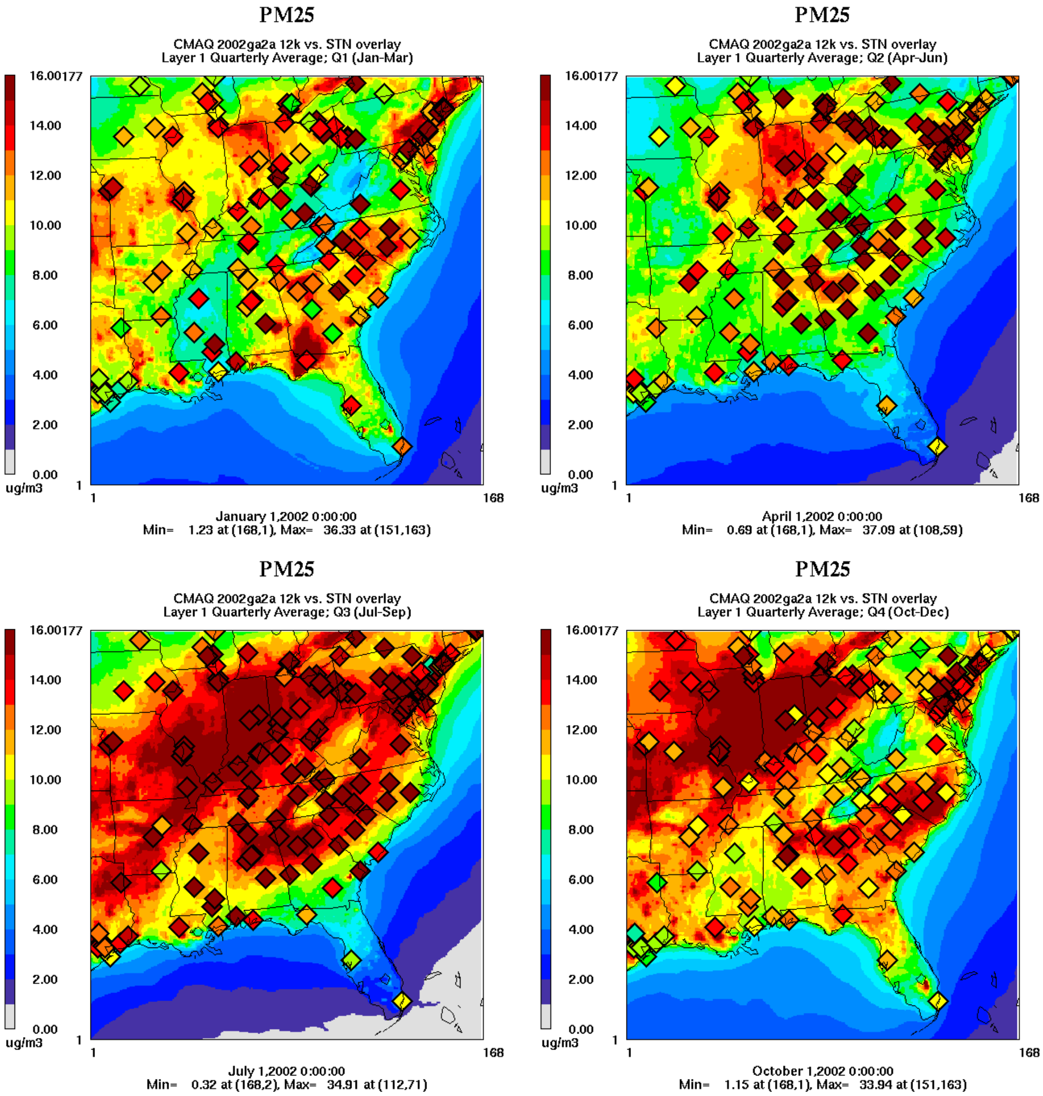


Figure C-8b. 2002 Quarterly averages of CMAQ simulated and STN observed (diamonds) total $PM_{2.5}$ (PM25) concentrations over the VISTAS 12 km domain.

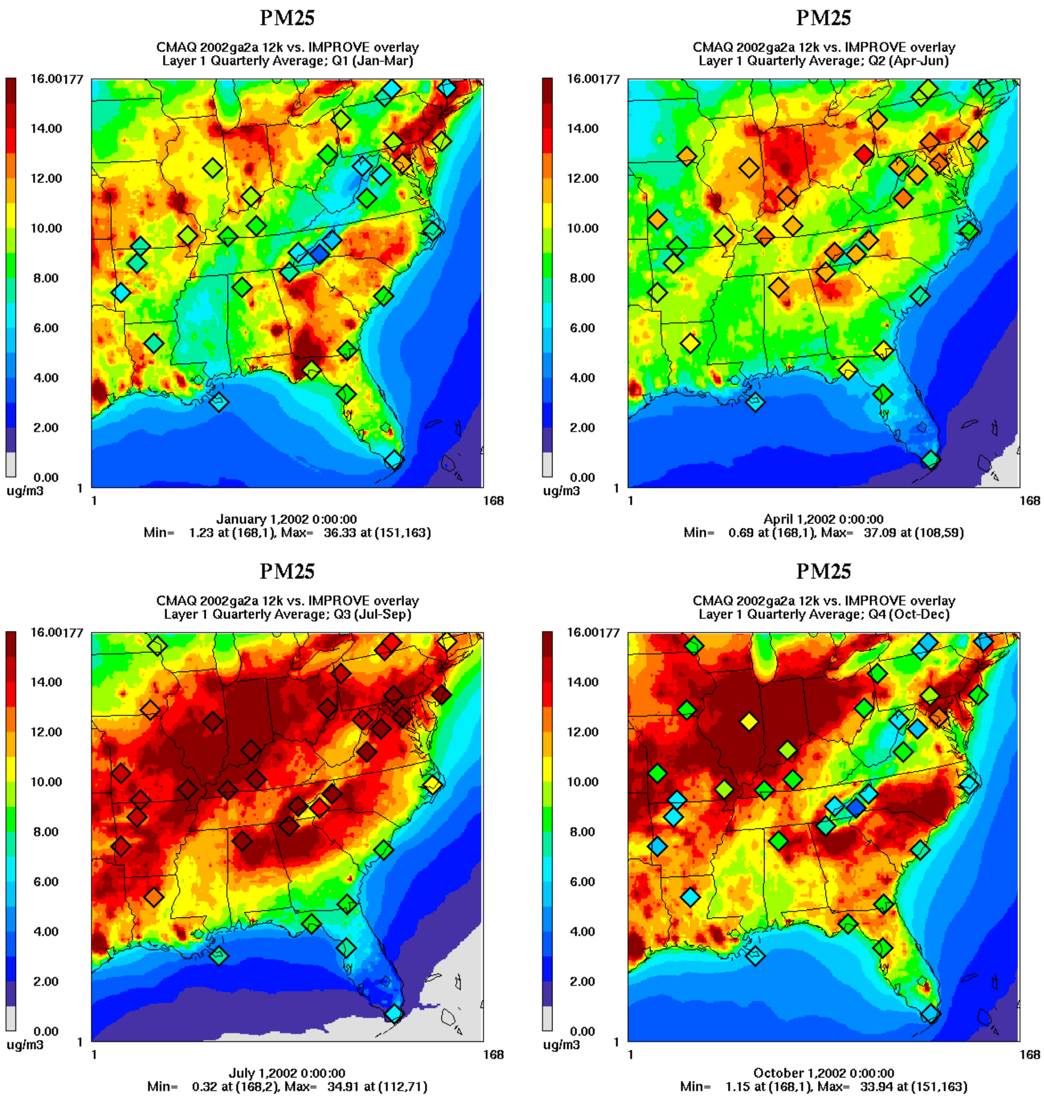


Figure C-8c. 2002 Quarterly averages of CMAQ simulated and IMPROVE observed (diamonds) total $PM_{2.5}$ (PM25) concentrations over the VISTAS 12 km domain.

APPENDIX D

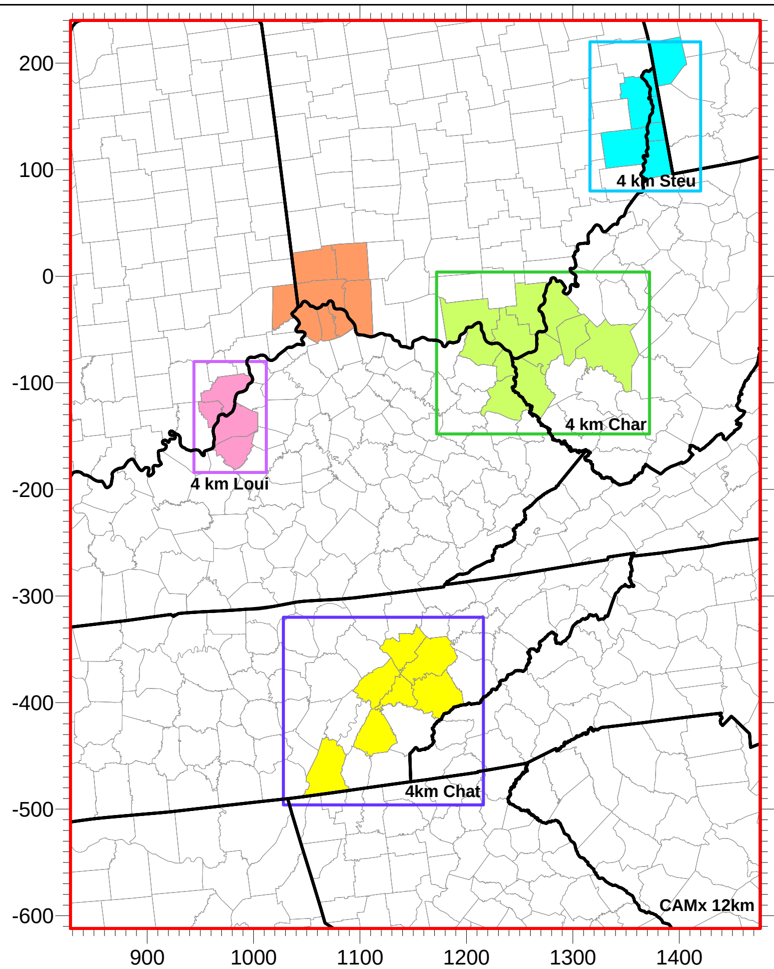
Comparative Model Performance Evaluation of the CMAQ and CAMx Models

D.1 OVERVIEW

In this Appendix we present a comparison of the PM model performance evaluation between the CMAQ 2002 12 km Base G2 Actual base case and the CAMx 12/4 km Base G2 Typical base case simulations. In Chapter 3 and Appendices B and C, as well as in the VISTAS regional haze modeling TSD (Morris et al., 2009), we presented a detailed model performance evaluation of the 2002 CMAQ 36/12 km Base G2 Actual base case simulation. The basic features of model performance between the two modeling systems are similar. So just a summary model performance comparison is presented in this section. We first present a broad brush evaluation of the two models across the CAMx 12 km modeling domain, and then present a more detailed evaluation of model performance within each of the four 4 km modeling domains (see Figure D-1).

Although the basic meteorological, emissions and initial and boundary conditions used in the CMAQ and CAMx 2002 base case simulations were similar, there were several updates to the 2002 Base G2 emissions used in the CAMx modeling. Because the CAMx 2002 base case simulation was performed more recently than the CMAQ base case, we were able to implement several emission corrections to the 2002 Base G2 emissions. The following is a list of the major differences in the CMAQ and CAMx 2002 base case simulations:

- Addition of 65,000 tons per year SO2 emissions at the W.H. Sammis EGU in northern West Virginia.
- Addition of SO2 and PM emissions in Jefferson County, Kentucky (Louisville) that were inadvertently left out of the CMAQ 2002 Base G2 emissions scenario when only ozone precursor emissions were provided in the emissions update.
- The treatment of SOA from biogenic VOCs is different in the two models.
- The used of 4 km resolution over the four 4 km domains and two-way grid nesting in CAMx between the 12/4 km grids versus CMAQ 12 km domain.
- The CMAQ base case used Actual and the CAMx Typical emissions for EGUs and fires.
- Other differences related to model formulation.



CAMx 12km:	**54 x 71**	**(828, -612) to (1476, 240)**	
CAMx 04km (includes buffer cells):			
Steubenville/Wierton	**26 x 35**	**(1316, 80) to (1420, 220)**	
Charleston	**50 x 38**	**(1172, -148) to (1372, 4)**	
Louisville	**17 x 26**	**(944, -184) to (1012, -80)**	
Chattanooga/Knoxville	**47 x 44**	**(1028, -496) to (1216, -320)**	

Figure D-1. CAMx 12 km modeling domain with four 4 km nested grids where a CMAQ and CAMx comparative model performance evaluation was conducted.

D.2 EVALUATION ACROSS THE CAMx 12 KM DOMAIN

Numerous statistical performance measures and graphical displays of model performance were generated comparing the CMAQ 12 km Base G2 Actual and CAMx 12/4 km Base G2 Typical base case simulations. Below we evaluate the performance for each of the major components of $PM_{2.5}$ as well as for total $PM_{2.5}$ mass using PM measurements across the CAMx 12 km domain (Figure D-1) and observations from the IMPROVE, STN[1], CASTNet and FRM monitoring networks.

D.2.1 SO4 Model Performance Across the CAMx 12 km Domain

Bugle Plots and Time Series Plots of monthly fractional bias and error for sulfate (SO4) concentrations and the CMAQ and CAMx models using observed SO4 concentrations across the CAMx 12 km domain and the IMPROVE, STN and CASTNet monitoring networks are shown in Figures D-2 and D-3, respectively. In the Bugle Plots in Figure D-2, the filled symbols are for the CAMx 2002gt3 base case, whereas the unfilled symbols are for the CMAQ 2002ga2 base case simulations. The two models SO4 performance measures are quite good with both models almost always achieving the PM performance goal (bias/error ≤±30%/50%) and frequently achieving the more stringent ozone performance goal (bias/error ≤±15%/35%) for many months. Although both models achieve performance goals for SO4, there are differences in the two models' performance. CMAQ tends to underestimate the observed SO4 concentrations, whereas CAMx has an overestimation tendency. This is clearly seen in the monthly fractional bias bar charts in Figure D-3. Which model is performing better for SO4 depends on the month and monitoring network examined.

Across the IMPROVE network, the two models have similar SO4 performance that is very good from January to August, albeit with the CMAQ underestimation and CAMx overestimation tendency mentioned previously. In September and October, the CAMx overestimation tendency becomes greater with the October fractional bias (40%) exceeding the PM performance goal (≤ ±30%). However, for the last two months of the year the CAMx bias is lower than CMAQ.

Across the STN monitoring network the two models SO4 performance is quite good achieving the most stringent ozone model performance goal for most months, again with CMAQ exhibiting and underestimation and CAMx an overestimation tendency; the degradation of the CAMx fractional bias in September and October that was seen across the IMPROVE network is not present across the STN network.

For the first half of 2002, the CAMx exhibits near zero SO4 fractional bias across the CASTNet network that is much lower than CMAQ. During the summer (June-September) both models have near zero fractional bias and error that achieves the PM performance goal. The CAMx October SO4 overestimation bias seen in the IMPROVE network is also present in the CASTNet network resulting in degraded model performance for that month.

The bottom right monthly bar chart in Figure D-3 displays model performance for ammonium (NH4) across the STN network. During the non-summer months, both models exhibit an overestimation bias for NH4, with the CAMx overestimation bias greater than CMAQ. During the summer months the bias is lower with the CAMx performance slightly better than CMAQ.

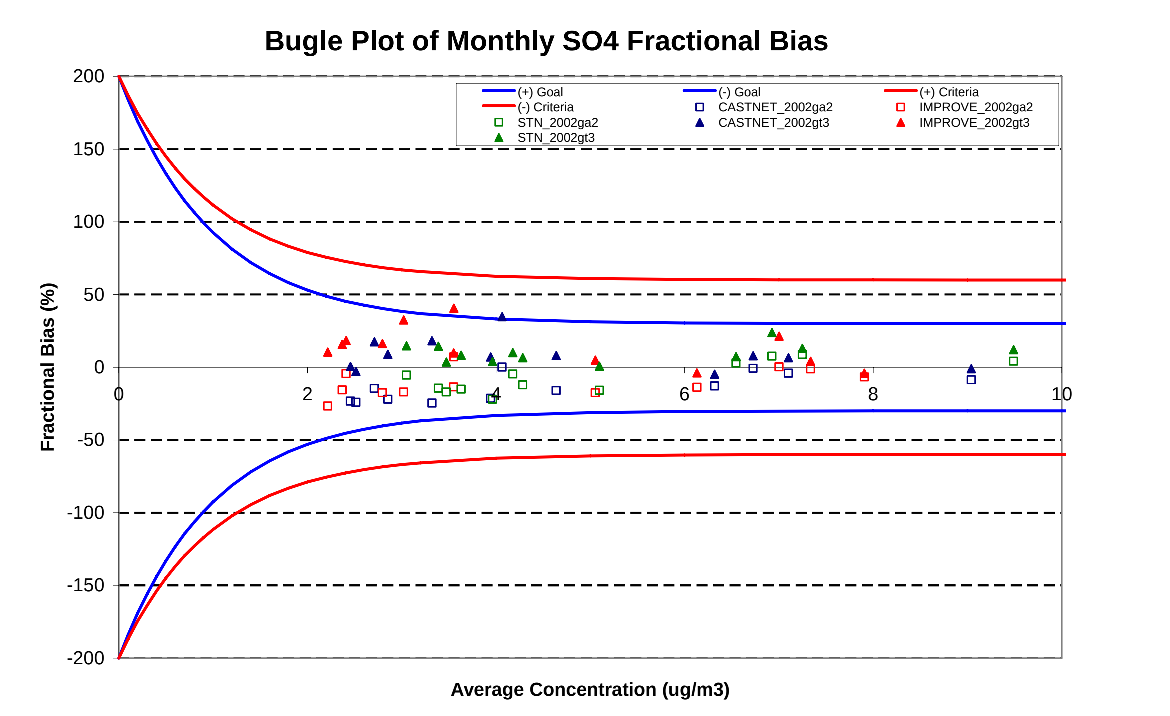
[1] Note that the Speciated Trends Network (STN) is now called the Chemical Speciation Network (CSN)

Figure D-4 displays scatter plots of predicted and observed 24-hour SO4 (IMPROVE and STN) and weekly SO4 (CASTNet) SO4 concentrations and 24-hour STN NH4 concentrations for January, April, July and October, 2002. In January (Figure D-4a), the SO4 performance of the two models is similar with both models always achieving the PM performance goals and both models achieving the more stringent ozone performance goal across the STN network, with the CAMx model also achieving it across the CASTNet network.

The CMAQ and CAMx SO4 performance is also very good in April with both models achieving the ozone model performance goal across all three monitoring networks. Similarly, in July the model performance of both models is very good and, with the exception of fractional error across the IMPROVE network, achieves the most stringent ozone performance goal; the CMAQ and CAMx fractional error values across the IMPROVE network were 36% and 39% that just barely exceeds the ozone performance goal (≤35%).

In October, the CAMx increase in SO4 overestimation tendency results in degraded SO4 model performance across the IMPROVE and CASTNet networks, although SO4 performance of both models using the STN network is quite good. The reason for the CAMx degraded SO4 model performance in October is unclear, but it appears to be an isolated occurrence to this month for the more rural IMPROVE and CASTNet monitors.

In conclusion, based on the fractional bias and error statistical performance measures the performance of both the CMAQ and CAMx models for simulating SO4 concentrations across the CAMx 12 km KY/TN/WV modeling domain can be characterized as being very good. The CMAQ model tends to have an underestimation tendency, whereas the CAMx model tends to have an overestimation tendency. For most months the two models achieve the most stringent ozone performance goal and, except for the CAMx October performance, always achieve the PM performance goal.



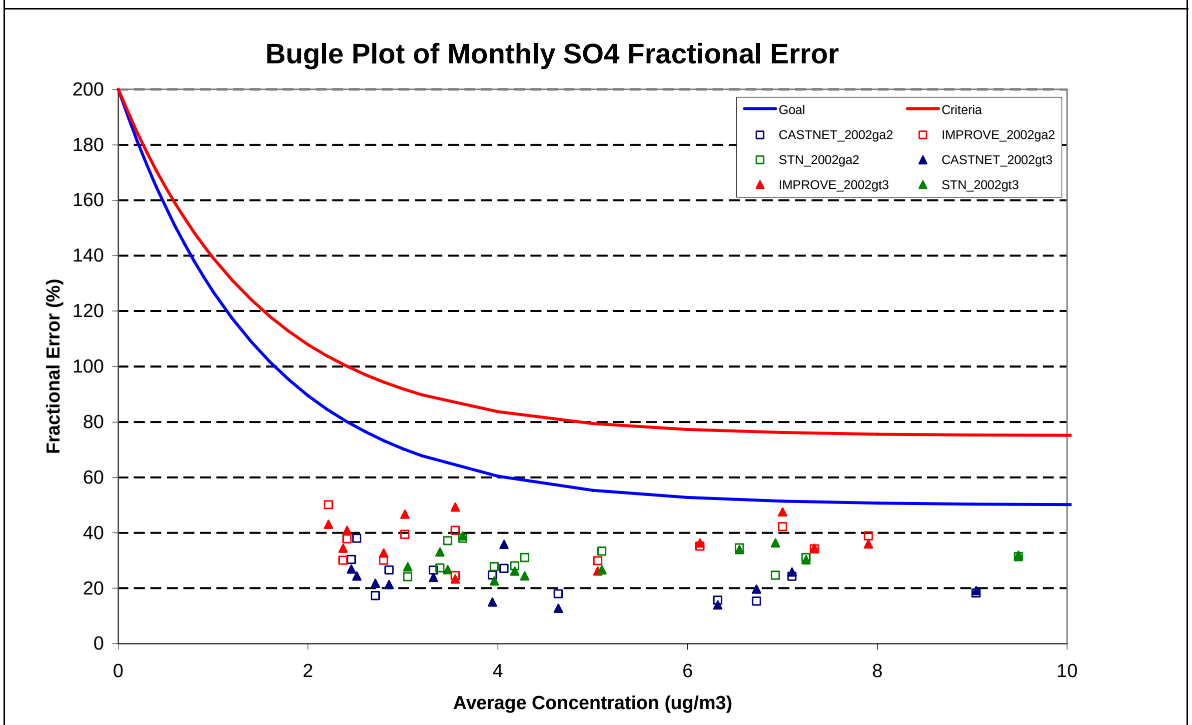


Figure D-2. Bugle Plot of monthly Fractional Bias (top) and Error (bottom) for CMAQ and CAMx estimated sulfate (SO4) concentrations across the CAMx 12 km domain.

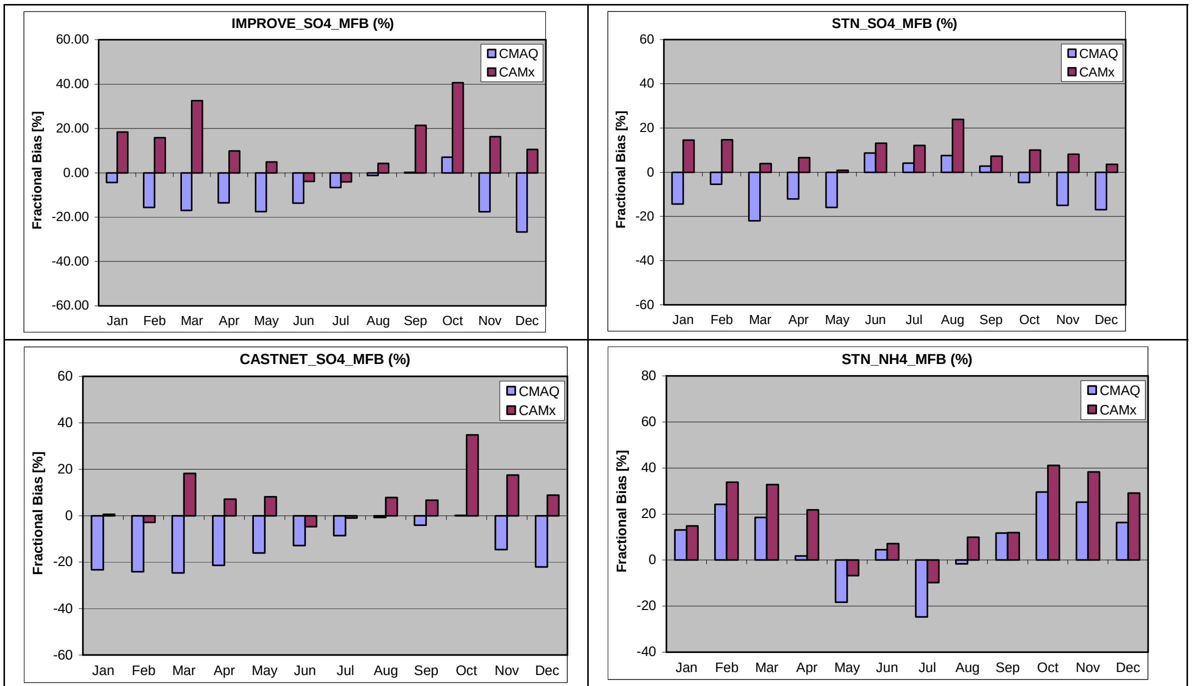


Figure D-3a. Monthly Fractional Bias across the 12 km CAMx domain for the CMAQ 12 km and CAMx 12/4 km 2002 Base G2 base case and for IMPROVE SO4 (top left), STN SO4 (top right), CASTNet SO4 (bottom left) and STN NH4 (bottom right).

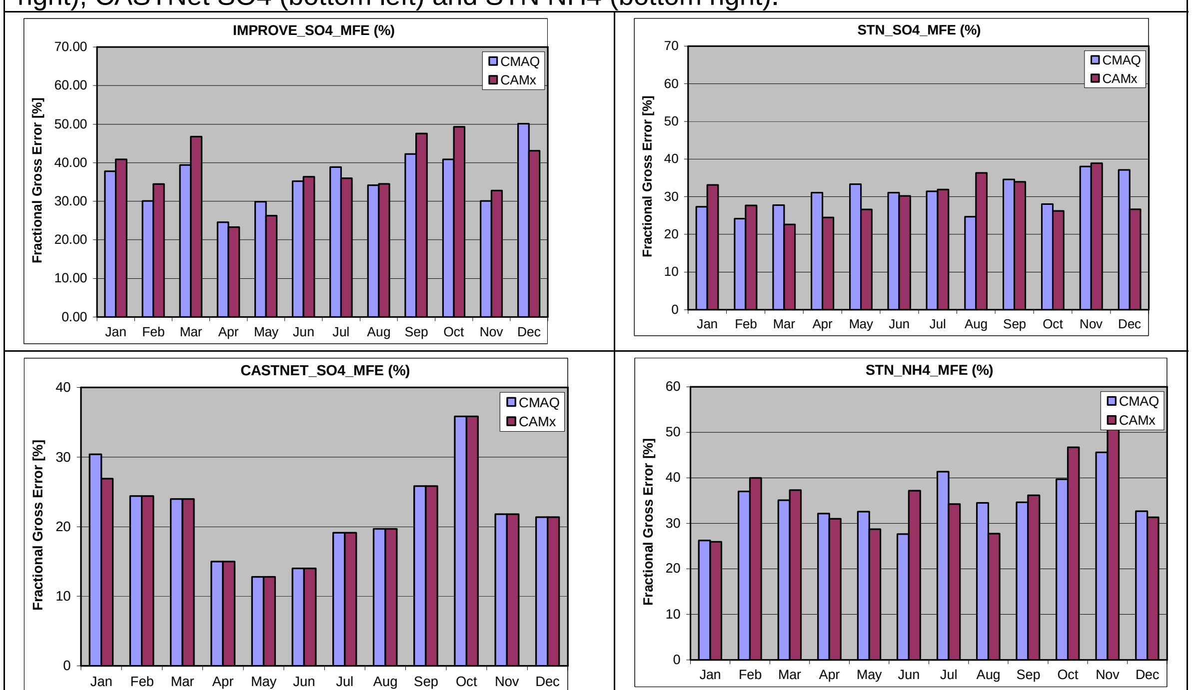


Figure D-3b. Monthly Fractional Error across the 12 km CAMx domain for the CMAQ 12 km and CAMx 12/4 km 2002 Base G2 base case and for IMPROVE SO4 (top left), STN SO4 (top right), CASTNet SO4 (bottom left) and STN NH4 (bottom right).

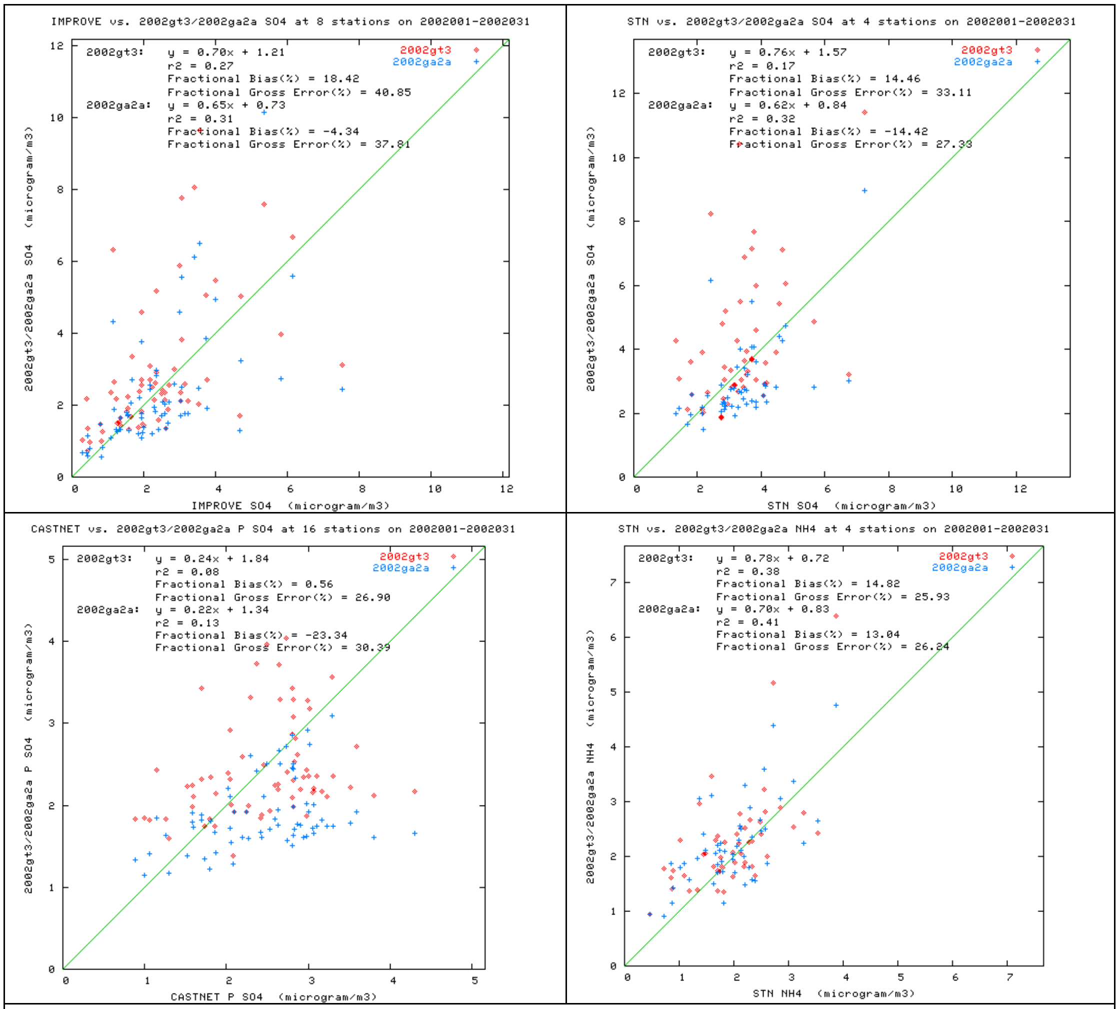


Figure D-4a. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain using the IMPROVE SO4 (top left), STN SO4 (top right), CASTNet SO4 (bottom left) and STN NH4 (bottom right) during January 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

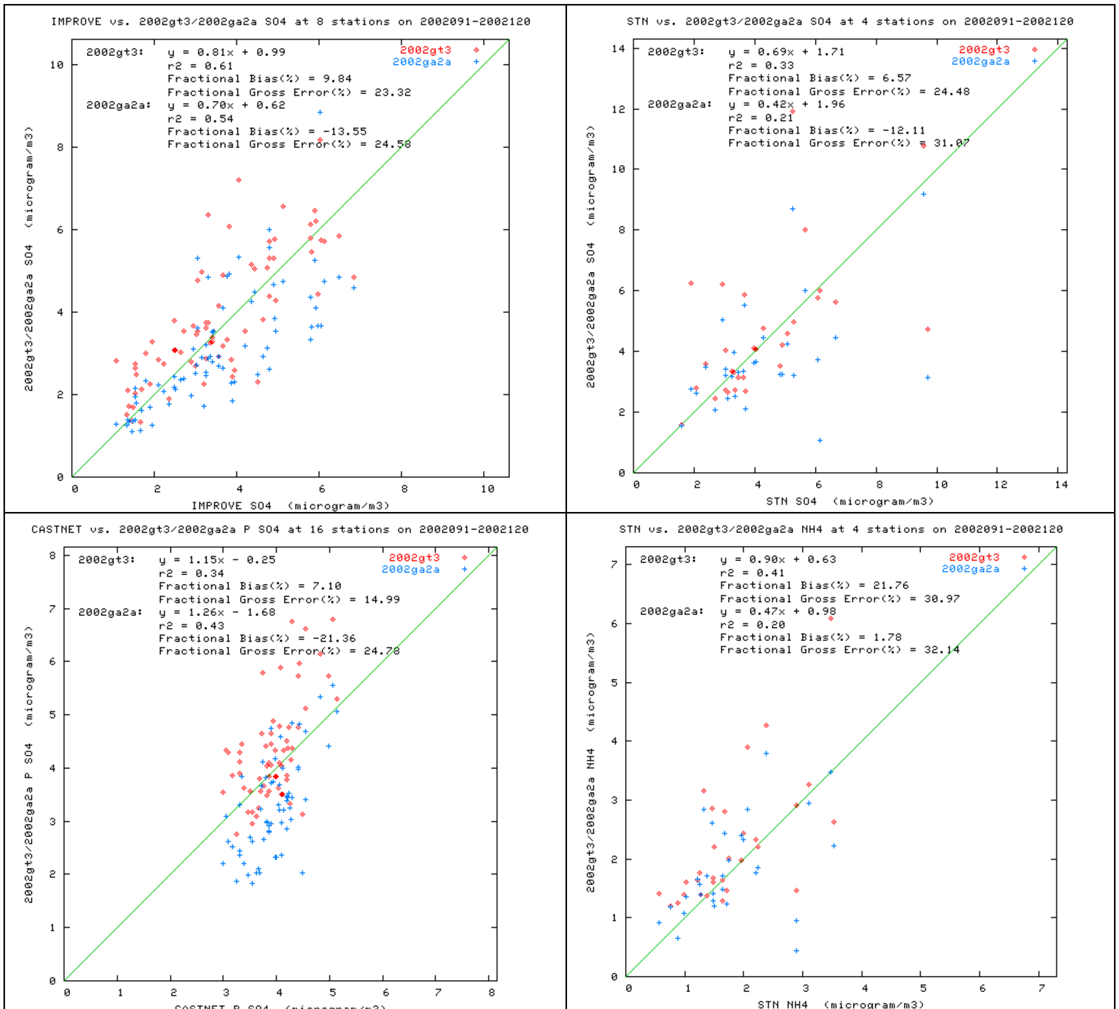


Figure D-4b. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain using the IMPROVE SO4 (top left), STN SO4 (top right), CASTNet SO4 (bottom left) and STN NH4 (bottom right) during April 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

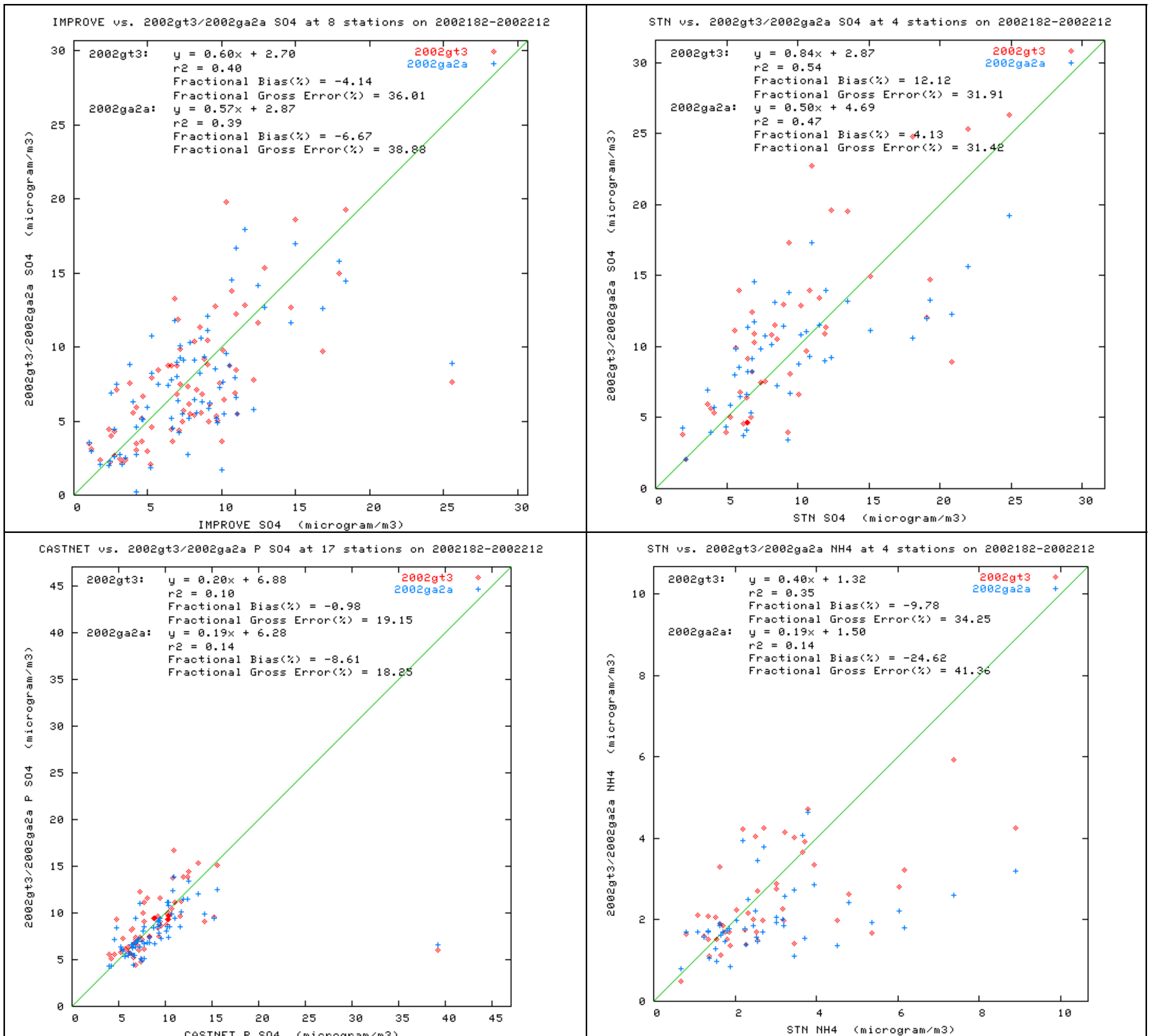


Figure D-4c. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain using the IMPROVE SO4 (top left), STN SO4 (top right), CASTNet SO4 (bottom left) and STN NH4 (bottom right) during July 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

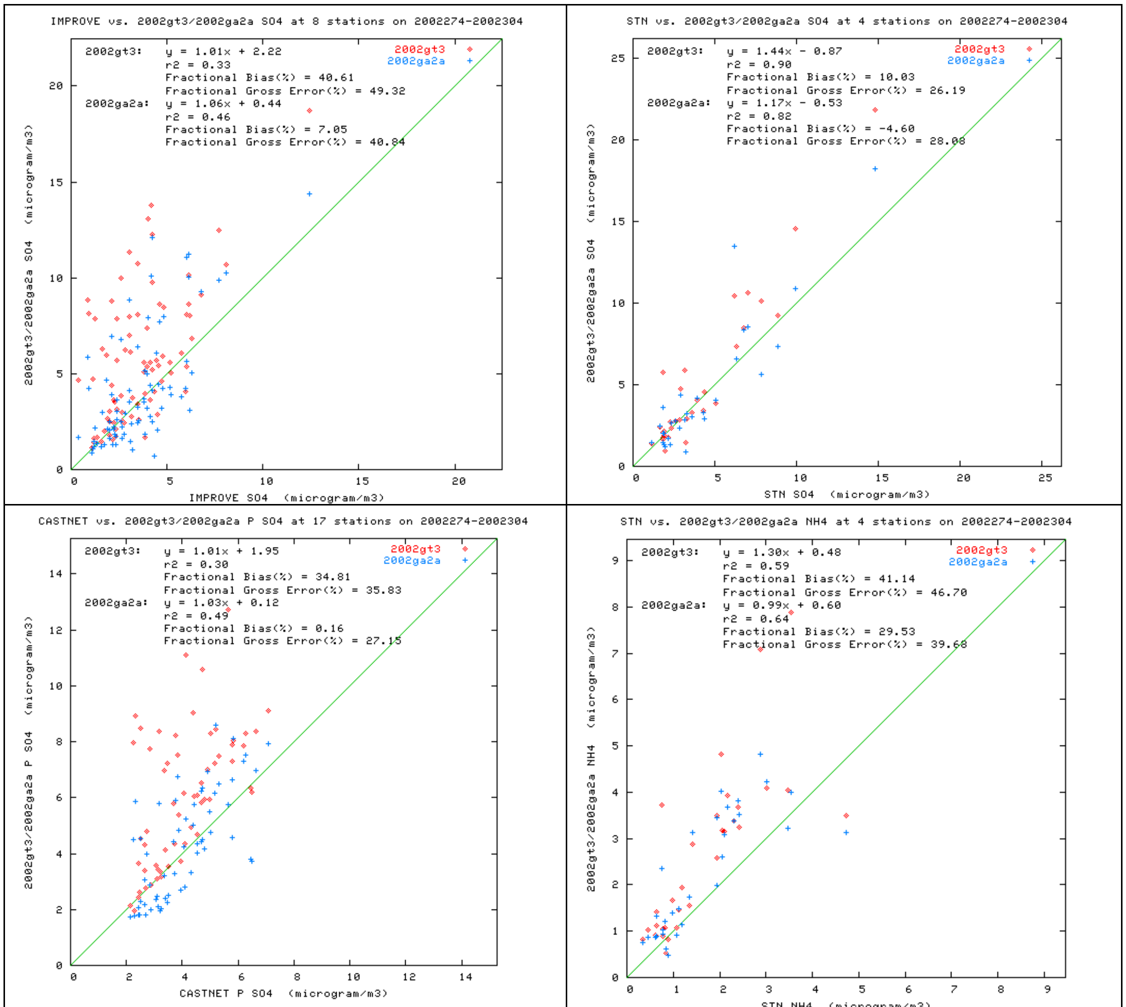


Figure D-4d. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain using the IMPROVE SO4 (top left), STN SO4 (top right), CASTNet SO4 (bottom left) and STN NH4 (bottom right) during October 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

D.2.2 NO3 Model Performance Across the CAMX 12 km Domain

The monthly Bugle, Time Series and Scatter Plots of model performance for particulate nitrate (NO3) are shown in, respectively, Figures D-5, D-6 and D-7. As seen for the CMAQ performance discussed in Chapter 3 and Appendices B and C, the NO3 performance is not as good as seen for SO4. Both models exhibit a general winter overestimation and summer underestimation bias. This results in the NO3 performance for both models exceeding the PM performance goal, and even the PM performance criteria on occasion (Figure D-5). Although the summer underestimation bias is greater in magnitude than the winter overestimation bias, it occurs when the observed NO3 concentrations are very low so is not as big of a concern (Figure D-5).

The Scatter Plots in Figure D-7 display the predicted and observed NO3 comparisons for four months and across the IMPROVE, STN and CASTNet networks, as well as a Scatter Plot for total nitrate (NO3+HNO3) across the CASTNet network (bottom right in Figure D-7). An examination of the performance for total nitrate allows an assessment of whether any NO3 model performance issues may be due to an incorrect characterization of the oxidation of NOx to nitric acid and/or an incorrect thermodynamic partitioning between gaseous HNO3 and particulate NO3. For January, April and July, the CMAQ and CAMx model performance for total nitrate is quite good suggesting that the model's NO3 performance issues for these months may be more due to the partitioning of total nitrate. Errors in meteorology, such as temperature and relative humidity, ammonia emissions, and sulfate all affect this partitioning. In October, both models overestimate total nitrate across the CASTNet network, as well as overestimating particulate NO3. For October, this suggests too much oxidation of NOx to nitric acid is also occurring; overstated photochemical activity in October is also consistent with the CAMx SO4 overestimation bias for that month.

In summary, NO3 performance by both models is characterized by a summer underprediction and winter overprediction bias, with the summer underprediction bias being more severe. However, the summer underprediction bias is not that important as it occurs when the observed NO3 is very low ($< 1\ \mu g/m^3$). When NO3 concentrations are higher in the winter and adjacent months, the model performance is better usually achieving the PM model performance goal and almost always achieving the PM model criteria. This is illustrated in the Bugle Plot in Figure D-5 where the high fractional bias and error values occur under low NO3 concentrations so are plotted in the flared area of the performance goal and criteria thereby achieving the PM performance goal and criteria.

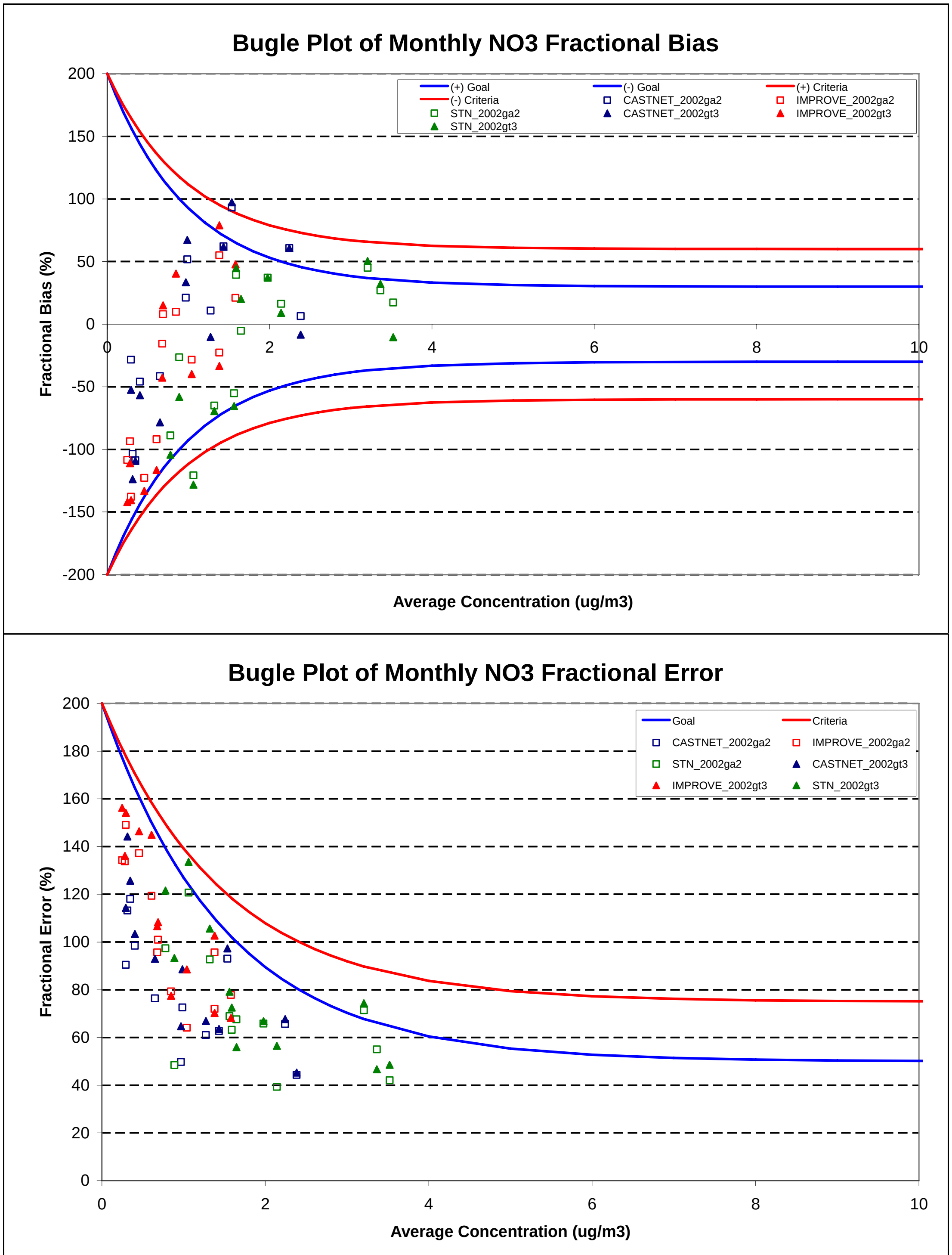


Figure D-5. Bugle Plot of monthly Fractional Bias (top) and Error (bottom) for CMAQ and CAMx estimated nitrate (NO3) concentrations across the CAMx 12 km domain.

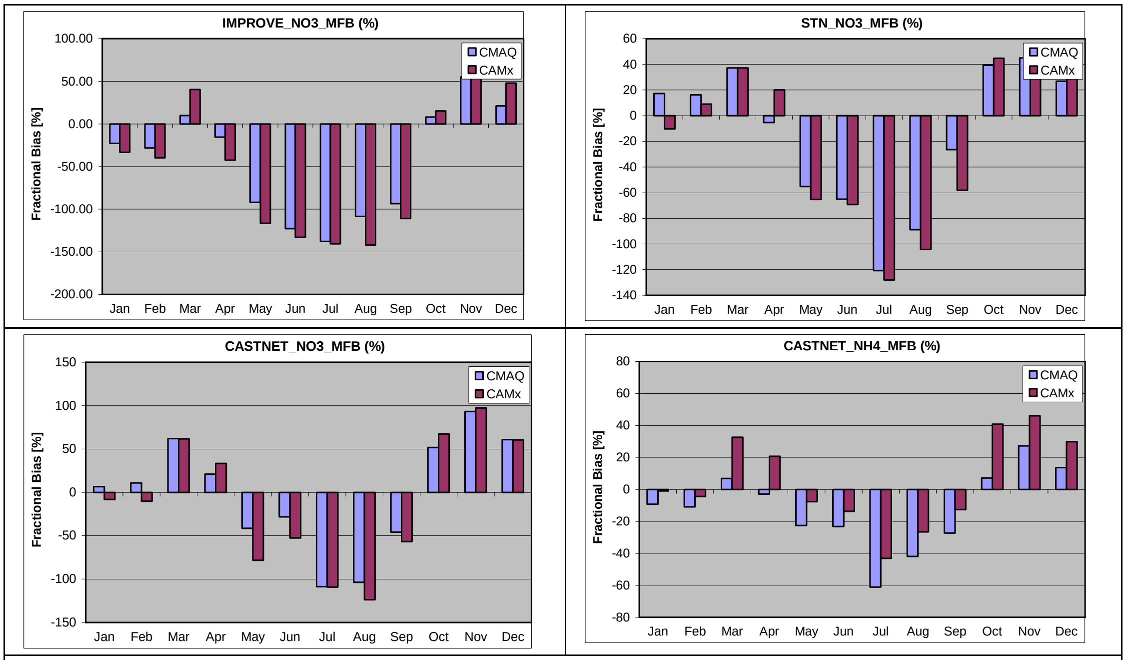


Figure D-6a. Monthly Fractional Bias across the 12 km CAMx domain for the CMAQ 12 km and CAMx 12/4 km 2002 Base G2 base case and the IMPROVE NO3 (top left), STN NO3 (top right), CASTNet NO3 (bottom left) and CASTNet NH4 (bottom right).

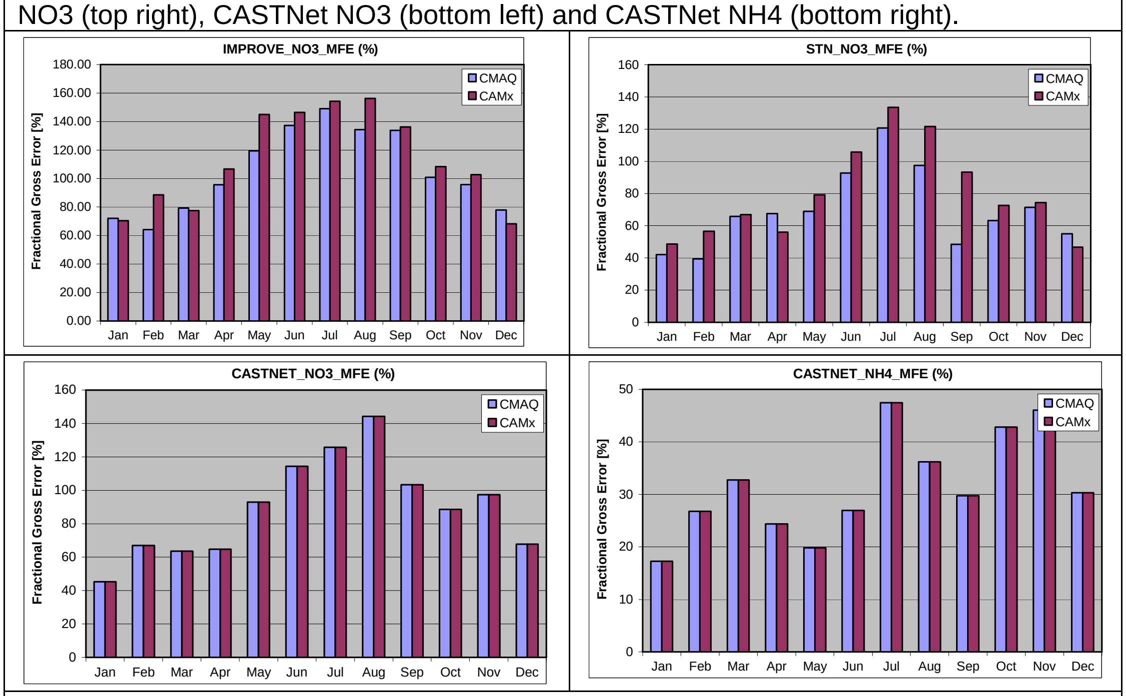


Figure D-6b. Monthly Fractional Error across the 12 km CAMx domain for the CMAQ 12 km and CAMx 12/4 km 2002 Base G2 base case and the IMPROVE NO3 (top left), STN NO3 (top right), CASTNet NO3 (bottom left) and CASTNet NH4 (bottom right).

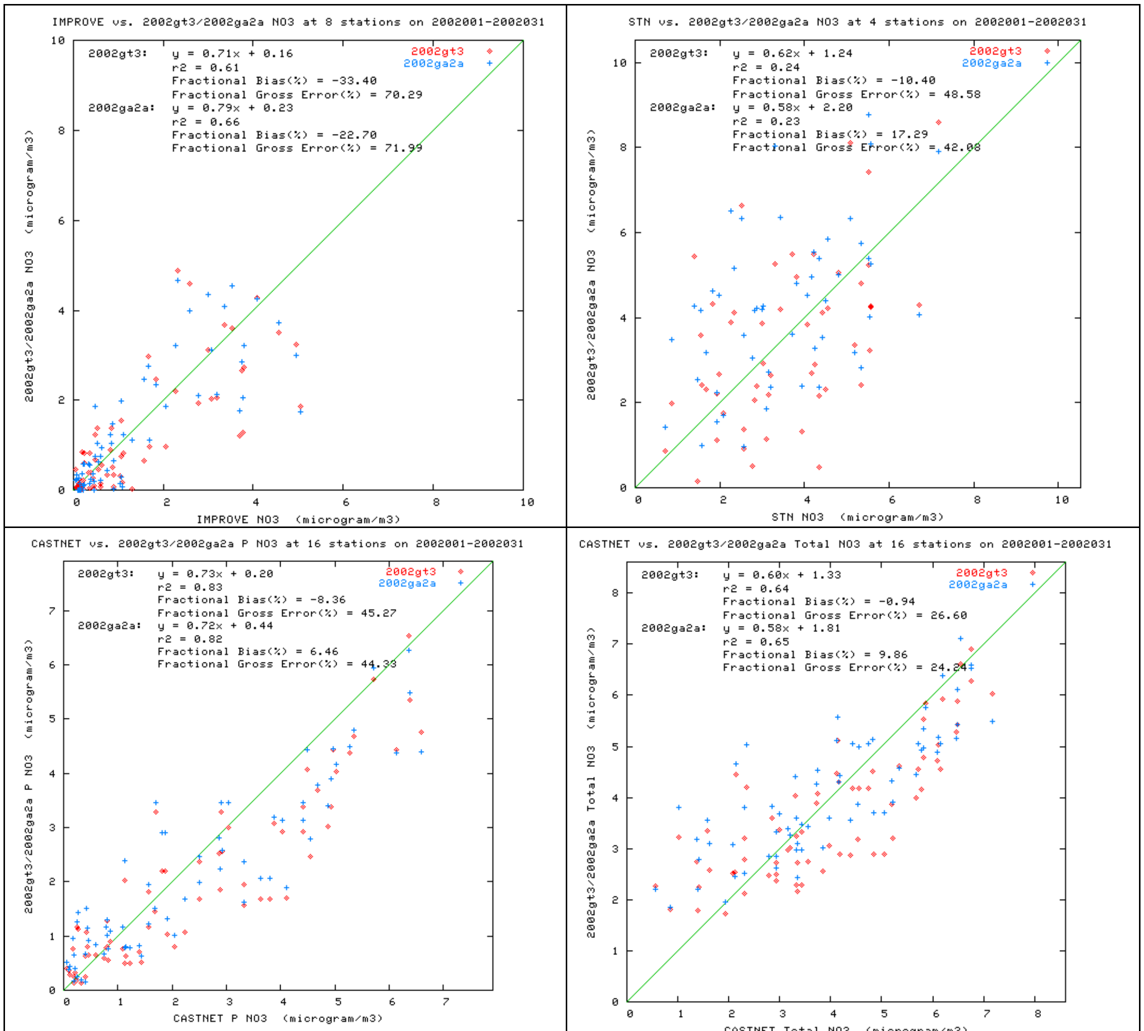


Figure D-7a. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain for IMPROVE NO3 (top left), STN NO3 (top right), CASTNet NO3 (bottom left) and CASTNet TNO3 (bottom right) during January 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

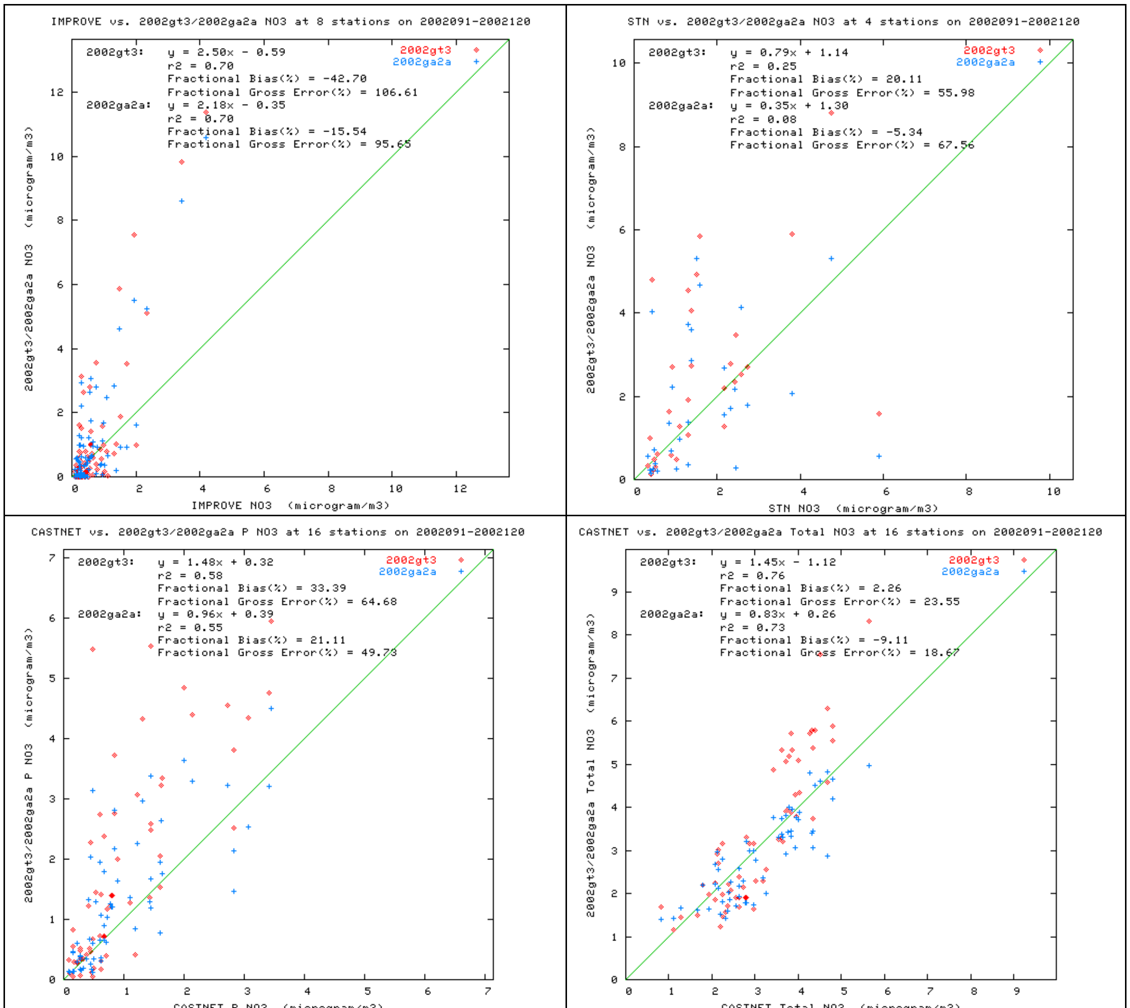


Figure D-7b. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain for IMPROVE NO3 (top left), STN NO3 (top right), CASTNet NO3 (bottom left) and CASTNet TNO3 (bottom right) during April 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

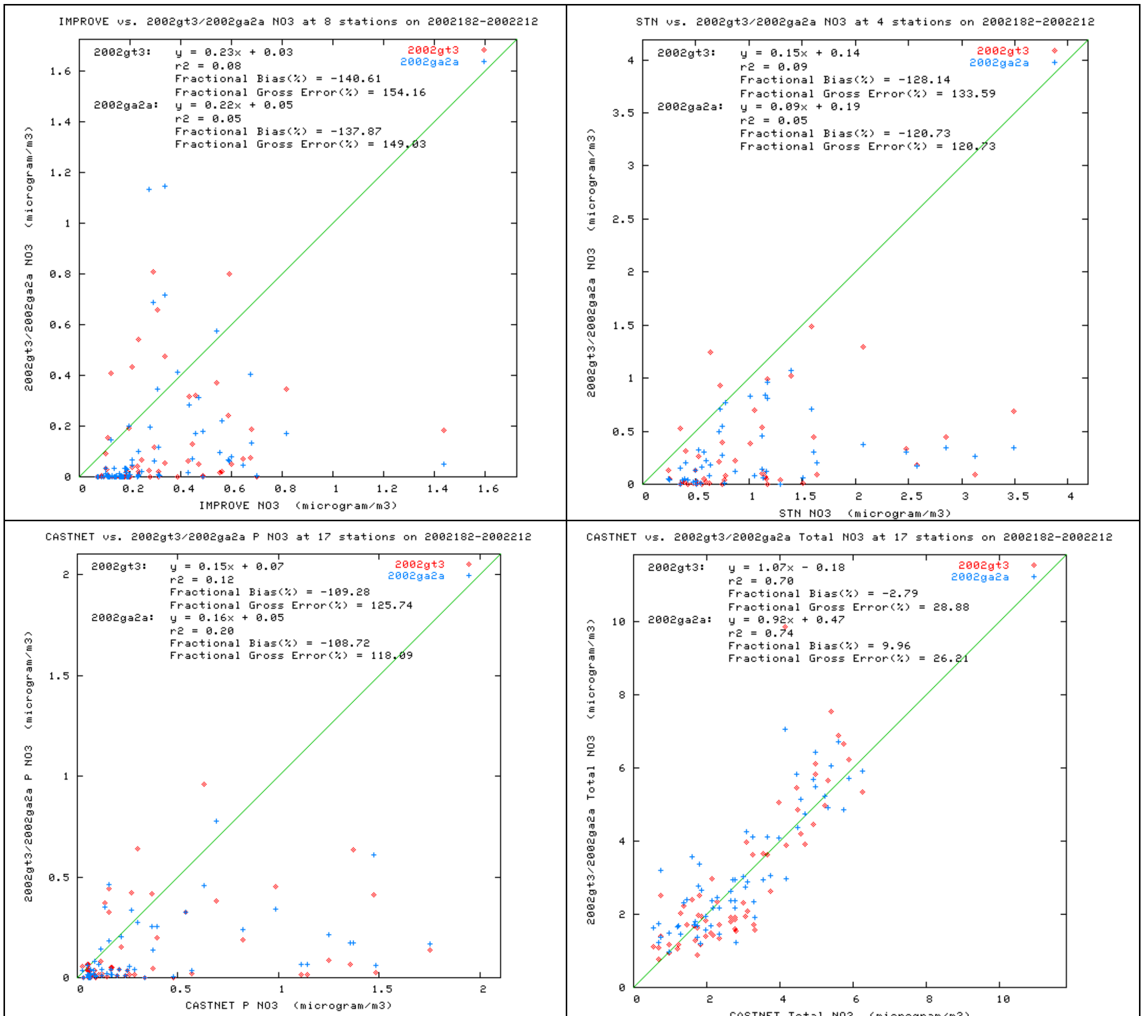


Figure D-7c. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain for IMPROVE NO3 (top left), STN NO3 (top right), CASTNet NO3 (bottom left) and CASTNet TNO3 (bottom right) during July 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

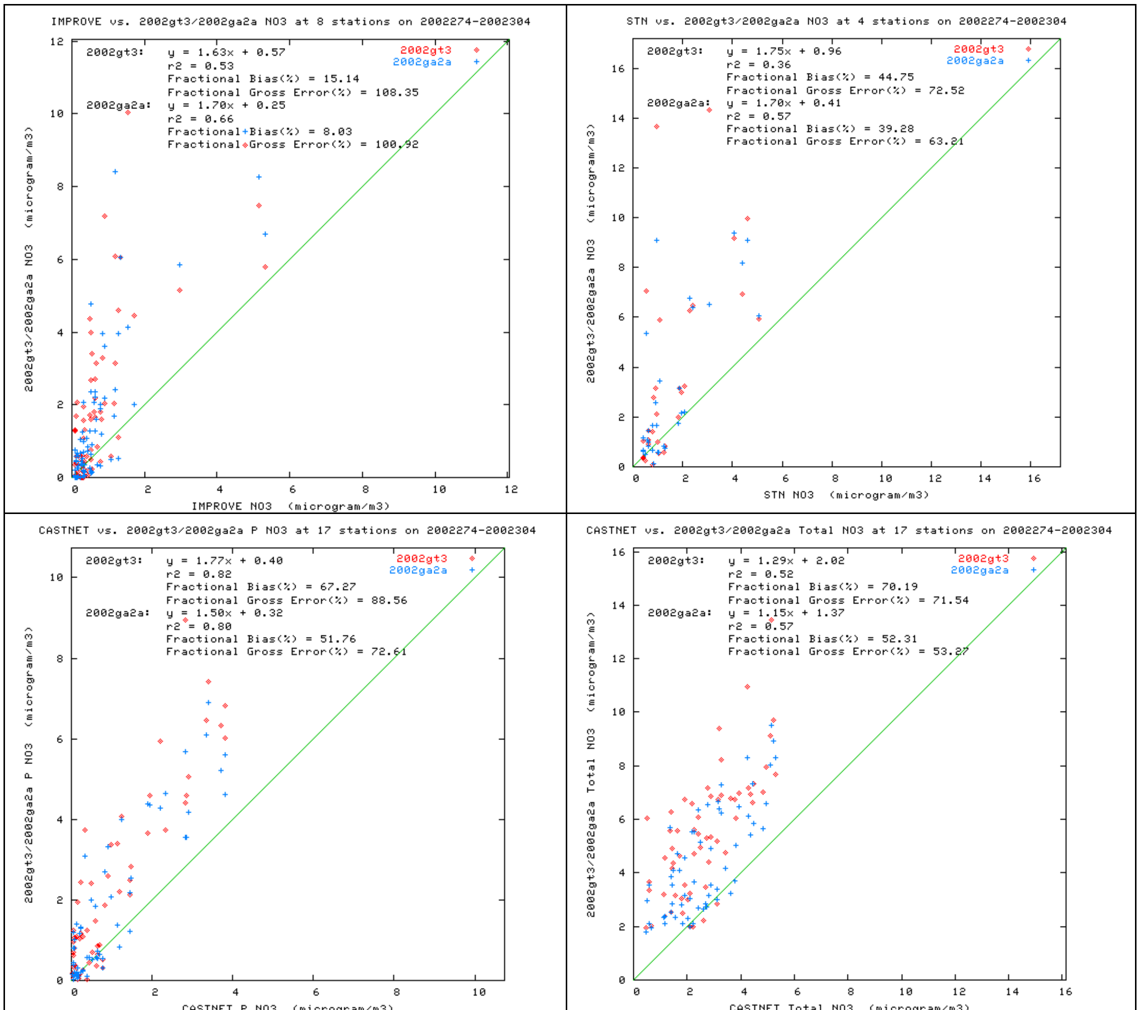


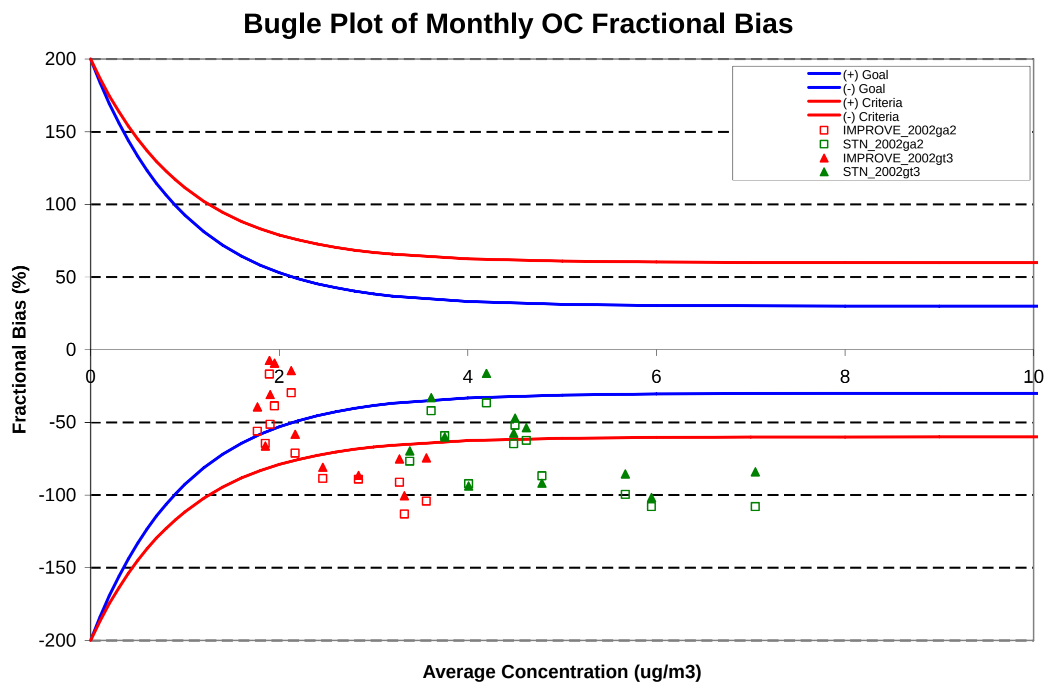
Figure D-7d. Scatter plots of predicted and observed SO4 and NH4 concentrations across the CAMx 12 km domain for IMPROVE NO3 (top left), STN NO3 (top right), CASTNet NO3 (bottom left) and CASTNet TNO3 (bottom right) during October 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

D.2.3 Particulate Carbon Model Performance Across the CAMx 12 km Domain

The performance of the CMAQ and CAMx models for Organic Carbon Mass (OCM) and Elemental Carbon (EC) using the IMPROVE and STN observations is given in Figures D-8, D-9 and D-10. OCM is usually one of the two most important components of $PM_{2.5}$ mass in the ASIP region. It is made up of numerous components, including primary OCM from combustion, biomass burning, meat cooking and vegetation detritus and secondary organic aerosols (SOA) from biogenic and anthropogenic VOC emissions. Consequently, numerous emissions and atmospheric processes need to be simulated correctly to achieve good OCM performance and since routine OCM measurements do not distinguish between these different forms of OCM, there is the potential for introducing compensatory errors with one component of OCM compensating for an overestimation or underestimation of another. An added complication to the OCM evaluation is that the observations measure just the Organic Carbon (OC) portion of OCM and the additional components of OCM (e.g., oxygen) must be accounted for through a scaling factor. In this evaluation we used an OCM/OC scaling factor of 1.4. The OCM/OC ratio generally varies from 1.2 to 2.2 with lower values for fresh OCM emissions (e.g., urban areas) and larger ratios for more aged air masses that have been photochemical processed (e.g., rural areas). Thus, the 1.4 OCM/OC ratio is probably appropriate for the urban STN monitors, but is likely too low for the more rural IMPROVE monitors. In fact, the new IMPROVE equation uses an OCM/OC ratio of 1.8.

Given the above uncertainties, the OCM evaluation is less certain than other PM components. However, it is clear that both the CMAQ and CAMx models underestimate OCM concentrations across the CAMx 12 km domain at both the more rural IMPROVE as well as more urban STN monitoring sites. This underprediction tendency is greatest in the summer with the CMAQ model exhibiting a slightly more severe underestimation bias than CAMx. The summer period is when OCM and SOA is the highest so such underpredictions could suggest insufficient SOA formation. The summer OCM underprediction is severe enough that both the CMAQ and CAMx models fail to achieve PM performance criteria (Figure D-8a).

The two models' performance for EC is generally characterized by a summer underestimation bias across the more rural IMPROVE and a winter and adjacent months overestimation bias across the more urban STN network. CAMx tends to estimate higher EC concentrations than CMAQ so the summer EC underestimation bias is not as severe as seen for CMAQ. On the other hand, the CAMx EC overestimate bias across the STN network is more severe than seen for CMAQ. These results are also seen in the Scatter plots in Figure D-10.



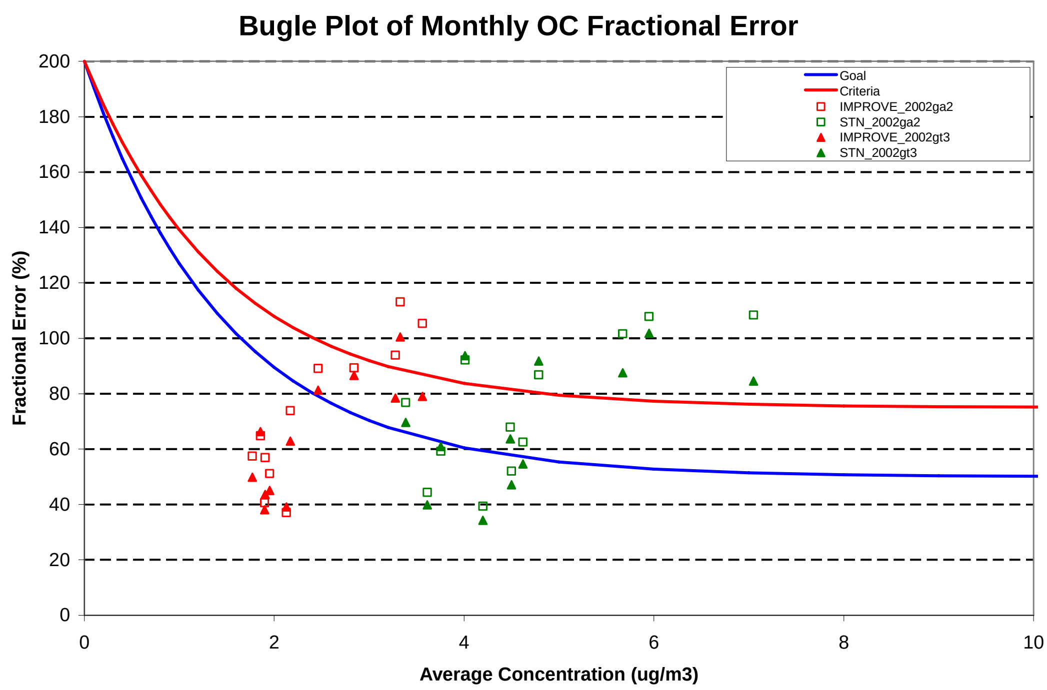
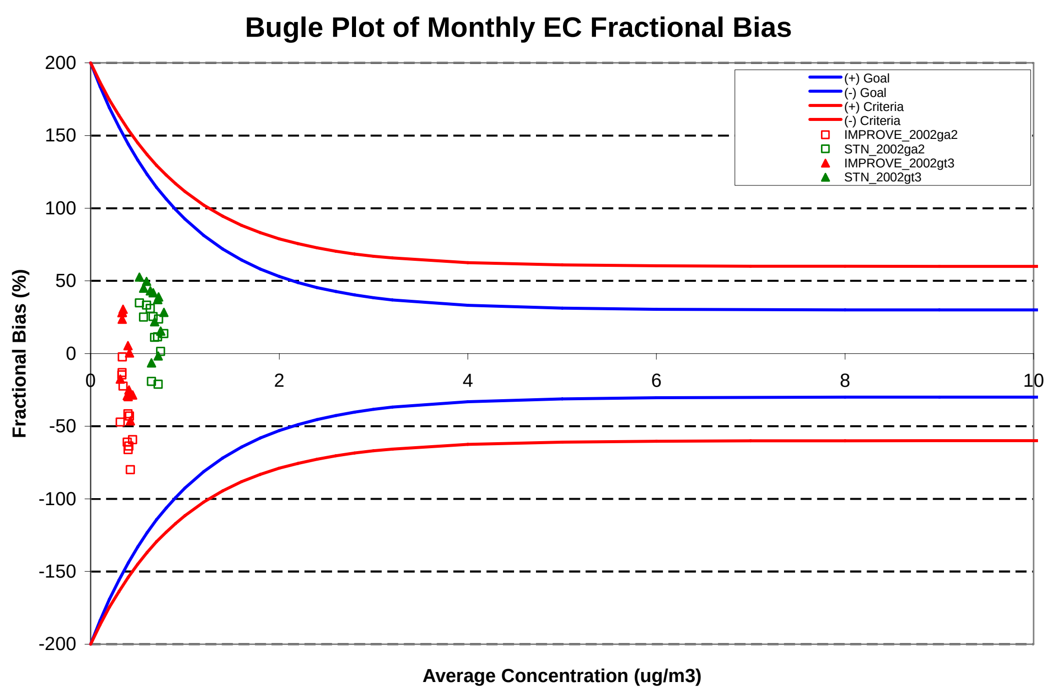


Figure D-8a. Bugle Plot of monthly Fractional Bias (top) and Error (bottom) for CMAQ and CAMx estimated Organic Carbon Mass (OCM) concentrations across the CAMx 12 km domain.



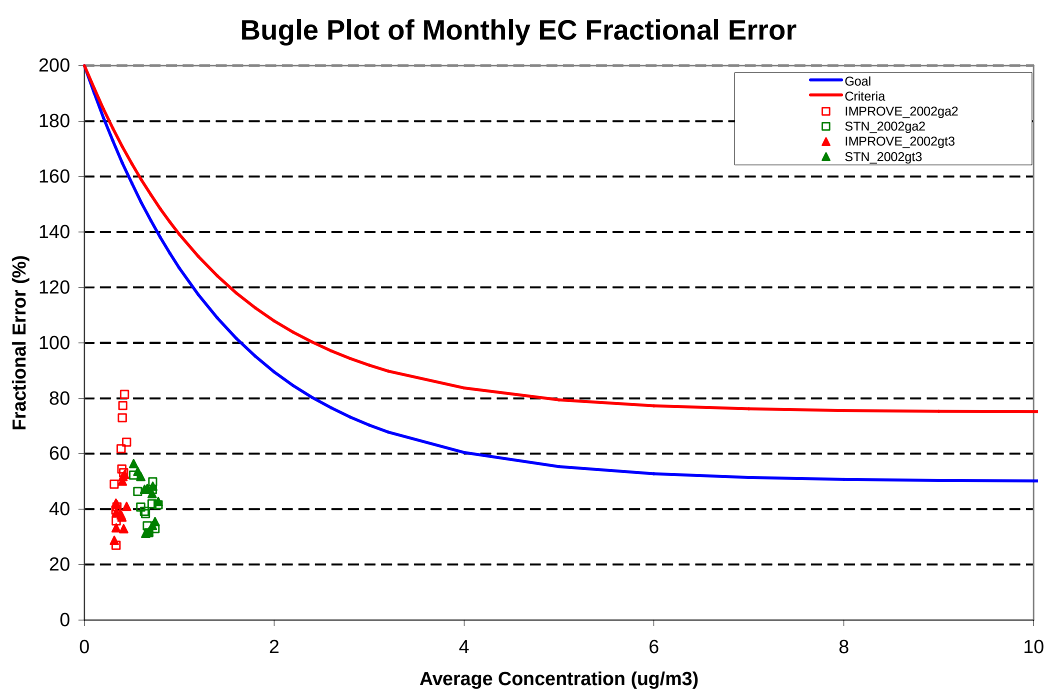


Figure D-8b. Bugle Plot of monthly Fractional Bias (top) and Error (bottom) for CMAQ and CAMx estimated Elemental Carbon (EC) concentrations across the CAMx 12 km domain.

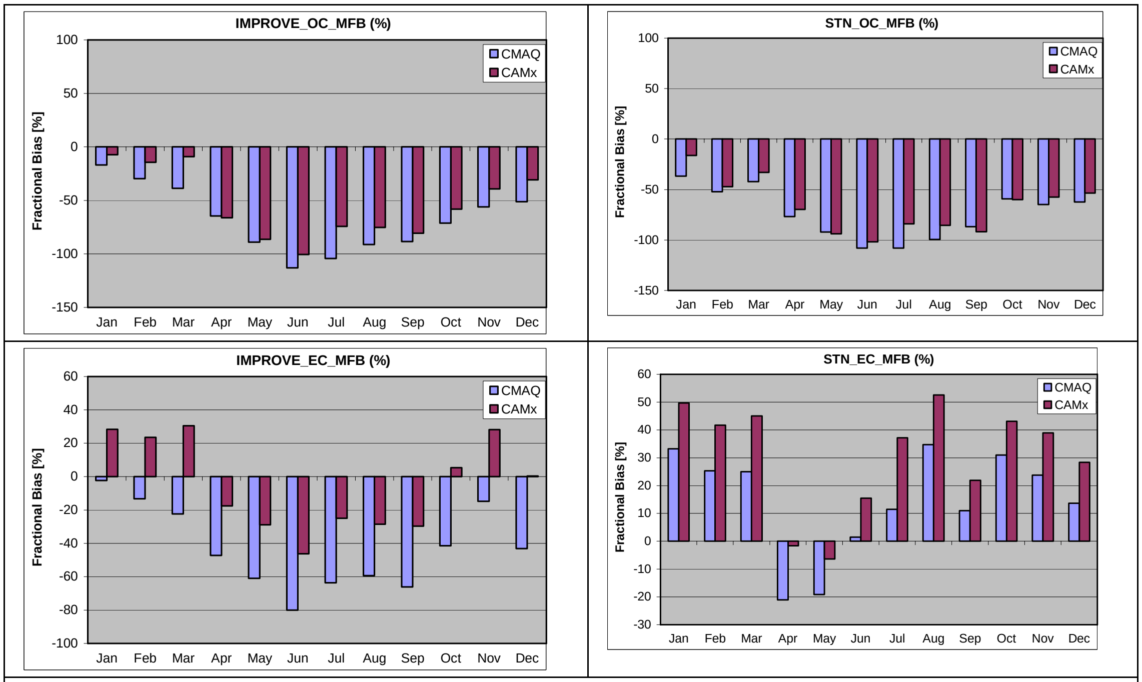


Figure D-9a. Monthly Fractional Bias across the 12 km CAMx domain for the CMAQ 12 km and CAMx 12/4 km 2002 Base G2 base case simulations and for IMPROVE OCM (top left), STN OCM (top right), IMPROVE EC (bottom left) and STN EC (bottom right).

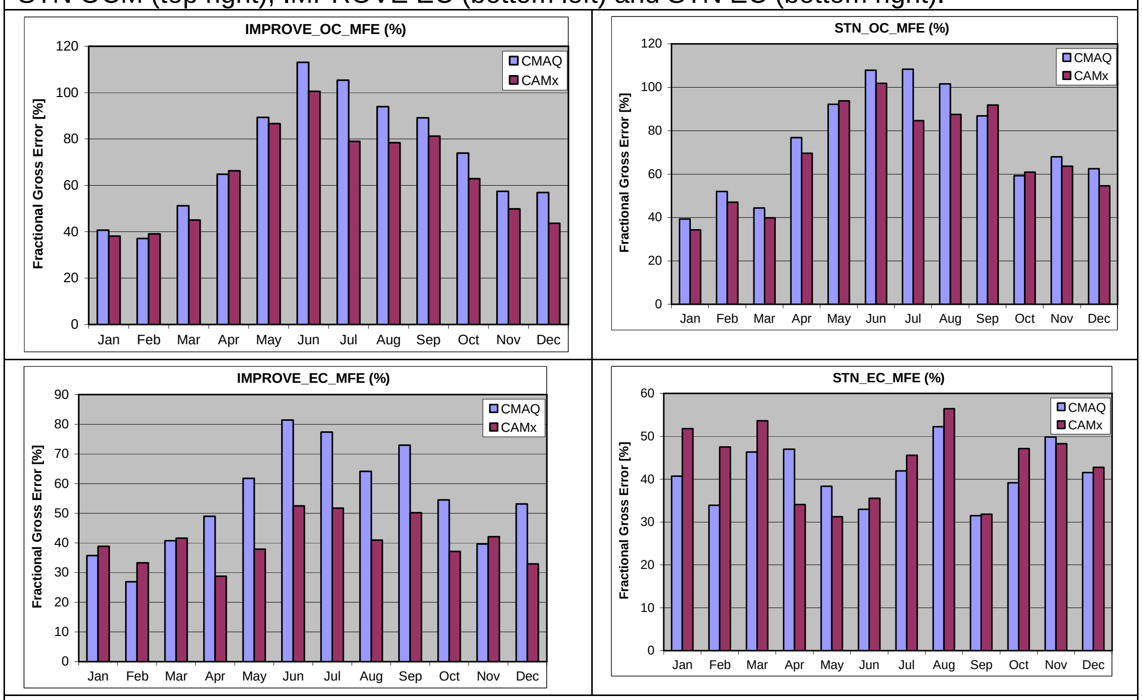


Figure D-9b. Monthly Fractional Error across the 12 km CAMx domain for the CMAQ 12 km and CAMx 12/4 km 2002 Base G2 base case simulations and for IMPROVE OCM (top left), STN OCM (top right), IMPROVE EC (bottom left) and STN EC (bottom right).

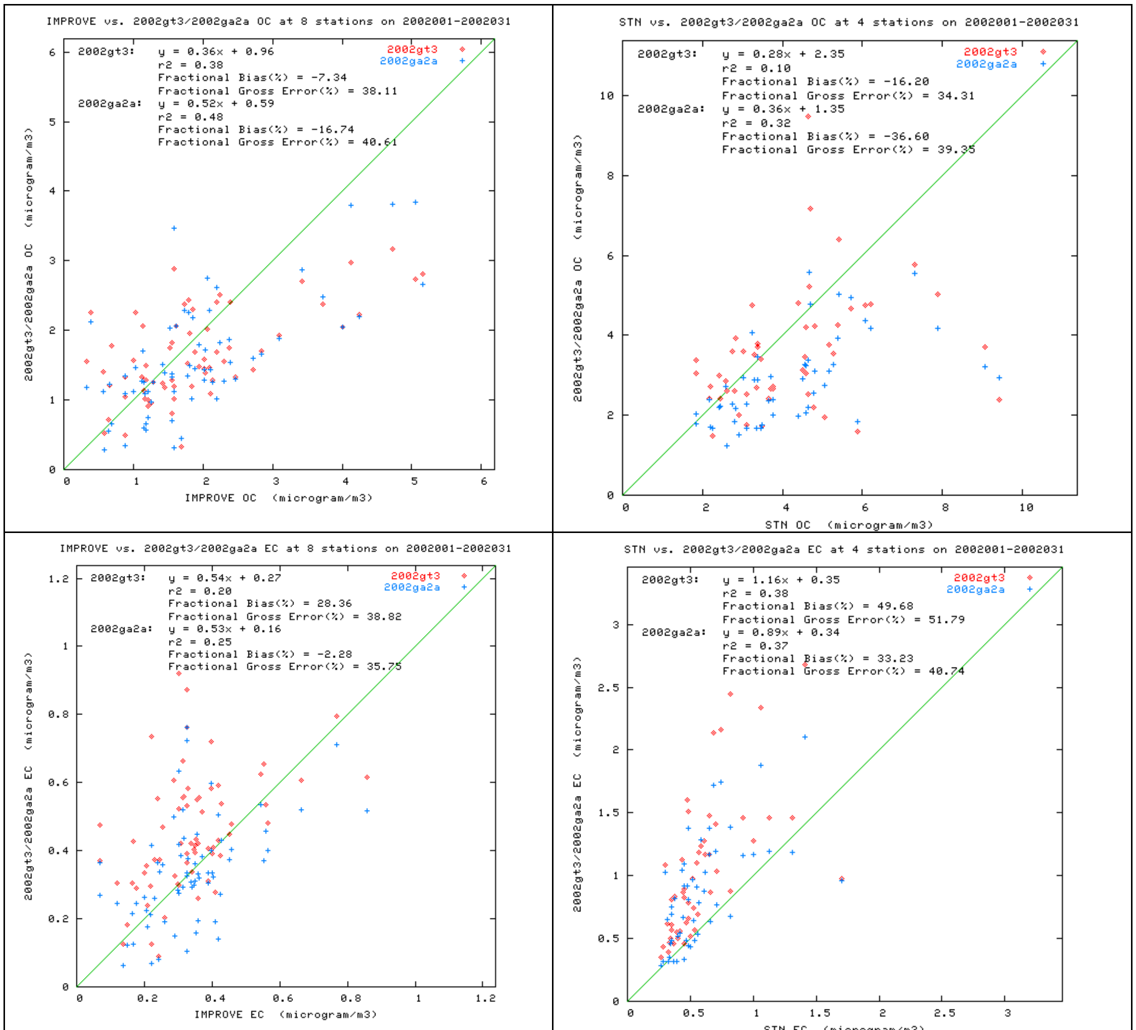


Figure D-10a. Scatter plots of predicted and observed OCM and EC concentrations across the CAMx 12 km domain for IMPROVE OCM (top left), STN OCM (top right), IMPROVE EC (bottom left) and STN EC (bottom right) during January 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

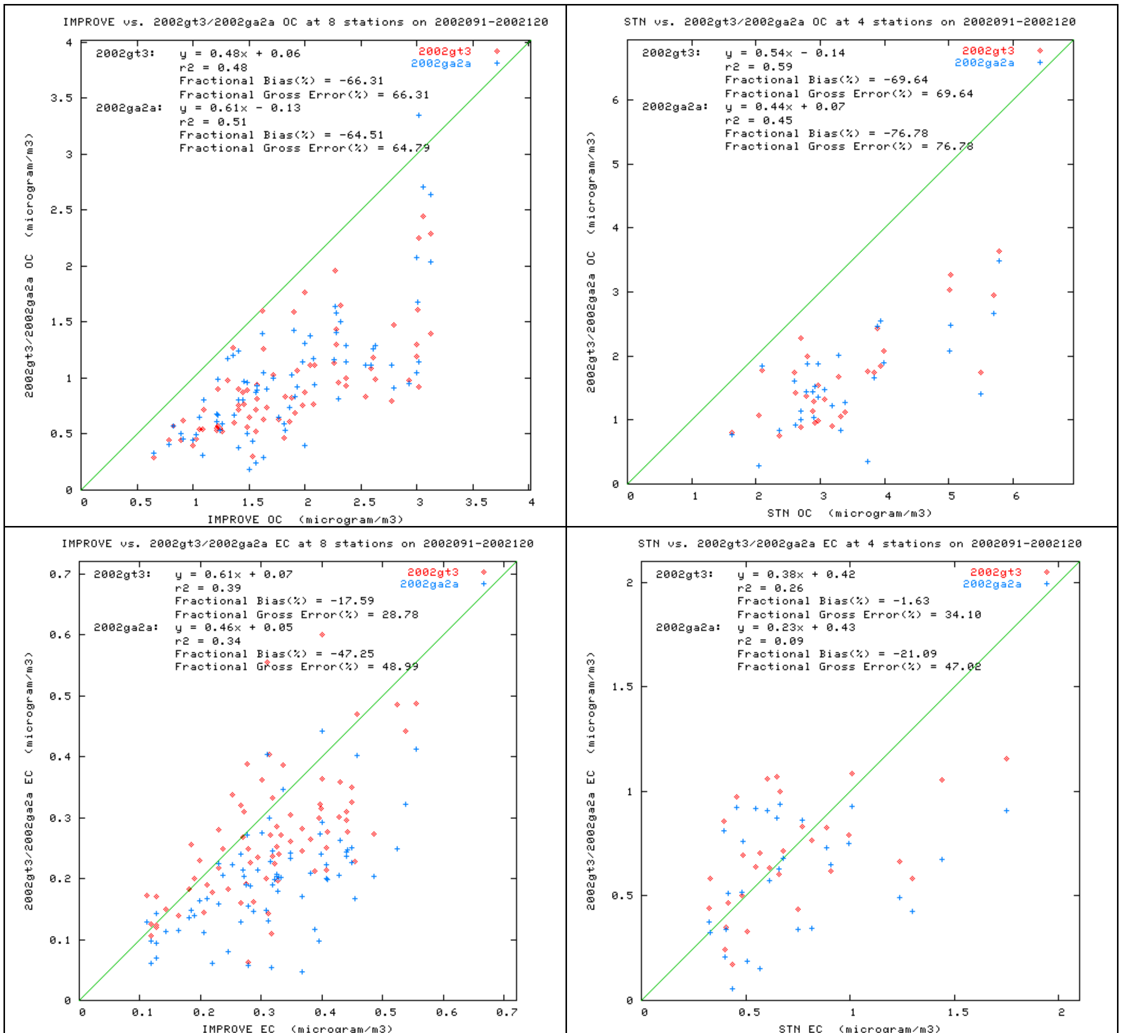


Figure D-10b. Scatter plots of predicted and observed OCM and EC concentrations across the CAMx 12 km domain for IMPROVE OCM (top left), STN OCM (top right), IMPROVE EC (bottom left) and STN EC (bottom right) during April 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

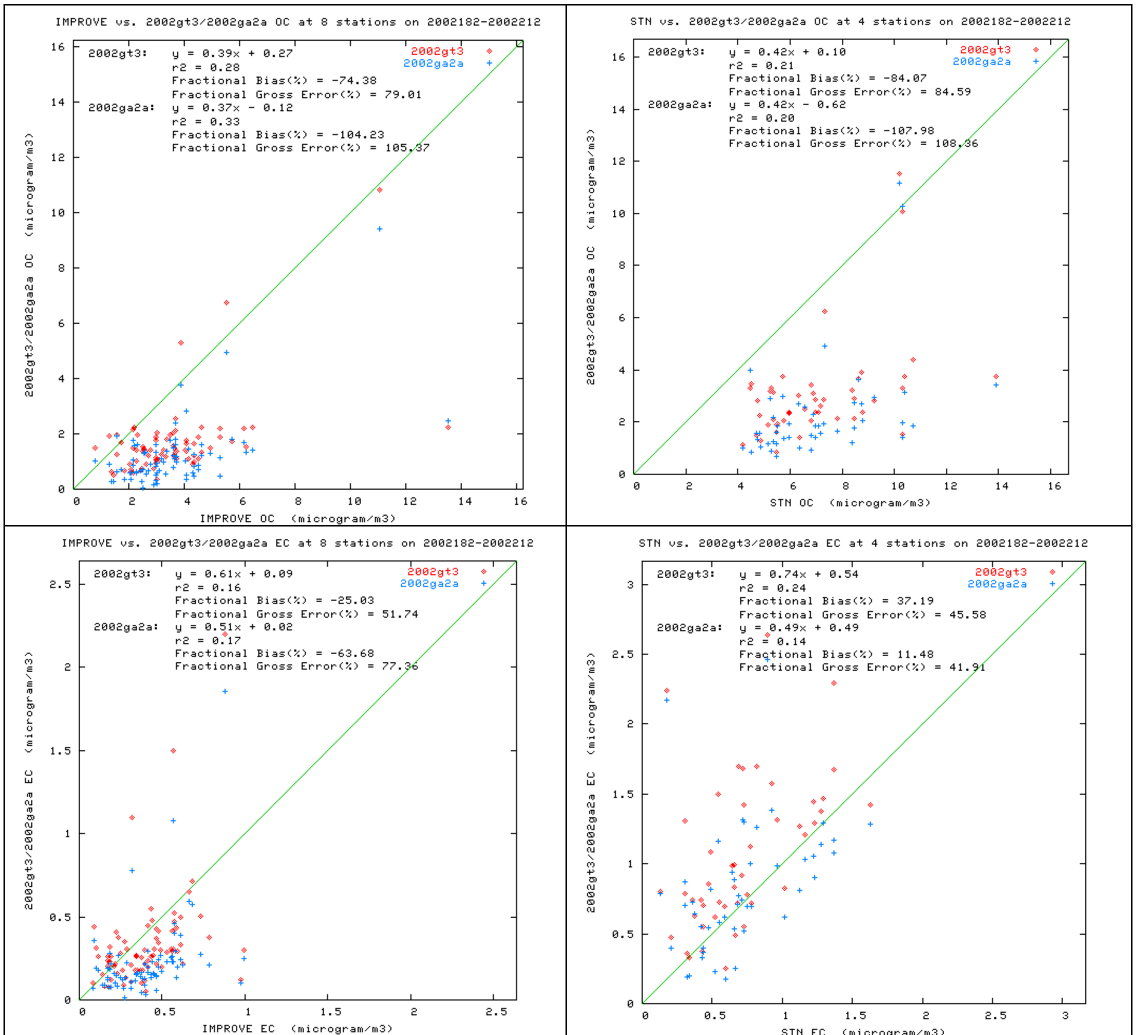


Figure D-10c. Scatter plots of predicted and observed OCM and EC concentrations across the CAMx 12 km domain for IMPROVE OCM (top left), STN OCM (top right), IMPROVE EC (bottom left) and STN EC (bottom right) during July 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

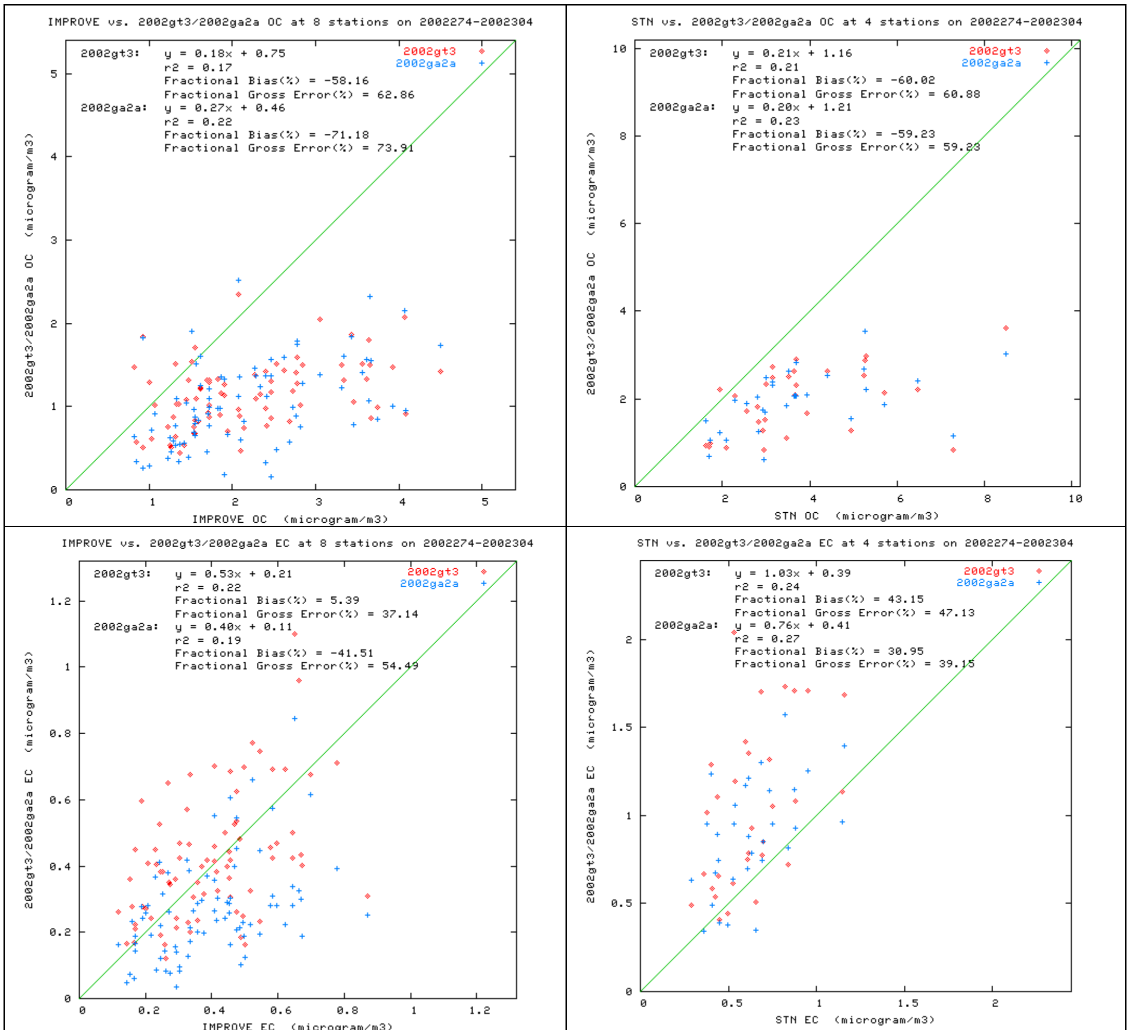
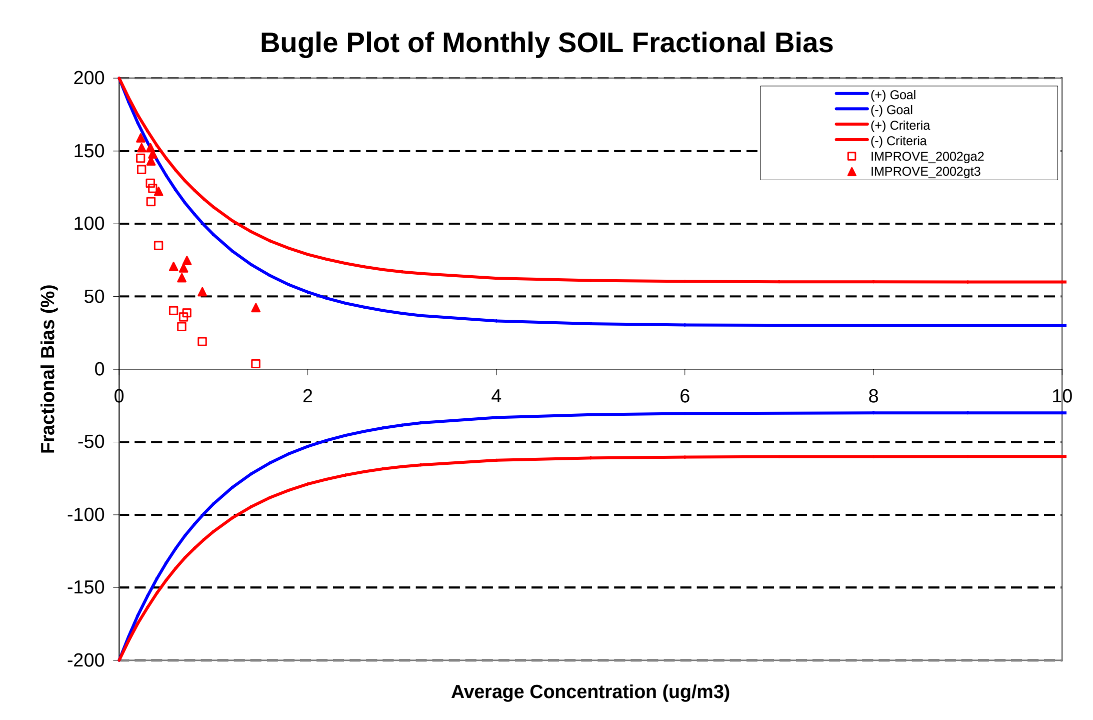


Figure D-10d. Scatter plots of predicted and observed OCM and EC concentrations across the CAMx 12 km domain for IMPROVE OCM (top left), STN OCM (top right), IMPROVE EC (bottom left) and STN EC (bottom right) during October 2002 using the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

D.2.4 Soil Model Performance Across the CAMx 12 km Domain

The Soil model performance is just presented for the IMPROVE network using Bugle and Time Series Plots of monthly fractional bias and error that are given in Figures D-11 and D-12, respectively. Both models appear to systematically overestimate the IMPROVE Soil observations with CAMx estimating higher values so has a more severe Soil overestimation tendency. As noted previously, there are incommensurability problems between the measured and modeled Soil. The IMPROVE measured Soil is constructed from measurements of key elemental components of Soil, whereas the modeled Soil is other $PM_{2.5}$, the left over component of the $PM_{2.5}$ emissions inventory that is not explicitly speciated as SO4, NO3, OCM or EC. The fact that the Soil overprediction bias is greater in the winter than summer suggests that the seasonal variations of the Soil emissions in the model may overstate Soil emissions in the winter. One potential cause could be a failure to fully account for the effects of a wetted surface that suppresses Soil emissions when rain or dew occurs (e.g., road dust, wind blown dust, etc.). In any event, despite the large Soil overestimation bias of both models for Soil, because Soil is such a small component of $PM_{2.5}$ in the ASIP region and has low concentrations, the CMAQ and CAMx models achieves the PM model performance goal as indicated in the Bugle Plot (Figure D-11).



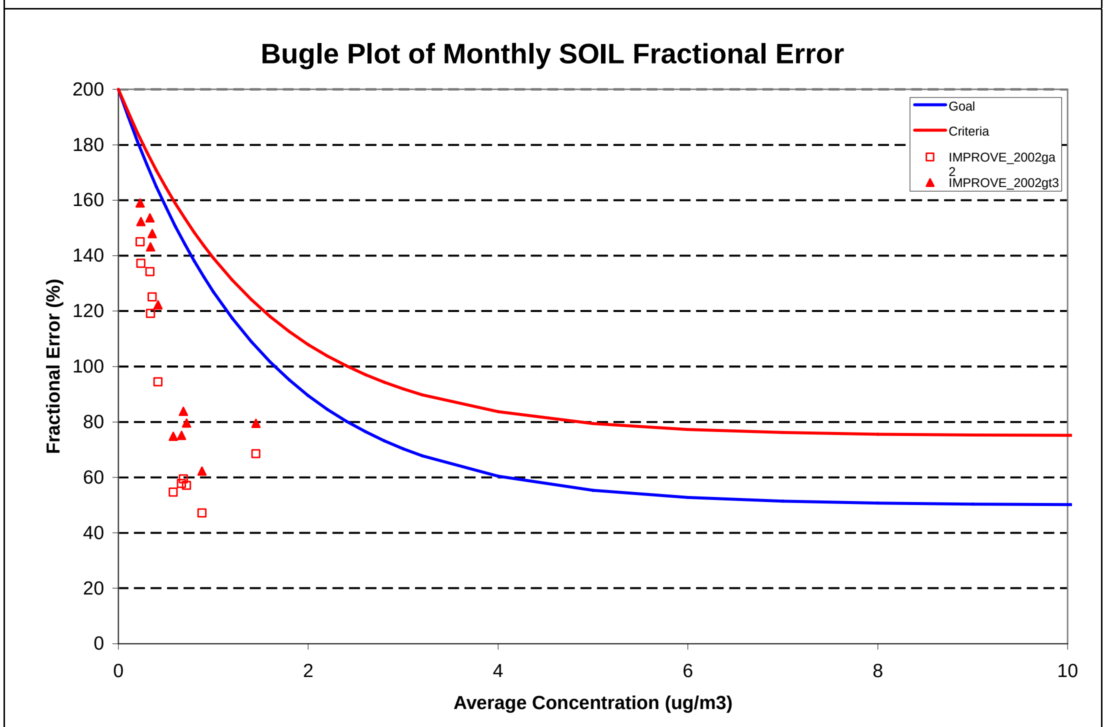


Figure D-11. Bugle Plot of monthly Fractional Bias (top) and Error (bottom) for CMAQ and CAMx estimated Soil $PM_{2.5}$ concentrations across the CAMx 12 km domain.

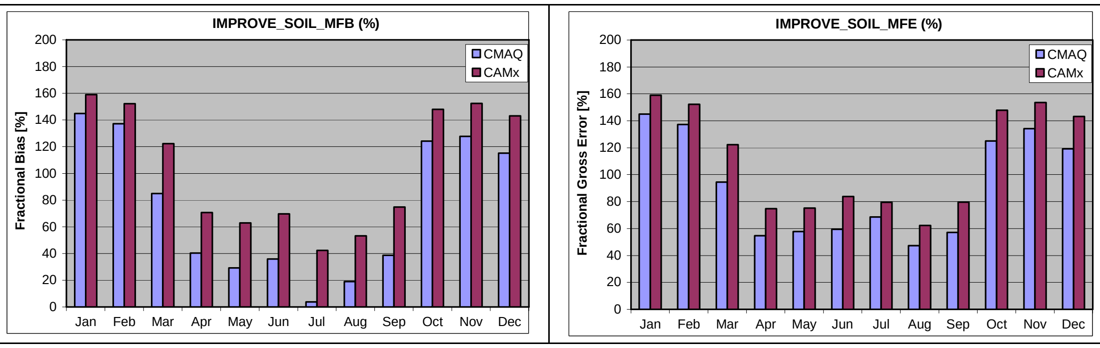


Figure D-12. Monthly Fractional Bias (left) and Error (right) across the 12 km CAMx domain for the CMAQ 12 km domain and CAMx 12/4 km 2002 Base G2 base case simulations Soil concentrations using the IMPROVE monitoring network.

D.2.5 Total $PM_{2.5}$ Mass Model Performance Across the CAMx 12 km Domain

The model performance statistics for the two models and total $PM_{2.5}$ mass across the CAMx 12 km domain using data from the IMPROVE, CASTNet and FRM monitoring networks are shown in Figures D-13, D-14 and D-15. The two models $PM_{2.5}$ performance usually achieves the PM model performance goal and always achieves the PM performance criteria. The CMAQ model fails to achieve the PM model performance goal during the summer due to an underprediction bias, whereas when the CAMx fails to achieve the PM performance goal it is in the fall due to an overprediction bias.

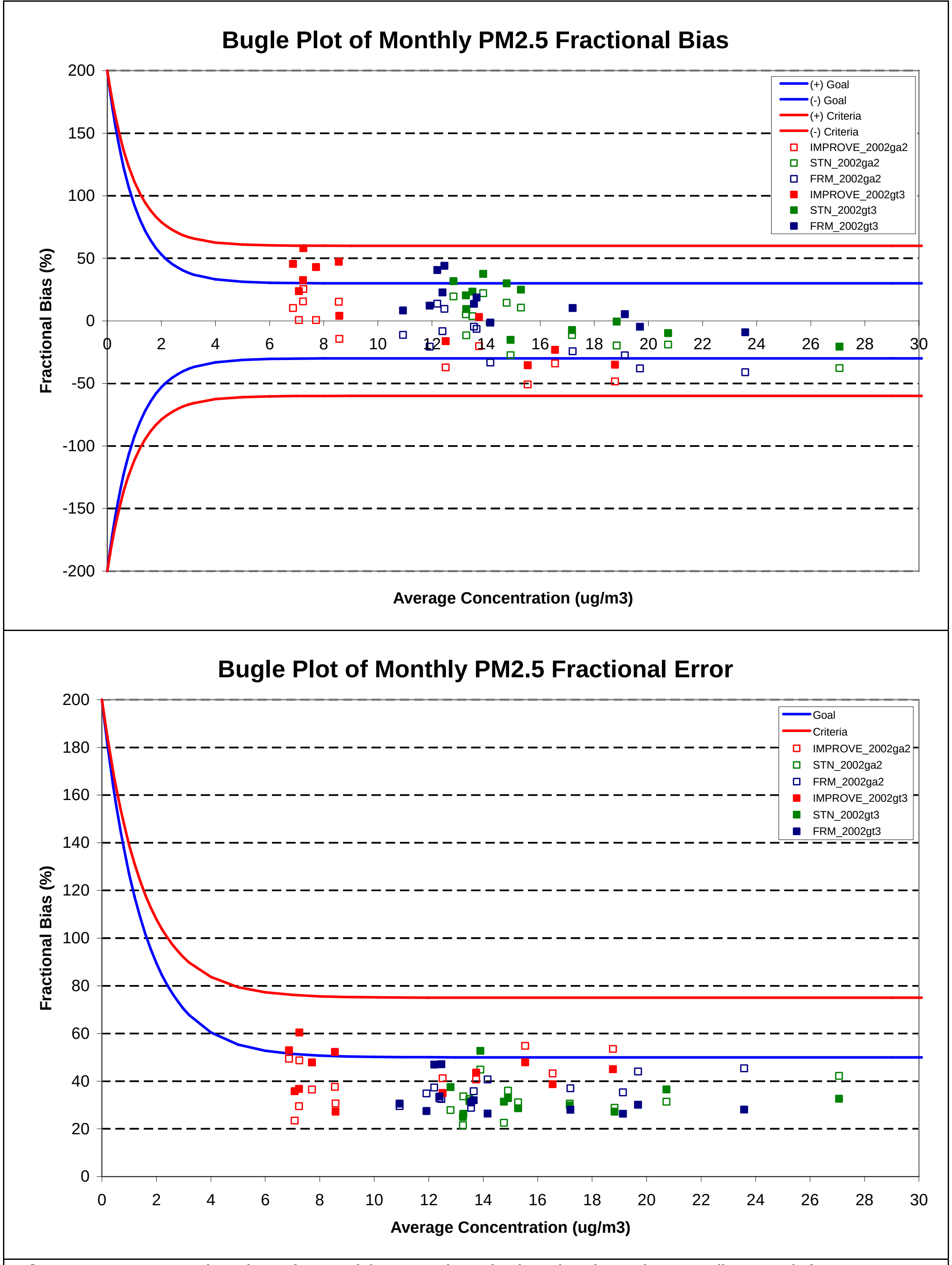


Figure D-13. Bugle Plot of monthly Fractional Bias (top) and Error (bottom) for CMAQ and CAMx estimated total $PM_{2.5}$ mass concentrations across the CAMx 12 km domain.

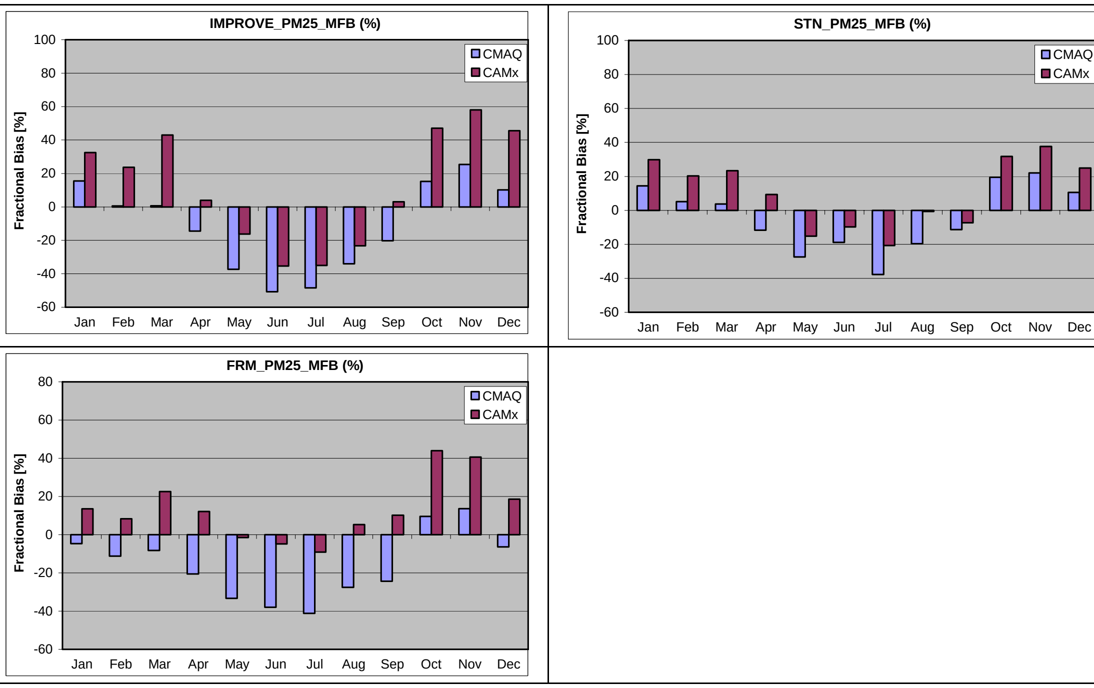


Figure D-14a. Monthly Fractional Bias across the 12 km CAMx domain for the CMAQ 12 km domain and CAMx 12/4 km 2002 Base G2 base case simulations total $PM_{2.5}$ mass concentrations suing the IMPROVE (top left), STN (top right) and FRM (bottom left) monitoring networks.

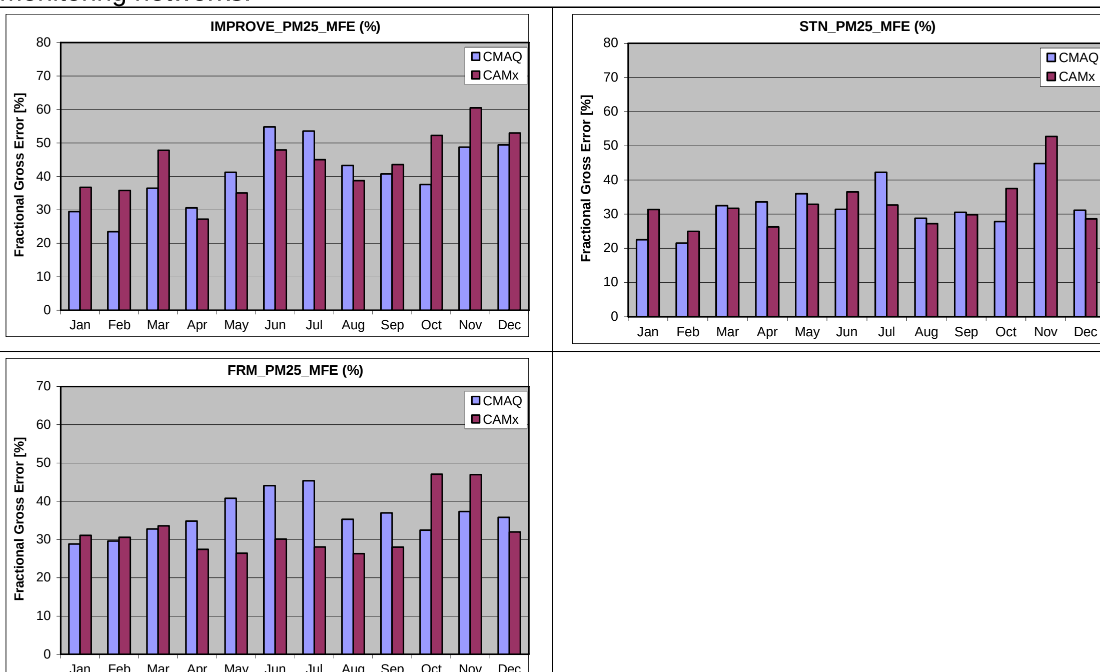


Figure D-14b. Monthly Fractional Error across the 12 km CAMx domain for the CMAQ 12 km domain and CAMx 12/4 km 2002 Base G2 base case simulations total $PM_{2.5}$ mass concentrations suing the IMPROVE (top left), STN (top right) and FRM (bottom left) monitoring networks.

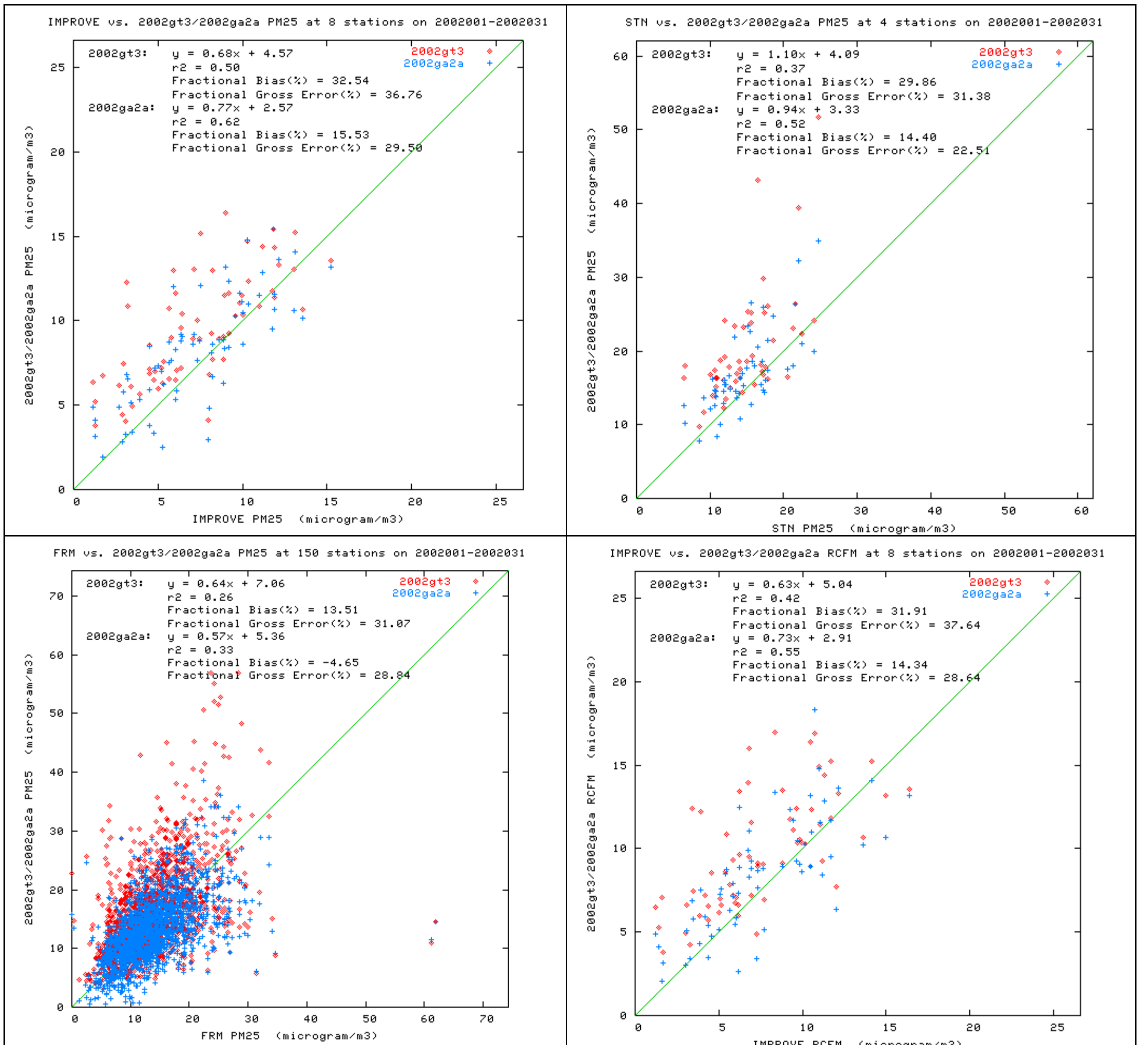


Figure D-15a. Scatter plots of predicted and observed total $PM_{2.5}$ mass concentrations across the CAMx 12 km domain using IMPROVE PM2.5 (top left), STN PM2.5 (top right), FRM PM2.5 (bottom left) and IMPROVE RCFM (bottom right) data during January 2002 and the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

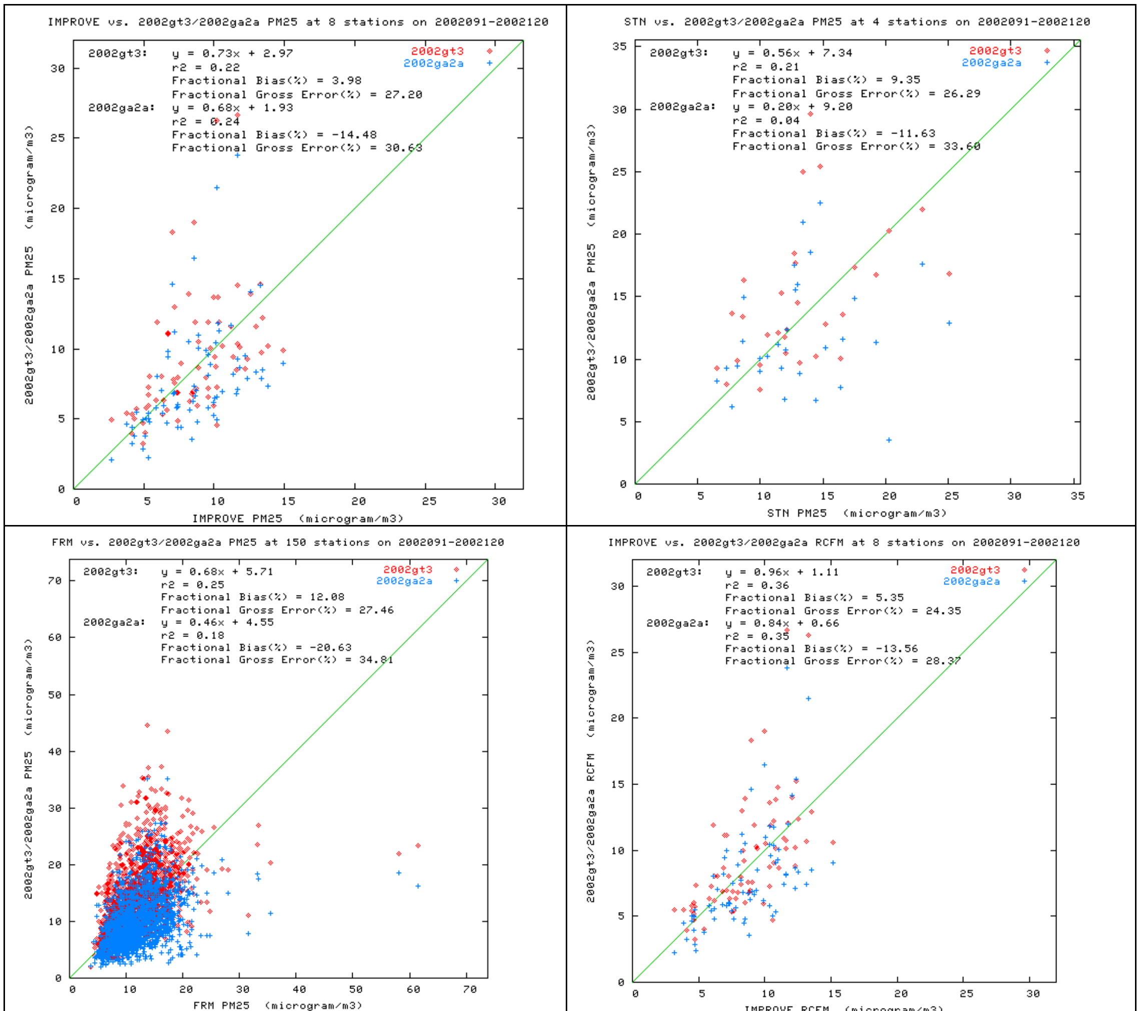


Figure D-15b. Scatter plots of predicted and observed total $PM_{2.5}$ mass concentrations across the CAMx 12 km domain using IMPROVE PM2.5 (top left), STN PM2.5 (top right), FRM PM2.5 (bottom left) and IMPROVE RCFM (bottom right) data during April 2002 and the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

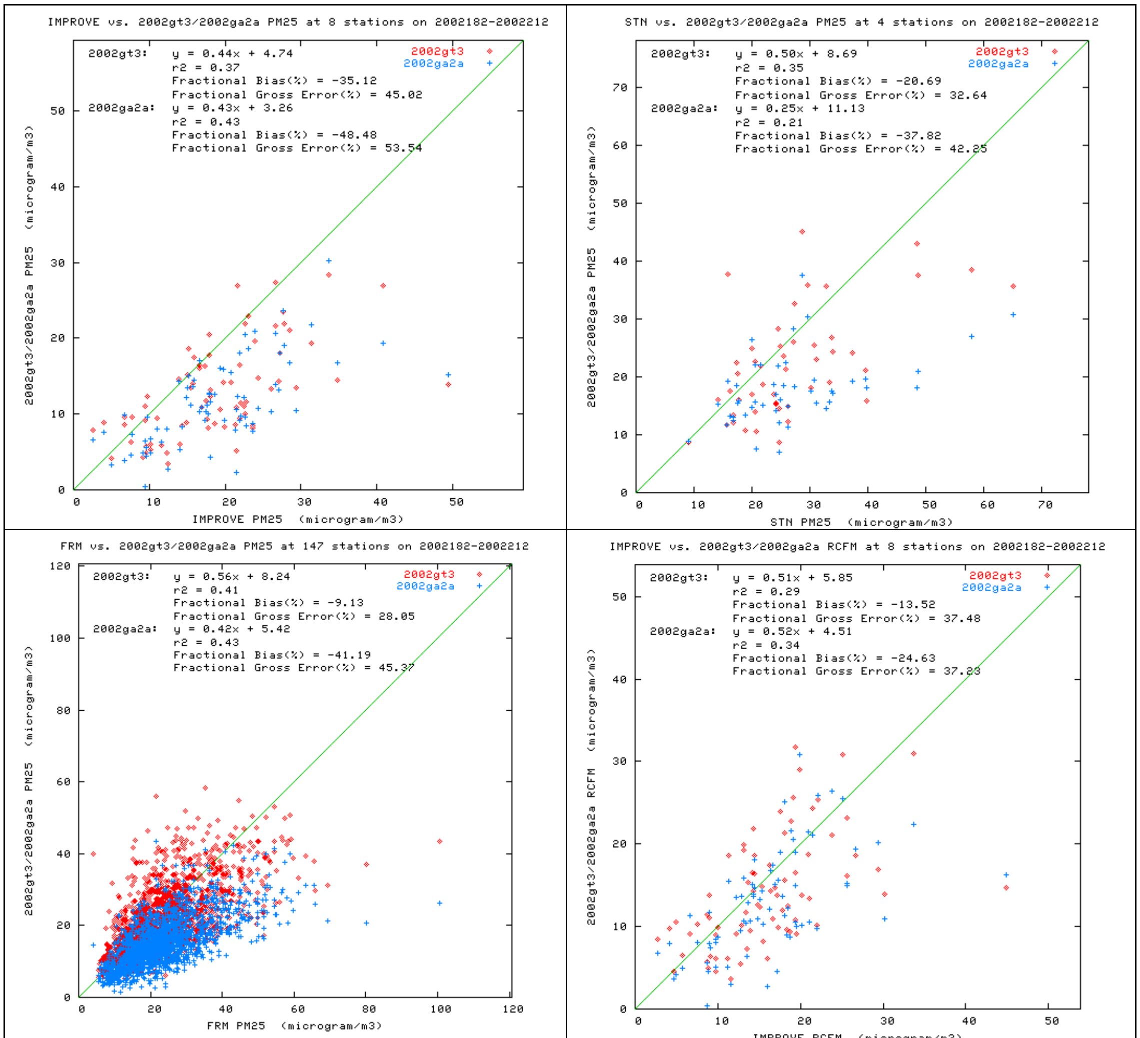


Figure D-15c. Scatter plots of predicted and observed total $PM_{2.5}$ mass concentrations across the CAMx 12 km domain using IMPROVE PM2.5 (top left), STN PM2.5 (top right), FRM $PM_{2.5}$ (bottom left) and IMPROVE RCFM (bottom right) data during July 2002 and the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

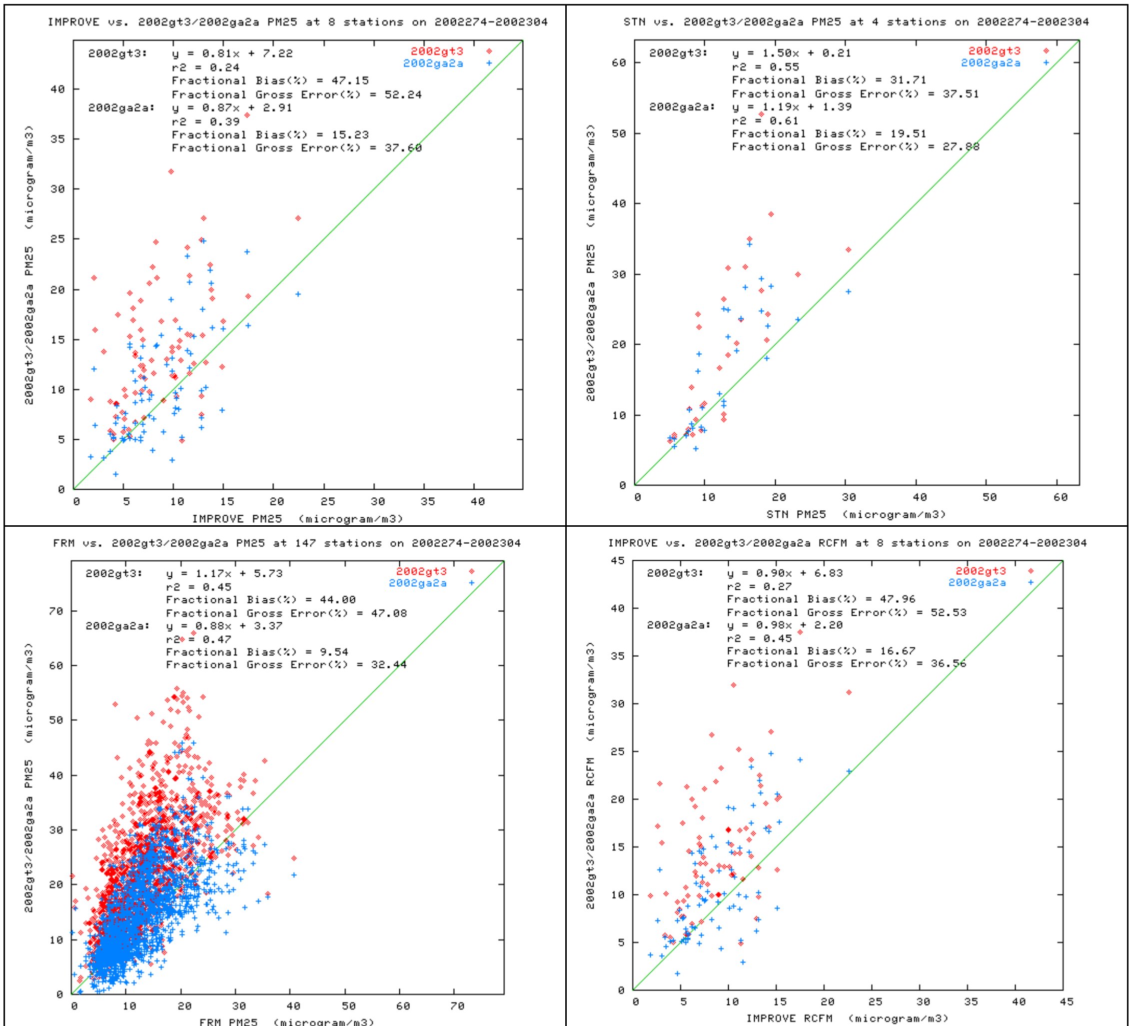


Figure D-15d. Scatter plots of predicted and observed total $PM_{2.5}$ mass concentrations across the CAMx 12 km domain using IMPROVE PM2.5 (top left), STN PM2.5 (top right), FRM $PM_{2.5}$ (bottom left) and IMPROVE RCFM (bottom right) data during October 2002 and the CAMx 2002gt3 and CMAQ 2002ga2a modeling results.

D.3 SUBREGIONAL $PM_{2.5}$ MODEL PERFORMANCE EVALUATION

The purpose of the CAMx 2002 12/4 km modeling was to use the PM Source Apportionment Technology (PSAT) to assess the separate contributions of 31 point source facilities to 2009 $PM_{2.5}$ concentrations at FRM monitors in four 4 km subregional modeling subdomains (see Section 5.3):

- Charleston-Huntington-Ashland WV-KY-OH
- Knoxville-Chattanooga TN-NC-GA
- Louisville KY-IN
- Wheeling-Weirton-Steubenville WV-OH-PA

In the sections below we evaluate the $PM_{2.5}$ model performance of the CAMx 2002 4 km Base G2 Typical and CMAQ 2002 12 km Base G2 Actual in each of these subdomains.

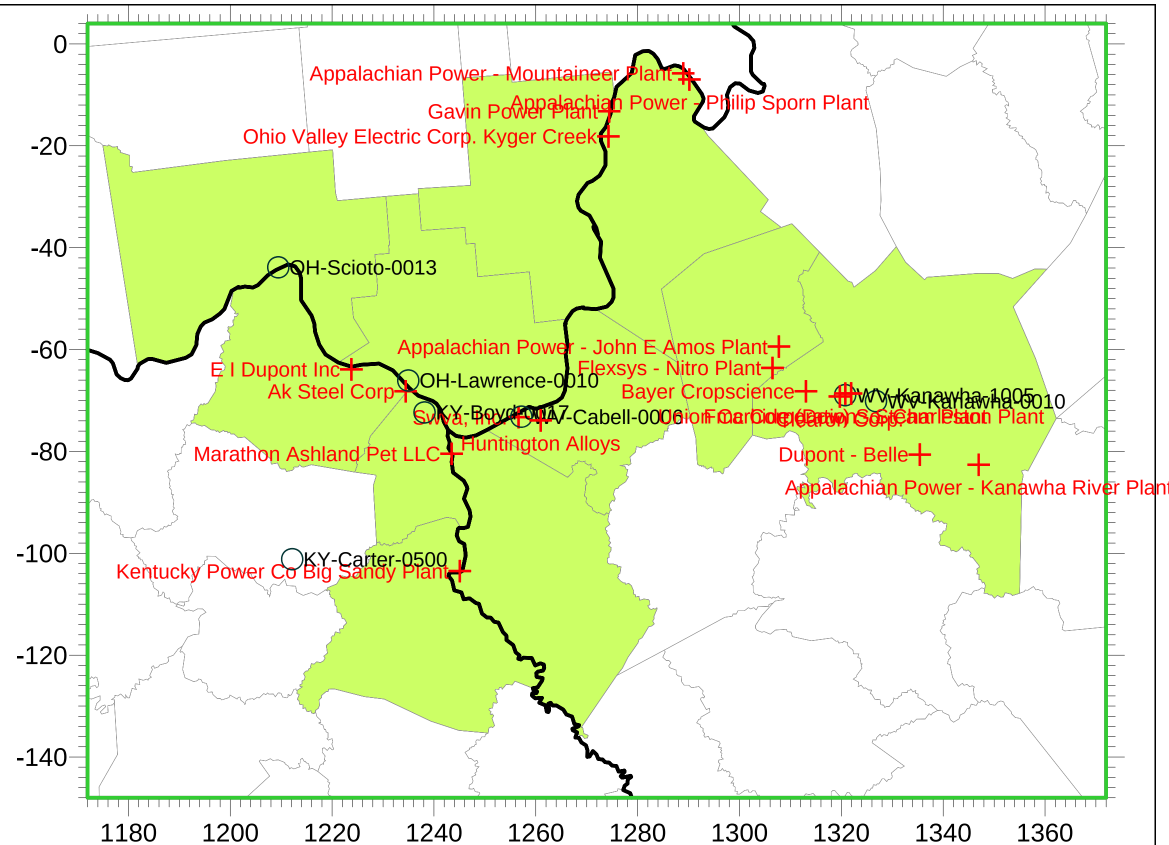
D.3.1 Charleston-Huntington-Ashland WV-KY-OH

Figure D-16 reproduces Figure 5-7 from Chapter 5 and displays the locations of FRM monitoring sites within the Charleston subdomain, as well as the locations of the PSAT facilities whose separate $PM_{2.5}$ contributions were assess in Section 5.3. Scatter plots of predicted and observed 24-hour total $PM_{2.5}$ mass for the seven FRM sites located in the Charleston subdomain by Quarter of 2002 are shown in Figure D-17. Also given in Figure D-17 is the Quarterly fractional bias and error performance statistics for FRM $PM_{2.5}$ mass and the CMAQ and CAMx models.

The CMAQ model $PM_{2.5}$ performance in the Charleston subdomain is characterized by an underprediction tendency. This underprediction is sufficient that CMAQ does not achieve the ≤±30% PM performance goal for fractional bias during the first three Quarters of the year, and CMAQ's fractional error even exceeds the ≤50% PM performance goal for Quarter 2. Much better CMAQ $PM_{2.5}$ performance is seen for Quarter 4 where the fraction bias (-1%) achieves the most stringent ozone performance goal (≤±15%) and its error (37%) almost achieves the ozone goal (≤35%).

The CAMx total $PM_{2.5}$ mass model performance is quite different than CMAQ. The CAMx fractional bias/error performance statistics for Quarters 1 and 3 of 2002 (-8%/29% and -6%/24%) achieves the most stringent ozone bias/error performance goal (≤±15%/≤35%) and the PM performance goal (≤±30%/≤50%) is achieved for the first three Quarters of 2002. However, in Quarter 4 the CAMx overprediction bias results in the fractional bias (32%) falling just outside of the PM performance goal (≤±30%), although the CAMx fractional error does achieve the PM performance goal in Quarter 4.

Time series of predicted and observed 24-hour $PM_{2.5}$ concentrations at the seven FRM sites in the Charleston subdomain are shown by Quarter in Figure D-18. The CMAQ and CAMx $PM_{2.5}$ concentrations track each other well, with the CAMx estimating higher values that better match the observed values through the first three Quarters of the year. The observed day-to-day variations in the 24-hour $PM_{2.5}$ concentrations are frequently well matched by the two models. However, the models, and especially CMAQ, fail to capture the magnitude of the observed high concentrations $PM_{2.5}$ spikes on some of the days during 2002.



CAMx 04km (includes buffer cells):
Charleston 50 x 38 (1172, -148) to (1372, 4)

Figure D-16. Charleston-Huntington-Ashland 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

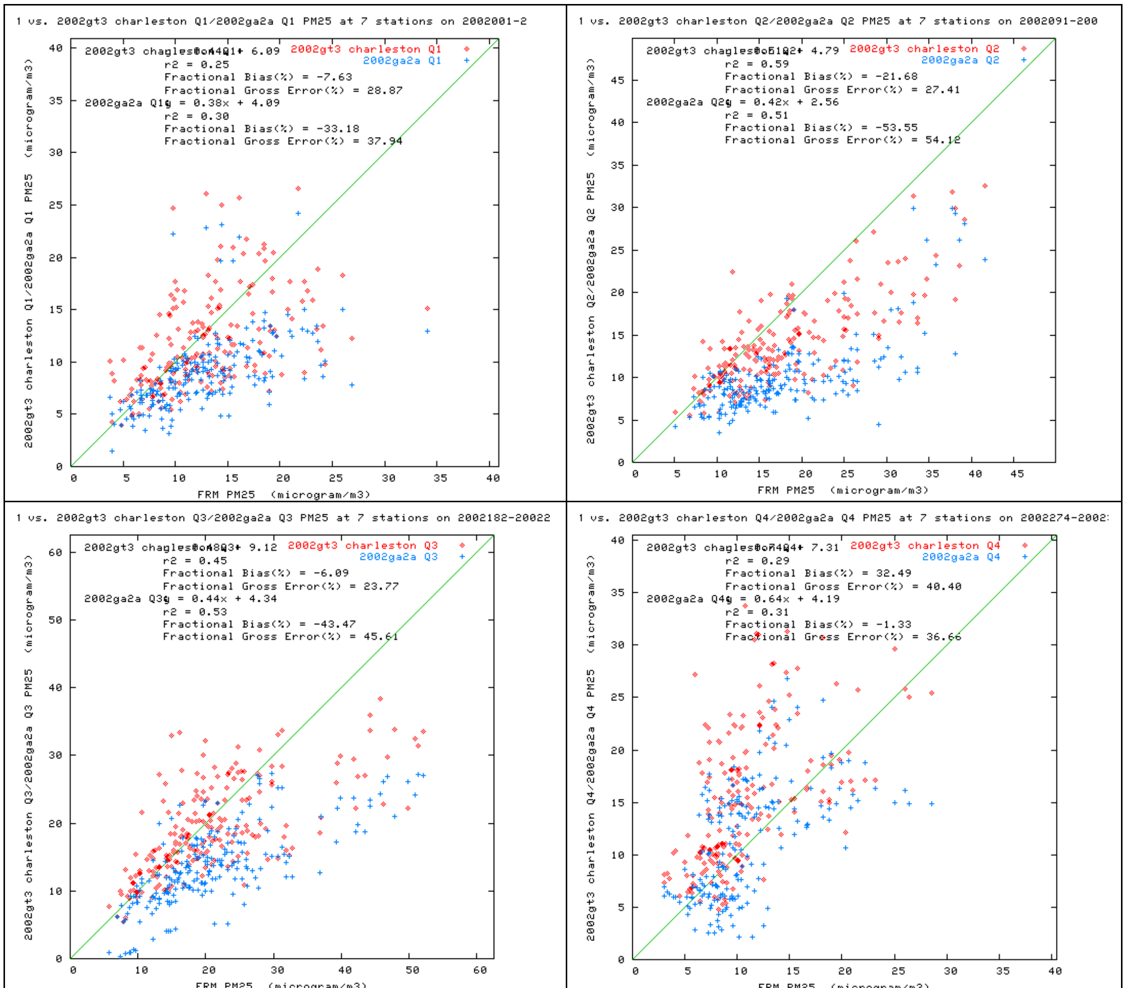


Figure D-17. Scatter Plots and performance statistics for predicted and observed 24-hour FRM $PM_{2.5}$ concentrations by Quarter during 2002, the CAMx 2002gt3 4 km and CMAQ 2002aga2 12 km base case simulations and the Charleston subdomain.

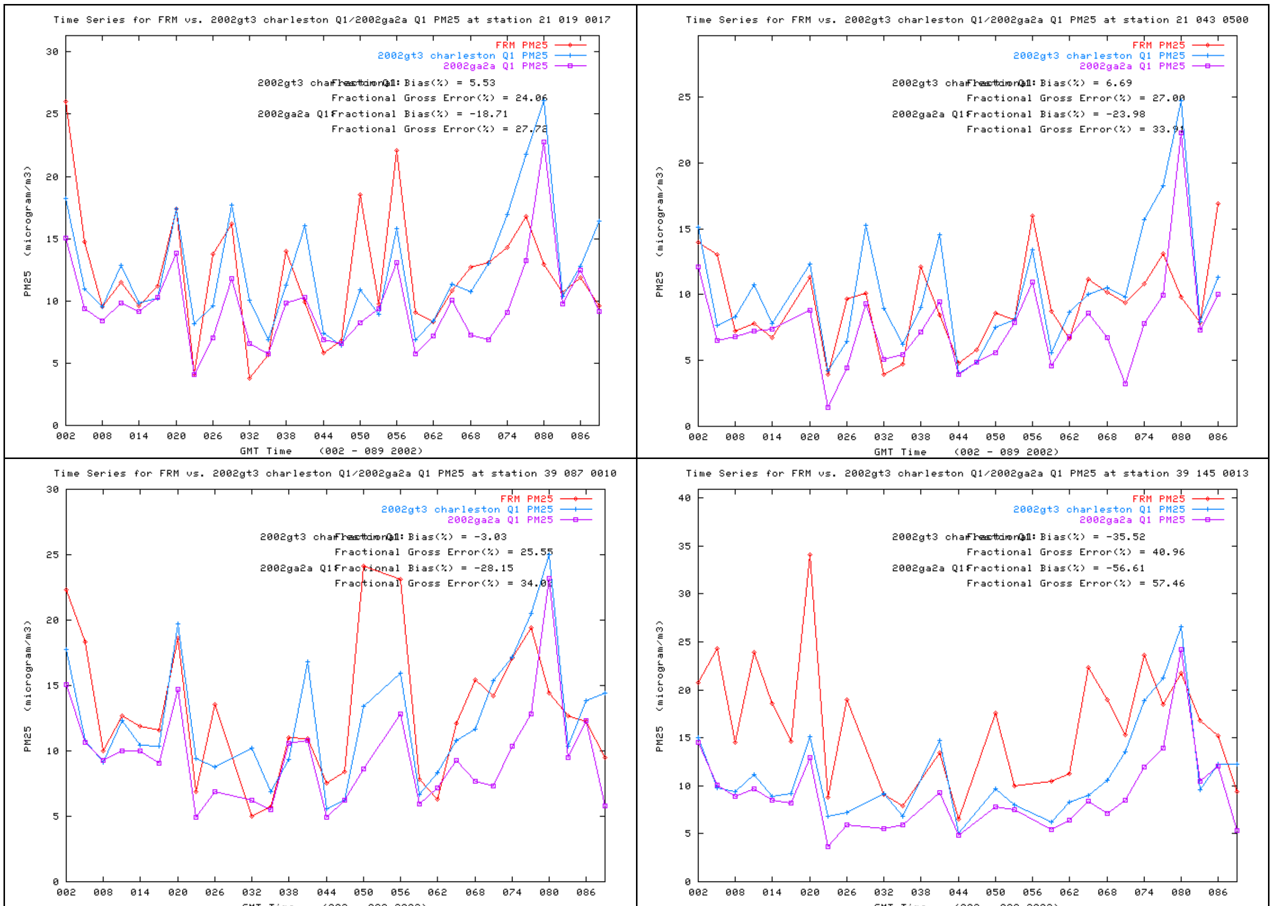


Figure D-18a. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 1 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

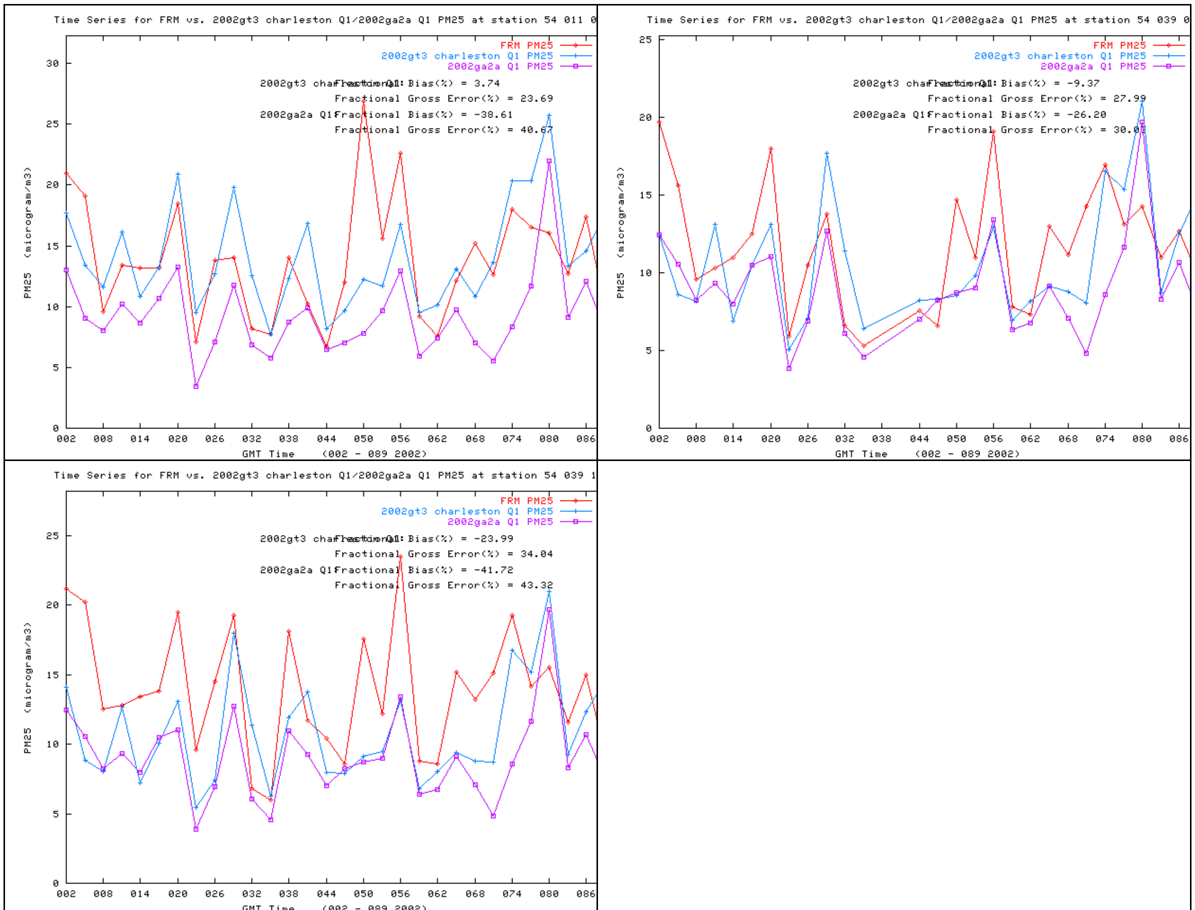


Figure D-18a. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 1 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

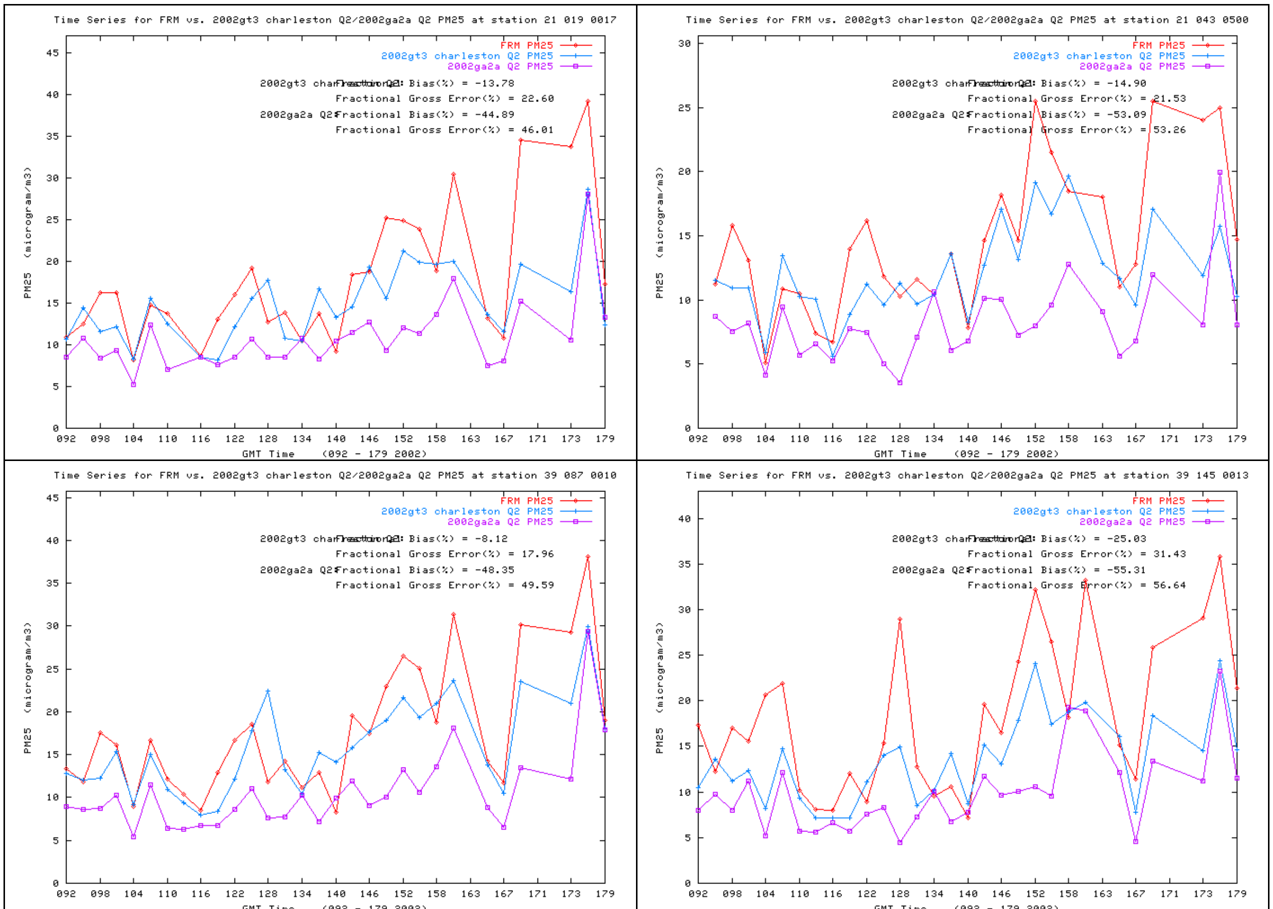


Figure D-18b. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 2 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

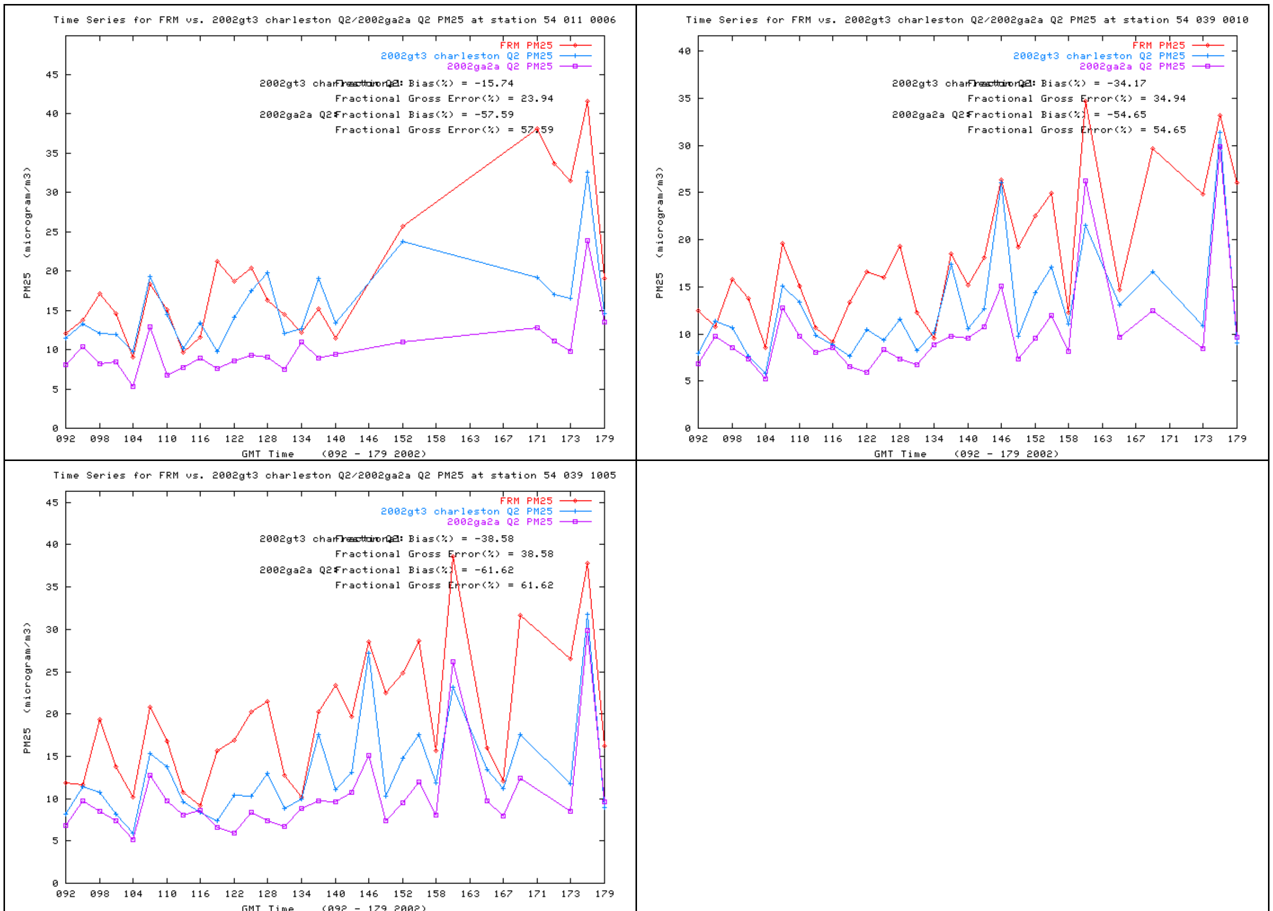


Figure D-18b. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 2 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

Figure D-18c. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 3 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

Figure D-18c. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 3 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

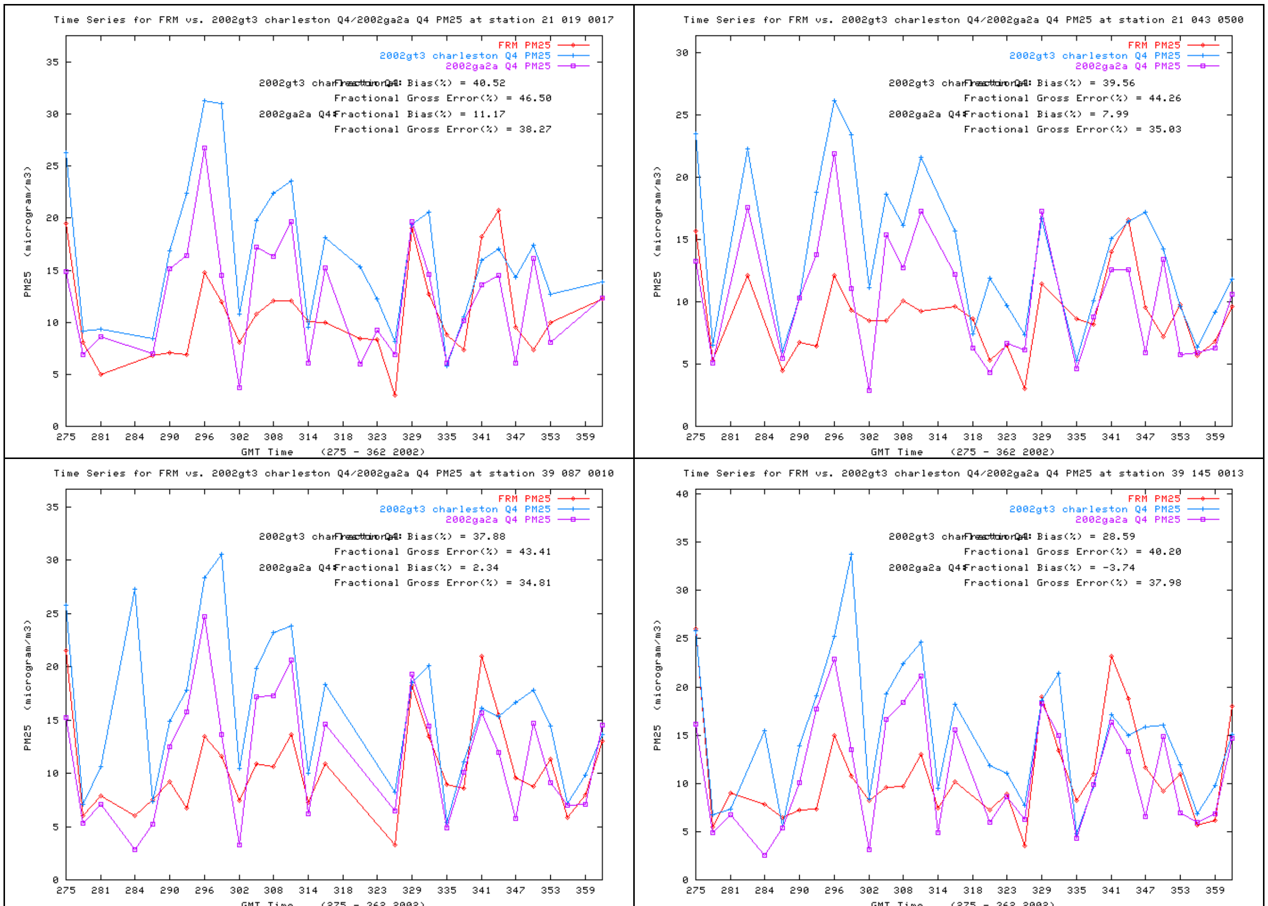


Figure D-18d. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 4 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

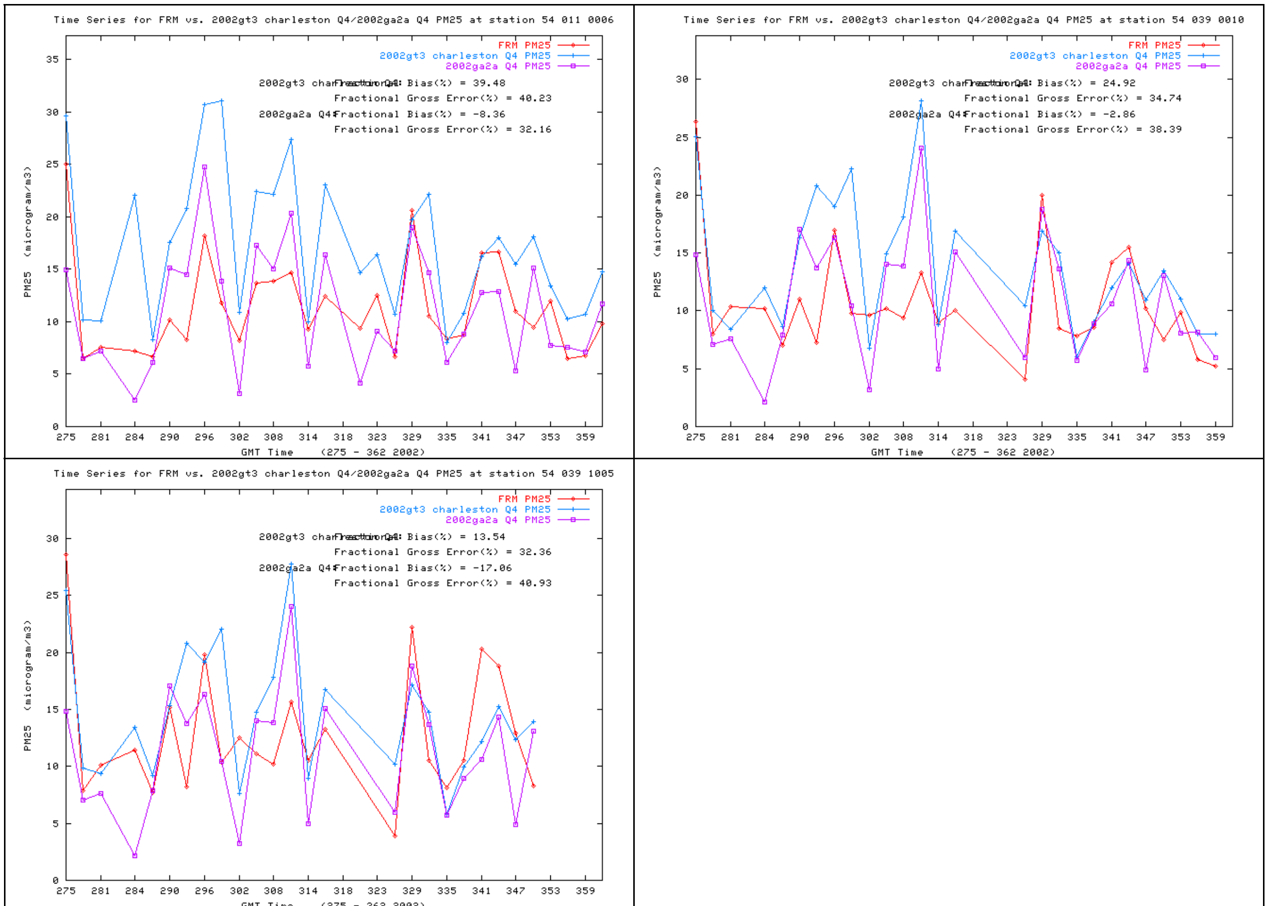


Figure D-18d. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Charleston subdomain, Quarter 4 and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

D.3.2 Knoxville-Chattanooga TN-NC-GA

Figure D-19 displays the Knoxville-Chattanooga 4 km subdomain, along with the FRM and PSAT point source locations. Figure D-20 displays scatter plots and performance statistics for 24-hour $PM_{2.5}$ concentrations across FRM monitors in the Knoxville subdomain and each Quarter of 2002. As seen for the Charleston subdomain, the CAMx exhibits much better $PM_{2.5}$ model performance than CMAQ for the first three Quarters of 2002, but for the last Quarter the reverse is true. For the first three Quarters of 2002, CAMx $PM_{2.5}$ performance achieves the most stringent ozone performance goal, whereas CMAQ does not exhibiting a large underprediction tendency that even fails to achieve the PM performance goal for Quarters 2 and 3. However, in Quarter 4 it is CMAQ that nearly achieves the ozone model performance goal and CAMx that fails to achieve the PM performance goal for fractional bias.

Example $PM_{2.5}$ time series comparisons for two sites in the Knoxville subdomain and each Quarter of 2002 are given in Figure D-21. There is a lot of day-to-day variation in the observed 24-hour $PM_{2.5}$ concentrations. The model reproduces much of the temporal variability in the observations. CAMx is doing a much better job in reproducing the observed $PM_{2.5}$ concentrations during the first three Quarters of the year. During Quarter 4 it appears that much of the CAMx overprediction bias is due to a few days of very high modeled $PM_{2.5}$ concentrations.

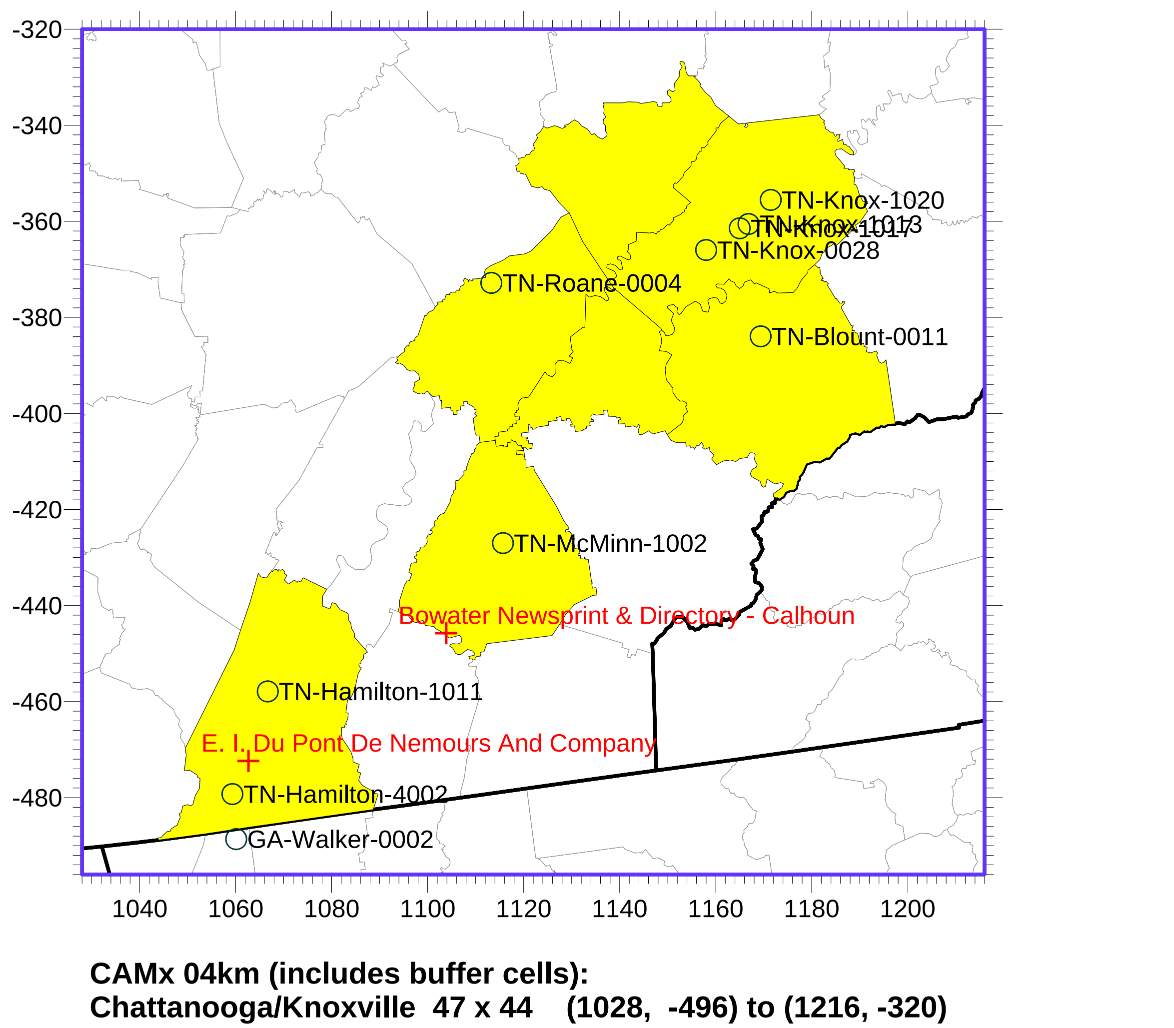


Figure D-19. Knoxville-Chattanooga TN-NC-GA 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

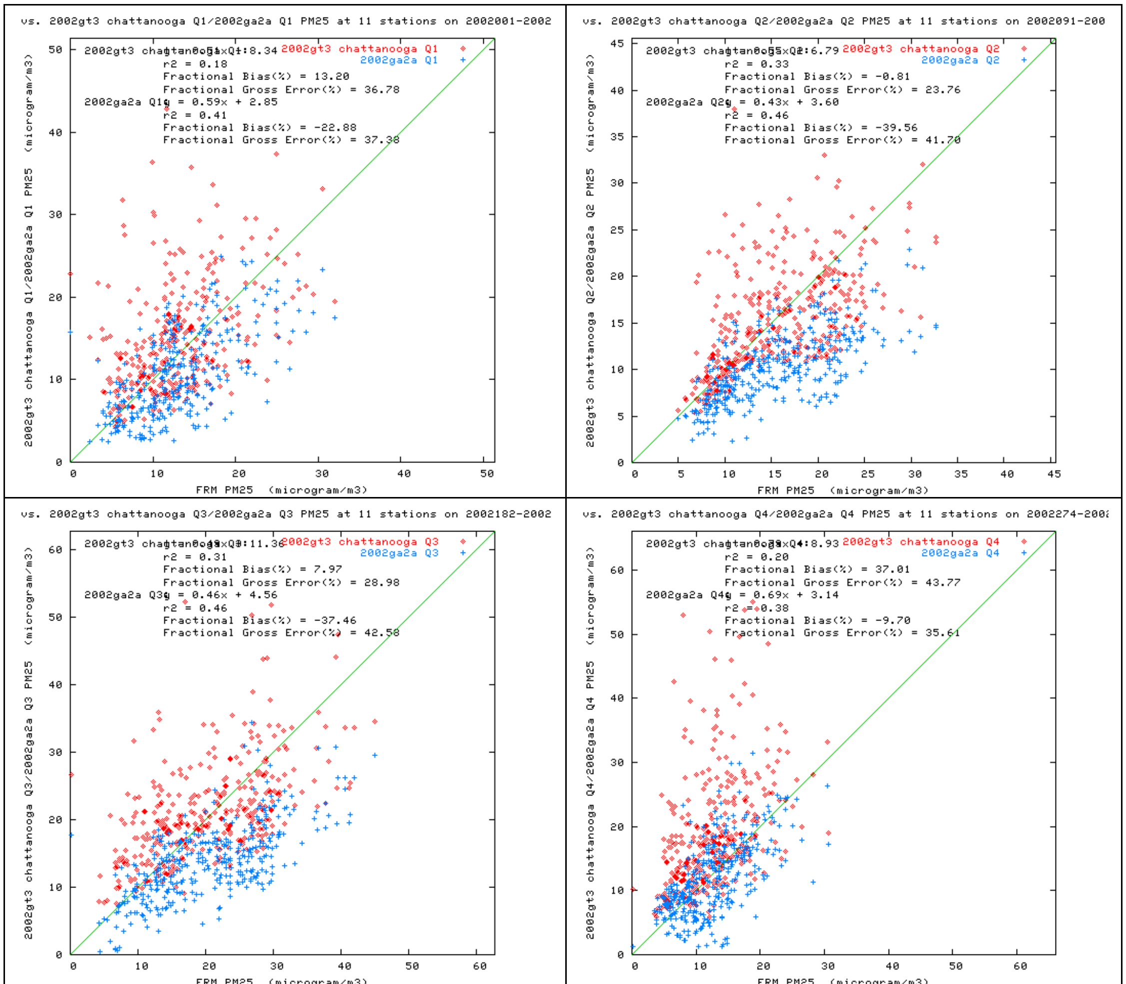


Figure D-20. Scatter Plots and performance statistics for predicted and observed 24-hour FRM $PM_{2.5}$ concentrations by Quarter during 2002, the CAMx 2002gt3 4 km and CMAQ 2002aga2 12 km base case simulations and the Knoxville subdomain.

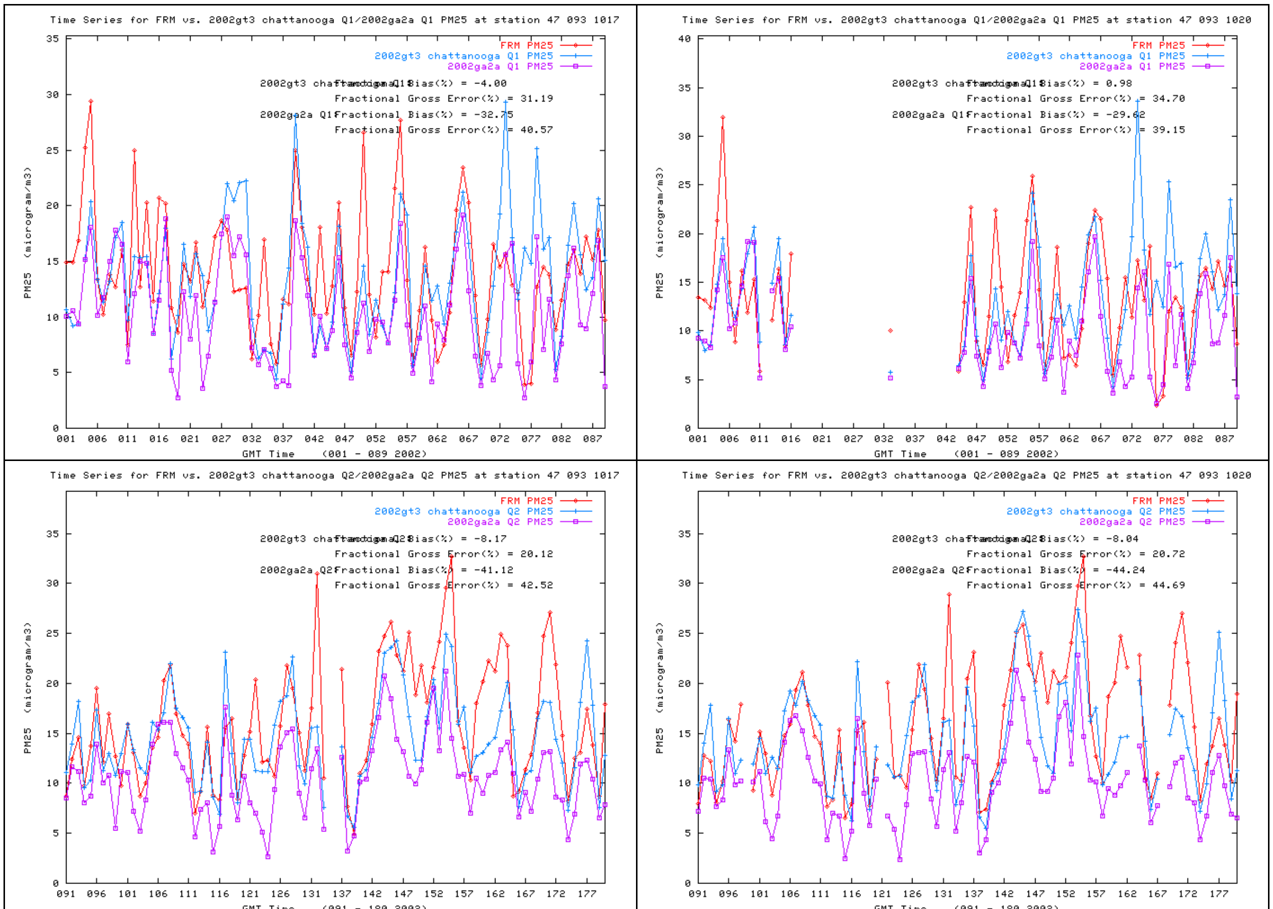


Figure D-21. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for two FRM sites in the Knoxville subdomain, Quarter 1 (top), 2, 3 and 4 (bottom) and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

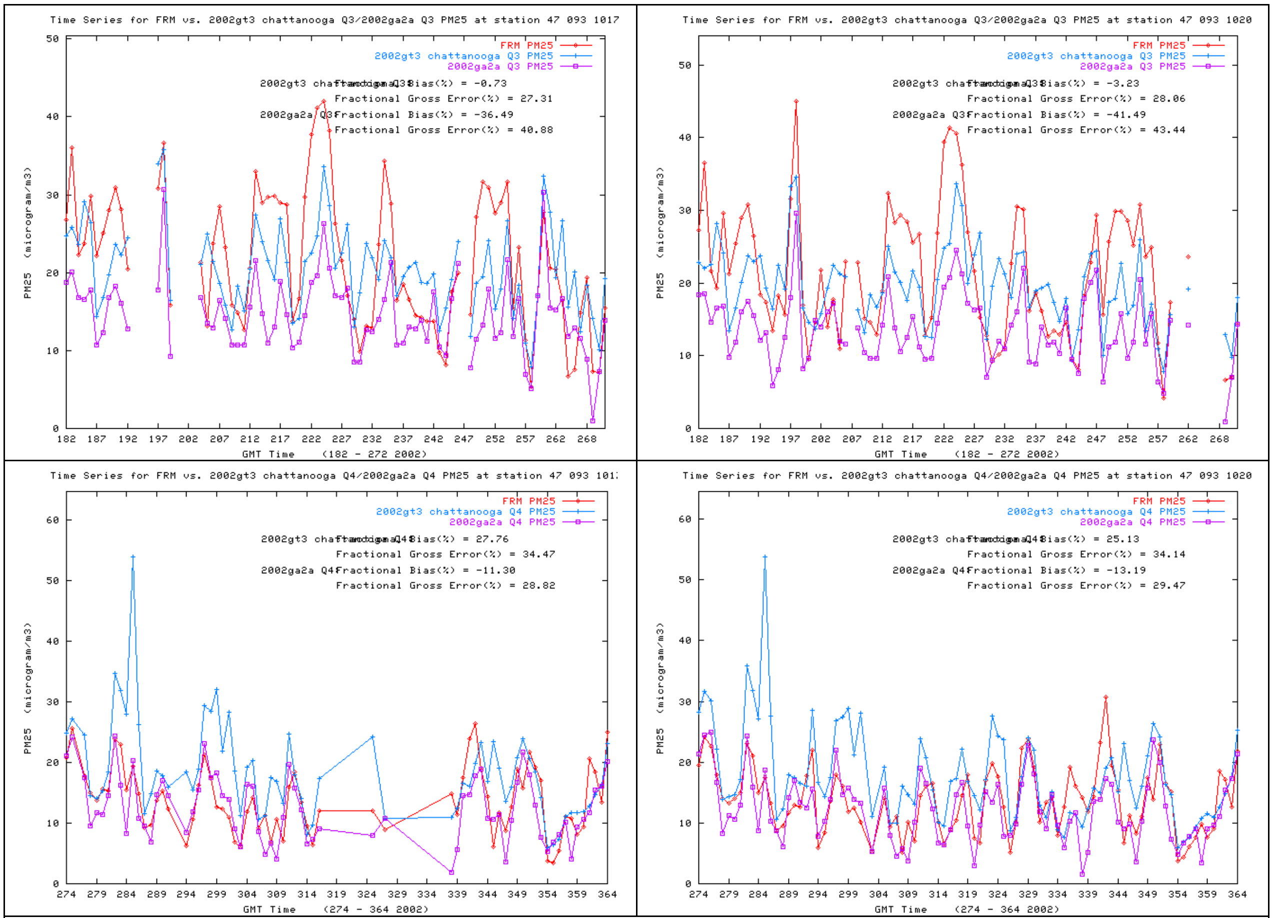


Figure D-21. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for two FRM sites in the Knoxville subdomain, Quarter 1 (top), 2, 3 and 4 (bottom) and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

D.3.3 Louisville KY-IN

$PM_{2.5}$ model performance across the Louisville subdomain is not as good as seen for the other subdomains. The CMAQ $PM_{2.5}$ performance in Louisville achieves the ozone performance goal in the first Quarter and achieves or nearly achieves the PM performance goal in all four Quarters. However, the CAMx $PM_{2.5}$ overprediction tendency exceeds the PM performance goal for Quarter 1 and 4, but for Quarter 2 is achieving the more stringent ozone goal. These findings are also seen in the time series comparisons for two example FRM monitoring sites in Figure D-24.

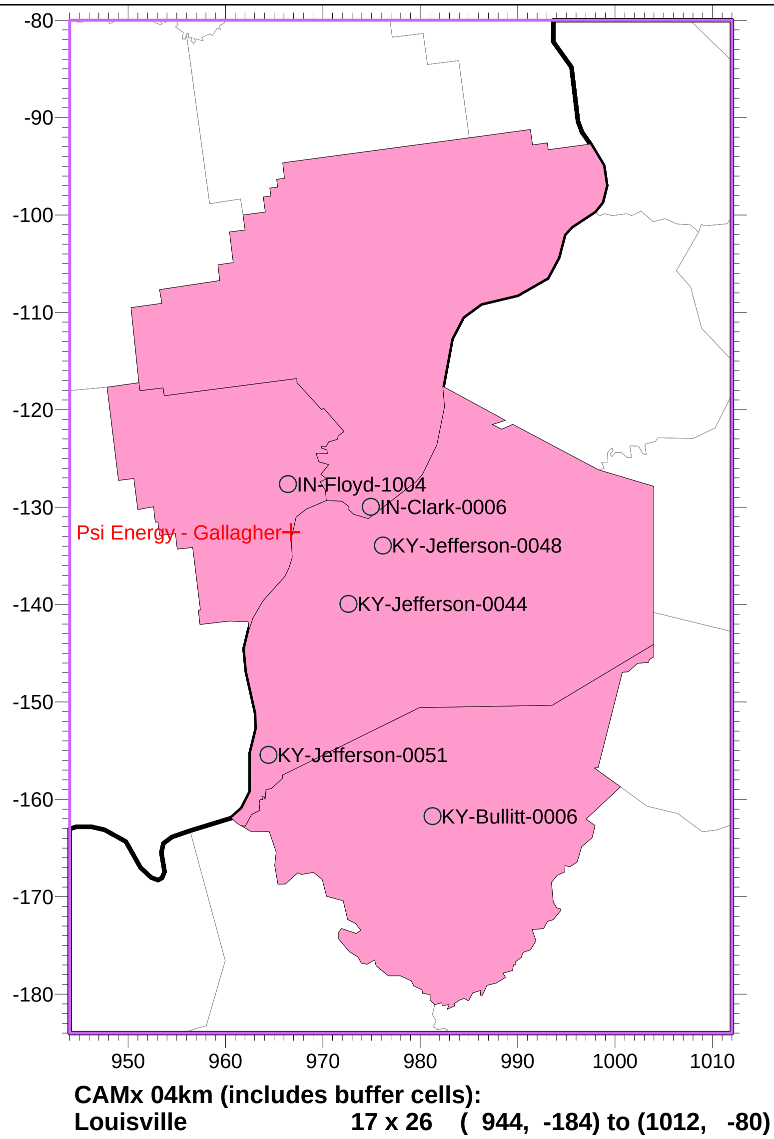


Figure D-22. Louisville KY-IN 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

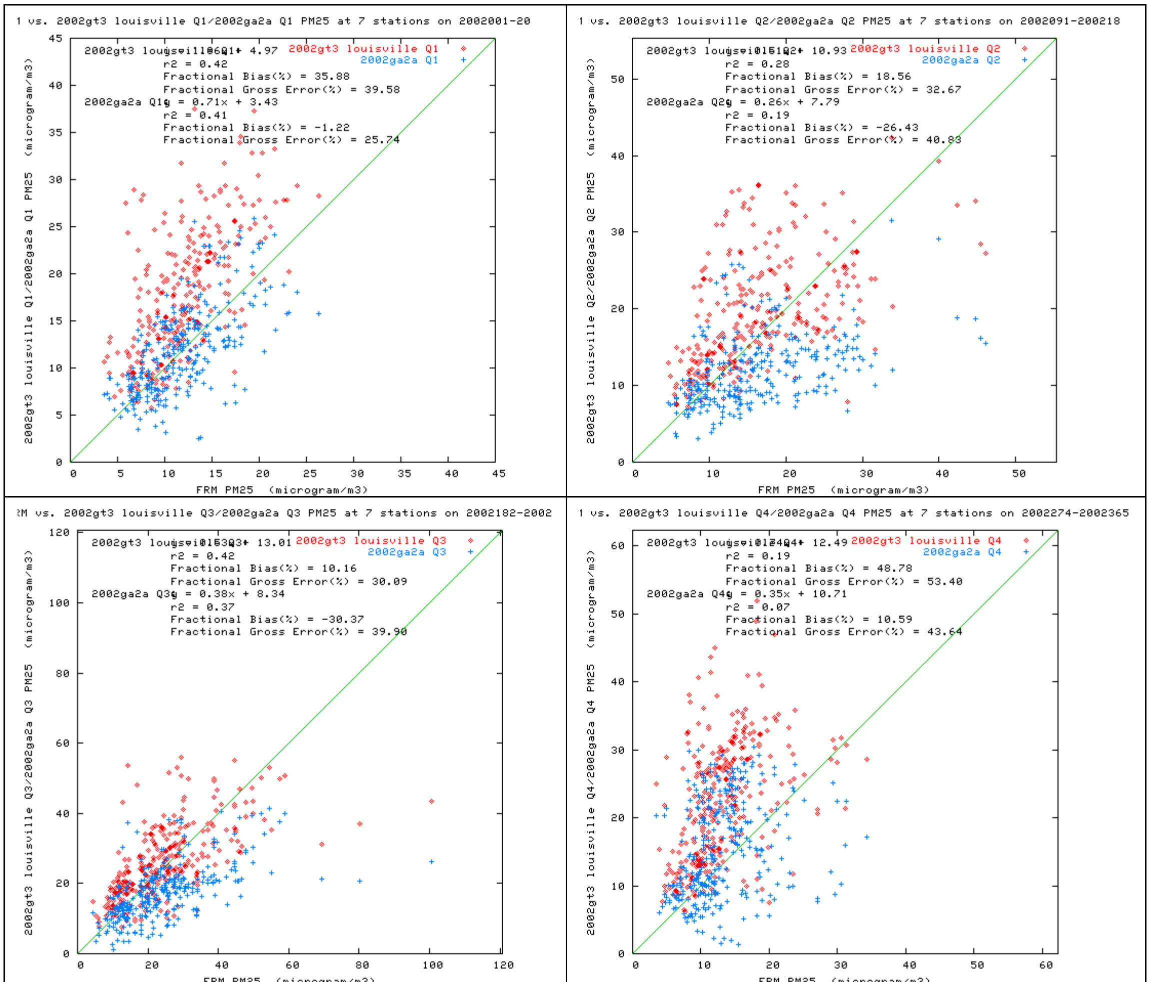


Figure D-23. Scatter Plots and performance statistics for predicted and observed 24-hour FRM $PM_{2.5}$ concentrations by Quarter during 2002, the CAMx 2002gt3 4 km and CMAQ 2002aga2 12 km base case simulations and the Louisville subdomain.

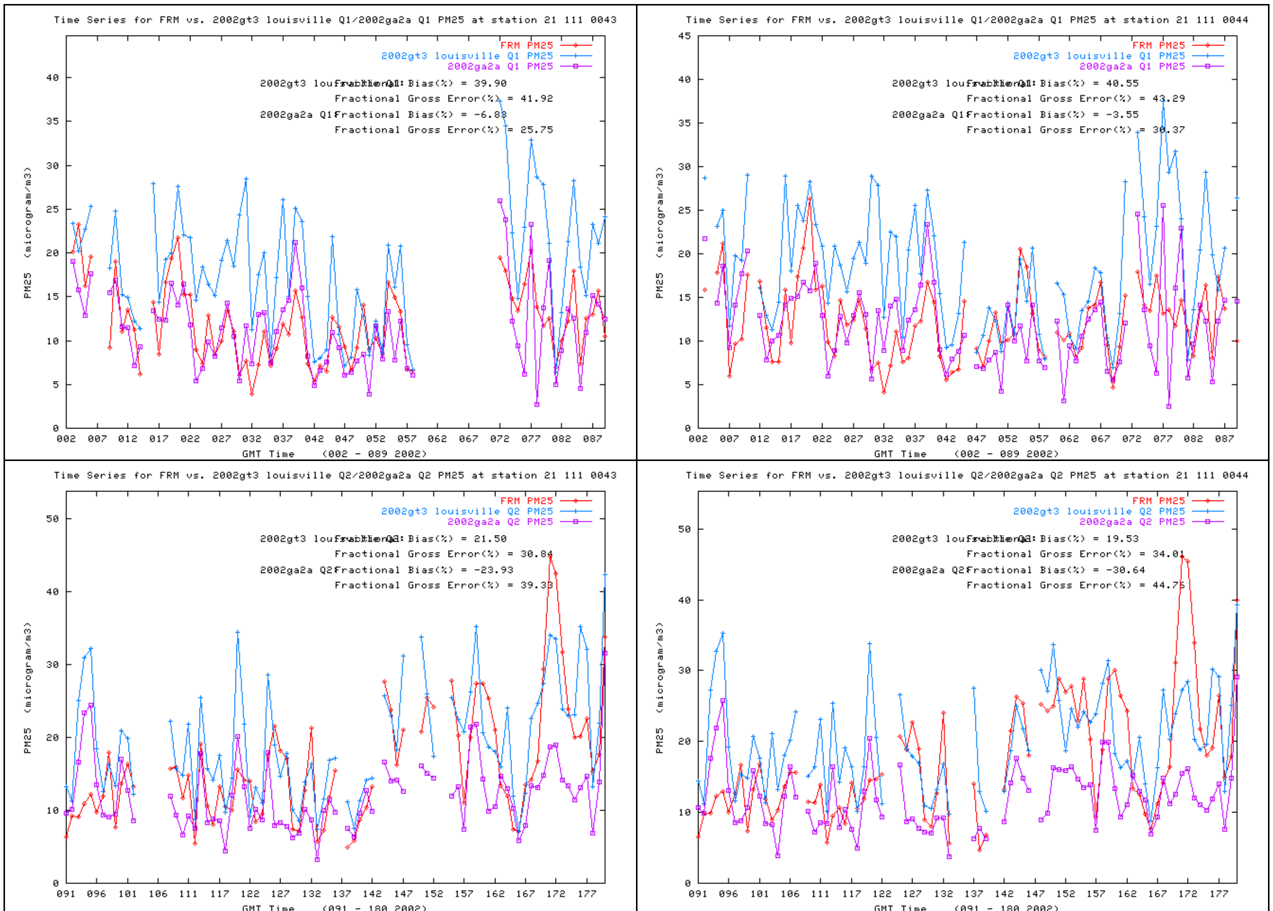


Figure D-24. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for two FRM sites in the Louisville subdomain, Quarter 1 (top), 2, 3 and 4 (bottom) and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

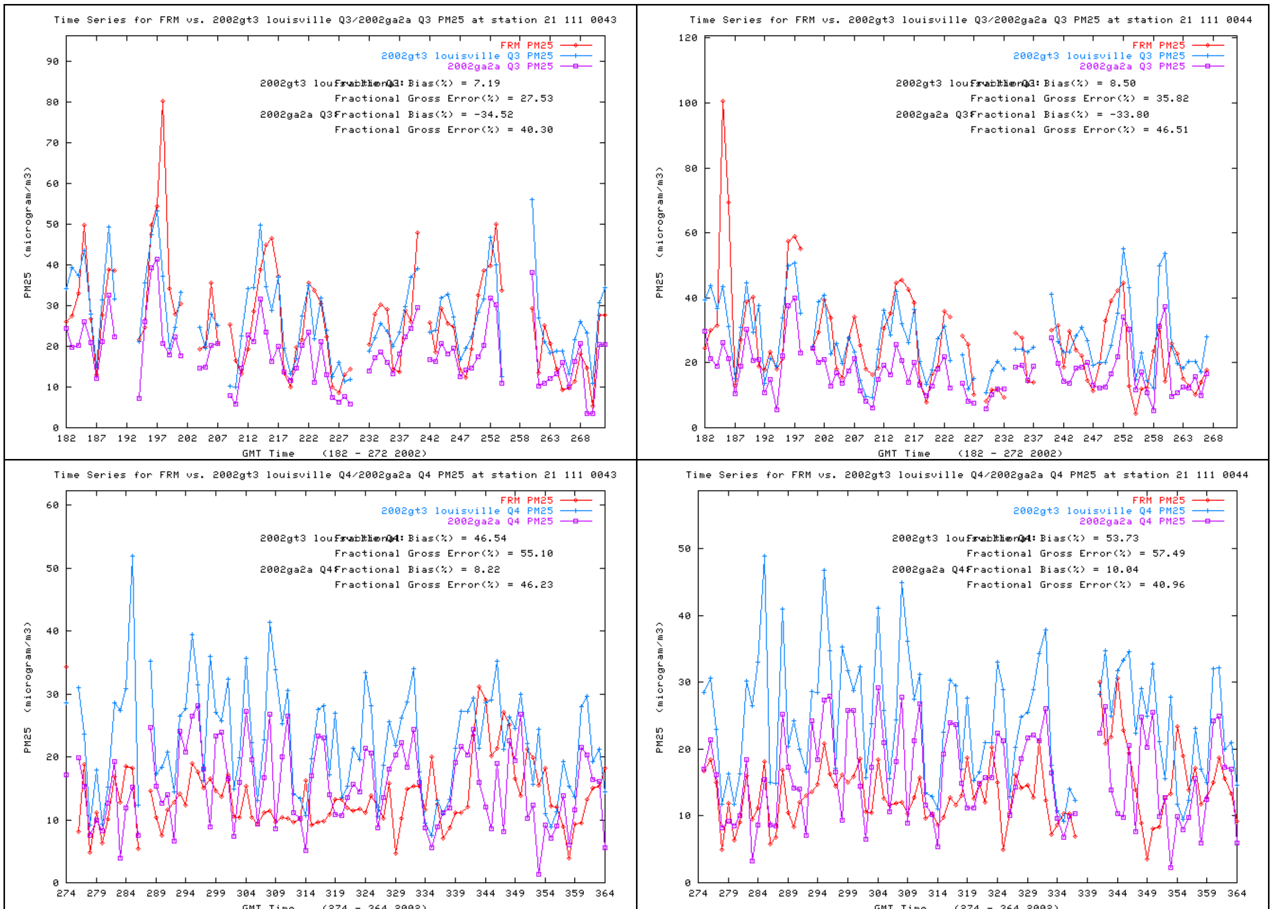


Figure D-24. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for two FRM sites in the Louisville subdomain, Quarter 1 (top), 2, 3 and 4 (bottom) and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

D.3.4 Wheeling-Weirton-Steubenville WV-OH-PA

The Wheeling subdomain and the $PM_{2.5}$ model performance results are shown in Figures D-25, D-26 and D-27. For the first three Quarters of 2002, CAMx is exhibiting better $PM_{2.5}$ performance than CMAQ with CAMx achieving the ozone model performance goal in Quarters 1, 2 and 3. Although CMAQ also achieves the ozone goal in Quarter 1, the underprediction bias in Quarters 2 and 3 (~-25%) exceeds the ozone performance goal, but does achieve the PM model performance goal. In fact, the PM model performance goals is achieved by both models for all four Quarters of 2002.

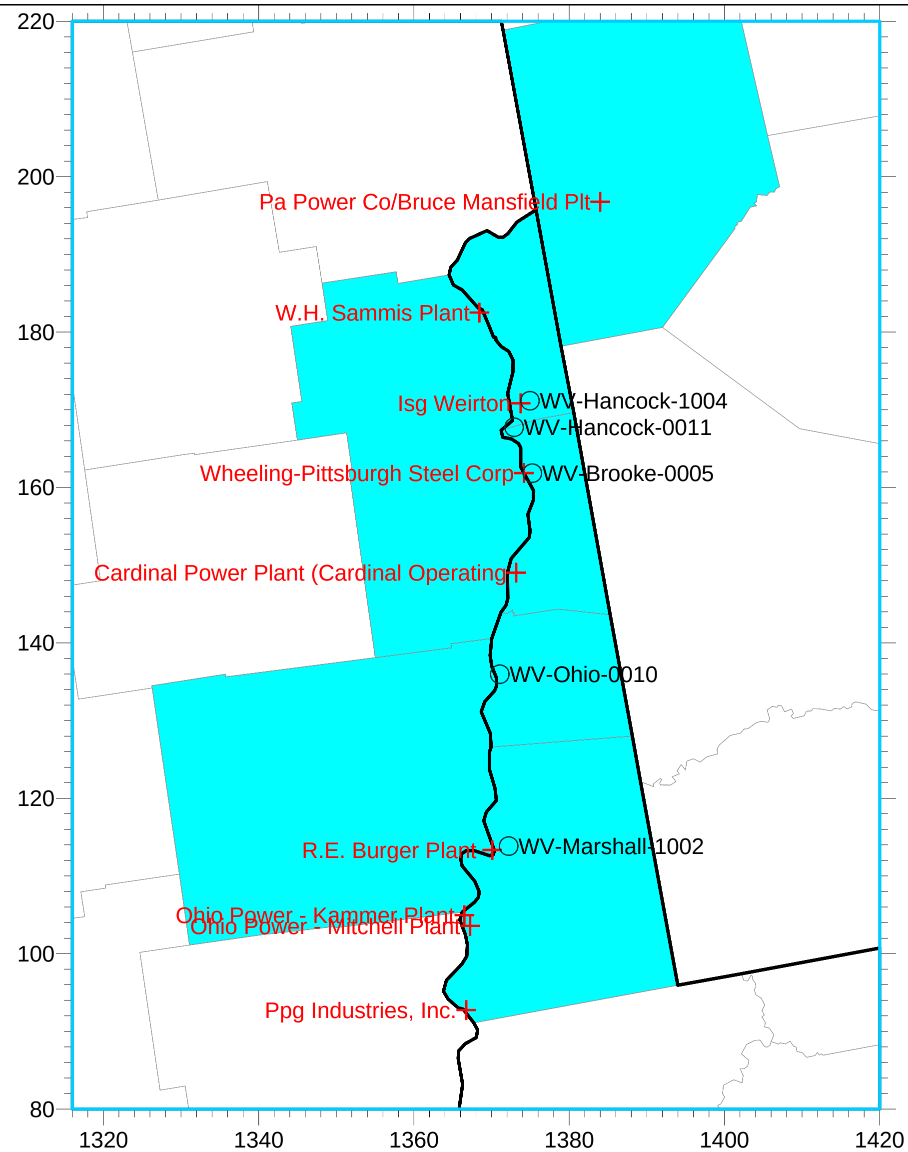


Figure D-25. Wheeling-Weirton-Steubenville WV-OH-PA 4 km domain and locations of FRM monitors (black circles) and facilities treated by PSAT PM source apportionment (red crosses).

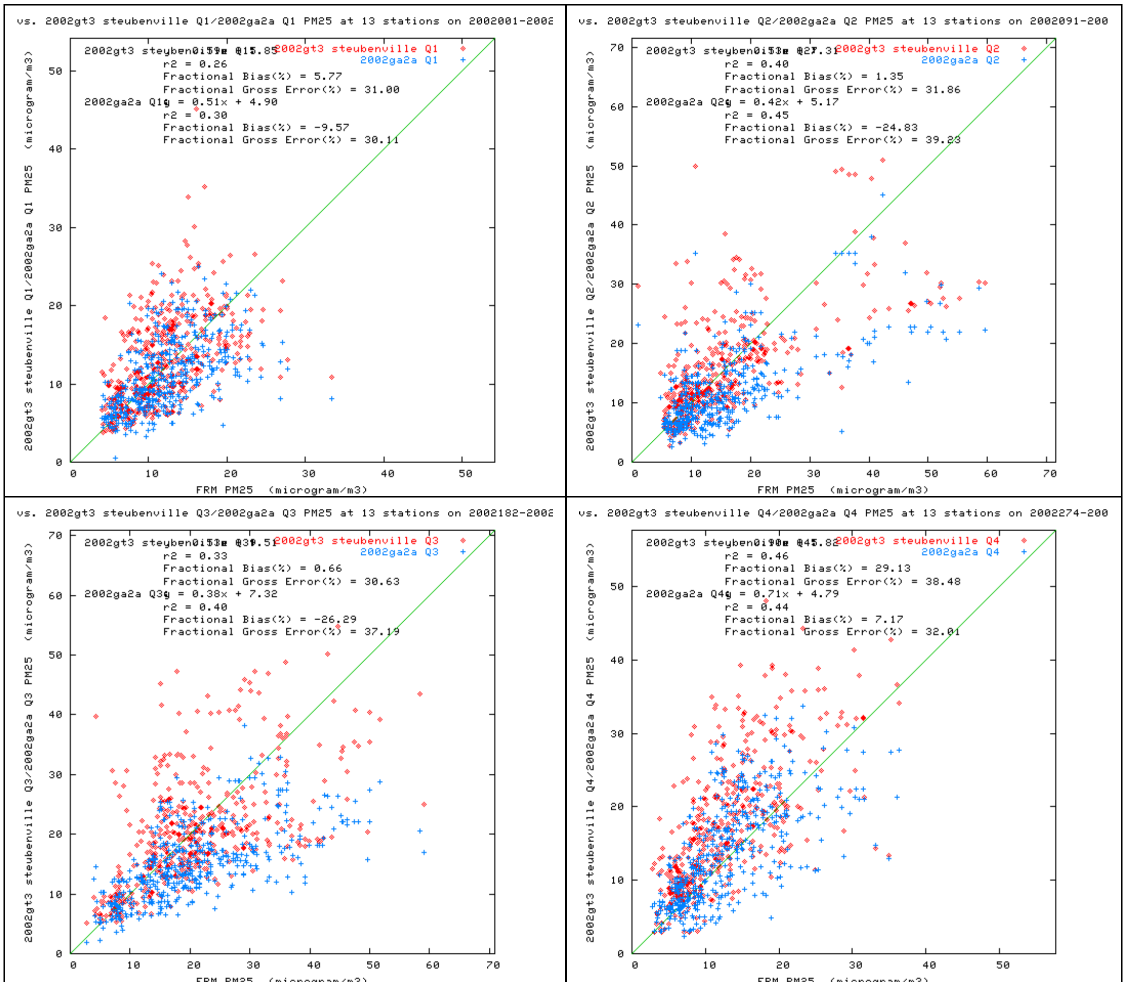


Figure D-26. Scatter Plots and performance statistics for predicted and observed 24-hour FRM $PM_{2.5}$ concentrations by Quarter during 2002, the CAMx 2002gt3 4 km and CMAQ 2002aga2 12 km base case simulations and the Wheeling subdomain.

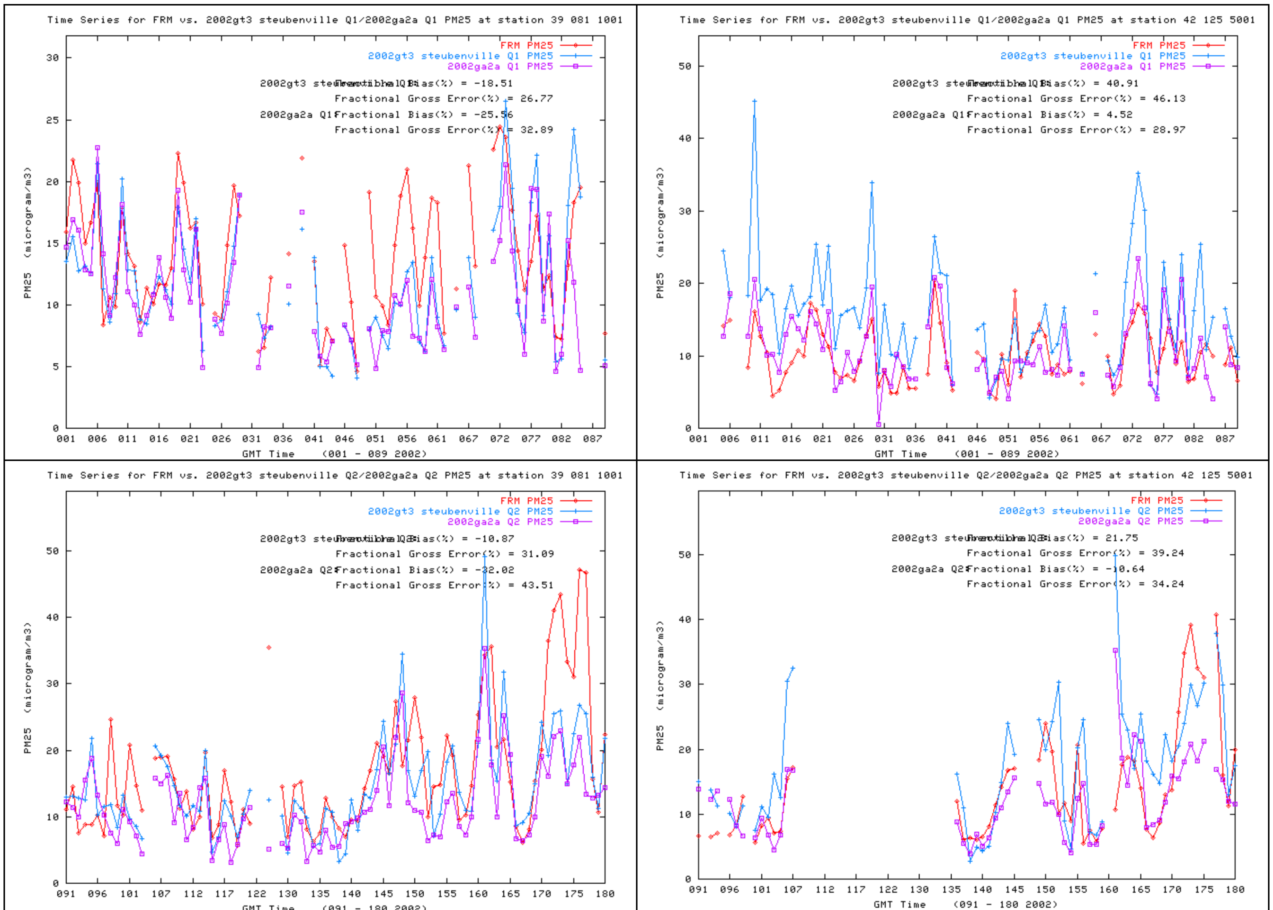


Figure D-27. Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Wheeling subdomain, Quarter 1 (top), 2, 3 and 4 (bottom) and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

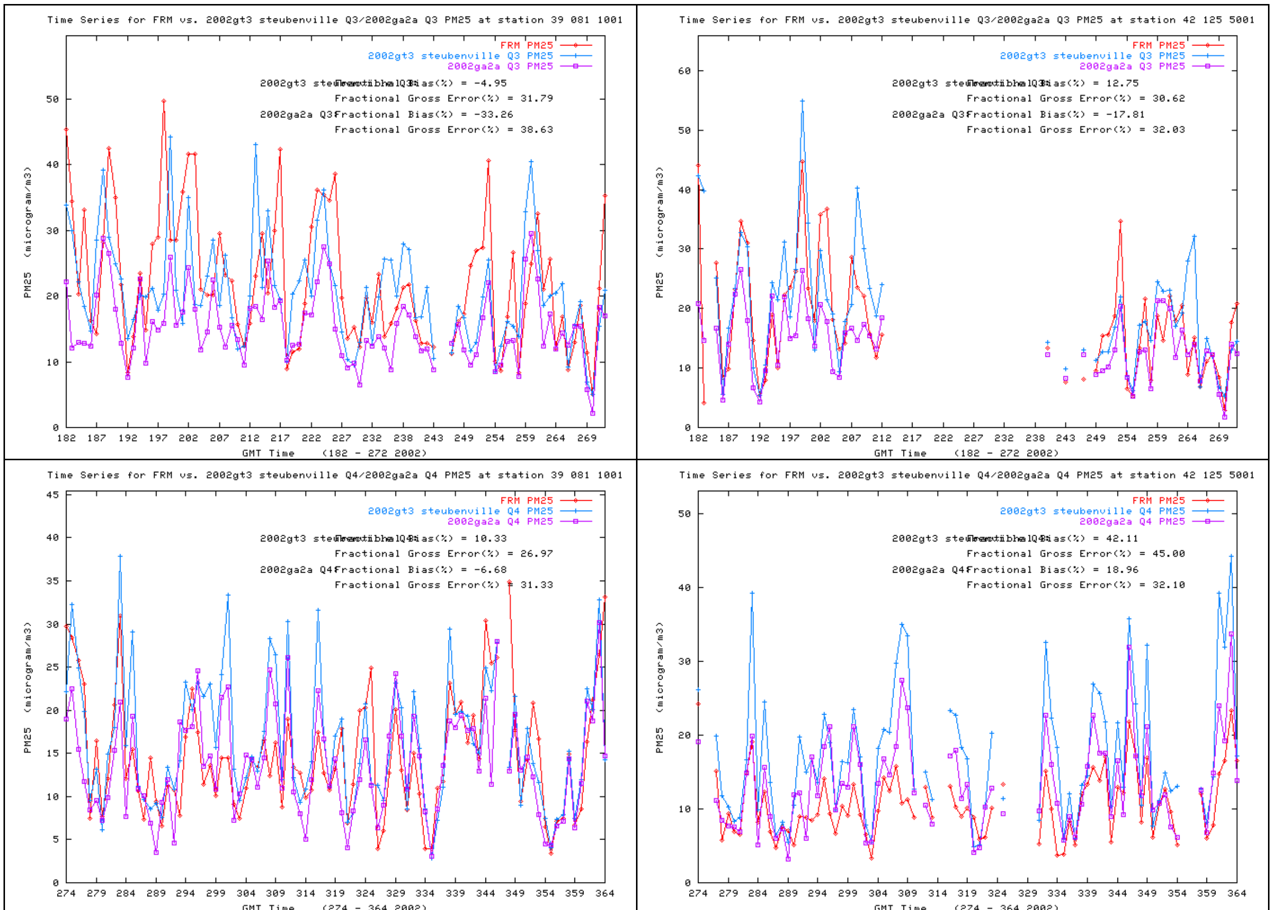


Figure D-27. (continued) Time Series of predicted and observed 24-hour $PM_{2.5}$ concentrations for FRM sites in the Wheeling subdomain, Quarter 1 (top), 2, 3 and 4 (bottom) and the CAMx 2002gt3 and CMAQ 2020aga2 base case simulations.

D.4 CONCLUSIONS

In general, the CMAQ and CAMx models are exhibiting similar model performance for $PM_{2.5}$, although CAMx usually has an overestimation and CMAQ usually has an underestimation tendency. Exceptions to this are for OCM, which both models underestimate during the summer, and Soil, which both models overestimate. The CMAQ and CAMx model performance usually meets the PM model performance goal for most months and PM species. The best model performance is achieved for SO4 and total $PM_{2.5}$ mass concentrations, with the models' frequently achieving the more stringent ozone model performance goal.

SUMMARY OF METEOROLOGICAL CONDITIONS AND CART RESULTS FOR IMPROVE SITES IN NC

Prepared by
Sharon Douglas and Belle Hudischewskyj
ICF International

Characterizing Meteorology

- Objectives:
  - Characterize relationship between meteorology, PM2.5, visibility, for IMPROVE, STN, and SEARCH sites
  - Evaluate how well meteorological and visibility conditions of the 2002 modeling year represents the 2000-2004 baseline period

Classifying Days using Visibility, Meteorology, and PM2.5

- Classification and Regression Tree (CART) analyses
  - Classify days based on extinction coefficient
  - 5 extinction classes defined for each site
    - 20th, 50th, 80th, and 95th percentiles
  - 2000-2004 data
  - 21 IMPROVE, 8 SEARCH, 16 STN sites

Classifying Days Using Visibility, Meteorology, and PM2.5

- Classification and Regression Tree (CART) methods
  - Use meteorological parameters at (or near) the site
  - Use PM2.5 on previous days at regional/upwind sites
  - CART decision tree sorts days using most influential parameters first
  - Assign days to “bins” of days with similar meteorology
  - Several bins assigned to same class
    - different combinations of meteorological conditions can lead to same extinction

CART Results for Visibility at IMPROVE sites

- Using only meteorological inputs, 65 to 80% of days are accurately classified
- Adding PM2.5 on previous day at upwind sites improves accuracy of classifying days for visibility to 73-88%
- Optimal CART decision tree has 25-35 bins
- Key parameters vary across sites and classes

CART Visibility Analyses – IMPROVE

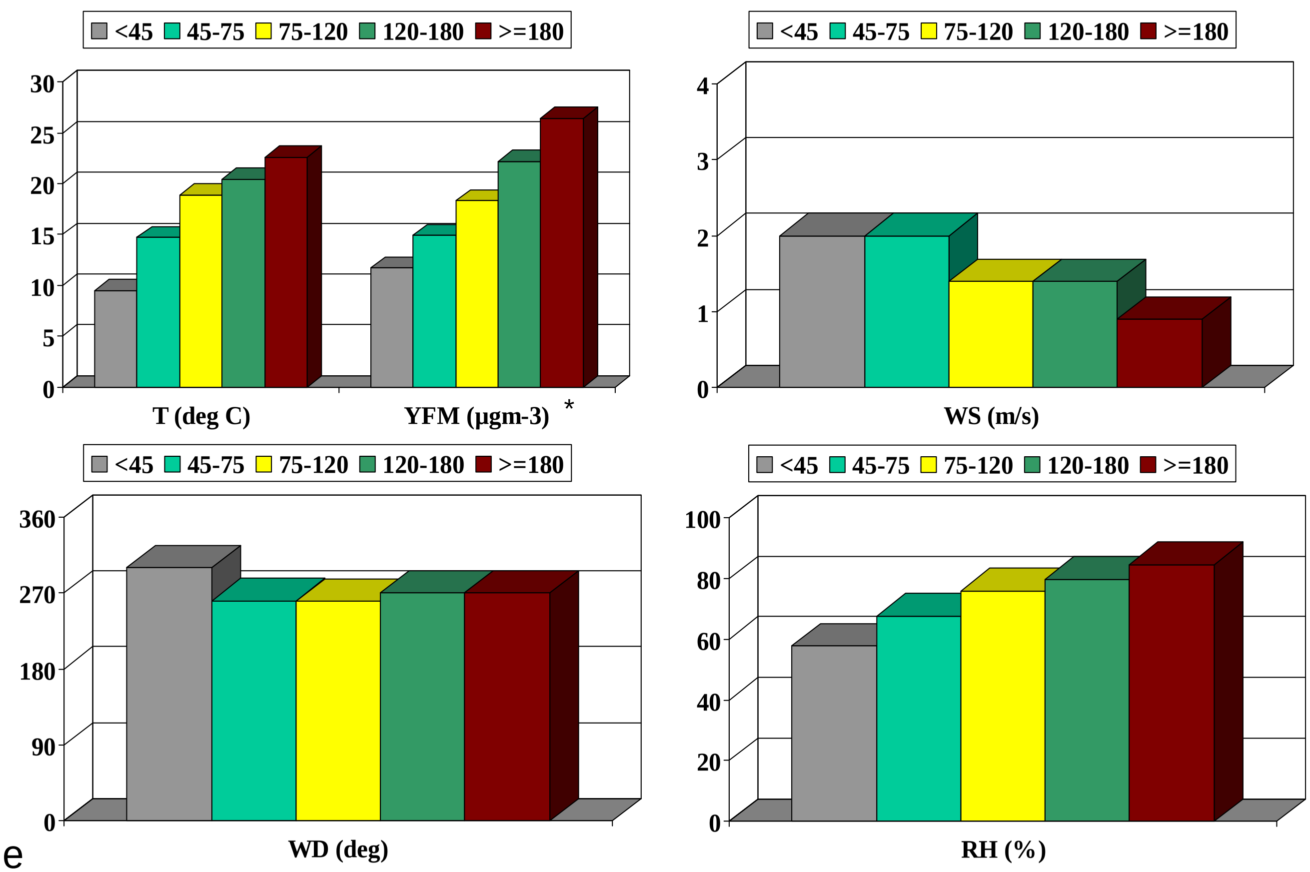
- In general, poor visibility days are associated with
  - High temperatures
  - High relative humidity
  - High PM2.5 on the previous day at upwind sites
  - Low wind speeds near the surface and aloft
  - Stable morning conditions
  - Predominant surface wind direction is site specific
- PM2.5 composition on poor visibility days varies by site
- Greater variability in conditions leading to good visibility

NOTES ON SUMMARIES OF RESULTS FOR VISIBILITY

- Classification accuracy for visibility combines Categories 2 & 3, so emphasis is on Category 1 (Best) and 4 & 5 (Worst) days
- References to high, low etc… are used mostly in a relative and site specific sense, rather than an absolute sense, to compare and distinguish the characteristics of the poor visibility categories (more detailed descriptions are included in the project report)

CATEGORICAL COMPARISONS FOR VISIBILITY FOR GRSM

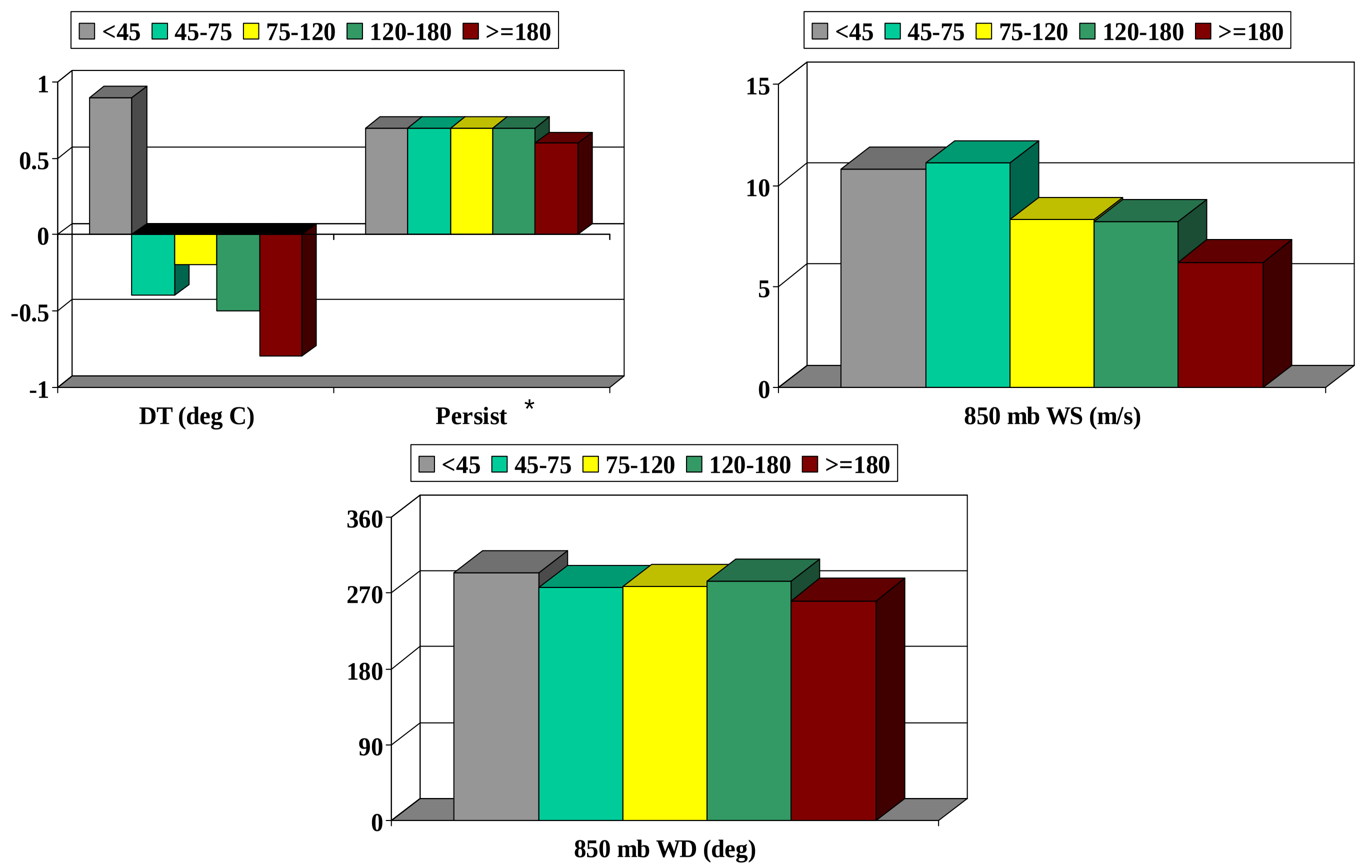
Surface Characteristics: All Days (2000-2004)/5 Ex. Coeff. Categories (Mm-1)



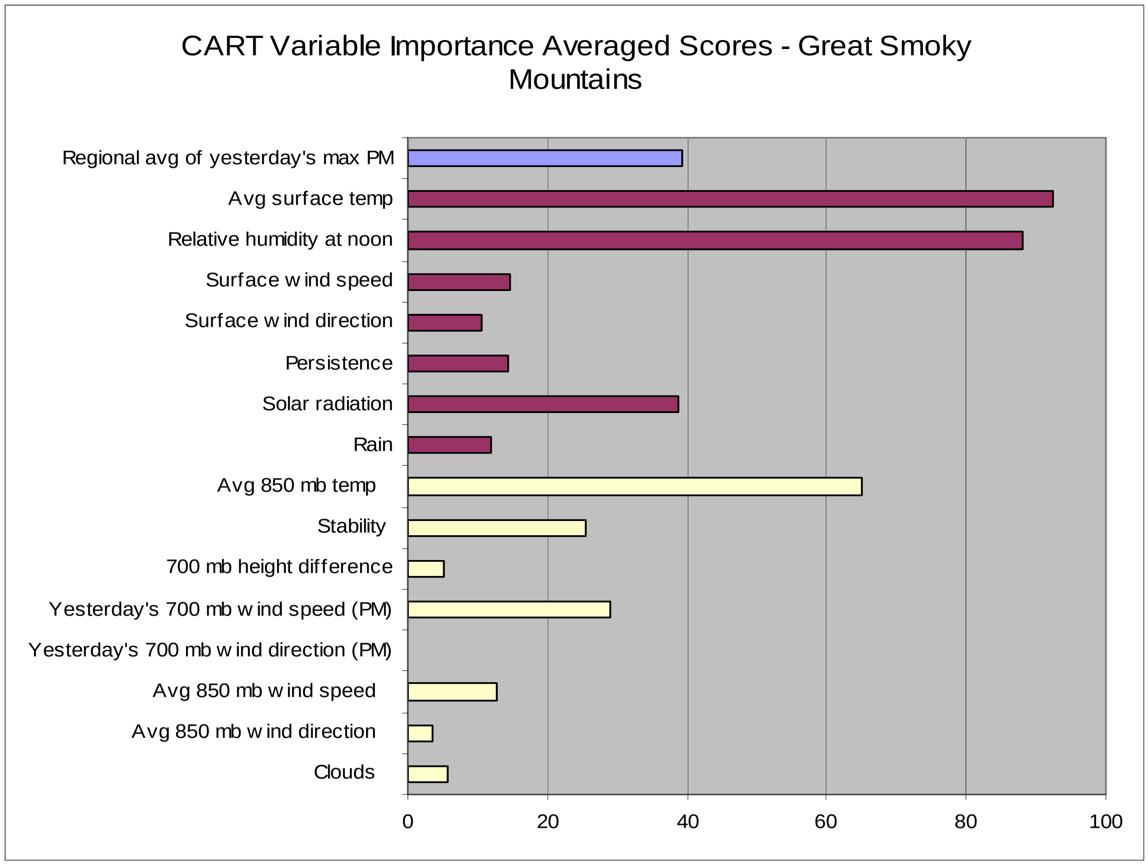
*Knoxville

CATEGORICAL COMPARISONS FOR VISIBILITY: GRSM

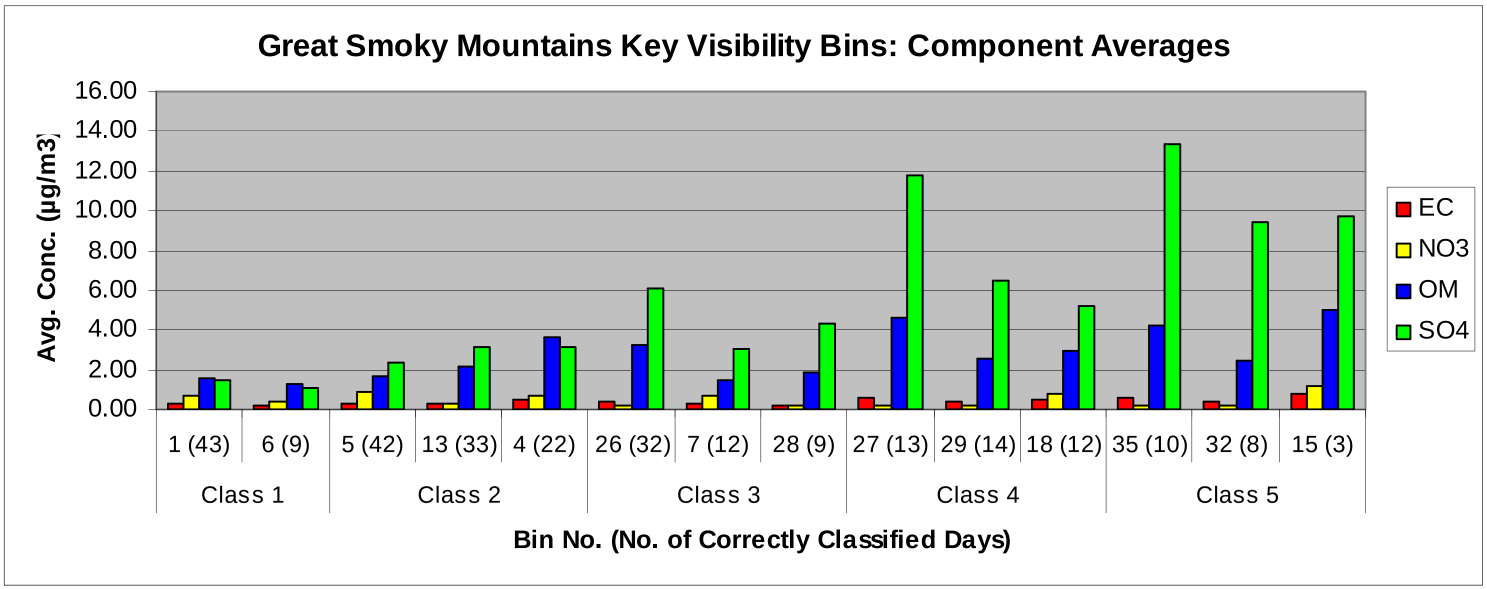
Upper-Air Characteristics: All Days (2000-2004)/5 Ex. Coeff. Categories



CART PARAMETER IMPORTANCE FOR VISIBILITY: GRSM



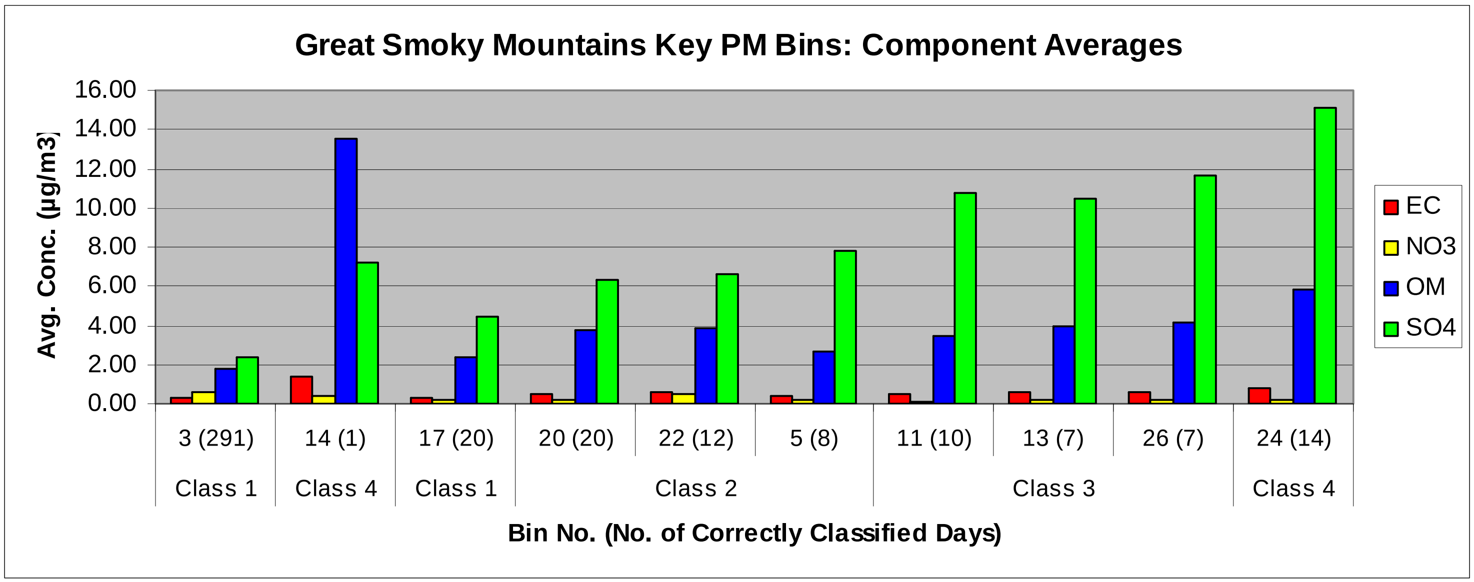
COMPOSITIONAL ANALYSIS FOR KEY VISIBILITY BINS: GRSM



SUMMARY OF RESULTS FOR VISIBILITY: GRSM

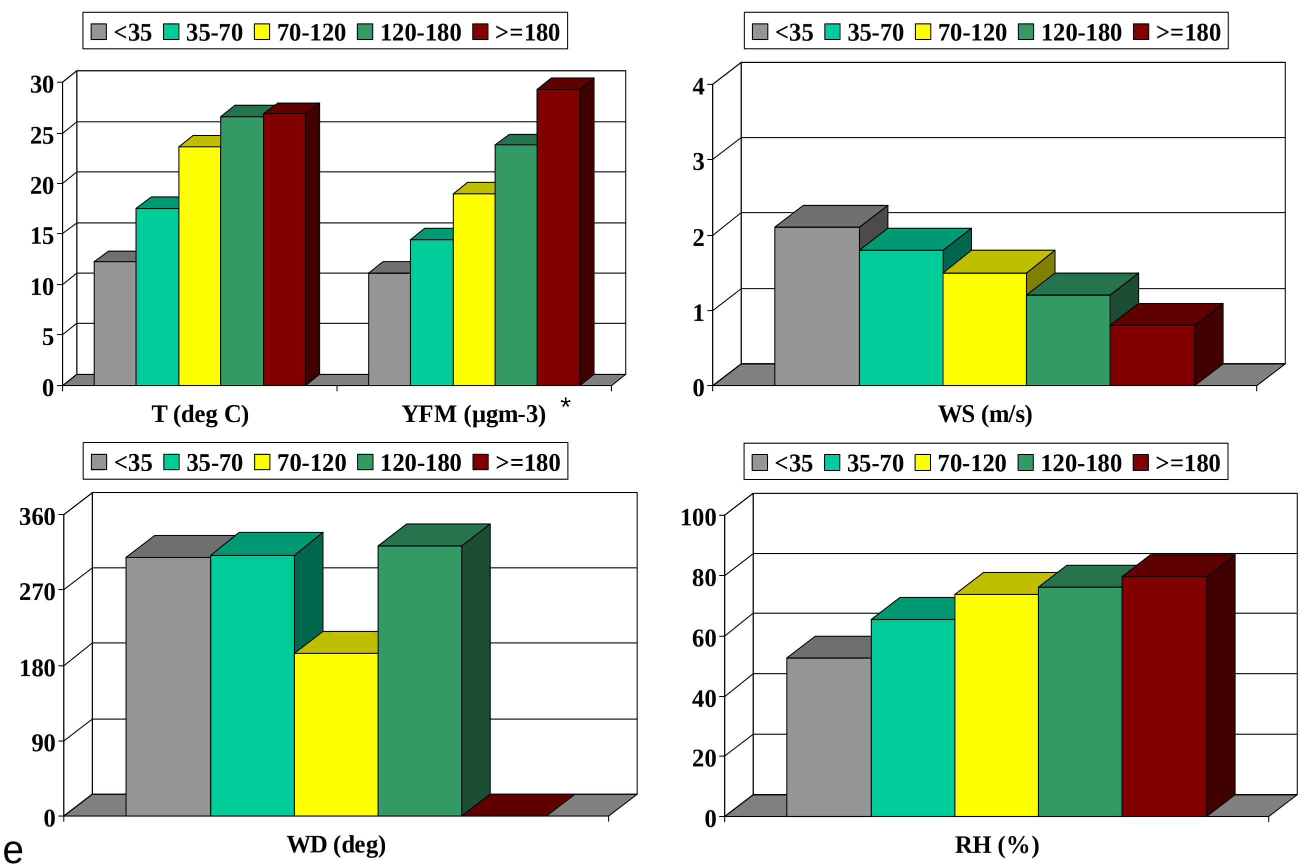
- Classification accuracy: 78%
- Poor visibility is associated with
  - Moderate to high prior-day PM2.5 (at upwind sites)
  - Moderate temperatures and high RH
  - Low wind speeds near the surface and aloft (esp. Category 5)
  - WSW winds both aloft and W winds near the surface
- PM2.5, temperature, humidity, stability and upper-air wind speed parameters important for CART
- Poor visibility regimes are associated with
  - Moderate to high SO4 and low to moderate OM

COMPOSITIONAL ANALYSIS FOR KEY PM2.5 BINS: GRSM



CATEGORICAL COMPARISONS FOR VISIBILITY FOR LINVILLE GORGE

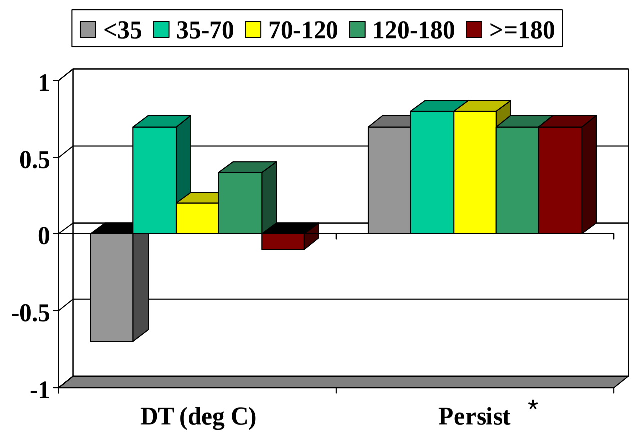
Surface Characteristics: All Days (2000-2004)/5 Ex. Coeff. Categories (Mm-1)

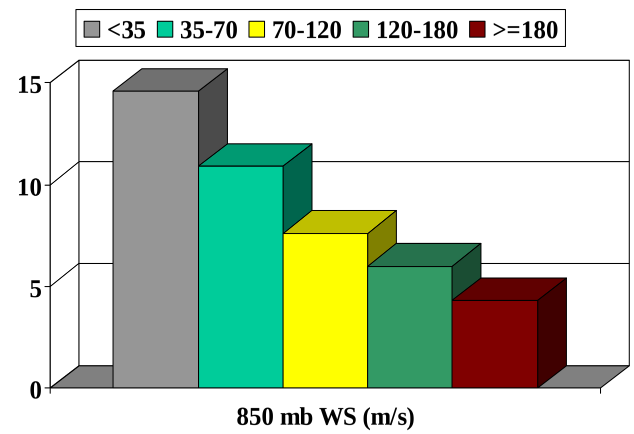


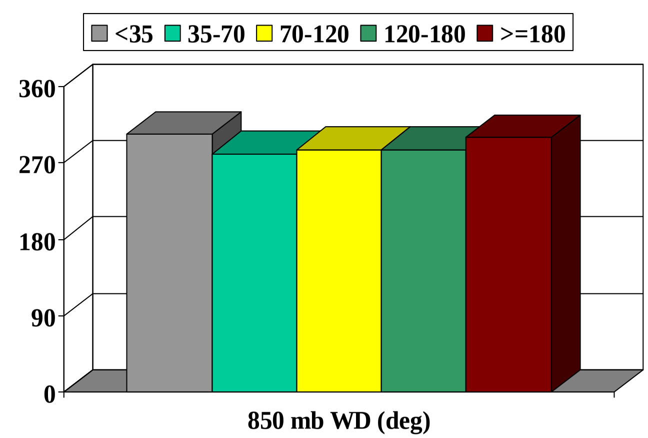
*Knoxville

CATEGORICAL COMPARISONS FOR VISIBILITY: LINVILLE GORGE

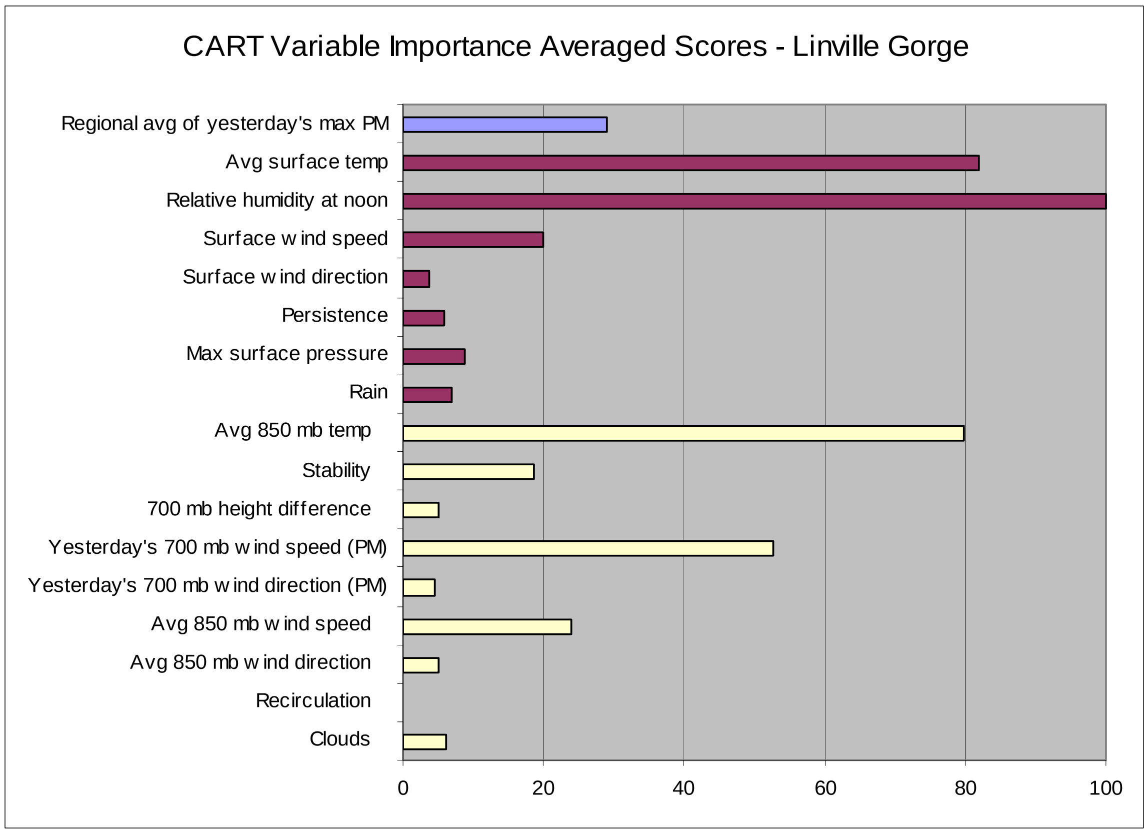
Upper-Air Characteristics: All Days (2000-2004)/5 Ex. Coeff. Categories



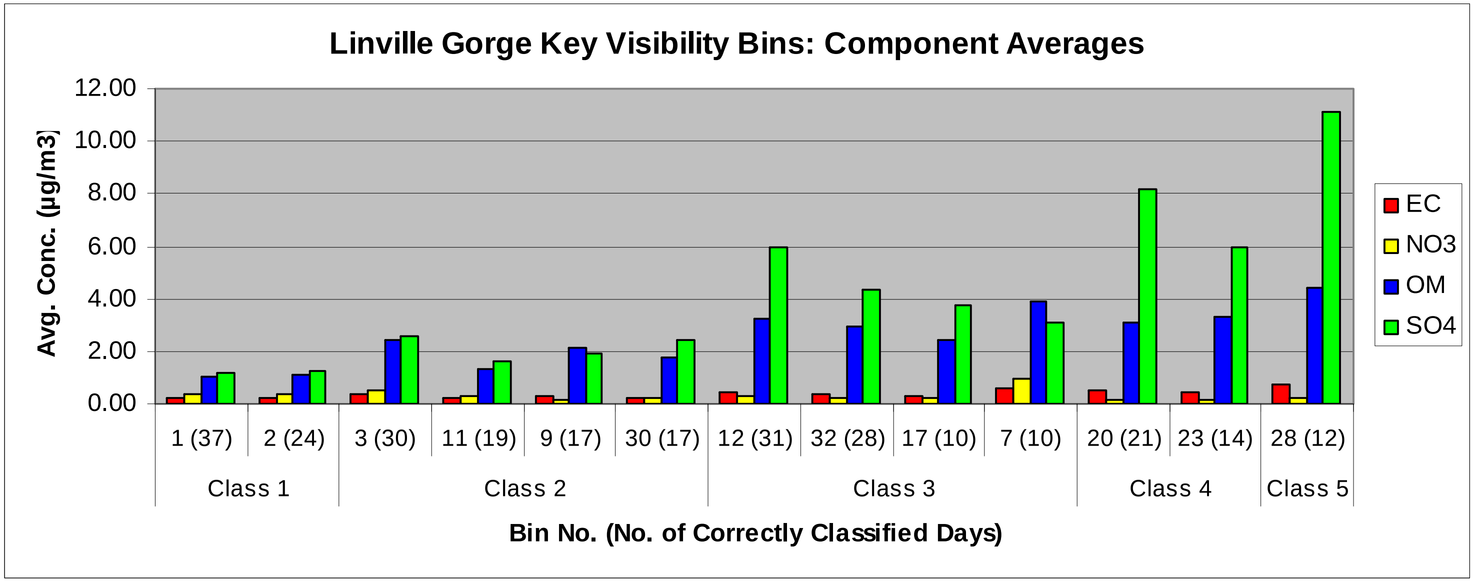




CART PARAMETER IMPORTANCE FOR VISIBILITY: LINVILLE GORGE



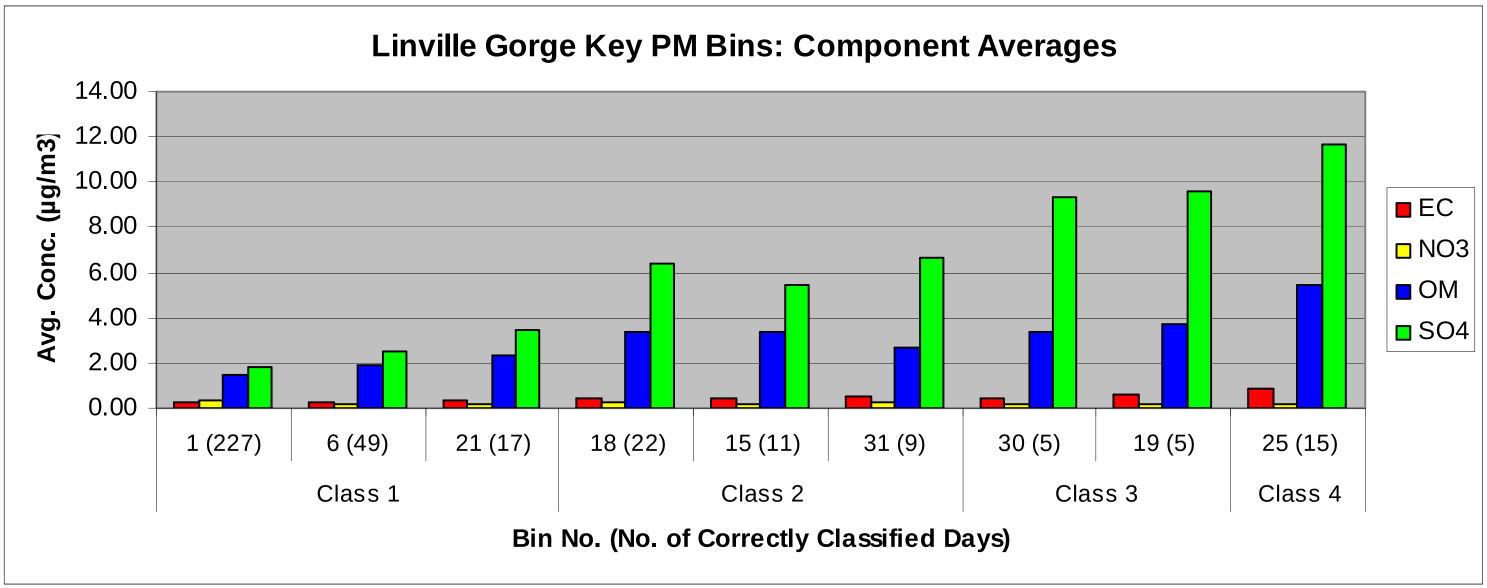
COMPOSITIONAL ANALYSIS FOR KEY VISIBILITY BINS: LINVILLE GORGE



SUMMARY OF RESULTS FOR VISIBILITY: LINVILLE GORGE

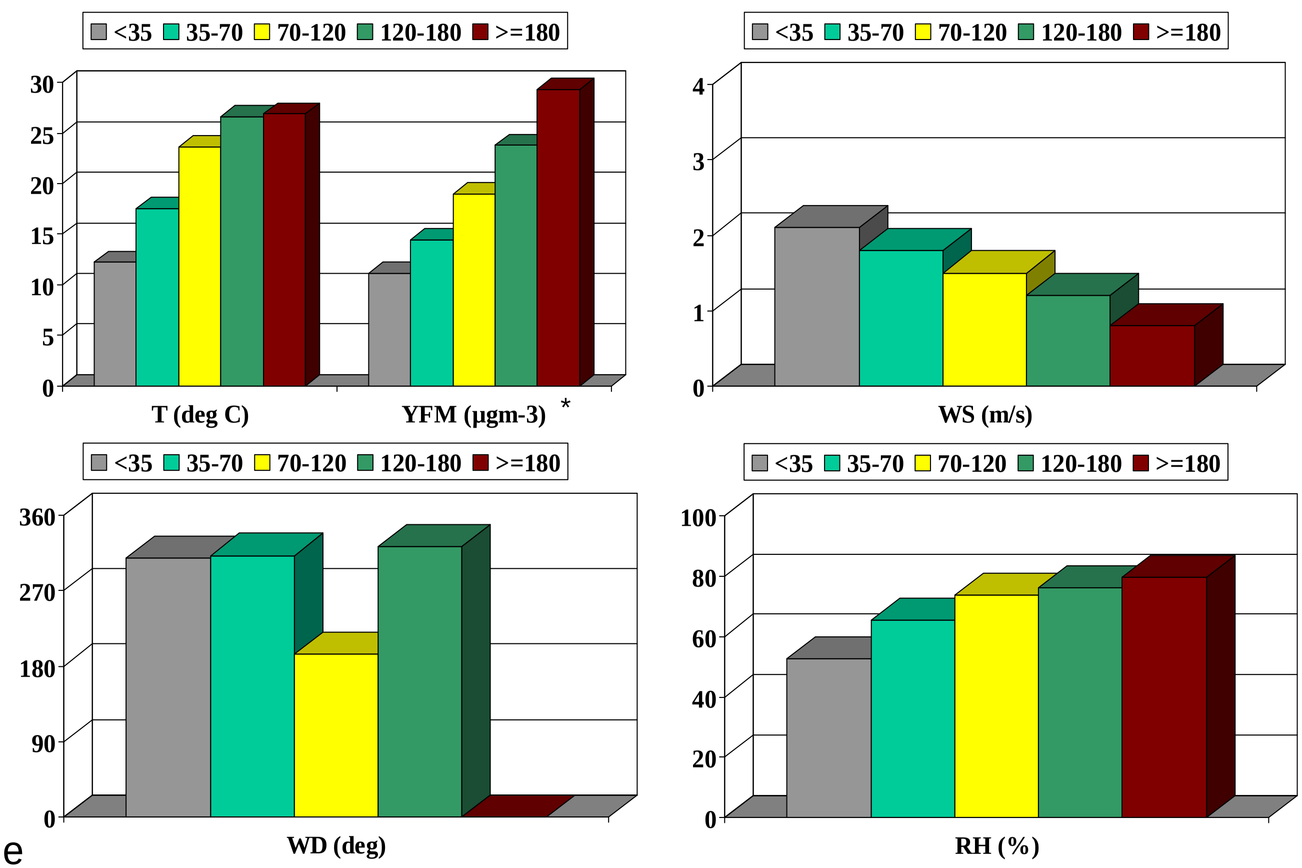
- Classification accuracy: 83%
- Poor visibility is associated with
  - High prior-day PM2.5 (at upwind sites)
  - High temperatures and relative humidity
  - Low wind speeds near the surface and aloft
  - W(NW) winds aloft; NW to N winds near the surface
- PM2.5, RH, temperature, stability, and upper-air wind speed parameters important for CART
- Poor visibility regimes are associated with
  - Moderate to high SO4 and low to moderate OM concentrations

COMPOSITIONAL ANALYSIS FOR KEY PM2.5 BINS: LINVILLE GORGE



CATEGORICAL COMPARISONS FOR VISIBILITY FOR LINVILLE GORGE

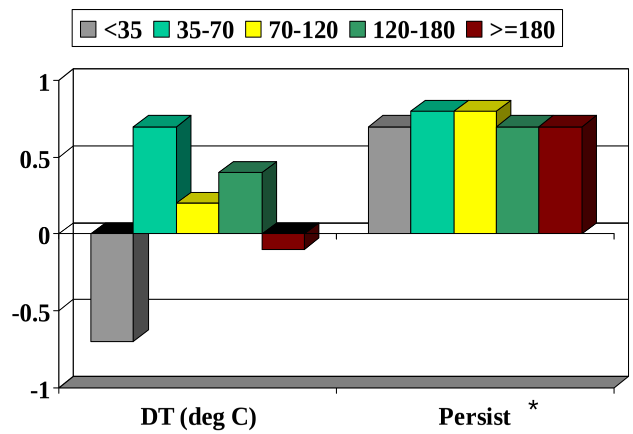
Surface Characteristics: All Days (2000-2004)/5 Ex. Coeff. Categories (Mm-1)

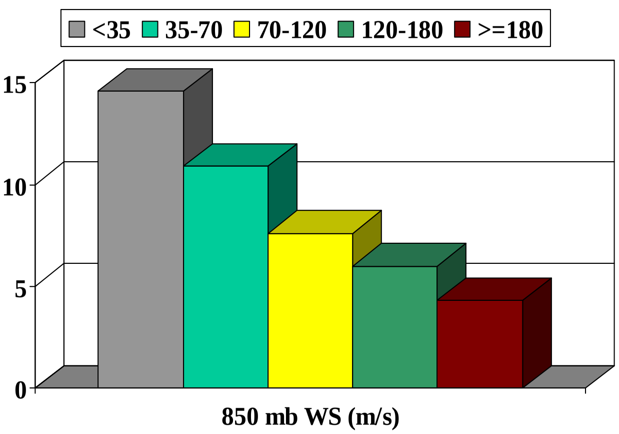


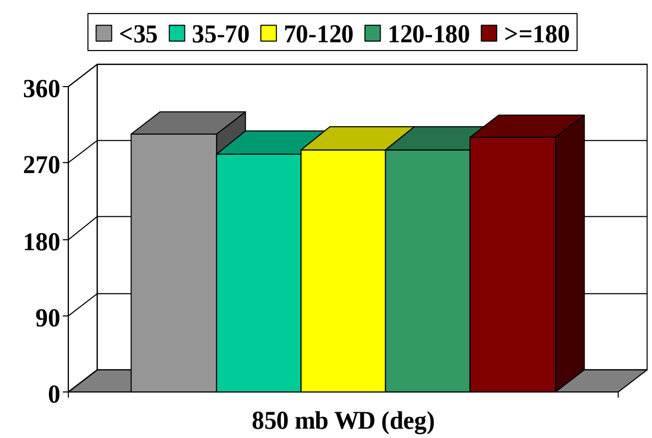
*Knoxville

CATEGORICAL COMPARISONS FOR VISIBILITY: LINVILLE GORGE

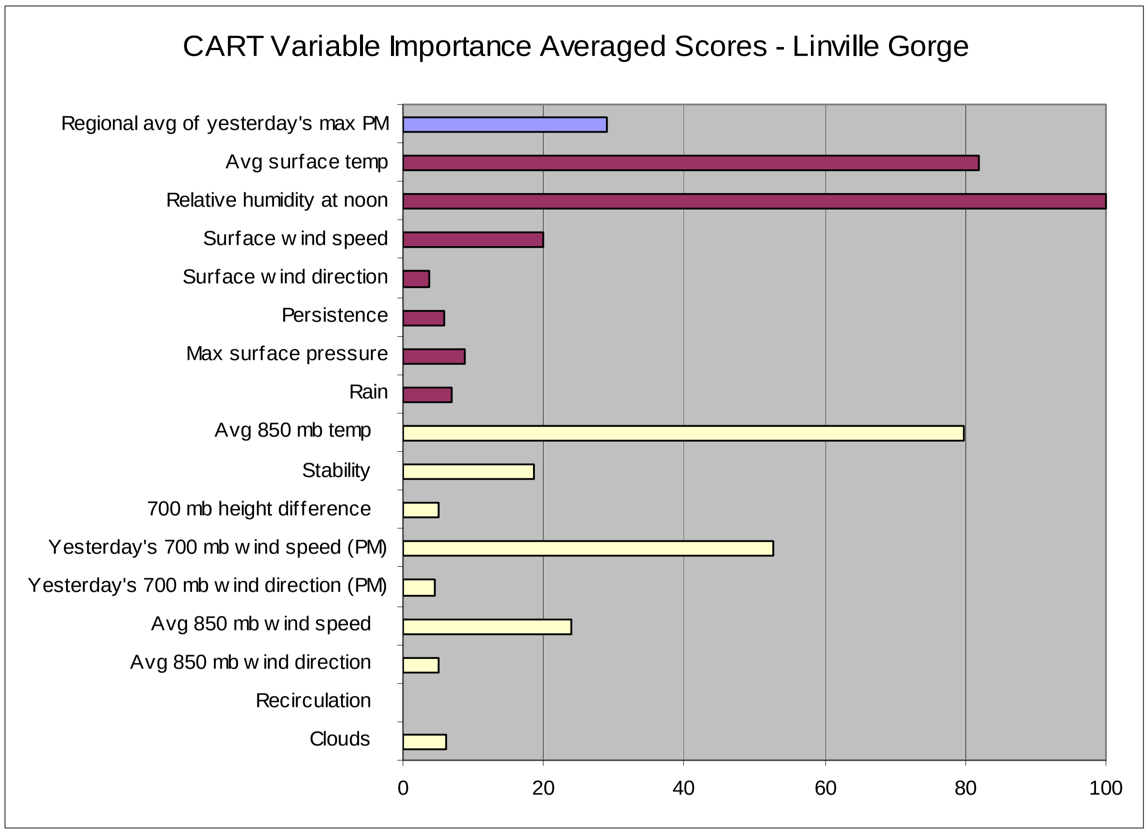
Upper-Air Characteristics: All Days (2000-2004)/5 Ex. Coeff. Categories



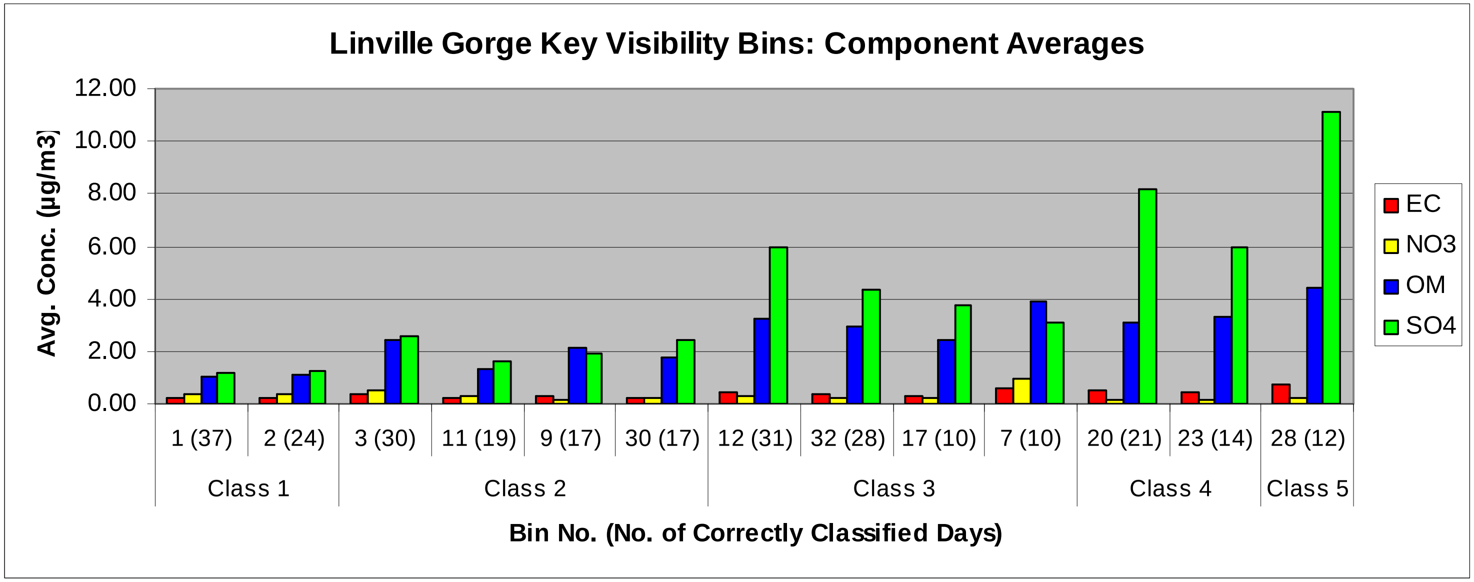




CART PARAMETER IMPORTANCE FOR VISIBILITY: LINVILLE GORGE



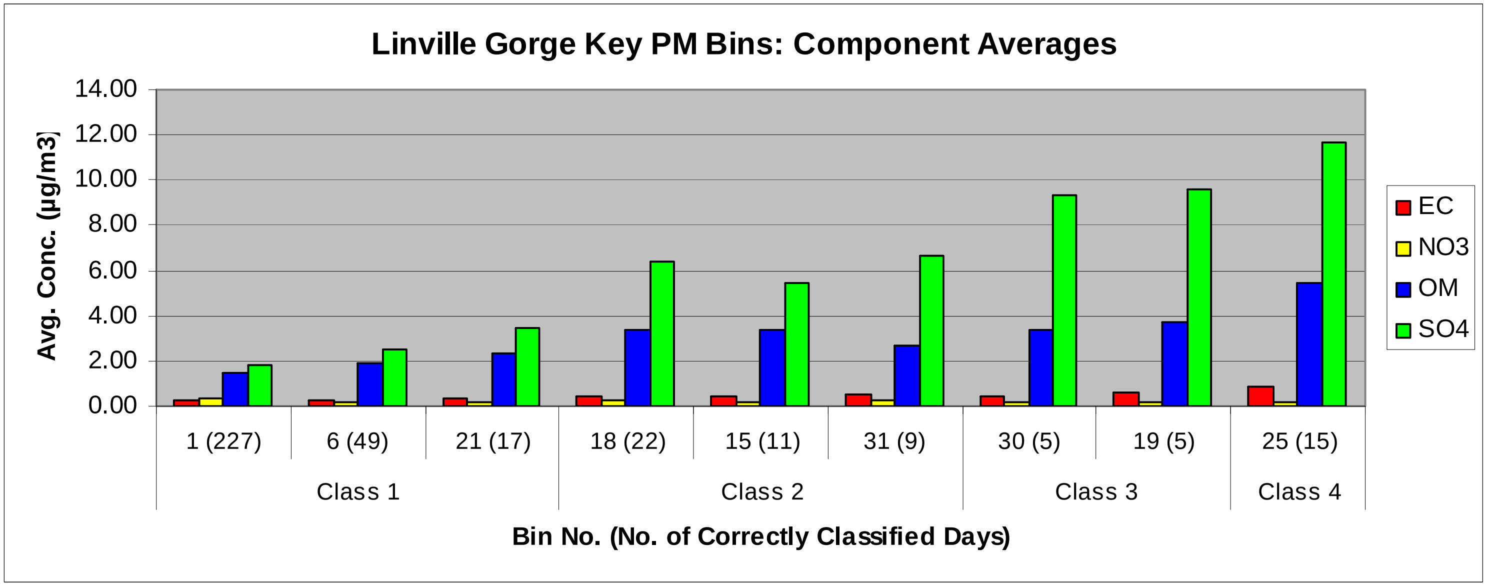
COMPOSITIONAL ANALYSIS FOR KEY VISIBILITY BINS: LINVILLE GORGE



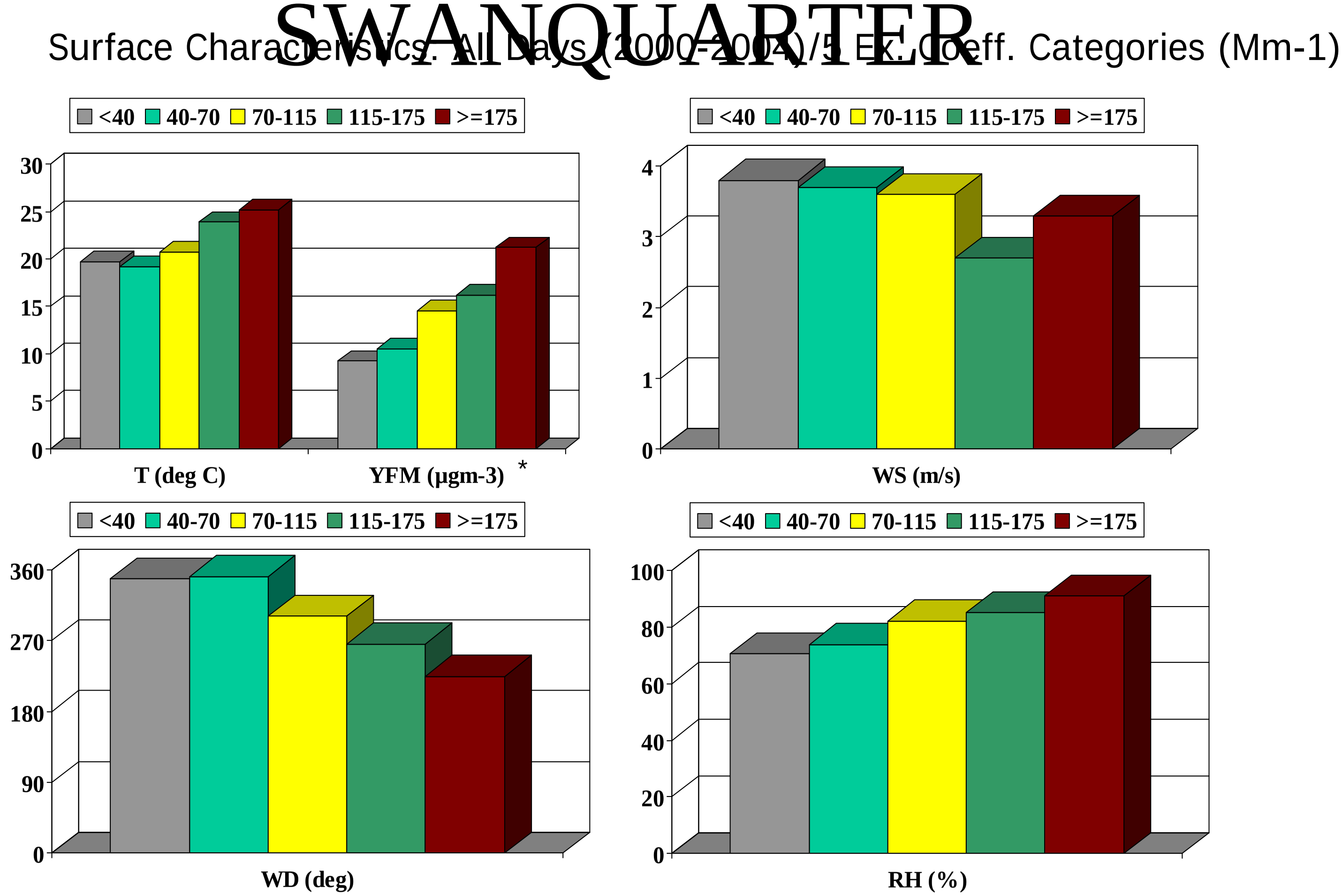
SUMMARY OF RESULTS FOR VISIBILITY: LINVILLE GORGE

- Classification accuracy: 83%
- Poor visibility is associated with
  - High prior-day PM2.5 (at upwind sites)
  - High temperatures and relative humidity
  - Low wind speeds near the surface and aloft
  - W(NW) winds aloft; NW to N winds near the surface
- PM2.5, RH, temperature, stability, and upper-air wind speed parameters important for CART
- Poor visibility regimes are associated with
  - Moderate to high SO4 and low to moderate OM concentrations

COMPOSITIONAL ANALYSIS FOR KEY PM2.5 BINS: LINVILLE GORGE



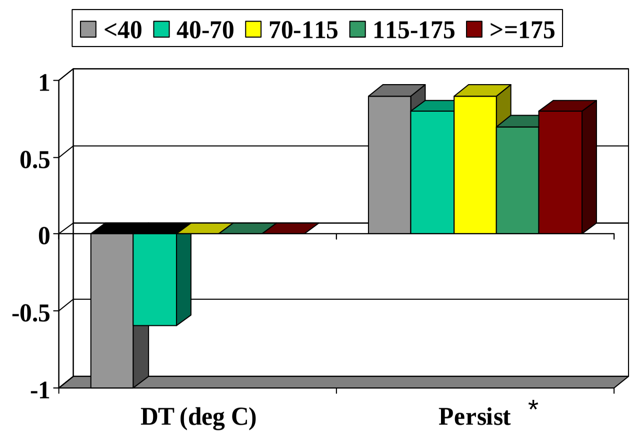
CATEGORICAL COMPARISONS FOR VISIBILITY FOR SWANQUARTER

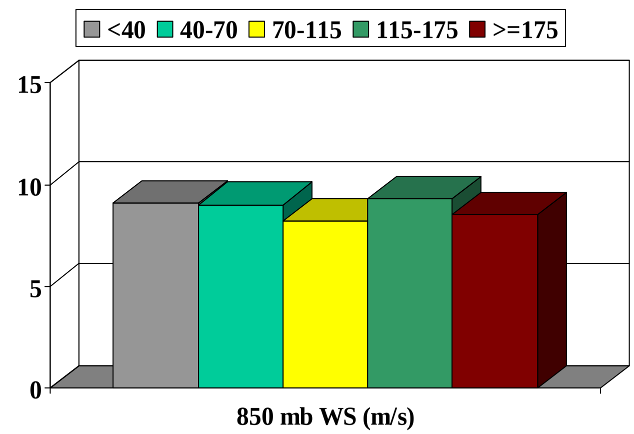


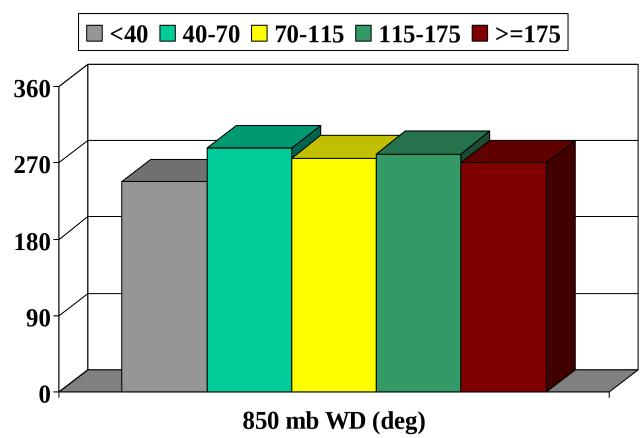
*Norfolk

CATEGORICAL COMPARISONS FOR VISIBILITY: SWANQUARTER

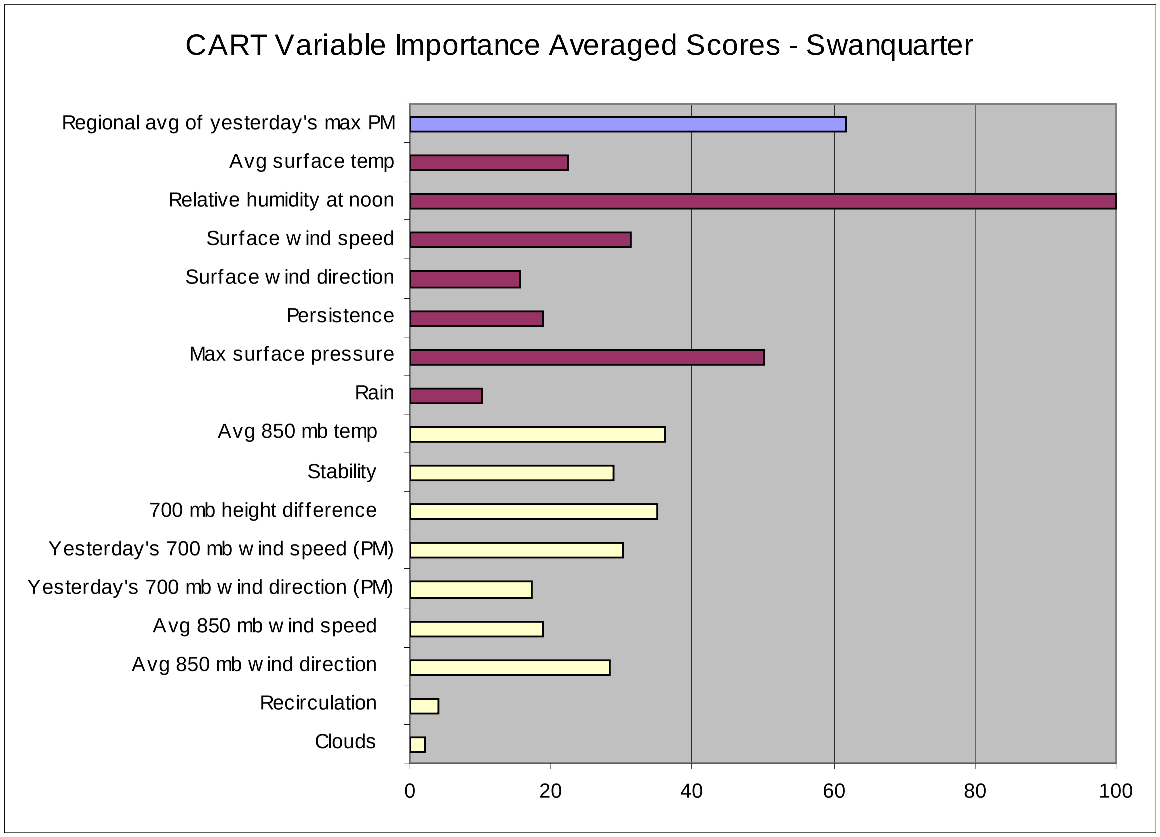
Upper-Air Characteristics: All Days (2000-2004) / 5 Ext. Coeff. Categories



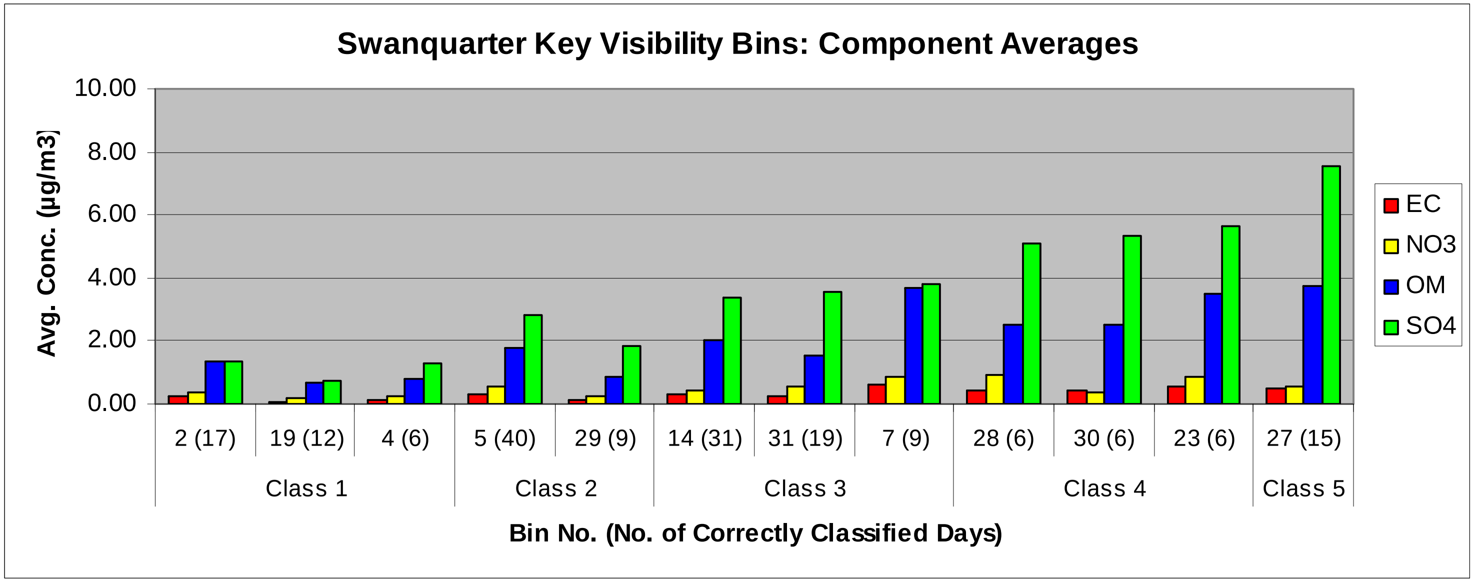




CART PARAMETER IMPORTANCE FOR VISIBILITY: SWANQUARTER



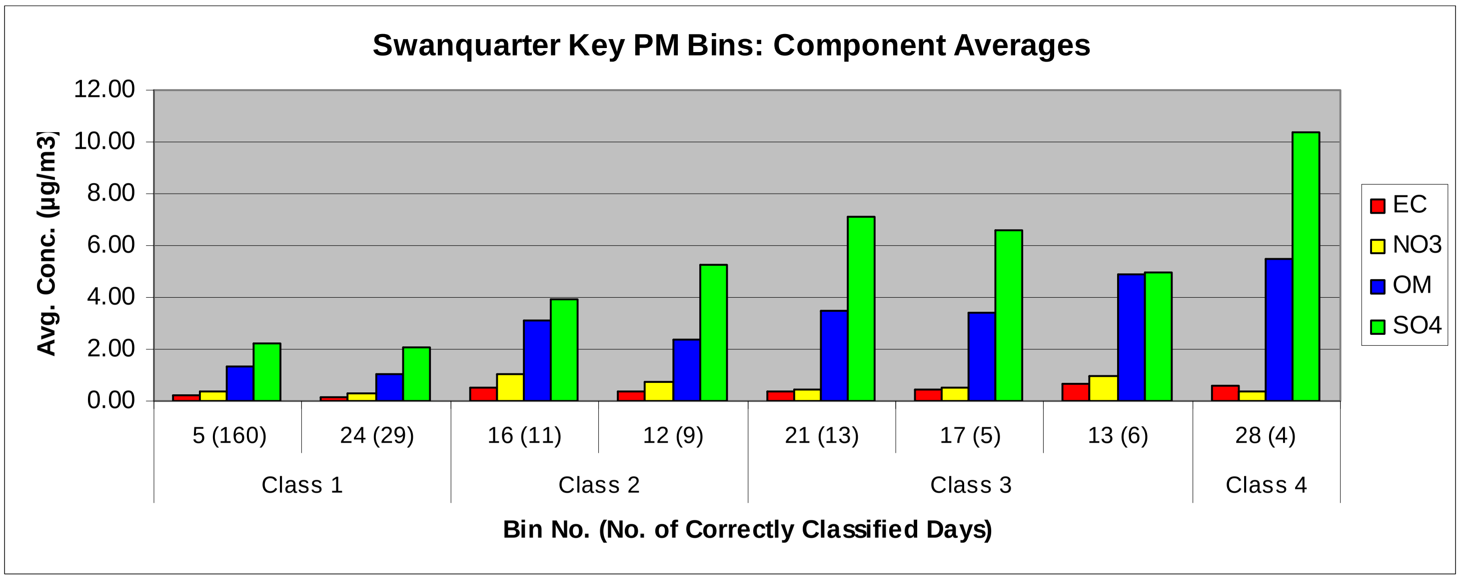
COMPOSITIONAL ANALYSIS FOR KEY VISIBILITY BINS: SWANQUARTER



SUMMARY OF RESULTS FOR VISIBILITY: SWANQUARTER

- Classification accuracy: 80%
- Poor visibility is associated with
  - Moderate prior-day PM2.5 (big jump to Category 5)
  - Moderate temperatures and high RH
  - Moderate wind speeds (slight decreasing tendency near sfc)
  - W winds aloft and SW to W winds near the surface
- PM2.5, RH, pressure and other surface and upper-air met parameters important for CART
- Poor visibility regimes are associated with
  - Moderate SO4 and low to moderate OM concentrations

COMPOSITIONAL ANALYSIS FOR KEY PM2.5 BINS: SWANQUARTER



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DOCUMENTATION AND EVALUATION OF THE GEOS-CHEM SIMULATION FOR 2002 PROVIDED TO THE VISTAS GROUP

Final Report

Principal Investigator: Daniel J. Jacob, Harvard University
(djacob@fas.harvard.edu)
Co-Investigators: Rokjin Park and Jennifer A. Logan, Harvard University

June 24, 2005

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1. PROJECT OBJECTIVE AND PRODUCTS DELIVERED

The objective of this project was to provide chemical boundary conditions with synoptic-scale resolution from the GEOS-Chem global chemical transport model (CTM) to serve as continental-scale CMAQ regional simulations for 2002 conducted by the VISTAS group. The GEOS-Chem simulations were to include a detailed representation of ozone-NO_x-VOC-PM chemistry as described by Park et al. [2003, 2004] (appended to this report). They were to replicate the Park et al. [2003, 2004] simulations but with coarser resolution (4^ox5^o horizontal resolution vs. 2^ox2.5^o), updated anthropogenic emissions from the EPA NEI 1999, and 2002-specific biomass burning emissions. They were also to include preliminary simulations of soil dust and sea salt. We conducted three full-year simulations for 2002:

1. A *baseline* simulation with best estimates of 2002 emissions;
2. A *background* simulation modified from the baseline by shutting off U.S. anthropogenic[1] emissions;
3. A *natural* simulation modified from the baseline by shutting off anthropogenic emissions worldwide.

3-D concentration fields with 3-hour temporal resolution were archived from each simulation to serve as boundary conditions for CMAQ. A model performance evaluation (MPE) was conducted through comparisons of the baseline simulation to IMPROVE and CASTNET observations in the United States, using the same metrics as in Park et al. [2003, 2004].

2. DESCRIPTION OF GEOS-CHEM SIMULATIONS FOR VISTAS

2.1. The GEOS-Chem model

The GEOS-Chem model (http://www-as.harvard.edu/chemistry/trop/geos) is a cooperative global CTM used by 21 institutions in North America and Europe, and centrally managed by Daniel Jacob's group at Harvard. It is driven by assimilated meteorological observations from the Global Earth Observation System (GEOS) of the NASA Global Modeling and Assimilation Office (GMAO). It is presently being applied to a wide range of atmospheric composition problems including greenhouse gases, oxidants, PM, mercury, and other species. The coupled ozone-NO_x-VOC-PM version of GEOS-Chem is described in Park et al. [2004] (appendix B). The GEOS-Chem model is documented in over 100 papers in the refereed literature (see above web site for the

[1] "Anthropogenic" here includes all fuel, industrial, and agricultural sources; it does not include biomass burning. See Park et al. [2004] for detail on source specifications.

publication list). Evaluations of the global PM simulation are presented in Park et al. [2003, 2004, 2005ab], Li et al. [2005], Alexander et al. [2005], and Heald et al. [2005].

2.2. Model configuration used for VISTAS

The GEOS-Chem simulations for VISTAS used GEOS meteorological observations for the year 2002. These were obtained from GMAO as a 6-hourly archive (3-hour for surface quantities such as mixing depths). The data through August 2002 are from the GEOS-3 assimilation, with horizontal resolution of $1^o x1^o$ and 55 vertical layers. The data after August 2002 are from the updated GEOS-4 assimilation, with horizontal resolution of $1^o x1.25^o$ and 48 vertical layers.

GEOS-Chem simulations can be conducted either with the native resolution of the GEOS meteorological data, or with degraded horizontal resolution to reduce computational expense. The Park et al. [2003, 2004] simulations used a $2^o x2.5^o$ horizontal resolution. Continental-scale simulations for North America have been conducted with the native $1^o x1^o$ resolution of the GEOS-3 data [Li et al., 2005; Park et al., 2005b]. The VISTAS simulations used a coarser horizontal resolution of 4^o latitude x 5^o longitude, as this was considered sufficient to provide boundary conditions outside of North America for use in continental-scale CMAQ simulations. In Fiore et al. [2003], we previously compared ozone simulations for North America using GEOS-Chem with $4^o x5^o$ and $2^o x2.5^o$ resolution, and the MAQSIP regional model with 36x36 km^2 resolution. We found that using the $4^o x5^o$ resolution of GEOS-Chem significantly degraded the ability of the model to reproduce the observed variability of concentrations over North America, but still maintained the synoptic-scale structure and did not incur a significant continental-scale mean bias.

Significant modifications to the representation of PM sources were made in the VISTAS simulations relative to the work of Park et al. [2003, 2004] and are described in more detail below. They include (1) use of U.S. anthropogenic emissions from the EPA NEI 1999 inventory; (2) use of forest fire information specific to 2002; (3) inclusion of the secondary organic aerosol (SOA) formation mechanism from Chung and Seinfeld [2002]; (4) inclusion of prototype soil dust and sea salt simulations. An additional modification was the application of surface emissions and dry deposition to the GEOS-diagnosed mixed layer column rather than to the surface layer of the model. This was introduced to correct for the effect of 1-hour operator splitting between transport and chemistry (including emissions and dry deposition) in the model, when dealing with a very shallow surface layer (only 10-m deep in GEOS-3). The effect is significant for fast-depositing gases such as HNO_3 and NH_3; correcting it is an objective model improvement that has since been implemented in the standard version of GEOS-Chem.

Other aspects of the simulation (transport, chemistry, deposition) are as described in Park et al. [2004]. Briefly, transport uses the advection scheme of Lin and Rood [1998], with instantaneous vertical mixing through the local mixing depth, and convective transport computed from GEOS-3 archived convective mass fluxes by replicating the convection algorithm of the parent GEOS general circulation model

(GCM). Natural sources are calculated within the GEOS-Chem simulation as a function of local values of meteorological variables (temperature, insolation, soil moisture, precipitation, wind speed, convective cloud tops). The description of ozone-NO_x-VOC-PM chemistry includes ~100 chemical species and ~400 chemical reactions. A full documentation of this mechanism is posted as a pdf document on the GEOS-Chem web site (http://www.env.leeds.ac.uk/%7Emat/GEOS-CHEM/geoschem_mech.pdf). Coupling of PM with ozone-NO_x-VOC oxidant chemistry takes place through sulfate, nitrate, and SOA formation and thermodynamics, aerosol effects on UV actinic fluxes, and heterogeneous radical chemistry. Wet deposition of soluble gases and PM follows the scheme of Liu et al. [2001] and includes contributions from scavenging in convective updrafts, rainout and washout in convective and large-scale precipitation, and partial or total release during re-evaporation below cloud base. Dry deposition is computed with a standard resistance-in-series scheme [Wang et al., 1998].

All simulations were conducted from September 1, 2001 to December 31, 2002. The first four months were used to achieve proper initialization. Results delivered to VISTAS are from the 12-month 2002 simulation.

2.3. PM sources used in VISTAS simulations

We describe here briefly the PM sources used in the VISTAS simulations. Description of the biomass burning emission inventory for 2002 is presented in section 2.4.

2.3.1. Sulfate-nitrate-ammonium

Global GEOS-Chem budgets of sulfate, nitrate, and ammonium aerosols, including breakdown by source types of emissions for sulfur, NO_x, and ammonia, are given by Park et al. [2004]. Anthropogenic emissions are from the Global Emission Inventory Activity (GEIA) with 1^ox1^o spatial resolution and seasonal temporal resolution, and are scaled for individual countries to the year 1998 on the basis of national emission inventories and fuel use statistics. Park et al. [2004] give global totals for non-U.S. anthropogenic emissions computed in this manner. They used the same procedure also for U.S. emissions. For the VISTAS baseline simulation, we used monthly mean anthropogenic U.S. emissions from the NEI 1999 inventory produced by EPA. An archive of monthly mean NEI 1999 emissions from that inventory with 0.25^ox0.25^o horizontal resolution was generated for us by Alice Gilliland of EPA/ORD, and was re-gridded to 4^ox5^o for application to VISTAS. The U.S. emission of ammonia in the NEI99 inventory (3.6 Tg N yr^{-1}) is known to be too high [Gilliland et al., 2004]. Therefore we retained for that species the U.S. emission inventory of Park et al. [2004] (2.2 Tg N yr^{-1})

Natural emissions except for biomass burning are as given by Park et al. [2004]. Volcanic sulfur emissions are from the GEIA climatology. Emission of dimethylsulfide (DMS) by phytoplankton uses a global distribution of DMS seawater concentrations from Kettle et al. [1999] and a standard sea-air exchange parameterization driven by the local wind. Soil emissions of NO_x are from GEIA and are function of local temperature and precipitation history. Lightning emissions of NO_x are computed globally with a standard algorithm based on convective cloud tops [Wang et al., 1998] and are scaled to yield a global source of 6 Tg N yr^{-1} [Martin et al., 2002]. Emissions of ammonia from soils and oceans are from GEIA.

2.3.2. Carbonaceous aerosols

Detailed discussion of the EC and OC emission source processes in the model is given in Park et al. [2003] (appendix A). Anthropogenic emissions of EC and OC outside the U.S. are from the Cooke et al. [1999] inventory. For the VISTAS baseline simulation we used U.S. anthropogenic emissions from Park et al. [2003], who optimized EC and OC sources using monthly IMPROVE observations for 1998. Both EC and OC have major sources from biomass burning; emission factors are from Andreae and Merlet [2001] and are applied to the 2002 biomass burning inventory described in section 2.4. Secondary organic aerosol (SOA) formation from biogenic hydrocarbons follows the scheme of Chung and Seinfeld [2002] developed for application in global models (the Park et al. [2003] simulations simply scaled the SOA source to 10% of monoterpene emission). The Chung and Seinfeld [2002] describes SOA formation from oxidation of several classes of biogenic hydrocarbons through gas-aerosol partitioning of the semi-volatile products as a function of local temperature and pre-existing OC mass concentration.

2.3.3. Soil dust

We included in the VISTAS simulations a preliminary representation of soil dust using the global dust mobilization scheme of Zender et al. [2003]. Dust particles in four different size classes were transported as separate tracers with different source and settling properties, thus allowing in particular some segregation of $PM_{2.5}$ and $PM_{10-2.5}$. A global evaluation of this preliminary dust simulation in GEOS-Chem was presented by Fairlie [2004]. Asian and African dust sources are simulated without obvious bias. There is a large overestimate at many IMPROVE sites in fall due to spurious local dust generation from seasonally dry and vegetation-deprived prairie ecosystems.

2.3.4. Sea salt

The sea salt concentrations in the VISTAS simulations are from a new GEOS-Chem capability developed by Alexander et al. [2005]. The simulation uses the standard source scheme of Monahan [1986] which is function of surface wind speed over the oceans, and transports sea salt PM in two size classes (0.1-1 and 1-10 μm). The resulting global source of sea salt in GEOS-Chem is 5400 Tg yr^{-1}, consistent with earlier literature (3500-7600 Tg yr^{-1}). Alexander et al. [2005] present further discussion of the global sea salt budget and distributions in GEOS-Chem, including comparisons to observations and previous global models.

2.4. Biomass burning emission inventory for 2002

2.4.1. The United States and Canada

We developed an inventory for emissions from fires in the United States using data for areas burned that are reported by several federal agencies, by regional interagency coordination centers such as the Pacific Northwest, Western Great Basin, Eastern Great Basin, and Southwest (www.or.blm.gov/nwcc/, www.nv.blm.gov/wgbcc/, www.blm.gov/utah/egbcc/, www.fs.fed.us/r3/fire/) and by various states. We also obtained a data base of fires in the southeastern United States from G. Stella of Alpine Geophysics. In the western half of the U.S. and Alaska, most of the land is federally owned, so the fire information is thought to be comprehensive. Reports from the Bureau of Indian Affairs, Bureau of Land Management (BLM), National Park Service, Fish and Wildlife Service, and U.S. Forest Service are available on-line (http://famweb.nwcg.gov/weatherfirecd). These reports give the fire name, start and end date, their location (latitude and longitude), and area burned. We analyzed these data to spatially and temporally allocate the fires. A simple concatenation of data was not possible as different agencies sometimes reported the same fires, so we ensured that duplicate reports for the same fire were eliminated. The Daily Incident Management Reports (www.cidi.org/wildfire) of the National Interagency Coordination Center (NICC) were consulted to corroborate incidence, location and sizes of major fires, and to determine whether these fires were surface or crown fires.

Our database of all fires with areas larger than 100 acres gives a total of 1626 fires, of which 338 are located in the southeastern states. These fires consumed 2.65 x 10^6 ha in the United States in 2002. The data provided by Alpine Geophysics for the southeast gave a total area of 0.044 x 10^6 ha. Six states accounted for over 80% of the national area burned, namely Alaska, Oregon, Colorado, California, New Mexico, and Arizona. Alaska accounted for one third of the area burned in the United States, and the seven largest fires in Alaska contributed 55% of the area burned for the state. For the entire United States, the largest 20 fires accounted for half the area burned nationally.

The area burned in the United States in 2002 was the second highest for the previous ten years. To put the area burned in a larger context, the area burned in Canada was similar to that in the United States, 2.76 x 10^6 ha, while 2.8 x 10^6 ha burned in Kazakhstan, and 11 x 10^6 ha in Asiatic Russia. It was also a very high fire year in Russia.

For our initial estimate of the amount of dry matter burned (used in the GEOS-CHEM simulations) we adopted a loading 2.6 kg DM/m^2 for Alaskan fires, and 1.8 kg DM/m^2 for the lower states. We found that 47 Tg of dry matter was consumed by fires in the United States, producing CO emissions of 5 Tg in about 3 months. We developed preliminary maps of dry matter burned on a 1^ox1^o grid by month by assuming that each fire burned at the same rate during each day of the burn period.

For Canada, we relied on a product provided by David Lavoue (Environment Canada). He is developing an inventory for Canada using a detailed data-base on the location of the size and position of the fires; that data-base is not yet publicly available. He gave us an interim product that consists of monthly totals of fuel consumed on a map with resolution of 1°x1° latitude by longitude. Lavoue estimates that 58 Tg of dry matter was consumed by fires in 2002, which gives rise to CO emissions of 7 Tg..

2.4.2. Russia and Kazakhstan

The most detailed fire information was available for eastern Russia. The IFFN report (http://www.fire.uni-freiburg.de/iffn/iffn_28/Russia-1.pdf) gives estimates by province of the total areas burned in Asian Russia for the fire season of 2002. The total area burned was 11 x 10^6 ha. The Fire Laboratory of the Sukachev Institute of Forest, Krasnoyarsk, provides maps showing the locations of large fires for 10-day periods derived from NOAA AVHRR data (http://www.fire.uni-freiburg.de/current/ archive/archive.htm). We used these maps to spatially and temporally apportion the area burned in each province among all of the fires logged for the province; burn scars at the end of the fire season were approximated as rectangles. The areas burned were put on a grid of 1°x1° (lat. x long.) for each 10 day period. The Kamchatka Peninsula was not included on the burning maps for eastern Russia. Areas burned there were confined to June and July (IFFN report). Maps of ATSR fire counts were used to locate the fires.

Most of the burning in Russia was in July-August in the northern province of Yakutia. There was a smaller peak in the burning in May, primarily in the provinces of southern Siberia. We relied on a detailed vegetation map of Russia to determine the dominant vegetation type in each gridbox, and applied appropriate fuel loads to determine the amount of biomass burned.

Table 1. Loadings used for fires in Russia, in kg dry matter (DM) m^{-2}

Vegetation Type	kg DM m^{-2}
Tundra	1.8
Wooded Tundra	2.0
Taiga	2.5
Boreal Forest	3.0
Grasslands	0.3
Steppe	0.3
Desert	0.3
Farmlands	0.3

Recent work indicates the importance of including the burning of peat as a component of boreal fires. We track peat burning separately from burning of other forest fuels as it has a higher moisture content, hence less efficient combustion, and higher emission factors for CO. The construction of peatland map is in progress for Russia (L. Pozdnyakova, personal communication), there is not one currently available. As a surrogate, we used maps of wetlands and soil drainage to give the distribution of boggy or poorly drained soils, as advised by S. Conard and M. Turetsky. The locations of individual fires given by the remote sensing data were superimposed on this map; burning of peat was confined to the area defined by the perimeter of the fires. Few experiments have been reported which describe measurements of fuel consumed and emissions from peat fires in boreal forests. We assumed that 2.2 kg C m^{-2} was burned.

For western Russia, wildfires other than peat bog fires were not reported in sufficient detail to ascertain their whereabouts. Qualitative descriptions of major peat bog fires in July to September around Moscow, St. Petersburg, Nizhny Novgorod, and other cities were abundant, but few estimates of areas burned and depth of peat burned were found. From the IFFN news and CNN reports, we used quantitative and qualitative information to approximate the areas burned in the peat bogs around four of the major cities. We distributed the burning homogeneously in the oblast (province) that contained each city and applied a fuel consumption estimate for peat burning as above.

Maps of fires for each month and the annual amount burned (2.8 x 10^6 ha) were available for Kazakhstan. Here also, ATSR fire counts were used to locate the fires on a monthly basis. We used a vegetation map for Kazakhstan [http://www.fire.unifreiburg.de/iffn/country/ kz/kz_2_1b.gif] and an agricultural map of the CIS (Major World Crop Areas and Climatic Profiles) to determine the fuel loads to use. Based on these maps, we postulated that the fires in the southern regions were burning of agricultural residues, for which we adopted a loading of 1.2 kg DM m^{-2}; for the pine forests in the north, we adopted a loading recommended for Kazakhstan's pine forests, 2 kg DM m^{-2}.

2.4.3. Summary

We find that 409 Tg dry matter was consumed in Russia, 52 Tg in Kazakhstan, and 47 Tg in the United States. For Canada, Lavoue's estimate of 58 Tg of dry matter consumed in 2002 is low in comparison to our estimate for Russia, given the ratio of areas. Lavoue did not include burning of peat in Canada as he believes it in not an important component of the Canadian fires (personal communication). These estimates were used in the GEOS-CHEM simulations to provide monthly emissions from biomass burning. In other regions we replied on the work of Van der Werf et al. (Science, 2003), based on VIRS satellite data.

3. MODEL PERFORMANCE EVALUATION

Model performance evaluation (MPE) of the baseline VISTAS simulation focused on the annual and seasonal PM concentration statistics previously reported by Park et al. [2003, 2004] using observations from IMPROVE and CASTNET sites. The Park et al. simulations were conducted for 1998 and 2001, whereas the VISTAS simulation was for 2002. We use here observations from 145 IMPROVE sites and 84 CASTNET sites available for 2002.

The limitations of using U.S. concentration data to evaluate a global PM simulation with 4^ox5^o horizontal resolution should be stressed. Any variability on scales less than ~500 km cannot be resolved. This compromises the evaluation for individual sites, particularly in urban, industrial, and coastal regions. We focus therefore our evaluation on the large-scale spatial distribution and on seasonal statistics for the national ensemble of sites. The evaluation figures shown here reproduce similar figures presented by Park et al. [2003, 2004] for their 1998 and 2001 simulations with 2^ox2.5^o resolution. Direct comparison to these figures can therefore be made to assess the relative quality of the simulations. We use the slopes of the regression lines in the simulated vs. observed scatterplots to diagnose mean biases in the model. Regression lines are computed with the reduced major axis method [Hirsch and Gilroy, 1984].

Figure 1 compares simulated and observed annual mean sulfate concentrations at the ensemble of IMPROVE and CASTNET sites for the year 2002, plotted on the 4^ox5^o model grid. Values are highest in the industrial midwest, in both model and observations, reflecting the distribution of anthropogenic emissions. Figure 2 shows scatterplots of simulated vs. observed annual and seasonal sulfate concentrations for the ensemble of (left) IMPROVE and (middle) CASTNET sites. The right column in Figure 2 compares simulated and observed sulfate precipitation data for 2002 at NADP sites. The correlation between model and observations is high for the annual mean values (R^2 = 0.82 for the concentration data and 0.71 for the deposition data) and also for the seasonal means (R^2 = 0.63–0.87 for the concentration data). An exception is the deposition data in summer, for which correlation between model and observations is low (R^2 = 0.18). Overall, the correlations presented here are consistent with those presented by Park et al. [2004] for 2001 (see Figures 3 and 4 of appendix B) although that simulation was more successful in capturing the variance in summer deposition.

Figure 3 compares simulated and observed annual mean concentrations of ammonium at CASTNET sites. Observed concentrations are higher in the east than in the west and are highest in the midwest, reflecting agricultural operations. The model reproduces this spatial distribution. Scatterplots of simulated vs. observed annual and seasonal ammonium concentrations are shown in Figure 4 for the ensemble of sites. The model reproduces the variability of observed ammonium concentrations, both in an annual mean sense (R^2 = 0.81) and in different seasons (R^2 = 0.72-0.81). The R^2 values are slightly lower than the values from the Park et al. [2004] simulation (Figure 6 of appendix B). That simulation showed a factor of 2 high bias in fall due to too high seasonal ammonia emission. Despite the same ammonia emission, the VISTAS simulation shows much reduced bias (50% for ammonium concentration in fall). This reflects in part the increase in the effective ammonia deposition velocity resulting from application of the dry deposition sink throughout the mixed layer column, as described in section 2.2.

Figure 5 compares simulated and observed annual mean nitrate concentrations at the IMPROVE and CASTNET sites. Maximum concentrations are in the Midwest, reflecting the limitation of ammonium nitrate formation by the availability of ammonia. The model captures the observed spatial distribution of nitrate concentrations but tends to be high on an annual mean basis (slope = 1.41-1.80 in Figure 4). This is however also an improvement over Park et al. [2004], which found a factor of 2 high bias (slope = 1.87 – 2.43 in Figure 6 of appendix B), and reflects the improved treatment of HNO_3 dry deposition. The high bias in the VISTAS simulation is mainly driven by the fall months, when the model appears to produce too much ammonium nitrate due to too high ammonia emission [Park et al., 2004].

Figure 6 compares simulated and observed annual mean concentrations of EC at IMPROVE sites, and the scatterplots of Figure 7 compare seasonal mean concentrations. The model reproduces about half of the observed spatial variability in different seasons (R^2 = 0.42-0.58) except in summer (R^2 = 0.18). Simulated concentrations tend to be higher than observed (slope = 1.58-1.74) except in summer (slope = 0.76). The high bias is mostly driven by IMPROVE sites in the northeastern corridor.

Figure 8 compares simulated and observed annual mean concentrations of organic carbon mass (OMC) at IMPROVE sites, and Figure 9 shows the seasonal scatterplots. Although the ability of the model to reproduce variability in the observations is poor, particularly in summer, the simulated seasonal mean concentrations are generally within a factor of two of observations. The simulation is significantly worse than that described by Park et al. [2003]; this reflects the use of the Chung and Seinfeld [2002] SOA parameterization, which appears to underestimate the source from vegetation.

Overall, the MPE conducted for the VISTAS simulation for the U.S. shows the level of agreement that can be expected considering the state of the science in large-scale aerosol modeling and the intrinsic limitations of a simulation with 4^ox5^o horizontal resolution. Simulated concentrations are mainly within a factor of 2 of observations on regional and seasonal scales, and can generally account (except for OC) for most of the observed variability on those scales.

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Figure 1. Annual mean concentrations of sulfate in surface air over the United States in 2002. The top panel shows results from the GEOS-CHEM model. The middle and bottom panels show the observations from the IMPROVE and CASTNET networks, respectively, averaged over the model $4^o \times 5^o$ grid.

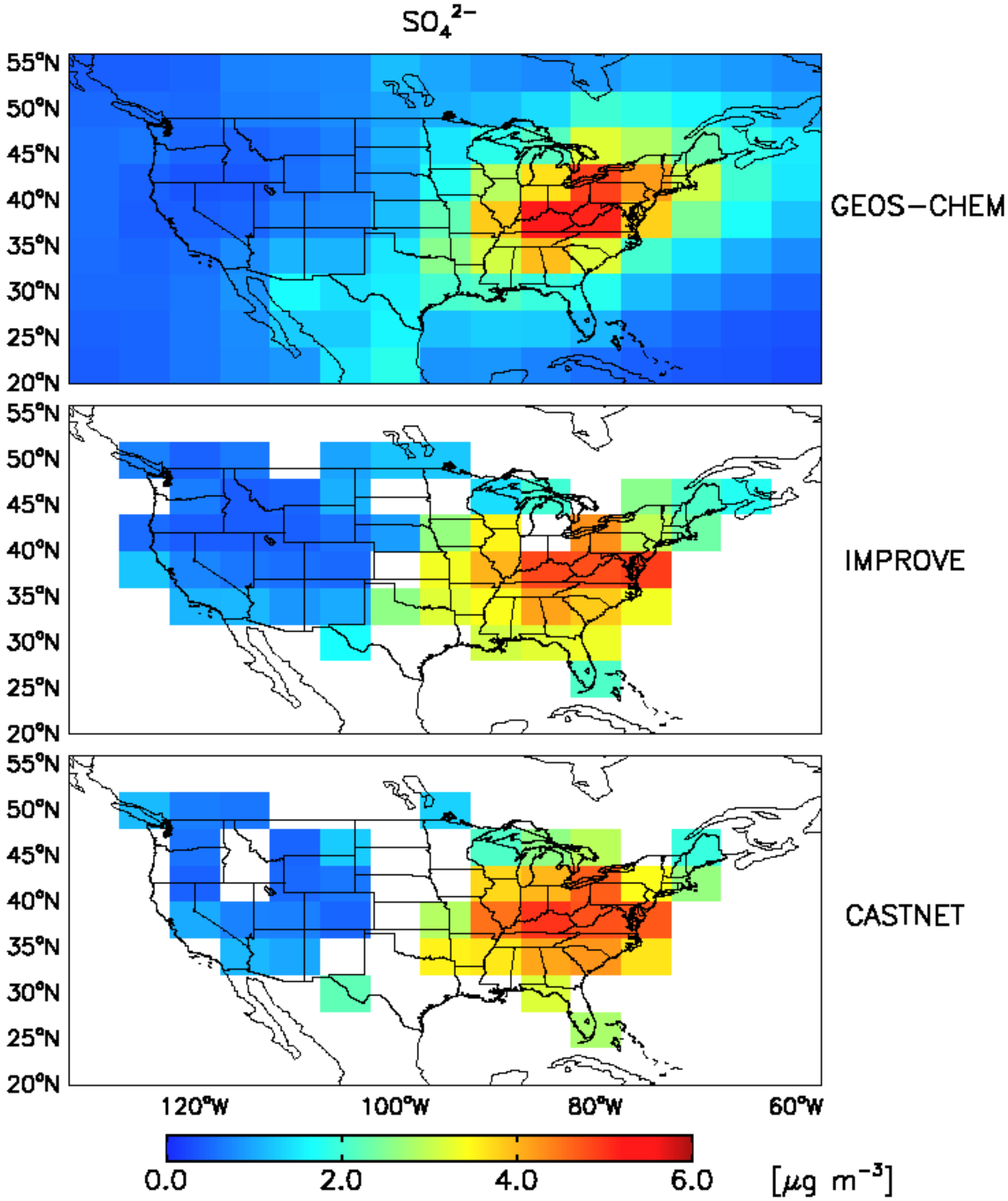


Figure 2. Scatterplot of simulated versus observed sulfate concentrations at the IMPROVE and CASTNET sites, and sulfate deposition fluxes at NADP sites. Values are annual means (top panels) and seasonal means for 2002. Sites in the western and eastern United States (separated at 95°W) are shown as pluses and open circles, respectively. Thick solid lines are reduced major axis regressions for the ensemble of the data; regression equations and R^2 are shown inset. Thin solid lines show the y=x relationship.

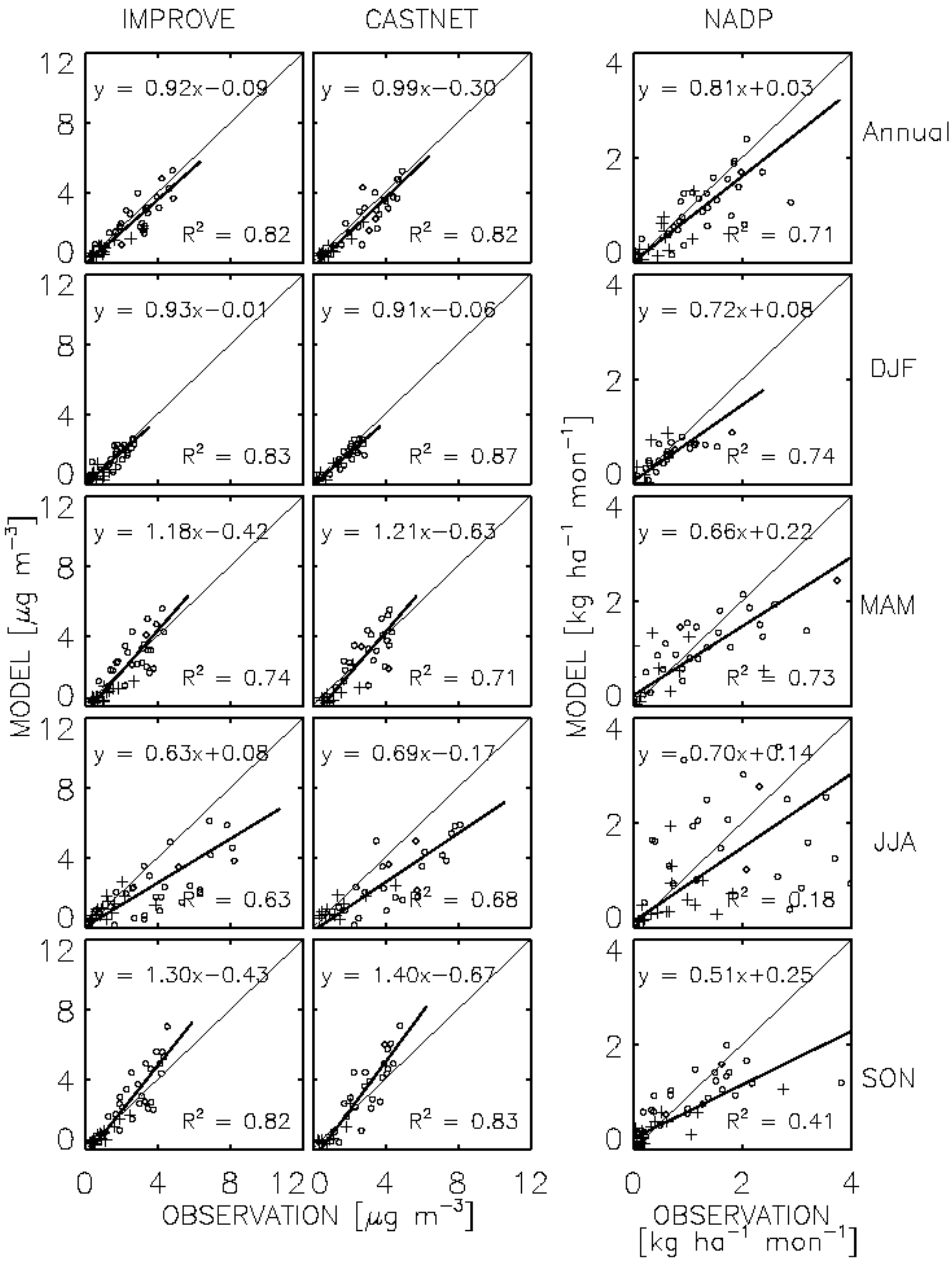


Figure 3. Annual mean concentrations of ammonium in surface air over the United States in 2002. The top panel shows results from the GEOS-CHEM model. The bottom panel shows the observations from the CASTNET network.

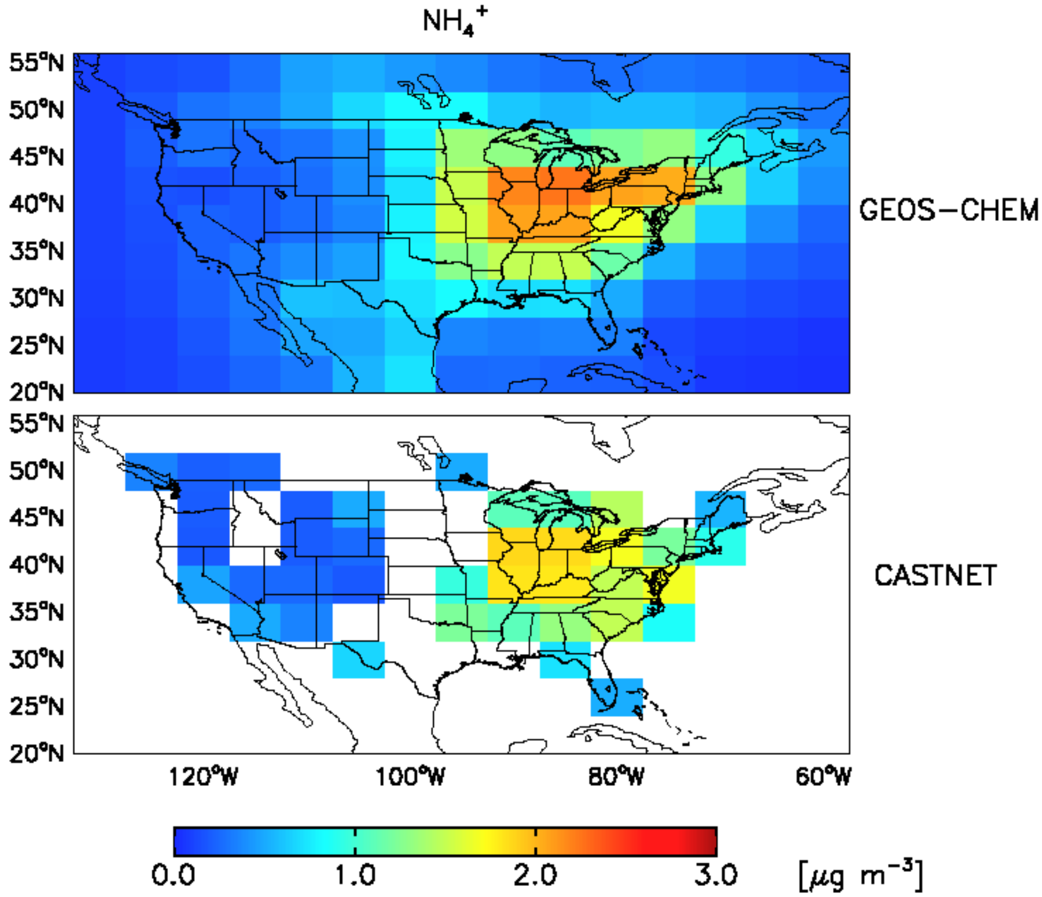


Figure 4. Scatterplot of simulated versus observed ammonium concentrations at the CASTNET sites (left column), and nitrate concentrations at the CASTNET and IMPROVE sites (right two columns). Values are annual means (top panels) and seasonal means for 2002. Sites in the western and eastern United States (separated at 95°W) are shown as pluses and open circles, respectively. Thick solid lines are reduced major axis regressions for the ensemble of the data; regression equations and R^2 are shown inset. Thin solid lines show the y=x relationship.

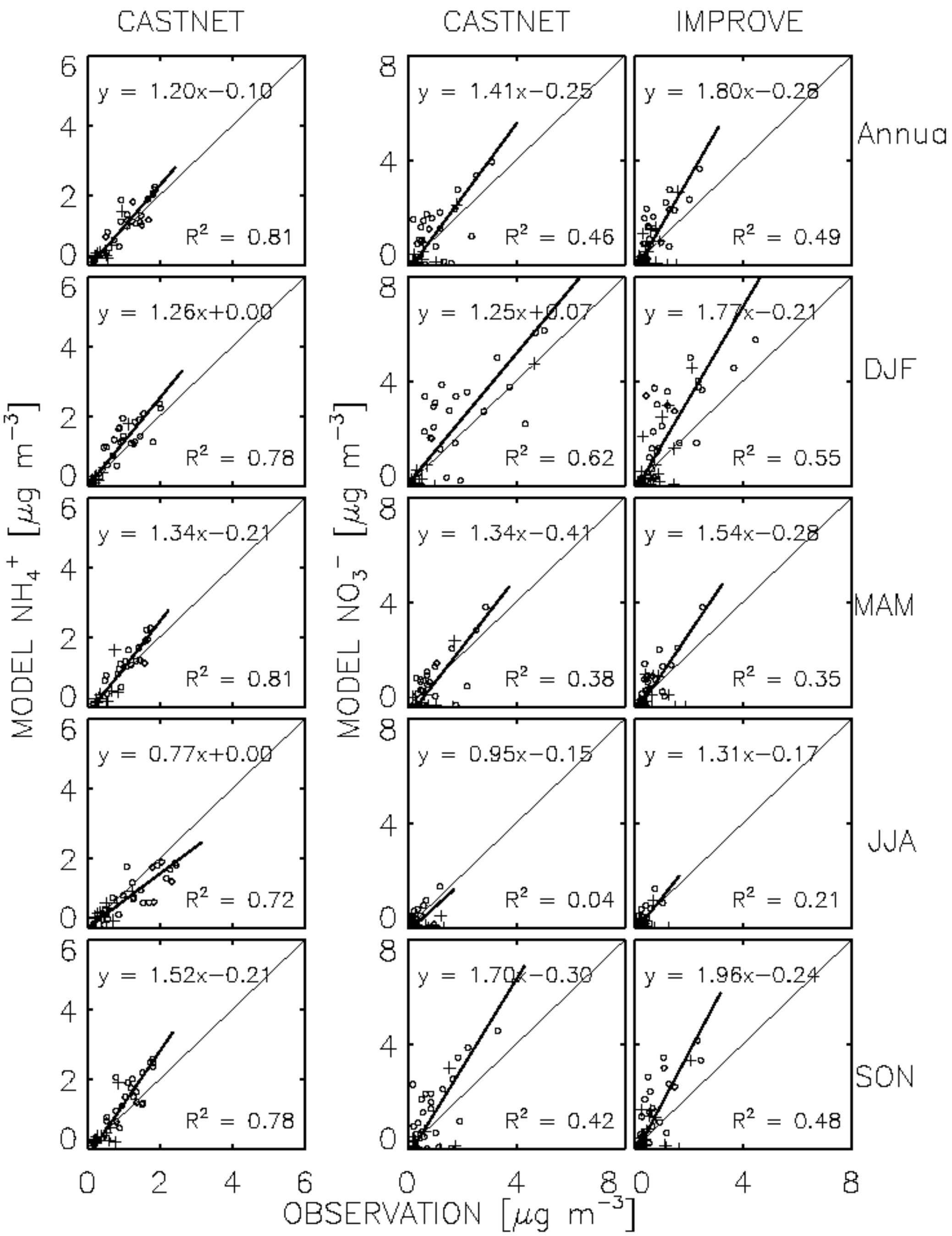


Figure 5. Same as Figure 3 but for nitrate.

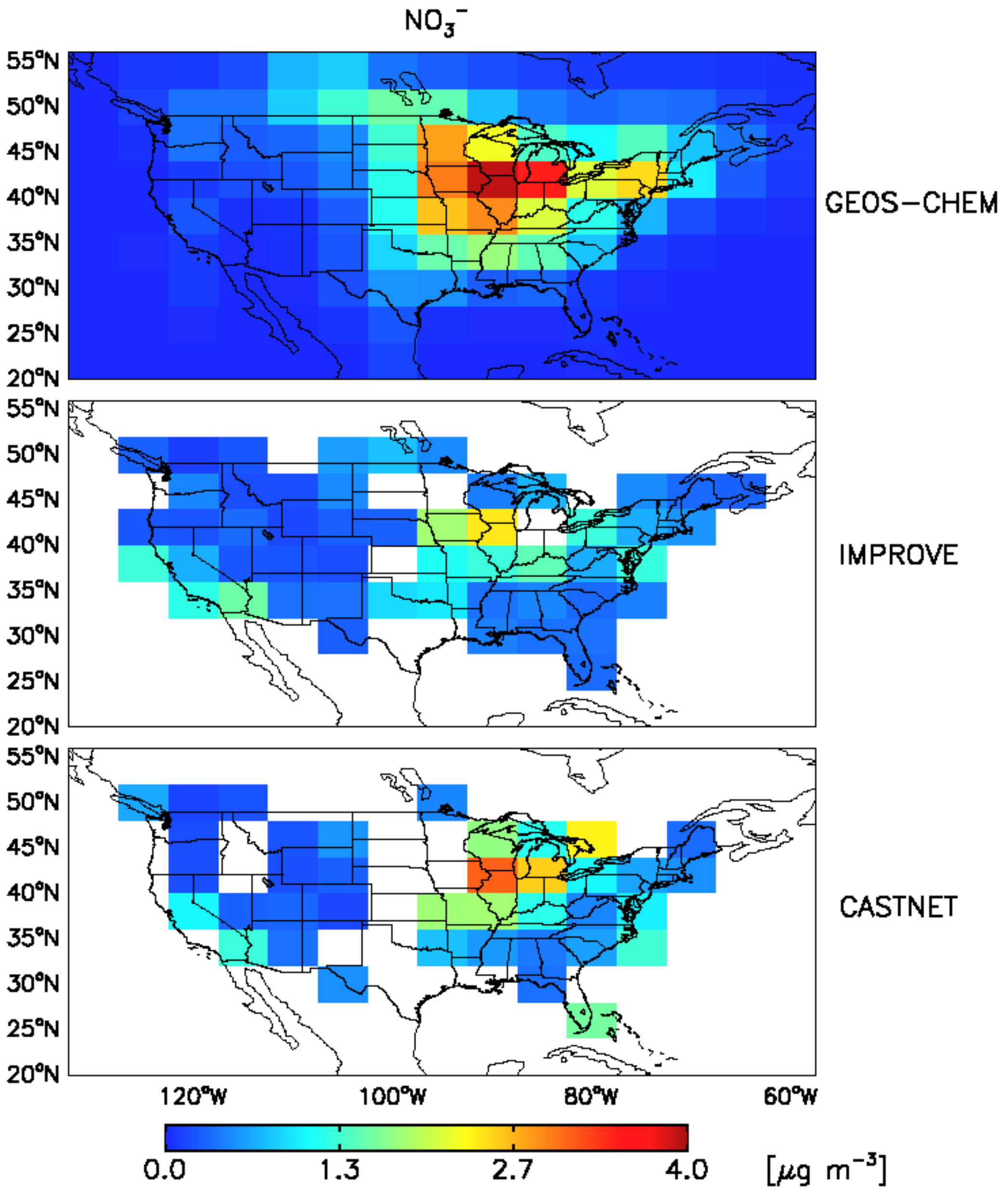


Figure 6. Annual mean concentrations of elemental carbon (EC) aerosol in surface air over the United States in 2002. The top panel shows results from the GEOS-CHEM model. The bottom panel shows the observations from the IMPROVE network.

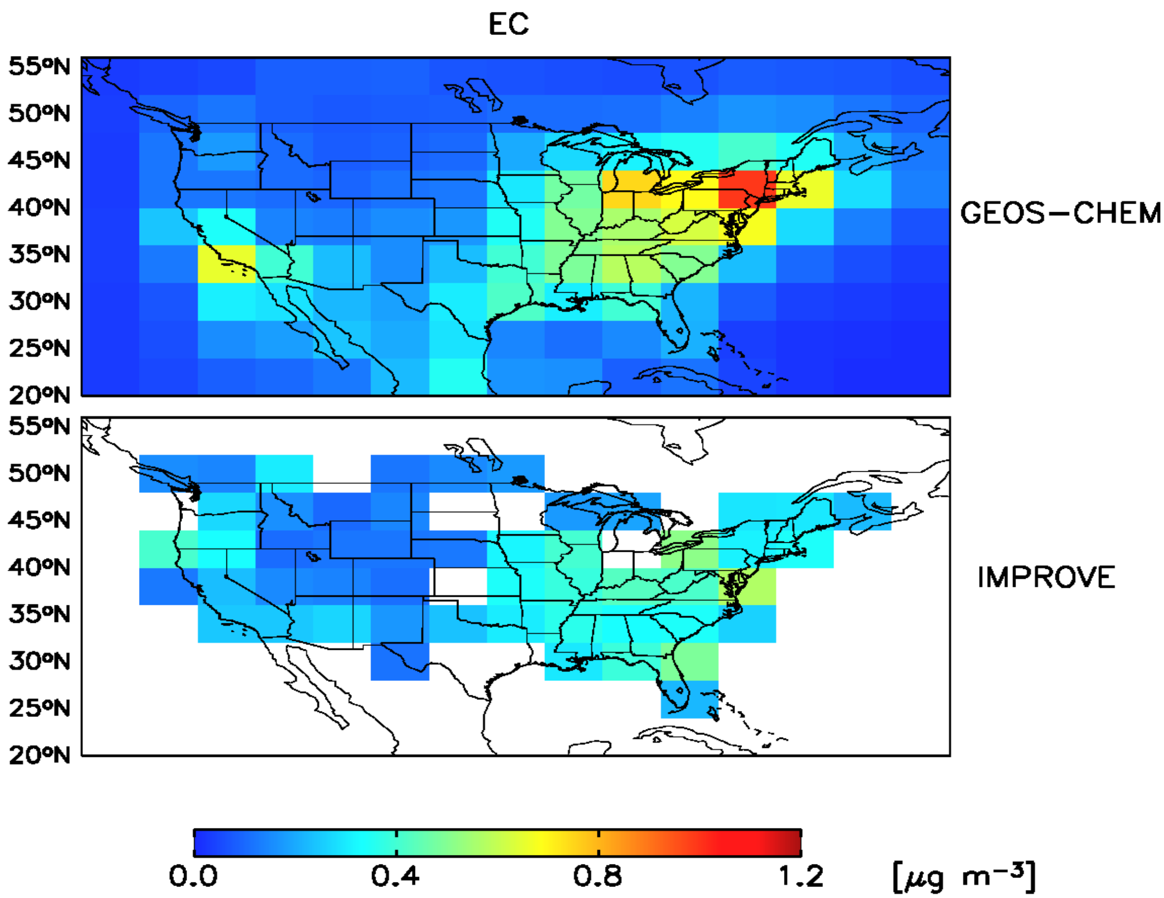


Figure 7. Scatterplot of simulated versus observed EC aerosol concentrations at the IMPROVE sites. Values are seasonal means for 2002. Sites in the western and eastern United States (separated at 95°W) are shown as pluses and open circles, respectively. Thick solid lines are reduced major axis regressions for the ensemble of the data; regression equations and R^2 are shown inset. Thin solid lines show the y=x relationship. Dotted lines show the y=2x and y=0.5x relationships.

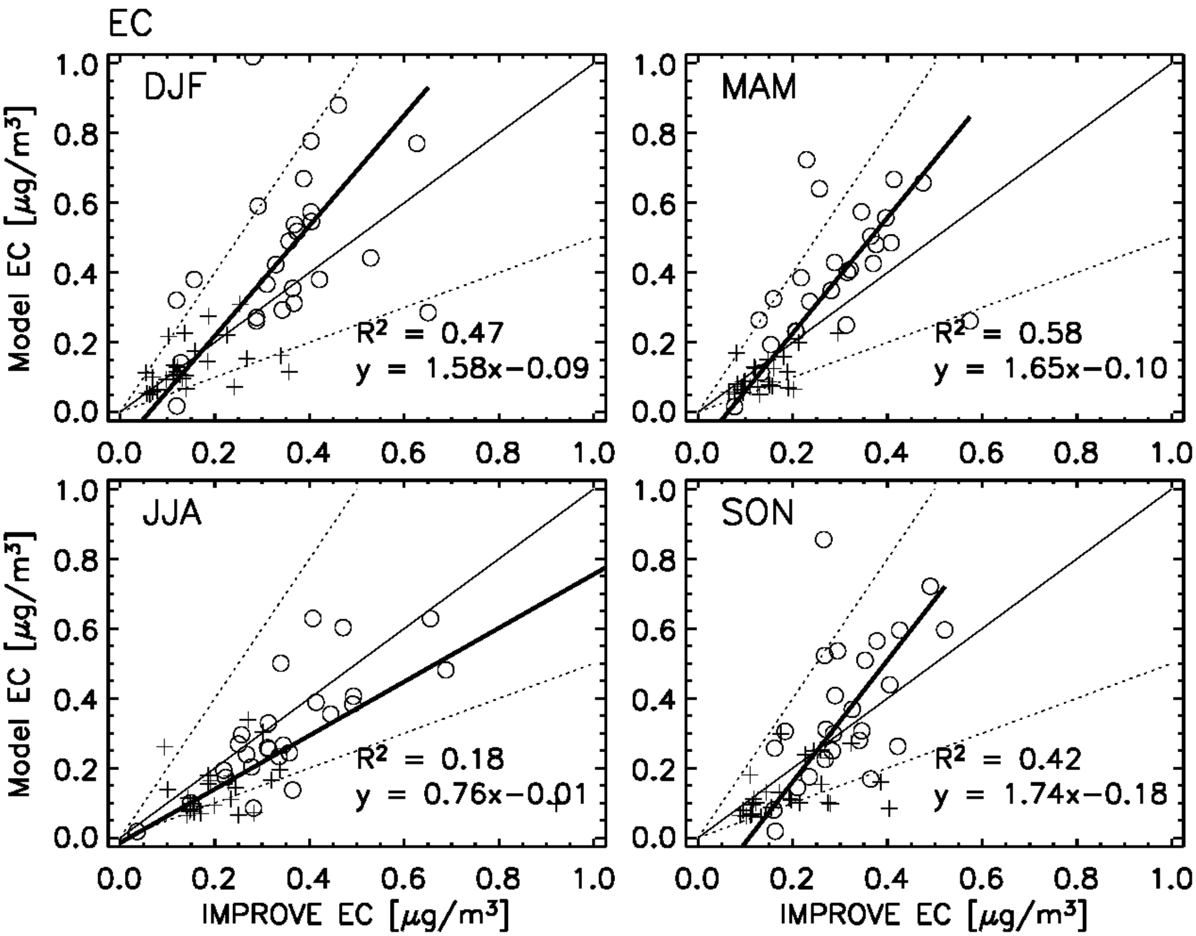


Figure 8. Same as Figure 6 but for organic carbon mass (OMC)

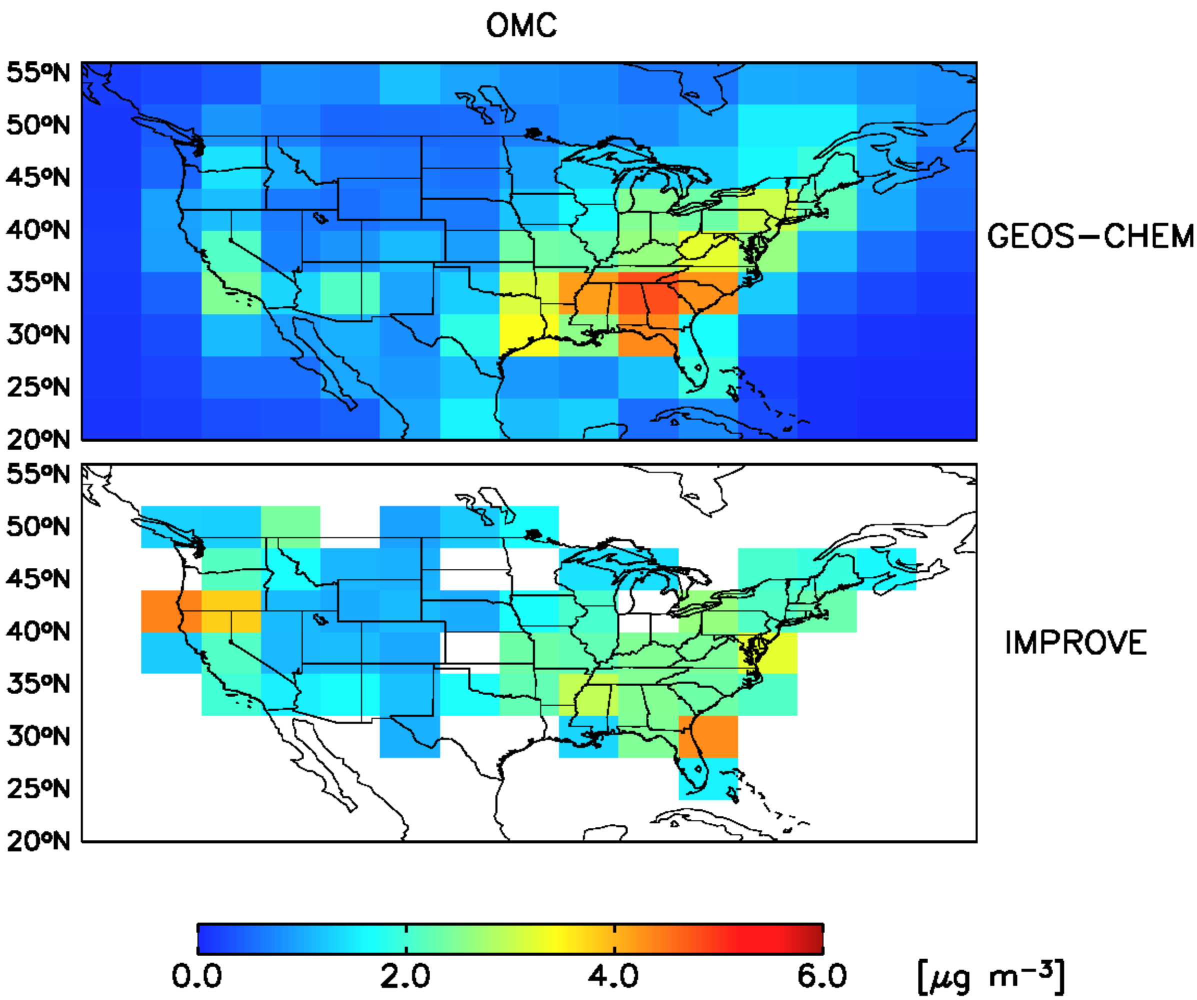
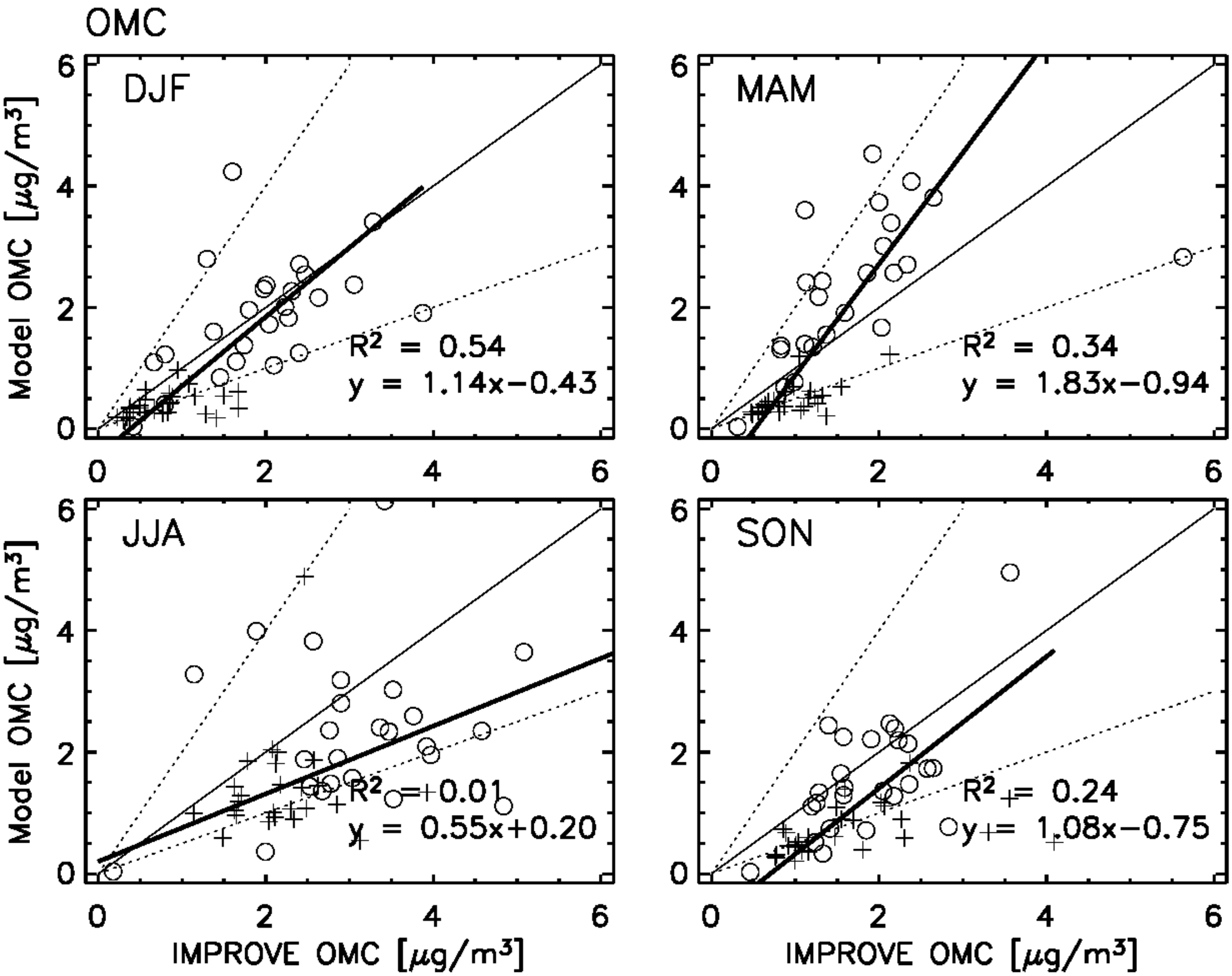


Figure 9. Same as Figure 7 but for organic carbon mass (OMC)



Appendix A: Rokjin J. Park, Daniel J. Jacob, Mian Chin, and Randall V. Martin (2003), Sources of carbonaceous aerosols over the United States and implications for natural visibility, *J. Geophys. Res.*, 108(D12), 4355, doi:10.1029/2002JD003190.

Abstract. We use a global 3-D model (GEOS-CHEM) to better quantify the sources of elemental carbon (EC) and organic carbon (OC) aerosols in the United States through simulation of year-round observations for 1998 at a network of 45 sites (IMPROVE). Simulation with our best *a priori* understanding of sources, including global satellite data to constrain fire emissions, captures most of the variance in the observations (R^2 = 0.84 for EC, 0.67 for OC) with a low bias of 15% for EC and 26% for OC. Multiple linear regression to fit the IMPROVE data yields best estimates of 1998 U.S. sources of 0.60 Tg yr^{-1} EC and 0.52 Tg yr^{-1} OC from fossil fuel; 0.07 Tg yr^{-1} EC and 0.89 Tg yr^{-1} OC from biofuel; 0.08 Tg yr^{-1} EC and 0.60 Tg yr^{-1} OC from wildfires; and 1.10 Tg yr^{-1} OC from vegetation. We find that fires in Mexico and Canada contributed 40-70% of annual mean natural EC in the United States for 1998, and 20-30% of annual mean natural OC. Transpacific transport from Asian pollution sources amounted to less than 10% of the natural EC and less than 2% of the natural OC; in contrast to ozone, we find that intercontinental transport of anthropogenic carbonaceous aerosols does not enhance significantly the natural background. IMPROVE observations and model simulations for the summer of 1995 show that Canadian fire emissions can produce large events of elevated EC and OC in the southeastern United States. Our best estimates of mean natural concentrations of EC and OC in the United States, using a model simulation with climatological monthly mean fire emissions, are 2-3 times higher than the default values recommended by the U.S. Environmental Protection Agency (EPA) for visibility calculations, except for OC in the eastern United States (16% lower).

1. Introduction

Carbonaceous aerosol is one of the least understood components of fine particulate matter (PM). It is usually divided in two fractions, elemental carbon (EC) and organic carbon (OC). OC is the second most abundant component of the aerosol in the United States after sulfate, and the dominant component of the natural continental aerosol [*Malm et al.*, 2000]. EC is the dominant component of the light-absorbing aerosol. Carbonaceous aerosol is presently the subject of intense scrutiny because of its impact on human health, visibility, and climate.

We present here an assessment of the sources of EC and OC in the United States by using a global 3-D model (GEOS-CHEM) simulation of observations from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. Our focus is on quantifying the anthropogenic and natural sources of these aerosols, the role of transboundary transport, and the implications for visibility. The U.S. Environmental Protection Agency Regional Haze Rule [*U.S. EPA*, 2001] mandates a schedule of increasing emission controls to achieve "natural visibility conditions" in national parks and other wilderness areas by 2064. The ambiguity in defining "natural visibility conditions" requires better information on natural PM concentrations and the perturbing effects from fires and from sources outside the United States.

Elemental carbon is emitted to the atmosphere by combustion. Major sources in the United States include coal burning and diesel engines. Organic carbon is emitted directly to the atmosphere (primary OC) and formed *in situ* by condensation of low-volatility products of the photooxidation of hydrocarbons (secondary OC). Primary sources of OC in the United States are wood fuel, coal burning, and wild fires [*Seinfeld and Pandis*, 1998; *Cabada et al.*, 2002]. Secondary OC includes an anthropogenic component from oxidation of aromatic hydrocarbons, and a biogenic component from oxidation of terpenes [*Griffin et al.*, 1999].

Our approach is to conduct a 3-D model simulation of EC and OC concentrations in the United States for 1998, with best *a priori* sources, compare results with observations from the IMPROVE network, and use the constraints from the comparison to optimize our treatment of sources by multiple linear regression. Our treatment of fire emissions accounts for year-to-year variability through satellite observations; 1998 was a particularly active fire year, thus offering good constraints on emissions from that source. We also present a case study for the summer of 1995 to demonstrate the large-scale enhancements of EC and OC concentrations in the United States that can arise from Canadian fires. We go on to quantify mean natural EC and OC concentrations in the United States for different seasons and regions, using climatological fire emissions and sources from vegetation, and to assess the enhancement of EC and OC background concentrations resulting from transpacific transport of Asian pollution.

2. Model Description

2.1 General

We use the GEOS-CHEM global 3-D model of tropospheric chemistry [*Bey et al.*, 2001] to simulate EC and OC aerosols for 1998 (1 year) and 1995 (summer). The model (version 4.23, http://www-as.harvard.edu/chemistry/trop/geos/index.html) uses assimilated meteorological data from the NASA Goddard Earth Observing System (GEOS) including winds, convective mass fluxes, mixed layer depths, temperature, precipitation, and surface properties. Meteorological data for 1995 and 1998 are available with 6-hour temporal resolution (3-hour for surface variables and mixing depths), 2^{o} latitude by 2.5^{o} longitude horizontal resolution, and 20 (GEOS1 for 1995) or 48 (GEOS3 for 1998) sigma vertical layers. We retain this spatial resolution in the GEOS-CHEM simulation. The lowest model levels are centered at approximately 50, 250, 600, 1100, and 1750 m above the local surface in GEOS1 and 10, 50, 100, 200, 400, 600, 900, 1200, and 1700 m in GEOS3.

The simulation of carbonaceous aerosols in GEOS-CHEM follows that of the Georgia Tech/Goddard Global Ozone Chemistry Aerosol Radiation and Transport (GOCART) model [*Chin et al.*, 2002], with a number of modifications described below. The model resolves EC and OC, with a hydrophobic and a hydrophilic fraction for each (i.e., four aerosol types). Combustion sources emit hydrophobic aerosols that then become hydrophilic with an e-folding time of 1.2 days following *Cooke et al.* [1999] and *Chin et al.* [2002]. We assume that 80% of EC and 50% of OC emitted from all primary sources are hydrophobic [*Cooke et al.*, 1999; *Chin et al.*, 2002; *Chung and Seinfeld*, 2002]. All secondary OC is assumed to be hydrophilic. The four aerosol types in the model are further resolved into contributions from fossil fuel, biofuel, and biomass burning, plus an OC component of biogenic origin, resulting in a total of 13 tracers transported by the model.

Simulation of aerosol wet and dry deposition follows the schemes used by *Liu et al.* [2001] in previous GEOS-CHEM simulations of ^{210}Pb and ^{7}Be aerosol tracers. Wet deposition includes contributions from scavenging in convective updrafts, rainout from convective anvils, and rainout and washout from large-scale precipitation. Wet deposition is applied only to the hydrophilic component of the aerosol. Dry deposition of aerosols uses a resistance-in-series model [*Walcek et al.*, 1986] dependent on local surface type and meteorological conditions; it is small compared to wet deposition. *Liu et al.* [2001] found no systematic biases in their simulations of ^{210}Pb and ^{7}Be with GEOS-CHEM.

2.2 *A priori* sources of EC and OC

We use global anthropogenic emissions of EC (6.4 Tg yr^{-1}) and OC (10.5 Tg yr^{-1}) from the gridded *Cooke et al.* [1999] inventory for 1984. This inventory includes contributions from domestic, vehicular, and industrial combustion of various fuel types. In the GOCART simulation of *Chin et al.* [2002], the *Cooke et al.* [1999] inventory was used with no seasonal variation. However, the source from heating fuel should vary with season [*Cabada et al.*, 2002]. *Cooke et al.* [1999] do not resolve the contributions to EC and OC emissions from heating fuel. We assume these contributions to represent 8% (EC) and 35% (OC) of total anthropogenic emissions, based on data for the Pittsburgh area from *Cabada et al.* [2002] and apply local seasonal variations of emissions using the heating degree days approach [*EIA*, 1997; *Cabada et al.*, 2002]. In this manner we find that anthropogenic EC emission in the United States in winter is 15% higher than in summer. For OC the anthropogenic winter emission is twice that in summer.

The *Cooke et al.* [1999] inventory does not include biofuels, which provide however an important source of heating in rural households and are also used in agroindustrial factories. We use a global biofuel use inventory with $1^{o}x1^{o}$ spatial resolution from *Yevich and Logan* [2002] with emission factors of 1.0 g EC and 5 g OC per dry mass burned [*Street et al.*, 2001; *Dickerson et al.*, 2002]. For the United States and Canada, we supersede that inventory with data on wood fuel consumption for residential and industrial sectors available for individual states and provinces [*EIA*, 2001] and which we distribute on a rural population map. Emission factors for this North American wood fuel source are 0.2 g EC and 3.0 g OC per kg dry wood burned [*Cabada et al.*, 2002]. Seasonal variation in biofuel emissions is included for the United States only and is estimated according to the heating degree-days approach.

Biomass burning emissions of EC and OC are calculated using the global biomass burning inventory of *Duncan et al.* [2002]. This inventory uses a fire climatology compiled on a $1^{o}x1^{o}$ grid by *Lobert et al.* [1999], and applies monthly and interannual variability to that climatology from satellite observations. Emission factors are 2g EC and 14 g OC per kg dry mass burned [*Chin et al.*, 2002], higher than for biofuels because combustion is less efficient. For boreal forest fires, which are of particular interest here, emission factors reported in the literature range from 0.38 to 2.55 g EC per kg dry mass burned [*Lavoué et al.*, 2000, and references therein], consistent with the value assumed here. The OC/EC emission ratio of 7 is within the range of 6.9 to 8.2 used by *Liousse et al.* [1996]. Figure 1 shows the resulting annual OC emissions from biomass burning in North and Central America for 1997-2000 as well as the climatological mean. An ENSO-related drought resulted in catastrophic wildfires in the tropical forests of southern

Mexico and Central America in 1998 [*Peppler et al.*, 2000]. Canadian fire emissions were also unusually large in 1998. Fire emissions in the United States were 38% higher than the climatological mean.

Figure 2 shows the spatial and seasonal distribution of biomass burning OC emission from our model in 1998. Fires in Mexico and Central America were most intense in May [*Peppler et al.*, 2000, *Cheng and Lin*, 2001]. Canadian fires peaked in July-September. In the United States, most fires occurred in the northwest (Idaho, Montana) in summer; additional fires occurred in spring in Florida, due to the ENSO-induced drought.

Secondary formation of OC from oxidation of large hydrocarbons is an important source but uncertainties are large [*Griffin et al.*, 1999; *Kanakidou et al.*, 2000; *Chung and Seinfeld*, 2002]. *Chung and Seinfeld* [2002] find that biogenic terpenes are the main source of secondary OC aerosols. We assume a 10% carbon yield of OC from terpenes [*Chin et al.*, 2002], and apply this yield to a global terpene emission inventory dependent on vegetation type, monthly adjusted leaf area index, and temperature [*Guenther et al.*, 1995].

Table 1 shows a summary of *a priori* EC and OC emissions used in the GEOS-CHEM simulation for 1998. The most important global source for both is biomass burning. In the United States, EC is mostly emitted from the combustion of fossil fuel and OC originates mostly from vegetation (but with large seasonal variation, as discussed below).

3. Model evaluation

A global evaluation of the EC and OC aerosol simulation was done by *Chin et al.* [2002] as part of a more general evaluation of aerosol optical depth using ground and satellite observations. Our simulation of aerosol sources and meteorological processes is similar to that of *Chin et al.* [2002] and our global distributions of EC and OC concentrations are comparable. We focus here our model evaluation on the United States, using observations at the IMPROVE sampling sites. The IMPROVE monitoring program was initiated in 1987 in national parks and other protected environments to identify the contribution of different aerosol components to visibility degradation [*Malm et al.*, 1994]. The data for 1995 and 1998 consist of 24-h speciated aerosol concentrations measured twice a week. The EC and OC concentrations are determined using the Thermal Optical Reflectance (TOR) method, which is state of the science but is subject to uncertainties that are difficult to quantify [*Chow et al.*, 1993; *Malm et al.*, 1994]. In the present paper we take the data at face value. There are 45 IMPROVE sites with continuous measurements for 1998 (Figure 3).

Figure 4 compares simulated and observed annual mean EC and OC concentrations at the 45 IMPROVE sites for the year 1998. The IMPROVE measurements are plotted on the 2^o x 2.5^o model grid. The bottom panels show the differences (model bias). A general objection to evaluating model results with 24-hr averaged concentrations in continental surface air is the inability of models to resolve nighttime stratification [*Jacob et al.*, 1993]. This is not an issue in our case because of high vertical resolution of the model near the surface and because the IMPROVE sites are not in the vicinity of large sources. We verified that the 24-h average concentrations simulated by the model in layers 1 (0-10m), 2 (10-50m), and 3 (50-100m) are not significantly different.

Observed concentrations of EC and OC are generally higher in the eastern than the western United States, reflecting higher anthropogenic and vegetative (OC) emissions in the east. The OC maximum is shifted south relative to the EC maximum, and shows a secondary maximum along the west coast, reflecting the vegetative source. The model captures well this large-scale spatial distribution of EC and OC. Fires in the model also lead to high concentrations over Central America and western Canada.

Site-to-site comparisons reveal however some major discrepancies between model and observations, as shown in the bottom panel of Figure 4 and in the scatterplot of Figure 5. Some of these discrepancies appear to reflect inadequate spatial resolution in the model. Model overestimates at coastal sites with large local urban or fire sources (BRIG in New Jersey; OKEF in Georgia; REDW, PORE, and PINN in California) are due to the inability of the model to simulate steep subgrid land-to-sea gradients in mixing depth [*Fiore et al.*, 2002]. Model overestimates at SEQU (California) and GLAC (Montana) are due to local fire emissions (Figure 1) for which averaging over the grid scale may induce large errors in the simulation of local observations. We exclude these seven sites in further statistical data analysis.

The model overestimates OC concentrations at THSI (Oregon) and MORA (Washington) sites due to a particularly large vegetative source in the model in summer that is apparently not seen in the observations. The discrepancy is local in nature (it is not found at nearby sites). As discussed further below, our specification of the vegetative OC source appears inadequate to describe OC concentrations at these two sites, and therefore we exclude them from further statistical analysis.

Figure 5 shows that the model generally reproduces the annual mean EC and OC concentrations to within a factor of two and captures the spatial pattern well (R^2=0.84 for EC and R^2=0.67 for OC). However, the slope of the reduced major axis line [*Hirsch and Gilroy*, 1984] is 0.85±0.06 for EC and 0.74±0.08 for OC, reflecting a low bias in the model. We will correct for this model bias by adjusting the sources, as discussed below.

Figure 6 and Figure 7 compare seasonal variations of simulated and observed EC and OC concentrations at selected IMPROVE sites. Contributions from individual sources to the model concentrations are shown. Seasonal variations for EC differ considerably from site to site, and the model has significant success in capturing these differences. Fossil fuel is the dominant source for EC at most sites, but seasonal maxima in May-September over the western United States are due to forest fires. The OC concentrations are generally highest in summer and lowest in winter, both in the model and in the observations; this seasonal variation is mostly due to the biogenic source. Peaks in OC in May-September in the western United States are seen both in the model and in the observations and are due to wildfires, as for EC. Wintertime OC is higher in the eastern than the western United States, and includes contributions of comparable importance from biofuels and fossil fuels.

Rogers and Bowman [2001] used satellite measurements and air parcel trajectory calculations to illustrate the transport of the 1998 fire plumes from Central America to the central and southern United States. Our model successfully captures the corresponding peaks of EC and OC observed in May at the IMPROVE sites (e.g., BIBE in Texas, CHIR in Arizona, CANY in Utah, MOZI in Colorado, UPBU in Arkansas, GRSM in Tennessee). The enhancement in concentrations is much stronger for OC than for EC, both in the model and in the observations, reflecting high OC/EC fire emission ratios and the relatively large fossil fuel source of EC in the United States.

The model has also some success in reproducing the influences from fire emissions within the United States. For example, the high OC in April-June at CHAS in Florida is well captured in the model. Fires in the western United States result in peak EC and OC concentrations in September at several sites (MORA, Washington; THSI, Oregon; LAVO, California; JARB, Nevada).

Figure 8 compares simulated and observed monthly mean concentrations for the ensemble of IMPROVE sites and for separate seasons. The model simulation with *a priori* sources has success in reproducing the variability of observed EC and OC for winter and spring, as measured by the high R^2 (0.67-0.79) correlation between model and observations. The slope of the regression line (0.84-0.98) is close to one for both EC and OC. The R^2 is lower in summer and fall, particularly for OC (0.37-0.40) and the slope of the regression line is off from one (0.72-0.74 for EC and 0.74-1.06 for OC). The slope of the OC regression line in fall is close to one only because high model bias from wildfire sources at western sites offsets the low model bias at eastern sites.

4. Top-down emission estimates

The statistical model biases apparent in Figure 8 could reflect errors in the *a priori* sources. We examine what adjustments in the sources would be needed for least-squares minimization of the bias between simulated and observed monthly mean EC and OC concentrations. We identify for this purpose four source components: fossil fuel, biofuel, biomass burning, and vegetation (the latter for OC only). We use a multiple linear regression to fit the annual mean U.S. source for each component to the monthly mean IMPROVE observations. In order to give equal weight to EC and OC concentrations in the least-squares minimization, we normalize them by their respective annual mean concentrations for the ensemble of IMPROVE sites (0.29 $\mu g\ m^{-3}$ for EC, 1.23 $\mu g\ m^{-3}$ for OC).

We find in this manner that fossil fuel and biofuel emissions should be increased by 15% and 65% respectively from *a priori* levels, while biomass burning emissions should be decreased by 17% and the biogenic source for OC should be increased by 11%. We consider these adjustments to be well within the uncertainties on the *a priori* estimates. The *a posteriori* values of our adjusted sources are given in Table 1. The increase in the biofuel source is largely determined by the model underestimate of observed OC for the cold season.

Figure 9 presents annual mean surface air concentrations of EC and OC in the model using *a posteriori* sources. Relative to the simulation with *a priori* sources (Figure 4), there are 15-20% increases in EC and OC concentrations in the eastern United States. Changes in the western United States are smaller because the decrease in the biomass burning source offsets the increase in the biogenic OC source.

The effect of source adjustment on the ability of the model to fit observed EC and OC concentrations is shown by the scatterplots in Figure 8. Compared to the simulation with *a priori* sources, the R^2 correlation coefficients are slightly higher and the slopes of the regression lines are closer to unity. Figures 6 and 7 show the effect of the *a posteriori* sources on the simulation at individual sites. The adjustments are generally too small to correct site-specific discrepancies, which would require modifying the geographic distributions of the sources.

Figures 10 and 11 show the contributions of individual *a posteriori* sources to EC and OC for winter and summer. Fossil fuel is the most important source of EC everywhere in the United States, except in some areas in the west in summer where wildfires make a more important contribution. For OC, the anthropogenic sources (fossil and biofuel) dominate in winter, while the natural sources (fires and vegetation) are more important in summer. The fossil fuel OC is mostly concentrated in the northeastern corridor, the industrial Midwest and Southern California, whereas the biofuel OC is more widely distributed. Biogenic OC in summer is highest in the southeast and along the west coast. We previously discussed in the context of Figure 7 the large OC enhancements in the southern United States due to fires in Central America, but these enhancements are in spring (cf. Figure 2) and thus not apparent in Figure 11. Figure 11 shows a large enhancement in OC concentrations over the north-central United States due to Canadian fires, but the IMPROVE sites are not well situated to observe this enhancement (Figure 3). We present below a case study for summer 1995 demonstrating Canadian fire influence over the eastern United States.

5. Canadian fire influence: a case study for the summer of 1995

Previous studies [*Wotawa and Trainer*, 2000; *Fiore et al.*, 2002; *McKeen et al.*, 2002] have shown that major Canadian wildfires in June-July 1995 caused large enhancements of CO and smaller enhancements of ozone in the southeastern United States. The Canadian fire plumes were carried by northerly flows associated with high pressure systems on the back side of cold fronts. We use here a GEOS-CHEM simulation for the summer 1995 to demonstrate large aerosol EC and OC enhancements from these fires at IMPROVE sites in Arkansas (UPBU), Tennessee (GRSM) and Kentucky (MACA).

Our simulation of the 1995 Canadian wildfires uses daily, geographically resolved emission data estimated from the area burned in each province. Those data are given by *Wotawa and Trainer* [2000] for CO, and are scaled here to our climatological biomass burning emission inventory for CO [*Lobert et al.*, 1999] to derive corresponding EC and OC emissions. The resulting EC and OC emissions from the fires are 0.34 and 2.41 Tg, respectively, and are distributed in five areas (Northwest Territories, Alberta, Saskatchewan, Manitoba, and Ontario) for four burning periods from 17 June to 13 July.

Figure 12 shows the time series of simulated and observed EC and OC concentrations at three sites in the southeastern United States: UPBU in Arkansas, MACA in Kentucky, and GRSM in Tennessee. There are two large peaks in the observations, for July 1 and July 8, which are captured by the model and are due to the Canadian fires (compare solid and dashed lines in Figure 12). The timing of those peaks is consistent with those concurrently observed for CO at nearby sites [*McKeen et al.*, 2002]. Our simulation of the magnitude of the July 7-9 event is improved in a sensitivity simulation where we assume initial lifting of the fire emissions up to 4 km altitude (Figure 12, dotted line). Such lifting can be expected from buoyancy, particularly for large crown fires [*Liousse et al.*, 1996; 1997; *Lavoué et al.*, 2000].

Our model simulation allows us to assess the influence of Canadian fire emissions on seasonal aerosol concentrations in the United States for the summer of 1995. We find that the events associated with Canadian fire plumes persisted typically for 3-5 days. On a seasonal basis, they caused the mean June-August 1995 natural EC to increase by 80% (east) and 36% (west) and the mean OC to increase by 23% (east) and 16% (west), relative to a sensitivity simulation with no Canadian fires.

6. Implications for natural visibility in the United States

We use results from our model to estimate the role of natural carbonaceous aerosols in visibility reduction and compare to the default values recommended by *EPA* [2001] for application of the Regional Haze Rule. Our 1998 simulation with *a posteriori* sources yields annual average concentrations of natural EC and OC from fires and vegetation of 0.09 μg/m^3 and 1.09 μg/m^3, respectively, for the western United States (west of 95^{o}W) and 0.06 μg/m^3 and 0.95 μg/m^3, respectively, for the eastern United States. In order to compute the light extinction by OC we need to multiply the OC mass by 1.4 to obtain an Organic Carbon Mass (OMC) that accounts for the non-carbon additional mass attached to OC aerosols [*Malm et al.*, 1994]. The resulting annual average for natural OMC is 1.52 μg/m^3 and 1.33 μg/m^3 for the west and east, respectively. Except for OMC in the eastern United States, our best estimates of natural concentrations for EC and OMC are significantly higher than the default values recommended by *EPA* [2001] which are 0.02 μg/m^3 for EC, and 0.47 μg/m^3 (west) and 1.40 μg/m^3 (east) for OMC.

Several issues need to be addressed in this comparison to the EPA default values. First, 1998 had unusually high fire emissions, principally from Mexico and Canada, as shown in Figure 1. Second, it is important to quantify the contribution of transboundary transport to natural EC and OC concentrations in the United States. Third, there is ambiguity from a U.S. policy standpoint as to whether intercontinental transport of anthropogenic pollution (as from Asia) should be considered part of the "natural" background. To address these issues we conducted three sensitivity simulations, with sources modified from those in our standard 1998 simulation. The first includes no EC and OC sources in the United States to quantify the contributions from transboundary transport, mostly from Canada and Mexico. The second includes EC and OC sources from Asia only, to quantify the transpacific transport. The third uses climatological biomass burning emissions as shown in Figure 1 in order to derive mean default values of natural EC and OC concentrations in the United States. The results are summarized in Table 2.

We find that the transboundary transport of anthropogenic sources makes only a small contribution (less than 10%) to the total anthropogenic concentrations of EC and OC in the United States. However, the transboundary transport of natural sources, mostly from fires in Canada and Mexico, makes a large contribution to annual mean natural concentrations in the United States for 1998 (44% in the west and 67% in the east for EC; 28% in the west and 37% in the east for OC).

Transpacific transport from Asian sources is found to make little contribution to EC and OC concentrations in the United States, even in the context of the natural background. The concentrations generated in the simulation with anthropogenic and natural Asian sources only (Table 2) amount to less than 2% of the natural OC concentrations from the standard simulation, and less than 10% of the natural EC. The small role of intercontinental transport in contributing to background EC and OC concentrations over the United States reflects the short lifetime of these species against wet deposition, particularly considering that the lifting of air from the continental boundary layer to the free troposphere involves wet processes [*Stohl*, 2001]. This can be contrasted to ozone, for which transport from outside North America makes a large contribution to the U.S. background [*Fiore et al.*, 2002].

Our best estimates of mean natural EC and OC concentrations for comparison to the EPA default values are obtained from the simulation using mean climatological fire emissions. We find annual average concentrations of natural EC and OMC of 0.06 $\mu g/m^3$ and 1.25 $\mu g/m^3$, respectively, for the western United States and 0.04 $\mu g/m^3$ and 1.17 $\mu g/m^3$, respectively, for the eastern United States (Table 2). These are higher by a factor of 2-3 than the EPA default values except for OMC in the eastern United States which is lower by 16%.

The implications of our results for natural visibility estimates are substantial, particularly in the western United States. Our higher natural OMC component relative to EPA's default estimates results in lower natural visibility. For example, *EPA* [2001] uses its default natural PM concentrations to derive mean light extinctions of $15.60\times10^{-6}\ m^{-1}$ and $15.78\times10^{-6}\ m^{-1}$ at Bandelier National Monument (BAND, New Mexico) and at Yellowstone National Park (YELL, Wyoming). Applying the *EPA* [2001] visibility formula with our best estimates of natural EC and OMC (from the simulation with climatological mean fires), and using EPA default values for the other PM components, we find natural light extinctions of $19.13\times10^{-6}\ m^{-1}$ and $19.31\times10^{-6}\ m^{-1}$ at BAND and YELL, respectively, about 22% higher than EPA values.

7. Conclusions

We used the GEOS-CHEM global 3-D model to simulate observed concentrations of elemental carbon (EC) and organic carbon (OC) from a network of 45 sites in relatively remote regions of the United States (IMPROVE network). Our focus was to better quantify the anthropogenic and natural sources of EC and OC in the United States, and the role of transboundary and intercontinental transport, in the context of assessing the effect of these aerosols on visibility.

We conducted a 1-year simulation for 1998 using best *a priori* estimates of EC and OC sources, including global satellite observations of fires, and compared the results to observed concentrations at the IMPROVE sites. Wildfire emissions were from a gridded climatological inventory, scaled to monthly fire emissions for 1998 using satellite fire count data. The model reproduces well the spatial pattern in the observations ($R^2 = 0.84$ for EC, $R^2 = 0.67$ for OC) but is biased low by 15% for EC and 26% for OC. From a multiple linear regression fit we concluded that fossil fuel and biofuel emissions for EC and OC in the United States should be increased by 15%, and 65% respectively from *a priori* levels, while biomass burning emissions for both EC and OC should be decreased by 17% and the biogenic source for OC should be increased by 11%. Our best *a posteriori* estimates are given in Table 1.

Canadian fire influence on the United States in 1998 was largely confined to the upper Midwest, where no IMPROVE data are available. We conducted an additional simulation for the summer of 1995, for which large CO enhancements in the southeastern United States from Canadian fires had previously been reported [*Wotawa and Trainer*, 2000]. We find correspondingly large EC and OC enhancements in the IMPROVE observations for this region, which the model captures and diagnoses as being due to Canadian fire emissions. Model results indicate that Canadian fires in 1995 enhanced the mean June-August natural EC and OC concentrations in the eastern United States by 80% and 23%, respectively.

Our 1998 and 1995 simulations lead confidence in the representation of fire emissions of EC and OC in the model. We used a simulation with climatological monthly mean fire emissions, together with our best estimate of the biogenic OC source, to estimate natural concentrations of carbonaceous aerosols in the United States for purpose of natural visibility assessments and application of the EPA Regional Haze Rule [*EPA*, 2001]. Our best estimates of natural annual mean concentrations for EC are 0.06 μg/m^3 in the western United States (west of 95^{o}W) and 0.04 μg/m^3 in the east; for organic carbon mass (OMC = 1.4 OC, to account for the non-carbon contribution to OC aerosols), they are 1.25 μg/m^3 in the west and 1.17 μg/m^3 in the east. These values are 2-3 times higher than the default values recommended by *EPA* [2001] for application of the Regional Haze Rule, except for OMC in the east (16% lower). Our higher estimates of the natural OMC concentrations relative to EPA's default estimates result in higher natural light extinction (and hence lower natural visibility) by 22% in the western United States. We also find a large seasonal variability in natural light extinction from EC and OC, with highest values in summer due to sources from wildfires and vegetation.

We further investigated the contribution from transboundary transport to EC and OC concentrations in the United States. A sensitivity simulation with no EC and OC sources in the United States shows that fires in Mexico and Canada made a large contribution to annual mean natural concentrations of EC (40-70%) and OC (30-40%) in the United States in 1998. A sensitivity simulation with Asian sources only shows that transpacific transport contributes less than 10% of the natural background EC over the United States, and less than 2% of the natural background OC.

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Figures Captions

Figure 1. Yearly biomass burning OC emission in 1997-2000 for North and Central America, and climatological mean value (see text).

Figure 2. Annual biomass burning OC emission over North and Central America in 1998 (top) and seasonal variations for different regions (bottom).

Figure 3. IMPROVE sampling sites with continuous records for 1998.

Figure 4. Annual mean concentrations of EC (left) and OC (right) in surface air over the United States in 1998. The top panel shows results from the GEOS-CHEM model using a priori sources. The middle panel shows the IMPROVE observations plotted on the model $2^o \times 2.5^o$ grid. The bottom panel shows the difference between the two.

Figure 5. Scatterplot of simulated (GEOS-CHEM) vs. observed (IMPROVE) annual mean EC and OC concentrations for the data shown in Figure 4. The pluses and the circles indicate data in the western and eastern United States (separated at 95^oW), respectively. The asterisks with letter labels indicate sites discarded in the statistical analysis (see text): REDW(A), PORE(B), PINN(C), SEQU(D), GLAC(E), OKEF(F), and BRIG(G). The squares indicate OC data at MORA(H) and THSI(I) sites which were

discarded in statistical analysis for OC. The thin solid and dotted lines represent the y = x relation and a factor of 2 deviation. The thick solid line represents the reduced major-axis linear regression [*Hirsch and Gilroy*, 1984], excluding sites A-I. The Pearson correlation coefficients R^2 and regression equations are indicated.

Figure 6. Seasonal variation of monthly mean EC concentrations in 1998 at selected IMPROVE sites. Site locations are shown in Figure 1. Values are monthly means. Closed circles indicate the observations. Dashed and solid lines represent the model simulations with *a priori* and *a posteriori* sources, respectively. The *a priori* model components by source types are indicated as thin solid lines with symbols: asterisks (fossil fuel combustion), diamonds (biomass burning), and squares (biofuel use).

Figure 7. Same as in Figure 6 but for OC. The *a priori* model results by source types are represented as thin solid line with asterisks (fossil fuel), diamonds (biomass burning), squares (biofuel), and triangles (biogenic terpenes).

Figure 8. Scatterplots of monthly mean EC (left two columns) and OC (right two columns) simulated vs. observed concentrations with *a priori* (left) and *a posteriori* (right) sources, for the ensemble of IMPROVE sites and for individual seasons in 1998. Sites in the western and eastern United States (separated at 95^{o}W) are shown as pluses and open circles, respectively. Thin solid lines indicate a perfect match of the model results with observations, and dotted lines denote a factor of 2 departure. Thick solid lines represent the reduced major axis regression. The Pearson correlation coefficients R^2 are indicated.

Figure 9. Annual mean concentrations of EC (left) and OC (right) in surface air over the United States in 1998 from the GEOS-CHEM model using *a posteriori* sources.

Figure 10. Contribution from different sources types to EC concentrations (μg m^{-3}) in surface air for DJF and JJA. Values are model results for 1998 using a posteriori sources (Table 1).

Figure 11. Same as Figure 10 but for OC.

Figure 12. Concentrations of EC and OC at three southeastern U.S. sites (UPBU, MACA, and GRSM) in June-July 1995. Observations (24-h averages, twice a week) are shown as asterisks. The solid line shows results from the standard model simulation. Results from sensitivity simulations without Canadian fire emissions (dashed line) and with fire emissions initially mixed to 600 hPa (dotted line) are also shown.

Tables

Table 1. Carbonaceous aerosol sources in the GEOS-CHEM model (1998).

Aerosol	Source type	Global ($Tg\ yr^{-1}$)[a]	United States ($Tg\ yr^{-1}$) *A priori*	*A posteriori*
EC		22.0	0.66	0.75
	Fossil fuel	6.6	0.52	0.60
	Biofuel	1.4	0.04	0.07
	Biomass burning	14.0	0.10	0.08
OC		129.8	2.70	3.11
	Fossil fuel	10.6	0.45	0.52
	Biofuel	7.6	0.54	0.89
	Biomass burning	97.9	0.72	0.60
	Biogenic	13.7	0.99	1.10

[a] Including *a posteriori* emissions for the United States.

Table 2. Natural and anthropogenic EC and OC concentrations ($\mu g\ m^{-3}$) in the United States[a].

	Natural concentrations		Anthropogenic concentrations	
	West	East	West	East
EC				
1998 emissions (base)	0.09	0.06	0.21	0.62
No U.S. sources	0.04	0.04	0.02	0.02
Asian sources only	0.003	0.001	0.005	0.003
Climatological fire emissions	0.06	0.04	0.21	0.62
OMC[b]				
1998 emissions (base)	1.52	1.33	0.52	1.90
No U.S. sources	0.43	0.49	0.05	0.05
Asian sources only	0.022	0.013	0.013	0.007
Climatological fire emissions	1.25	1.17	0.52	1.90

[a]Values are annual means from the standard 1998 simulation (base) and from the sensitivity simulations described in section 5. Partition between West and East is at 95°W. The natural concentrations from the simulation with climatological fire emissions can be compared to the default estimates suggested by *EPA* [2001] for application of the Regional Haze Rule: 0.47 $\mu g\ m^{-3}$ (West) and 1.40 $\mu g\ m^{-3}$ (East) for OMC, and 0.02 $\mu g\ m^{-3}$ for EC.

[b]Organic carbon mass (OMC), defined as 1.4 times the OC mass to account for non-carbon contributions to the organic aerosol.

Figures

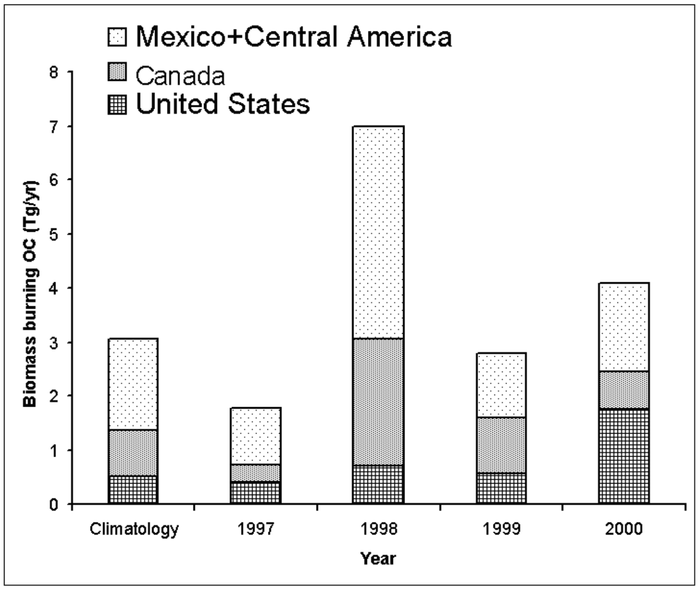
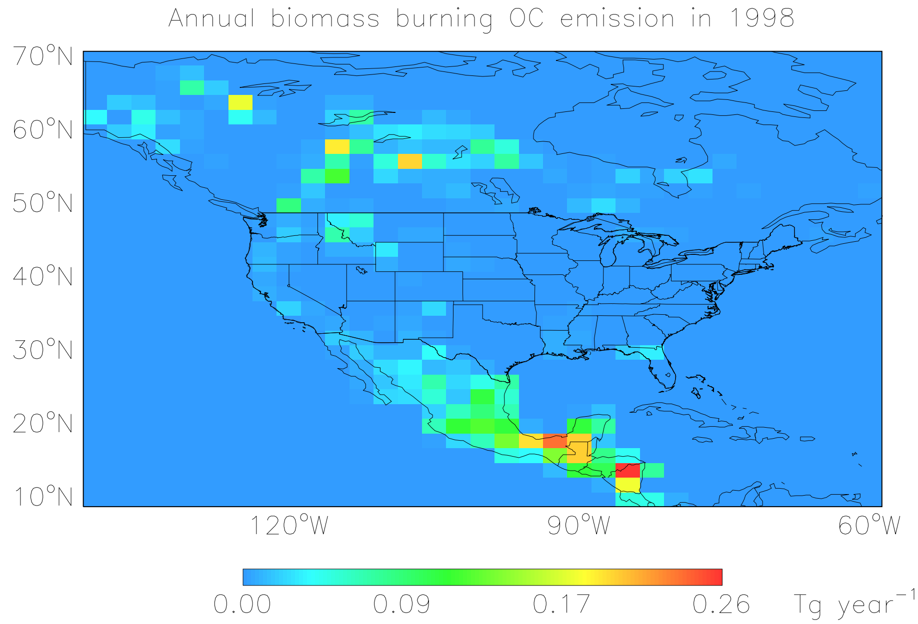


Figure 1. Yearly biomass burning OC emission in 1997-2000 for North and Central America, and climatological mean value (see text).



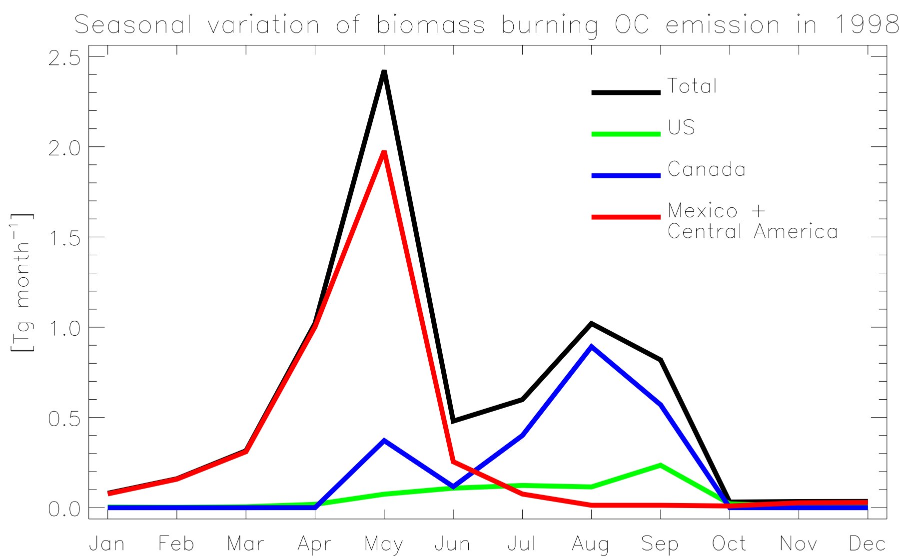


Figure 2. Annual biomass burning OC emission over North and Central America in 1998 (top) and seasonal variations for different regions (bottom).

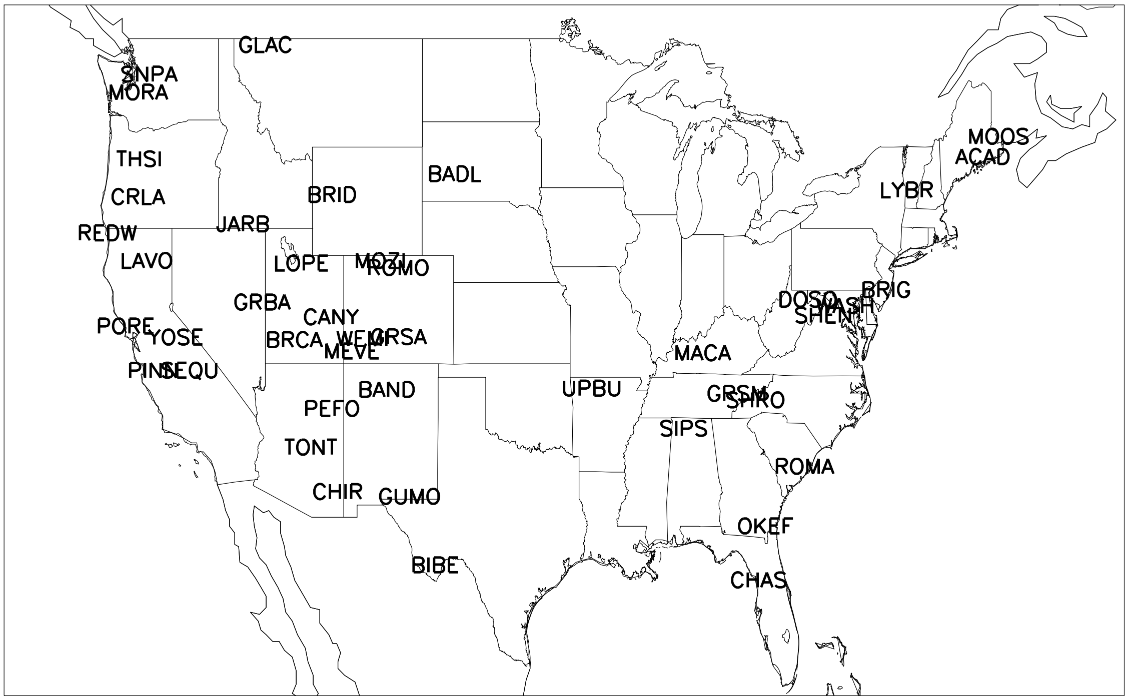


Figure 3. IMPROVE sampling sites with continuous records for 1998.

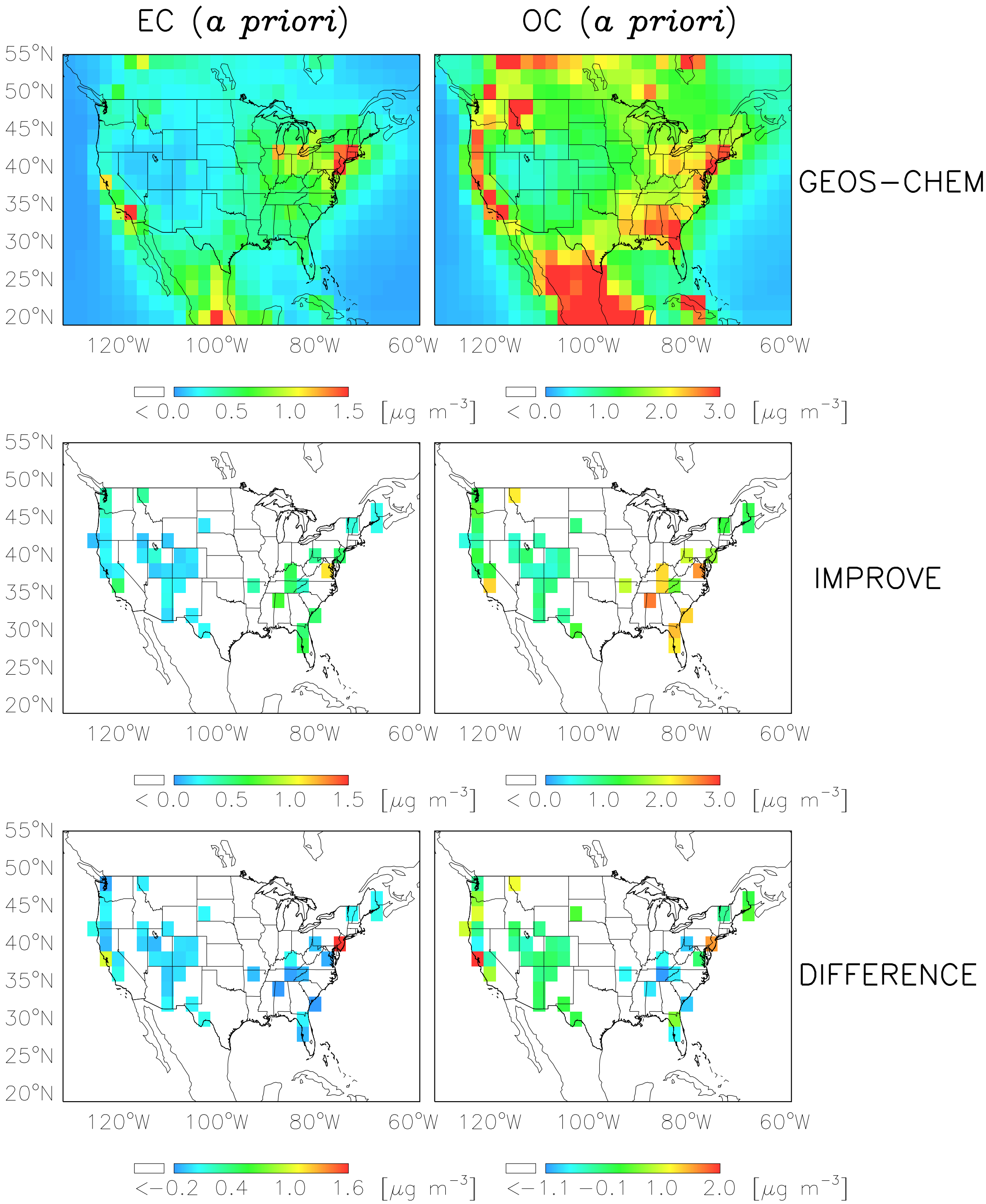
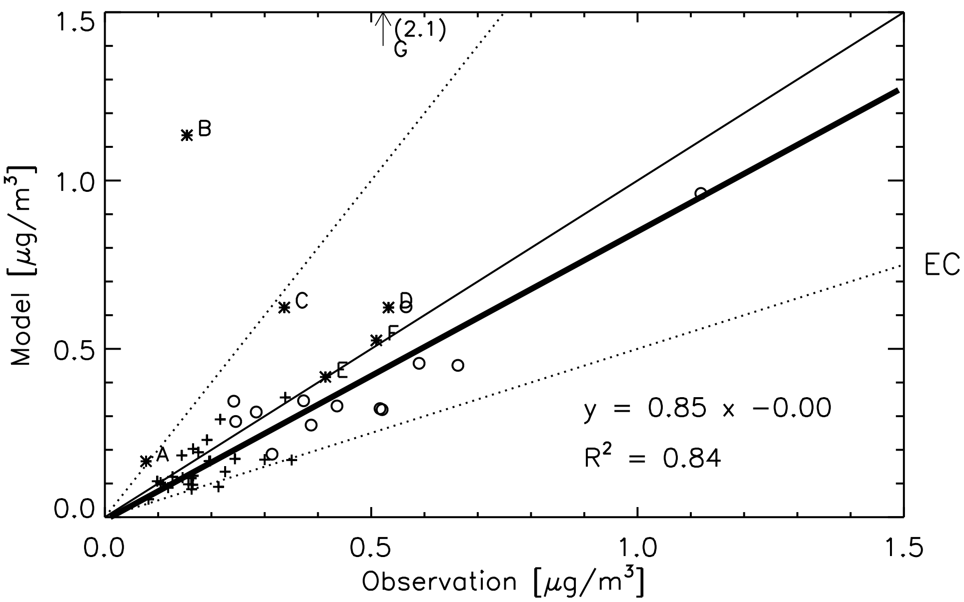


Figure 4. Annual mean concentrations of EC (left) and OC (right) in surface air over the United States in 1998. The top panel shows results from the GEOS-CHEM model using a priori sources. The middle panel shows the IMPROVE observations plotted on the model $2^o \times 2.5^o$ grid. The bottom panel shows the difference between the two.



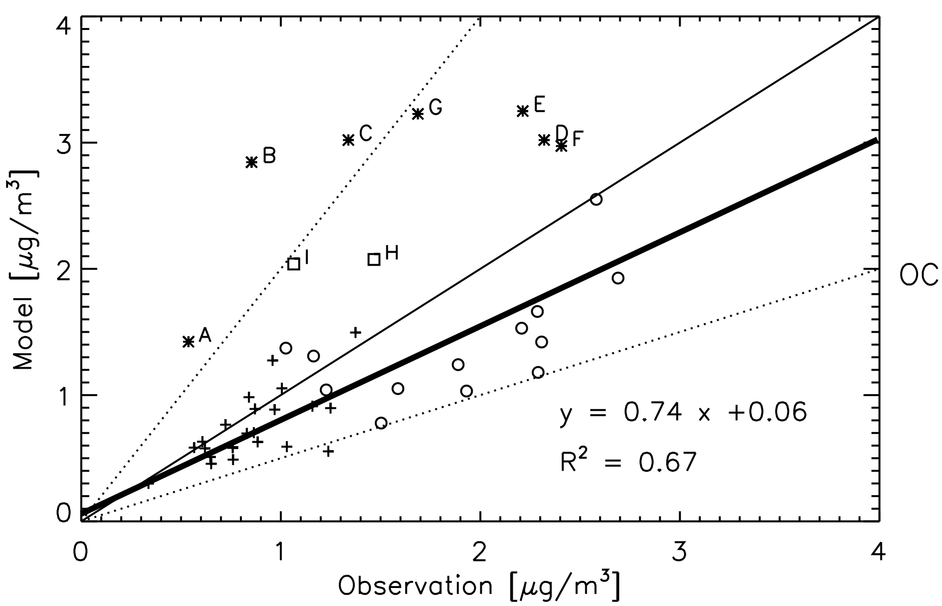


Figure 5. Scatterplot of simulated (GEOS-CHEM) vs. observed (IMPROVE) annual mean EC and OC concentrations for the data shown in Figure 4. The pluses and the circles indicate data in the western and eastern United States (separated at 95^{o}W), respectively. The asterisks with letter labels indicate sites discarded in the statistical analysis (see text): REDW(A), PORE(B), PINN(C), SEQU(D), GLAC(E), OKEF(F), and BRIG(G). The squares indicate OC data at MORA(H) and THSI(I) sites which were discarded in statistical analysis for OC. The thin solid and dotted lines represent the y = x relation and a factor of 2 deviation. The thick solid line represents the reduced major-axis linear regression [*Hirsch and Gilroy*, 1984], excluding sites A-I. The Pearson correlation coefficients R^2 and regression equations are indicated.

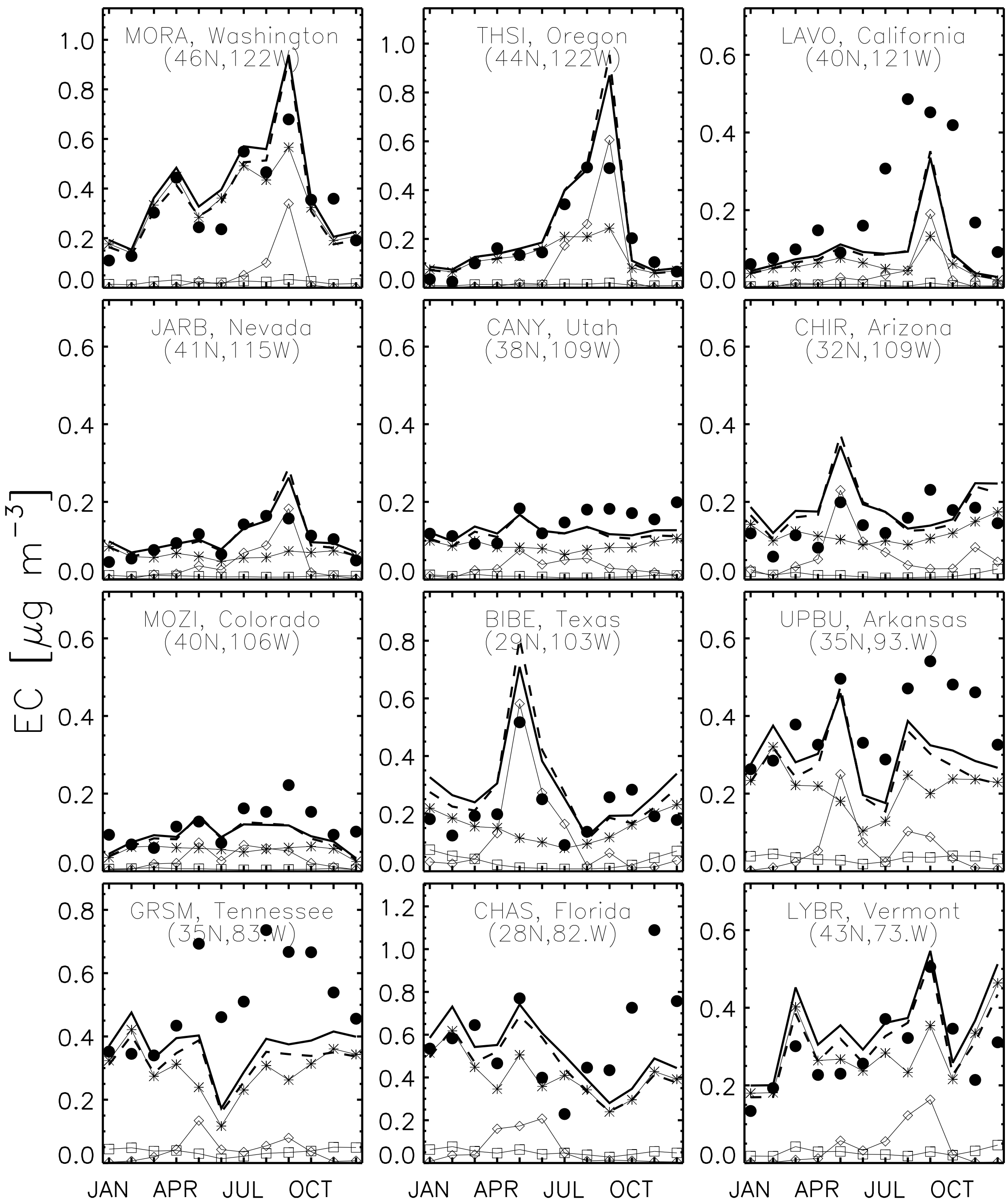


Figure 6. Seasonal variation of monthly mean EC concentrations in 1998 at selected IMPROVE sites. Site locations are shown in Figure 1. Values are monthly means. Closed circles indicate the observations. Dashed and solid lines represent the model simulations with *a priori* and *a posteriori* sources, respectively. The *a priori* model components by source types are indicated as thin solid lines with symbols: asterisks (fossil fuel combustion), diamonds (biomass burning), and squares (biofuel use).

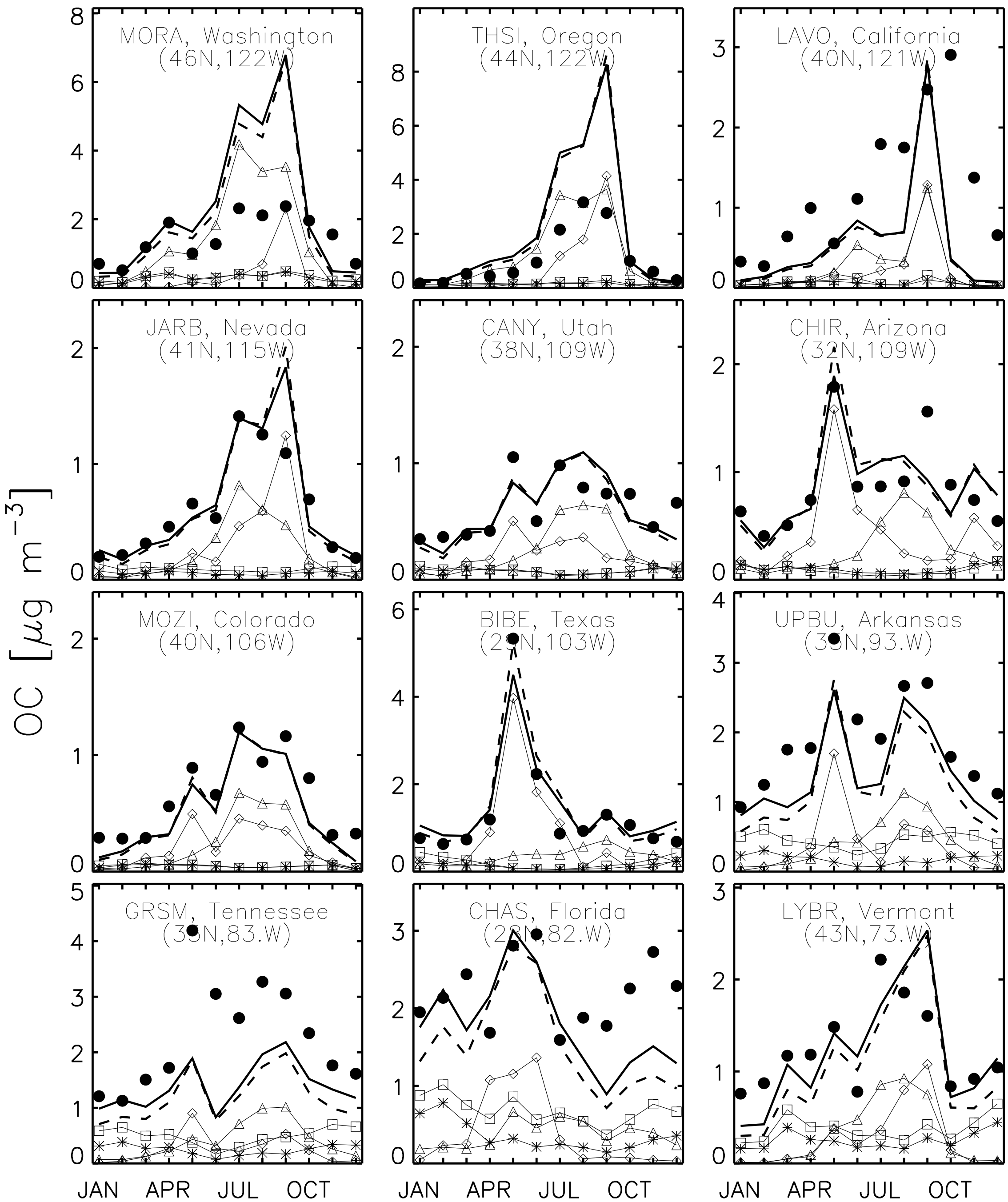


Figure 7. Same as in Figure 6 but for OC. The *a priori* model results by source types are represented as thin solid line with asterisks (fossil fuel), diamonds (biomass burning), squares (biofuel), and triangles (biogenic terpenes).

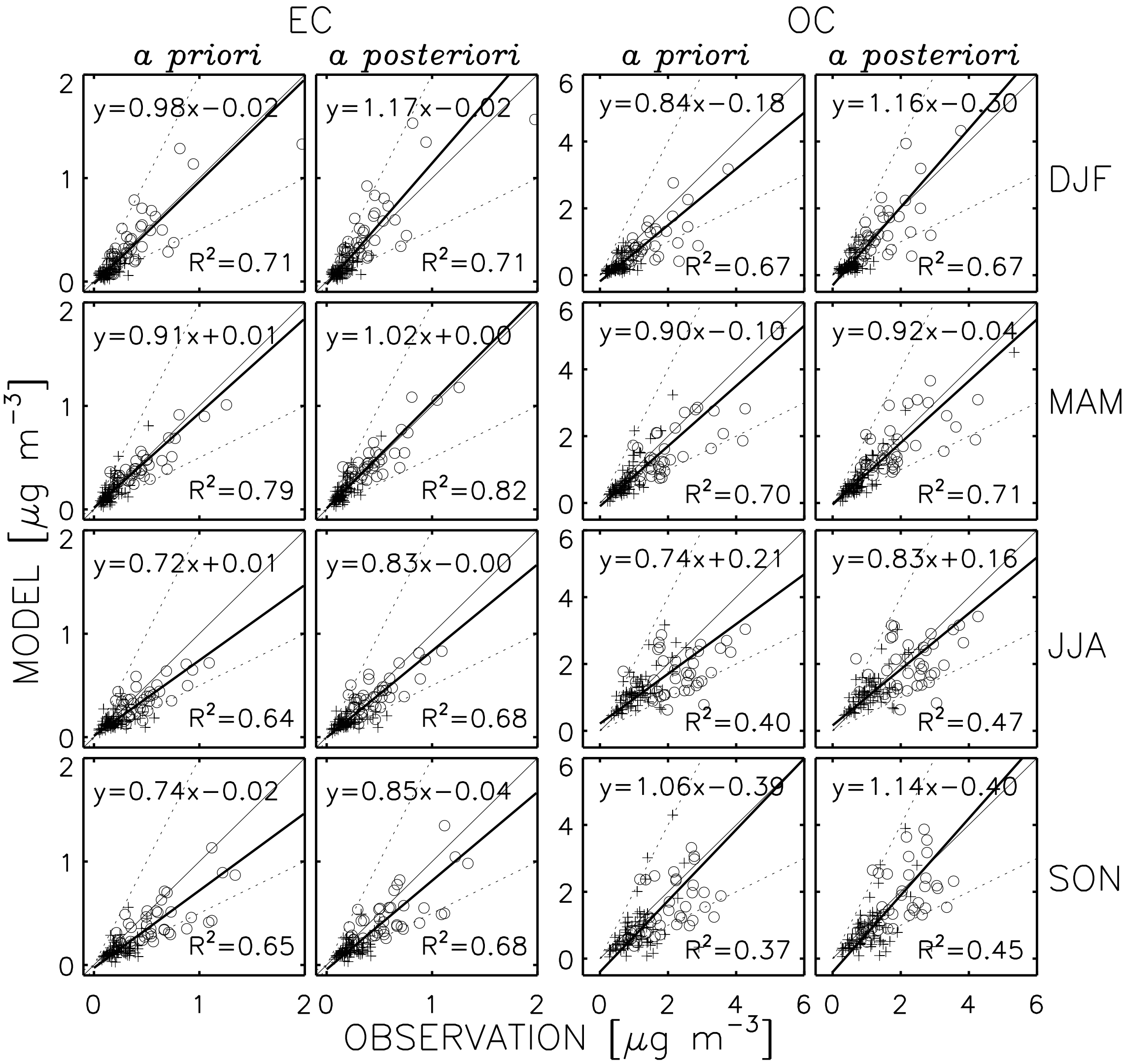


Figure 8. Scatterplots of monthly mean EC (left two columns) and OC (right two columns) simulated vs. observed concentrations with *a priori* (left) and *a posteriori* (right) sources, for the ensemble of IMPROVE sites and for individual seasons in 1998. Sites in the western and eastern United States (separated at 95°W) are shown as pluses and open circles, respectively. Thin solid lines indicate a perfect match of the model results with observations, and dotted lines denote a factor of 2 departure. Thick solid lines represent the reduced major axis regression. The Pearson correlation coefficients R^2 are indicated.

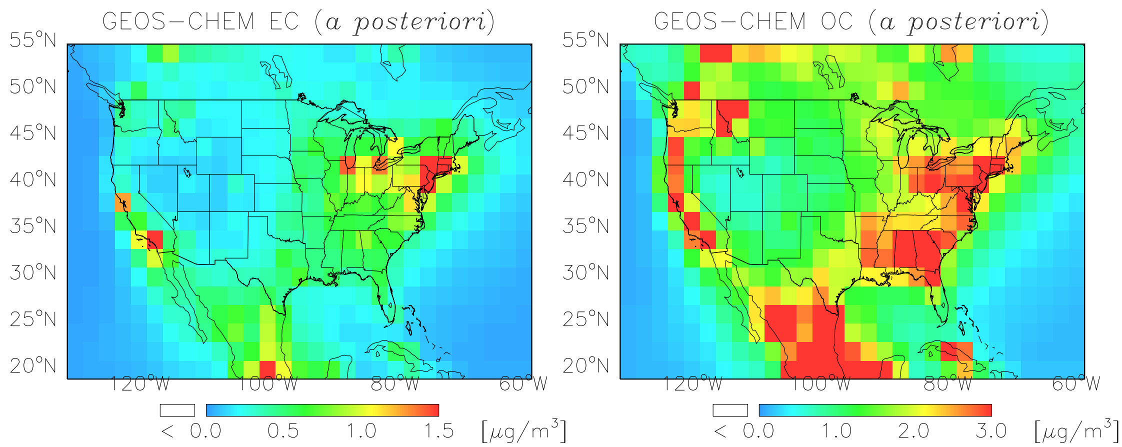


Figure 9. Annual mean concentrations (μg m^{-3}) of EC (left) and OC (right) in surface air over the United States in 1998 from the GEOS-CHEM model using *a posteriori* sources.

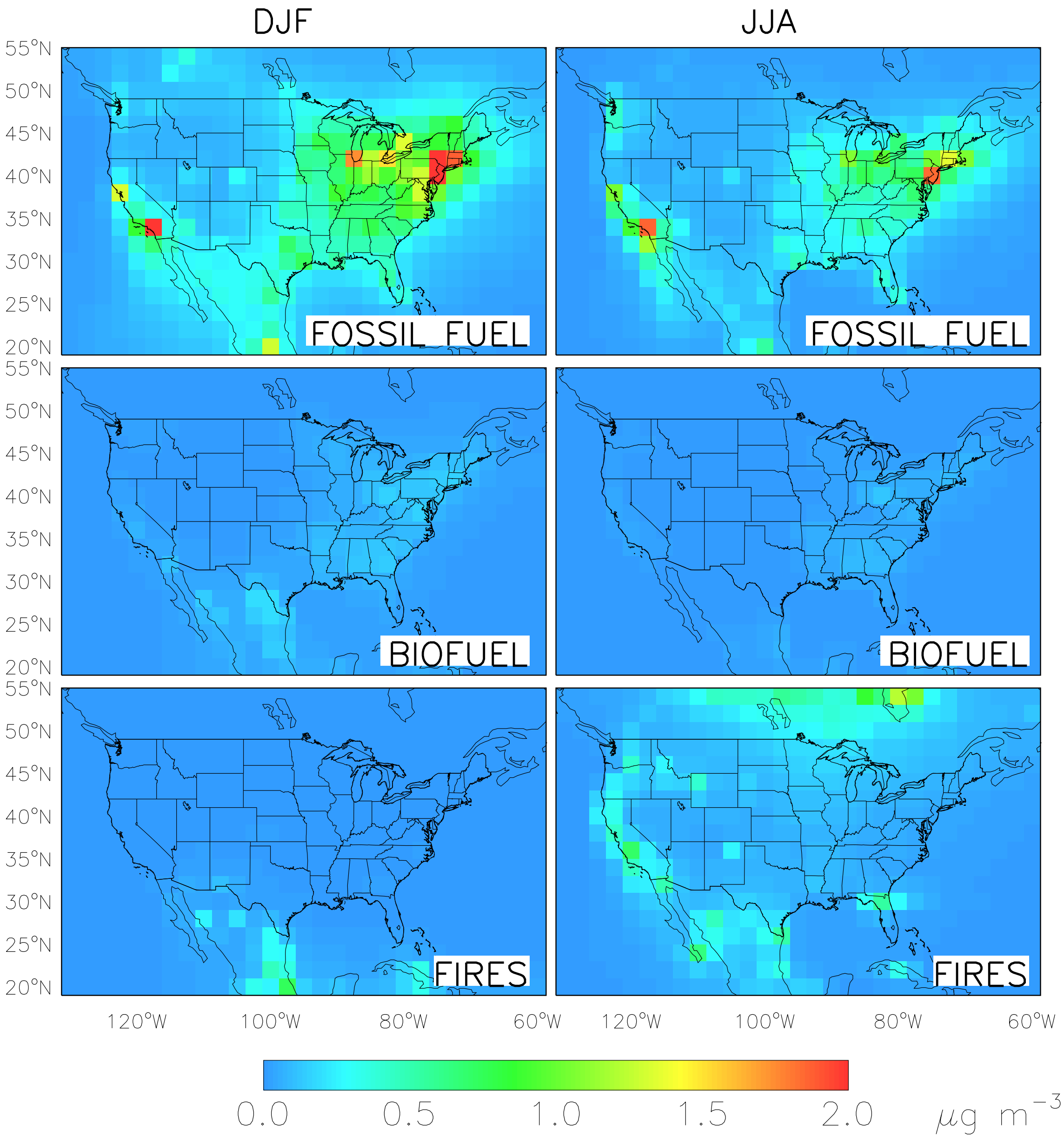


Figure 10. Contribution from different sources types to EC concentrations (μg m^{-3}) in surface air for DJF and JJA. Values are model results for 1998 using a posteriori sources (Table 1).

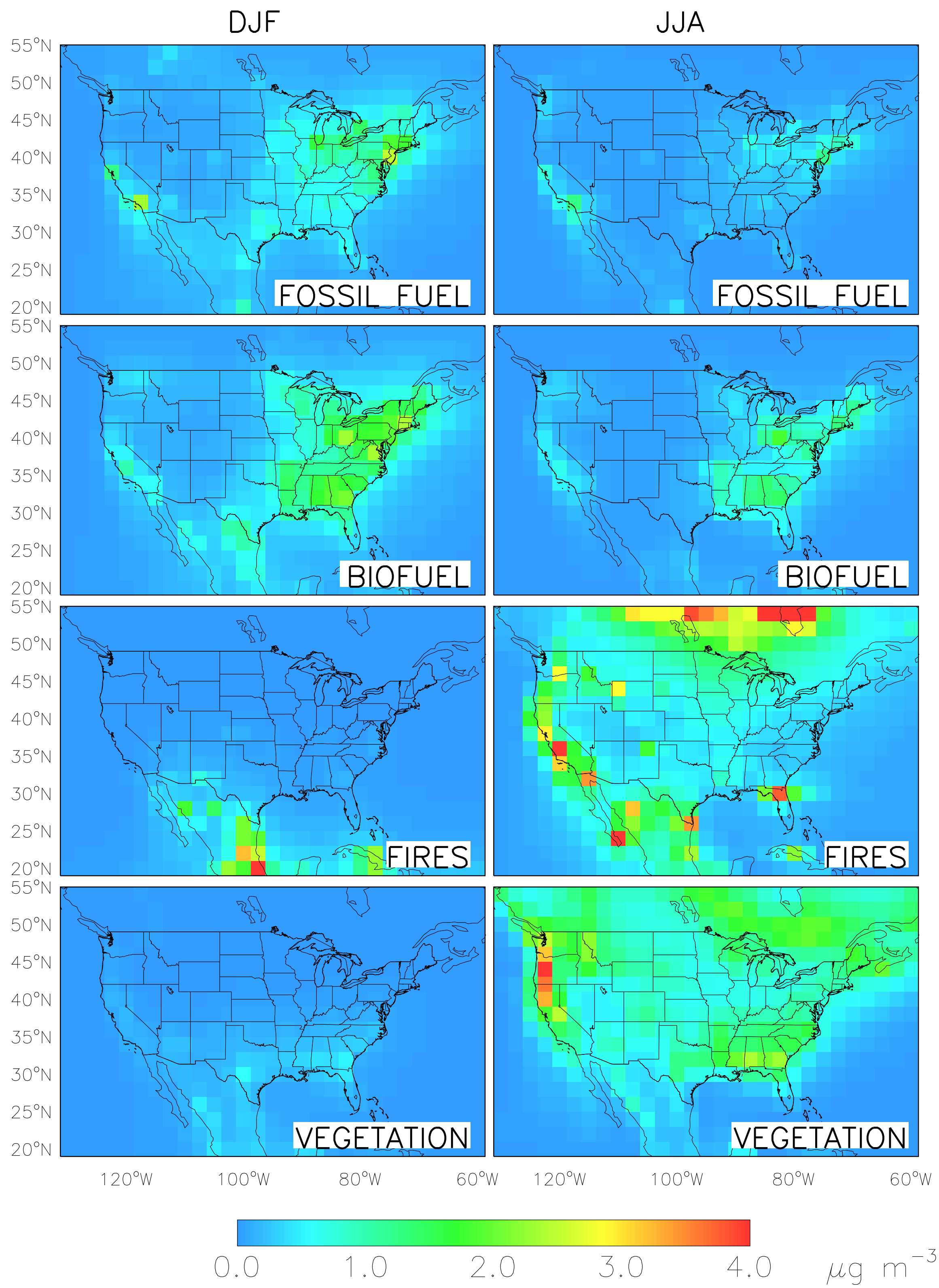


Figure 11. Same as Figure 10 but for OC.

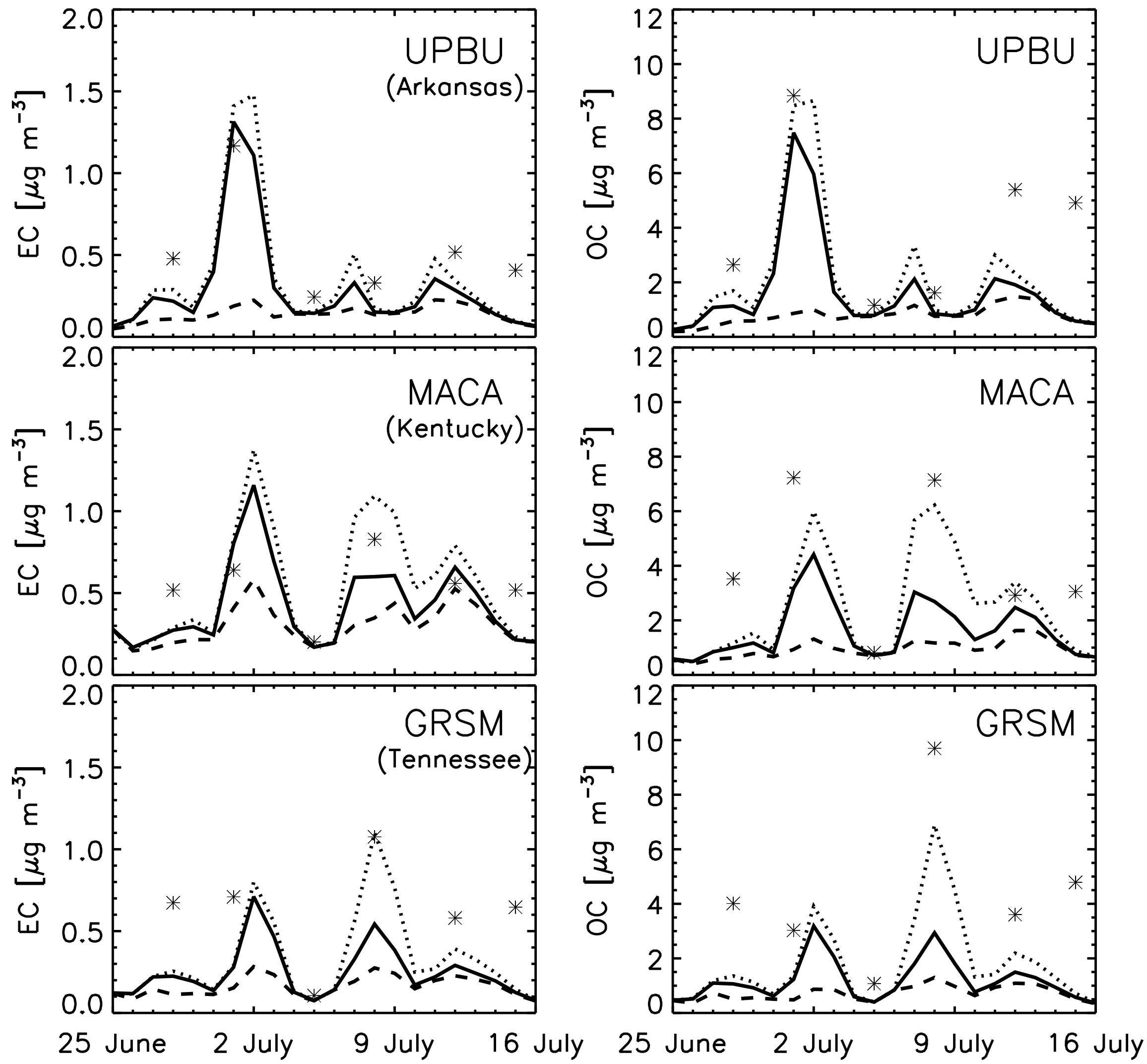


Figure 12. Concentrations of EC and OC at three southeastern U.S. sites (UPBU, MACA, and GRSM) in June-July 1995. Observations (24-h averages, twice a week) are shown as asterisks. The solid line shows results from the standard model simulation. Results from sensitivity simulations without Canadian fire emissions (dashed line) and with fire emissions initially mixed to 600 hPa (dotted line) are also shown.

Appendix B: Rokjin J. Park, Daniel J. Jacob, Brendan D. Field, Robert M. Yantosca, and Mian Chin (2004), Natural and transboundary pollution influences on sulfate-nitrate-ammonium aerosols in the United States: implications for policy, *J. Geophys. Res.*, 109, D15204, doi:10.1029/2003JD004473.

Abstract.

We use a global 3-D coupled oxidant-aerosol model (GEOS-CHEM) to estimate natural and transboundary pollution influences on sulfate-nitrate-ammonium aerosol concentrations in the United States. This work is motivated in part by the Regional Haze Rule of the U.S. Environmental Protection Agency (EPA), which requires immediate action to improve visibility in U.S. wilderness areas along a linear trajectory towards an endpoint of "natural visibility conditions" by 2064. We present full-year simulations for 1998 and 2001 and evaluate them with nationwide networks of observations in the United States and Europe (IMPROVE, CASTNET, NADP, EMEP) and with Asian outflow observations from the NASA TRACE-P aircraft mission. Shutting off U.S. anthropogenic emissions in the model defines "background" aerosol concentrations representing contributions from both natural and transboundary pollution sources. We find that transboundary transport of pollution from Canada, Mexico, and Asia dominates over natural influences for both sulfate and nitrate. Transpacific transport of Asian pollution accounts for 30% of background sulfate in both the western and eastern United States. Our best estimates of natural concentrations for ammonium sulfate and ammonium nitrate in the United States are either consistent with or lower than the default values recommended by EPA for natural visibility calculations. However, the large transboundary pollution influence in our calculation suggests that a natural visibility objective cannot be approached without international emission controls.

1. **Introduction**

Visibility degradation in the United States is mostly due to fine aerosols [*Malm et al.,* 2000] including carbonaceous (elemental and organic), sulfate, nitrate, and soil dust components. These aerosols originate from both anthropogenic and natural sources. The U.S. Environmental Protection Agency Regional Haze Rule [*U.S. EPA*, 2003a] mandates a schedule of increasing emission controls to achieve "natural visibility conditions" in national parks and other wilderness areas of the United States by 2064. Defining this natural visibility endpoint requires better information on natural aerosol concentrations and on the perturbing effects from transboundary transport of anthropogenic pollution. We previously examined this issue in a global 3-D model simulation of carbonaceous aerosols [*Park et al.*, 2003] and found that quantification of wildfire emissions was of critical importance. Transboundary transport of anthropogenic pollution was relatively unimportant for carbonaceous aerosols because of the large natural sources from wildfires and vegetation. We apply here the same analysis to sulfate and nitrate aerosols, which are other important components of visibility degradation and hence prime targets for regulation. As we will see, transboundary transport of pollution including intercontinental transport from Asia emerges in this case as a critical concern.

The main sources of sulfate and nitrate aerosols are atmospheric oxidation of SO_2 and nitrogen oxides ($NO_x \equiv NO + NO_2$) to H_2SO_4 and HNO_3, respectively [*NARSTO*, 2003]. Fossil fuel combustion is the dominant source of SO_2 and NO_x in the United States. Important natural sources include volcanoes and atmospheric oxidation of oceanic dimethylsulfide (DMS) for SO_2; and lightning, soils, and wildfires for NO_x [*NARSTO*, 2003]. The low vapor pressure of H_2SO_4 over H_2SO_4-H_2O solutions implies that all of sulfate is in the aerosol phase. The sulfate aerosols can be partly or totally neutralized by ammonia (NH_3) emitted from livestock, fertilizer use, and other less important sources. If excess ammonia is available beyond that required for sulfate neutralization to ammonium sulfate $(NH_4)_2SO_4$, then ammonium nitrate (NH_4NO_3) aerosol can form; otherwise, and except for cloudy conditions, nitric acid remains in the gas phase. This simple H_2SO_4-HNO_3-NH_3 thermodynamic framework provides a remarkably successful general description of sulfate and nitrate aerosols in the United States [*Seinfeld and Pandis*, 1998; *NARSTO*, 2003]. Sulfate and nitrate can also be incorporated in soil dust or sea salt particles, but these contributions appear to be significant only in desert and coastal areas.

Transboundary transport of pollution could compromise the objective of "natural visibility" in the Regional Haze Rule. We define here an aerosol "background" following *U.S. EPA* [2003b] as the aerosol concentration that would be present over the United States in the absence of domestic anthropogenic emissions. It includes contributions from natural sources but also from transboundary transport of pollution. If the latter are significant, then a "natural visibility" objective can be approached only through international emission controls. Alternatively, one should replace this objective by a "background visibility" objective that allows for uncontrollable emissions outside U.S. borders.

Intercontinental transport of Asian pollution is of particular interest for our study. Previous studies have shown that Asian pollution makes a significant (2-6 ppbv) contribution to background ozone concentrations in surface air in the United States [*Berntsen et al.*, 1999; *Jacob et al.*, 1999; *Fiore et al.*, 2002], principally by enhancing the northern hemispheric ozone background [*Fiore et al.*, 2003b]. Export and transpacific transport of Asian aerosol pollution is expected to be far less efficient than for ozone because the lifting of Asian air to the free troposphere involves wet processes (convection, warm conveyor belts) [*Liu et al.*, 2003] that scavenge aerosols with high efficiency [*Koike et al.*, 2003]. Most previous studies of transpacific transport of aerosols have focused on dust events, where the Asian source is very large and the lifting to the free troposphere takes place by dry processes [*Husar et al.*, 2001; *McKendry et al.*, 2001; *Vaughan et al.*, 2001]. However, *Jaffe et al.* [1999, 2003] and *Bertschi et al.* [2003] also showed significant aerosol enhancements in Asian pollution plumes sampled over the west coast of the United States in spring. As we will see, our model results suggest that transpacific Asian pollution is a major contributor to the sulfate background over the United States on an annual average basis.

2. Model description

2.1 General description

We use the GEOS-CHEM chemical transport model (CTM) [*Bey et al.*, 2001a] to conduct full-year simulations for 1998 and 2001 of the sulfate-nitrate-ammonium inorganic aerosol system coupled to oxidant chemistry. Most of our analysis focuses on the 2001 simulation. The 1998 simulation is used for evaluation with European observations, as 2001 observations were not available in a timely manner. The GEOS-

CHEM model (version 5.03, http://www-as.harvard.edu/chemistry/trop/geos) uses assimilated meteorological data from the NASA Goddard Earth Observing System (GEOS) including winds, convective mass fluxes, mixed layer depths, temperature, clouds, precipitation, and surface properties. Meteorological data for 1998 and 2001 are available with 6-hour temporal resolution (3-hour for surface variables and mixing depths), 1^o latitude by 1^o longitude ($1^o \times 1^o$) horizontal resolution, and 48 sigma vertical layers. We degrade the horizontal resolution to $2^o \times 2.5^o$ for computational expediency. The lowest model levels are centered at approximately 10, 50, 100, 200, 400, 600, 900, 1200, and 1700 m above the local surface.

The GEOS-CHEM simulation of tropospheric oxidant chemistry includes a detailed ozone-NO_x-hydrocarbon chemical mechanism (~80 species, ~300 reactions). Results from this simulation have been reported in a number of papers [*Bey et al.,* 2001ab; *Li et al.,* 2001, 2002ab; *Liu et al.*, 2002; *Martin et al.,* 2002] including focused studies of surface ozone in North America and North American outflow [*Fiore et al.,* 2002, 2003ab; *Li et al.*, 2004]. GEOS-CHEM simulations of aerosols have been reported previously for radionuclides [*Liu et al.,* 2001] and carbonaceous species [*Park et al.,* 2003]. The H_2SO_4-HNO_3-NH_3 aerosol simulation is a new capability for GEOS-CHEM and is described in more detail below. The aerosol and oxidant simulations are coupled through formation of sulfate and nitrate, HNO_3(g)/NO_3^- partitioning of total inorganic nitrate, heterogeneous chemistry [*Jacob*, 2000], and aerosol effects on photolysis rates [*Martin et al.,* 2003]. Partitioning of total ammonia and nitric acid between the gas and aerosol phases is calculated using the MARS-A thermodynamic equilibrium model [*Binkowski and Roselle,* 2003].

The wet deposition scheme for aerosols is described by *Liu et al.* [2001]. It includes contributions from scavenging in convective updrafts, rainout and washout from convective anvils and large-scale precipitation, and it allows for return to the atmosphere following evaporation. We extend it here to soluble gases on the basis of their effective Henry's law partitioning in warm clouds, retention efficiency upon droplet freezing in mixed clouds, and surface coating or co-condensation of ice crystals in cold clouds [*Mari et al.*, 2000]. Scavenging of SO_2 is limited by the local availability of H_2O_2 as a fast aqueous-phase oxidant converting SO_2 to sulfate [*Chin et al.*, 1996, 2000a]. Dry deposition of aerosols and gases uses a standard resistance-in-series model dependent on local surface type and meteorological conditions [*Wesely*, 1989], and implemented as described by *Wang et al.* [1998].

We conducted five different simulations for 2001 including one standard simulation as described above, and four sensitivity simulations excluding anthropogenic emissions (1) globally, (2) in the United States, (3) in North America, and (4) in Asia. From these we quantify the influences of natural, transboundary, and intercontinental pollution sources on sulfate-nitrate-ammonium aerosol concentrations in the United States.

Each simulation was carried out as follows. We first conducted a fully coupled oxidant-aerosol simulation at $4^o \times 5^o$ horizontal resolution for computational expediency. Oxidant concentration fields (OH, O_3, NO_3), H_2O_2 production rates and photolysis frequencies, and total inorganic nitrate concentrations (gas-phase nitric acid plus aerosol nitrate) were archived from this simulation and used to conduct an aerosol-only simulation at finer $2^o \times 2.5^o$ horizontal resolution. The aerosol-only simulation includes 9 prognostic chemical species: dimethylsulfide (DMS), SO_2, sulfate, methane sulfonic acid (MSA), HNO_3(g), NO_3^-, NH_3(g), NH_4^+, and H_2O_2. The 2001 and 1998 simulations were initialized on October 1, 2000 and October 1, 1997, respectively, and conducted for 15 months. The first three months were used to achieve proper initialization, and we focus our attention on the following 12 months.

2.2 Sulfur simulation

The sulfur simulation in GEOS-CHEM is based on the Georgia Tech/Goddard Global Ozone Chemistry Aerosol Radiation and Transport (GOCART) model [*Chin et al.,* 2000a], with a number of modifications described below. Our fossil fuel and industrial emission inventory is for 1999-2000 and is obtained by scaling the gridded, seasonally resolved inventory from the Global Emission Inventory Activity (GEIA) for 1985 [*Benkovitz et al.*, 1996] with updated national emission inventories and fuel use data [*Bey et al.*, 2001a]. The emissions for the United States and Canada are from *U.S. EPA* [2001], and the emissions for European countries are from *EMEP* [2003]. Asian sulfur emission in the model is 20 Tg S yr^{-1}, which can be compared to year 2000 estimates of 17 Tg S yr^{-1} by Streets et al. [2003] and 25 Tg S yr^{-1} by IPCC [2001]. Anthropogenic sulfur is emitted as SO_2 except for a small fraction as sulfate, 5% in Europe and 3% elsewhere [*Chin et al.*, 2000a].

Other anthropogenic sources of SO_2 in the model include gridded monthly aircraft emissions (0.07 Tg S yr^{-1}) taken from *Chin et al.* [2000a] and biofuel use. We use a global biofuel CO emission inventory with $1^o \times 1^o$ spatial resolution from *Yevich and Logan* [2003] and apply an emission factor of 0.0015 moles SO_2 per mole CO [*Andreae and Merlet*, 2001]. Seasonal variations in biofuel emissions are specified from the heating degree-days approach [*Park et al.,* 2003].

Natural sources of sulfur in the model include DMS from oceanic phytoplankton and SO_2 from volcanoes and biomass burning. The oceanic emission of DMS is calculated as the product of local seawater DMS concentration and sea-to-air transfer velocity. The seawater DMS concentrations are gridded monthly averages from *Kettle et al.* [1999], and the transfer velocity of DMS is computed using an empirical formula from *Liss and Merlivat* [1986] as a function of the surface (10m) wind speed. The GEOS surface winds used here assimilate remote sensing data from the Special Sensor Microwave Imager (SSM/I) instrument. Volcanic emissions of SO_2 from continuously active volcanoes are included from the database of *Andres and Kasgnoc* [1998]. Emissions from sporadically erupting volcanoes show large year-to-year variability and are not included in the model. No major volcanic eruptions occurred in 2001. Biomass burning emissions of SO_2 are calculated using a gridded monthly biomass burning inventory of CO constrained from satellite observations in 2001 by *Duncan et al.* [2003] with an emission factor of 0.0026 moles SO_2 per mole CO [*Andreae and Merlet*, 2001].

Table 1a summarizes global and contiguous U.S. (excluding Alaska and Hawaii) sulfur emissions for 2001. The United States contribute 10% of the global source (15% of the global anthropogenic source). Natural sources contribute 27% globally and are negligible within the contiguous United States.

The gas-phase sulfur oxidation chemistry in the model includes DMS oxidation by OH to form SO_2 and MSA, by nitrate radicals (NO_3) to form SO_2, and SO_2 oxidation by OH to form sulfate. Reaction rates are from *DeMore et al.* [1997] and the yields of

SO_2 and MSA from DMS oxidation are from *Chatfield and Crutzen* [1990]. Aqueous-phase oxidation of SO_2 by O_3 and H_2O_2 in clouds to form sulfate is included using kinetic data from *Jacob* [1986] and assuming a pH of 4.5 for the oxidation by O_3. Cloud liquid water content is not available in the GEOS data and we specify it instead in each cloudy grid box by using a temperature-dependent parameterization [*Somerville and Remer*, 1984]. The cloud volume fraction in a given grid box is specified as an empirical function of the relative humidity following *Sundqvist et al.* [1989].

2.3 Ammonia simulation

Ammonia emissions in the model are based on annual data for 1990 from the $1^o \times 1^o$ GEIA inventory of *Bouwman et al.* [1997]. Source categories in that inventory include domesticated animals, fertilizers, human bodies, industry, fossil fuels, oceans, crops, soils, and wild animals. We view the first five as anthropogenic and the last four as natural. Additional emissions from biomass burning and biofuel use are computed using the global inventories of *Duncan et al.* [2003] and *Yevich and Logan* [2003], with an emission factor of 1.3 g NH_3 per kg dry mass burned [*Andreae and Merlet*, 2001]. The resulting total annual source of ammonia for the United States is reduced by 10% to match that derived by *Gilliland et al.* [2003] from an inverse model analysis of monthly precipitation chemistry (NH_4^+) data.

Table 1b shows a summary of global and contiguous U.S. ammonia emissions for 2001. The United States account for 5% of the global source (6% of the global anthropogenic source). Natural sources amount to 37% of global ammonia emissions and 21% of contiguous U.S. emissions.

Several ammonia sources in Table 1b have strong seasonal variations. For the emissions from domesticated animals and soils we use exponential dependences on temperature reported by *Aneja et al.* [2000] and *Roelle and Aneja* [2002], respectively. Ammonia emissions from crops and fertilizers are assumed to vary seasonally with the number of daylight hours [*Adams et al.*, 1999]. Seasonal variations in biomass burning and biofuel emissions are specified from satellite observations [*Duncan et al.*, 2003] and the heating degree-days approach [*Park et al.,* 2003], respectively. Figure 1 shows the resulting seasonal variation of ammonia emission in the United States. The summer maximum is driven mainly by domesticated animals. Compared to the results of the *Gilliland et al.* [2003] inverse model analysis, also shown in Figure 1, our seasonal cycle lags in phase by 1-2 months and emission in October is a factor of 2 higher.

2.4 Nitrate simulation

Production of total inorganic nitrate (gas-phase nitric acid and aerosol nitrate) in the model is computed from the ozone-NO_x-hydrocarbon chemical mechanism (see section 2.1). Table 1c gives a summary of global and contiguous U.S. NO_x emissions; details on these sources are in *Bey et al.* [2001a] and *Martin et al.* [2002]. The United States account for 17% of global emissions (25% of global anthropogenic emissions). Natural sources from lightning, soils, and biomass burning account for 38% of global emissions and 9% in the contiguous United States.

2.5 Global budgets

Tabulated summaries of the global sulfate, nitrate, and ammonium aerosol budgets in GEOS-CHEM are given by *Martin et al.* [2004], who applied the model to an investigation of phase transition effects on aerosol radiative forcing. The global sulfate, nitrate and ammonium burdens for 2001 are 0.40 Tg S, 0.07 Tg N, and 0.32 Tg N, respectively. The lifetimes against deposition are 3.9, 3.2, and 3.8 days, respectively. Wet deposition accounts for 80 - 90% of total deposition.

Our global sulfate burden is lower than those (0.54-1.03 Tg S) from models that participated in the COmparison of large-scale atmospheric Sulfate Aerosol Models (COSAM) [*Barrie et al.,* 2001]. Our anthropogenic emission (57 Tg S yr^{-1}) is lower than that used in COSAM (67 Tg S yr^{-1}) because our emission inventory is for 1999-2000 (vs. 1985 in COSAM) and accounts for emission reductions in Europe (by 61% since 1985) and the United States (by 22% since 1985). The major natural sulfur sources in our model from oceans (15 Tg S yr^{-1}) and volcanoes (5 Tg S yr^{-1}) are also lower than those used in COSAM (29 and 10 Tg S yr^{-1}, respectively). These natural sources contribute disproportionately to the global atmospheric sulfate burden because their sulfur can be delivered efficiently to the free troposphere where precipitation is infrequent [*Chin and Jacob*, 1996]. The lifetime of sulfate in our simulation (3.9 days) is at the low end of the 3.6 – 7.5 days found in COSAM.

Our annual average tropospheric ammonium burden (0.32 Tg N) is consistent with values from previous model studies (0.30 – 0.33 Tg N) [*Dentener and Crutzen*, 1994; *Adams et al.*, 1999] and the lifetime of ammonium is also similar (4.2 – 4.5 days). Our annual average tropospheric nitrate burden (0.07 Tg N) is within the range of 0.03 to 0.09 Tg N found in the previous model study by *Adams et al.* [1999, 2001].

3. **Model evaluation**

We focus our model evaluation on surface networks of sulfate-nitrate-ammonium aerosol observations in the United States and Europe. We also use sulfate wet deposition data in the United States as a test of the sulfur budget, and aircraft observations off the Asian Pacific Rim as a test of Asian export. Previous evaluation with sulfate observations at remote sites has been presented by *Chin et al.* [2000b] using the GOCART model which is similar to ours. Previous evaluations of GEOS-CHEM with aerosol radionuclides globally, and with carbonaceous aerosols in the United States, have been presented by *Liu et al.* [2001] and *Park et al.* [2003], respectively. Other GEOS-CHEM studies have evaluated the simulation of ozone and nitrogen oxides in the United States [*Fiore et al*., 2002, 2003ab; *Li et al.*, 2004] and the transpacific transport of Asian ozone and CO pollution [*Jaeglé et al.*, 2003; *Heald et al.*, 2003].

3.1 United States

We use aerosol observations for the year 2001 at 141 IMPROVE and 79 CASTNET sites, and wet deposition data at 226 NADP sampling sites (Figure 2). The IMPROVE monitoring program was initiated in 1987 in national parks and other protected environments to identify the contributions of different aerosol components to visibility degradation [*Malm et al.*, 1994]. The data for 2001 consist of 24-h sulfate and nitrate concentrations measured every third day by Particle Induced X-ray Emission (PIXE) and ion chromatography (IC), respectively. There are no ammonium data. The CASTNET network of rural sites was initiated in 1990 to monitor regional air pollution

[*Lavery et al.*, 2002]. It provides weekly average concentrations of sulfate, nitrate, and ammonium measured by IC. The NADP network provides weekly chemical precipitation data [*NADP*, 2002]. Sites are predominantly located in rural areas and away from point sources of pollution. Weekly precipitation samples are analyzed for sulfate using IC.

Figure 3 compares simulated and observed annual mean sulfate concentrations at the 141 IMPROVE and 79 CASTNET sites for the year 2001, plotted on the $2^o \times 2.5^o$ model grid. Values are higher in the eastern than the western United States and are highest in the industrial midwest, reflecting the distribution of anthropogenic emissions. Figure 4 shows scatterplots of simulated vs. observed annual and seasonal sulfate concentrations for the ensemble of IMPROVE (left) and CASTNET sites (center). The right column in Figure 4 compares simulated and observed sulfate precipitation data at NADP sites. The correlation between model and observations is high for the annual mean values (R^2 = 0.91-0.94 for the concentration data, 0.75 for the deposition data) and also for the seasonal means (R^2 = 0.79-0.90 for the concentration data, 0.58-0.74 for the deposition data). Western sites in the scatterplots are represented with "+" symbols and should be in general most representative of background conditions. The R^2 coefficients between model and observations for the subset of western sites alone are 0.35-0.39 for the annual mean concentrations at the IMPROVE and CASTNET sites, lower than for the ensemble of U.S. sites, although this could largely reflect the weaker dynamic range. There is no significant bias in the simulation of concentrations at the cleanest western sites.

Regression lines are computed here and elsewhere with the reduced major axis method, which minimizes the area of the right triangle formed by vertical and horizontal lines running from the observed point to the regression line. It is the most appropriate linear regression to characterize a relationship between two data sets with uncertainties [*Hirsch and Gilroy*, 1984]. Results in Figure 4 show no significant model bias in the simulation of annual mean concentrations (slope = 0.91-0.95) but a 30% low bias in summer (slope = 0.71-0.74). Loss of SO_2 in convective updrafts accounts for about 50% of sulfate wet deposition in summer in the model, and much less in other seasons. Our algorithm scavenges SO_2 in convective updrafts as a titration reaction limited solely by the supply of H_2O_2 entrained in the updraft. However, kinetic limitations in the aqueous-phase reaction of SO_2 with H_2O_2, as well as scavenging of H_2O_2, can greatly reduce the SO_2 scavenging efficiency [*Mari et al.,* 2000; *Kreidenweis et al*, 2003]. Accounting for these limitations might correct the model bias but was not attempted here.

Figure 5 compares simulated and observed annual mean concentrations of ammonium at CASTNET sites. Observed concentrations are higher in the east than in the west and are highest in the midwest, reflecting agricultural operations. The model reproduces this spatial distribution but is too high in the midwest. Scatterplots of simulated vs. observed annual and seasonal ammonium concentrations are shown in Figure 6 (left column) for the ensemble of sites. The model reproduces the variability of observed ammonium concentrations, both in an annual mean sense (R^2 = 0.90) and in different seasons (R^2 = 0.82-0.85). It shows a 30% high bias in annual mean concentrations which is mainly driven by the fall (slope = 2.0). Comparison with results from the *Gilliland et al.* [2003] inverse model analysis suggests that our ammonia emissions are excessive in the fall (Figure 1). It appears that a simple exponential temperature dependence of emissions from livestock, as assumed here, does not adequately describe the seasonal variation of this dominant source. For the subset of western sites alone the model has a lower R^2 coefficient (0.53) between the simulated and observed annual mean concentration than that for the ensemble of U.S. sites but no apparent high bias (slope = 1.02).

Figure 7 compares simulated and observed annual mean nitrate concentrations at the 141 IMPROVE and 79 CASTNET sites for 2001. The spatial distribution is similar to that of ammonium concentrations in both the observations and the model, reflecting the limitation of ammonium nitrate formation by the availability of ammonia as discussed further below. The model tends to be too high, by a factor of 2 on an annual basis as shown by the scatterplots of Figure 6. Most of the bias is driven by summer and fall. Nitrate formation is determined by the availability of ammonia beyond that required for sulfate neutralization; we find in a sensitivity analysis that the summer high bias for nitrate can be explained in large part by the low bias of sulfate. High nitrate in fall is likely caused by excessive ammonia emissions. However, the factor of 2 high bias for the simulated annual mean nitrate concentration relative to the observation is not apparent for the subset of western sites alone (slope = 1.09 - 1.34).

Figure 8 shows the simulated Gas Ratio (GR) defined as

$$GR = \frac{[NH_3^T] - 2[SO_4^{2-}]}{[HNO_3^T]}, \quad (1)$$

where concentrations are in molar units, $[NH_3^T]$ is the sum of gas-phase ammonia and aerosol-phase ammonium concentrations, $[HNO_3^T]$ is the total inorganic nitrate concentration (sum of gas-phase nitric acid and aerosol nitrate), and $[SO_4^{2-}]$ is the sulfate concentration. The value of GR diagnoses the limiting reactant (ammonia or nitric acid) for the formation of ammonium nitrate [*Ansari and Pandis*, 1998]. We find that ammonium nitrate formation in most of North America is generally limited by the supply of ammonia (GR < 1). Exceptions are the upper Midwest and Mexico, where GR > 1 indicates that nitrate formation is limited by the supply of nitric acid. Negative GR values, indicating an acidic sulfate aerosol, are mainly confined to the oceans. This neutralization of the aerosol is further illustrated in Figure 9, which compares the simulated (top) vs. observed (bottom) acidity of aerosols at CASTNET sites for different seasons as the regression slopes of the $[NH_4^+]$ vs. $(2[SO_4^{2-}] + [NO_3^-])$ scatterplots. The observations show an annual mean slope of 0.84, i.e., within 16% of neutralization, and varying from 0.79 in summer to 0.93 in winter. The higher acidity in summer reflects the faster sulfate formation. The model is slightly less acidic than the observations on an annual mean basis (slope 0.90) but has the same seasonal trend (0.84 in summer, 0.98 in winter). The weaker apparent model acidity reflects at least in part the association of sulfate and nitrate in the observations with other alkaline cations (e.g., Ca^{2+}) not included in the model.

3.2 Europe

Figure 10 compares model results to annual and seasonal mean observations of sulfate, nitrate, and ammonium at 93 European EMEP sites in 1998. Sulfate in the model reproduces the variability in the observations (R^2 = 0.60 - 0.78) with no systematic bias (the regression slope for the annual mean data is 0.98). There is a slight underestimate in winter (slope = 0.84), possibly caused by seasalt sulfate included in the EMEP observations but not in the model [*Chin et al.*, 2000b; *Gong et al.*, 2002]. Simulated nitrate and ammonium compare less well with observations, with 40-60% overestimates of ammonium in summer and fall, likely due to excessive ammonia emission.

3.3 Asia

We evaluate our simulation of Asian outflow by using sulfate observations from the TRACE-P aircraft mission conducted off the Asian Pacific Rim from bases in Hong Kong and Japan during February-April 2001 [*Jacob et al.*, 2003]. Previous applications of GEOS-CHEM to simulation of TRACE-P observations for ozone, CO, CO_2, CH_4, and nitriles indicate a good simulation of Asian outflow pathways [*Liu et al.*, 2004; *Heald et al.*, 2003; *Palmer et al.*, 2003; *Kiley et al.*, 2003; *Suntharalingam et al.*, 2003; *Xiao et al.*, 2003; *Li et al.*, 2003]. Bulk aerosol measurements from the DC-8 aircraft indicate that 40% of non–seasalt sulfate (nss-SO_4^{2-}) on average was incorporated in dust particles [*Jordan et al.*, 2003]. Figure 11 compares mean vertical profiles of simulated and observed nss-SO_4^{2-} concentrations for the ensemble of DC-8 flights over the NW Pacific west of 177°E and at 30°-45°N latitude [*Liu et al.*, 2003]. Monthly mean concentrations in the model were sampled along the flight tracks. The observations shows strong outflow in the 0-5 km column. The model also shows an enhancement in that column but is lower than observations, by up to a factor of two. Targeted sampling of Asian outflow in the observations [*Jacob et al.*, 2003] could account for part of this discrepancy. In any case, the comparison argues that the model does not overestimate the outflow of sulfate from Asia. This is an important point for our later discussion of transpacific pollution influence.

4. **Background aerosol in the United States: transboundary pollution influence**

We now apply our model simulations to quantify background sulfate-nitrate-ammonium aerosol concentrations in the United States, and to separate the contributions to this background from natural sources and from transboundary pollution. We use for this purpose a sequence of four sensitivity simulations excluding anthropogenic emissions of both oxidant and aerosol precursors (1) globally, (2) in the United States, (3) in North America, and (4) in Asia. The results are summarized in Table 2 as annual averages for the western (west of 95°W) and eastern United States. The EPA Regional Haze Rule document [*EPA*, 2003a] recommends "default average natural concentrations of ammonium sulfate and ammonium nitrate" in these two regions to serve as 2064 endpoints for application of the Rule. For purpose of comparison we present our model results for sulfate and nitrate in Table 2 as those of the corresponding ammonium salts; in the model, almost all of the sulfate and nitrate are indeed associated with ammonium (Figure 9). Model results for the sum of natural and transboundary pollution contributions do not exactly add up to the independently calculated background concentrations because of chemical nonlinearities [*Chin and Jacob*, 1996; *West et al.*, 1999].

Our 2001 base simulation yields annual average concentrations of ammonium sulfate and ammonium nitrate of 1.52 and 1.53 μg m^{-3}, respectively, for the western United States and 4.11 and 3.26 μg m^{-3}, respectively, for the eastern United States. We use the sensitivity simulation with anthropogenic emissions shut off globally to estimate natural concentrations. They are 0.11 μg m^{-3} ammonium sulfate and 0.03 μg m^{-3} ammonium nitrate for both the western and eastern United States. Our estimate of natural concentrations for ammonium sulfate is consistent with the EPA default value (0.12 μg

m^{-3}) in the west but is factor of 2 lower than that (0.23 μg m^{-3}) in the east. Oxidation of DMS is the major natural source of sulfate in the United States in the model. Our estimate of natural ammonium nitrate is three times lower than the EPA default value (0.1 μg m^{-3}); it is not clear how that default value was obtained.

Let us now examine the background concentrations from the sensitivity simulation including anthropogenic emissions only outside of the United States. The mean annual concentrations of background ammonium sulfate and nitrate in surface air over the United States are 0.43 and 0.27 μg m^{-3} for the west and 0.38 and 0.37 μg m^{-3} for the east. These values are several-fold higher than the natural concentrations because of the influence from transboundary pollution. Background sulfate is slightly higher in the west than the east, because of Asian pollution influence as discussed further below, while background nitrate is higher in the east because of Canadian pollution influence.

We thus find that transboundary pollution influence dominates over natural sources in contributing to sulfate and nitrate background concentrations in the United States. Transboundary transport of anthropogenic emissions from Canada and Mexico is most important for nitrate, but for sulfate transpacific transport of Asian pollution is of comparable importance (Table 2). Remarkably, we find that this transpacific pollution source accounts for 30% of the sulfate aerosol background in the United States.

Figure 12a shows the global distribution of Asian pollution influence on sulfate-nitrate-ammonium aerosol concentrations in surface air, as determined by difference between the standard simulation and the sensitivity simulation with anthropogenic Asian emissions shut off. Transpacific transport from Asia to the United States mostly involves lifting of Asian air to the free troposphere by wet processes (convection, warm conveyor belts), followed by rapid advection in the westerlies and subsidence over the United States, generally behind cold fronts. Ammonium aerosol as well as gas-phase ammonia are scavenged in this wet lifting and we see therefore that transpacific transport of ammonium is negligible. In contrast, significant transpacific transport of sulfate can occur as SO_2 partly escapes scavenging during lifting [*Mari et al.*, 2000; *Koike et al.*, 2003; *Tu et al.*, 2003]. Subsidence over the United States takes place mainly in the downwelling regions of the west and east, less in the upwelling region in the center of the country. Ammonium nitrate as we have seen is largely determined by difference between the total ammonium [NH_3^T] and the sulfate concentration, and the preferential export of sulfate relative to ammonium from Asia leads to a slight negative effect of Asian pollution on nitrate concentrations in the United States.

It is of interest to compare the transpacific influence of Asian pollution on North America to the transatlantic influence of North American pollution on Europe. Figure 12b shows the latter as the difference between the standard simulation and the sensitivity simulation with anthropogenic emissions in North America shut off. We find a sulfate enhancement > 0.1 μg m^{-3} in surface air in Western Europe and northern Africa, comparable in magnitude to Asian pollution influence over North America. As in the case of Asian pollution, we find that export of ammonium from North American pollution is far less efficient than for sulfate, resulting in small negative influences on nitrate aerosol concentrations over Europe and Asia.

We show also in Table 2 the natural and background concentrations of elemental carbon (EC) and organic carbon mass (OMC) from our previous work [*Park et al.*, 2003]. In that work we derived optimized estimates of individual EC and OMC sources by fitting model results to observations from the IMPROVE sites. We concluded that the EPA default natural estimates were a factor of 3 too low in the west due to underestimate of wildfire influences. Our values for the east were more consistent with EPA. In contrast to sulfate and nitrate, transboundary transport of anthropogenic carbonaceous aerosols is insignificant relative to the large natural influences from wildfires and vegetation. We further find that transpacific transport of carbonaceous aerosols from Asian pollution is less efficient than for sulfate because of scavenging in the wet lifting processes involved in Asian outflow. The excess of SO_2 over H_2O_2 in the Asian outflow allows part of the sulfur to escape scavenging [*Koike et al.*, 2003; *Tu et al.*, 2003]. This result is consistent with *Jaffe et al.* [2003] who found a larger increase in sulfate concentrations relative to carbonaceous aerosol at three IMPROVE sites in the western United States during a transpacific transport event of Asian pollution.

5. **Policy implications: the Regional Haze Rule**

The U.S. EPA Regional Haze Rule [*U.S. EPA*, 2003a] requires states to develop plans for achieving natural visibility conditions in national parks and other wilderness areas by 2064. Visibility degradation is measured by the deciview index

$$dv = 10 \ln (b_{ext}/10) \, , \qquad (2)$$

where b_{ext} is atmospheric light extinction in units of inverse megameters ($Mm^{-1}=10^{-6}m^{-1}$). In the phase 1 implementation of the Regional Haze Rule, states have to show how they will decrease anthropogenic emissions over the 2004-2018 period in order to achieve a linear trajectory of decreasing deciviews towards the natural visibility endpoint of 2064. A linear decrease in deciviews implies an exponential decrease in aerosol extinction; as a result, and as we will see, the definition of the 2064 endpoint has important implications for determining the level of emission controls required during the 2004-2018 phase 1 implementation.

The EPA Regional Haze Rule document [*U.S. EPA*, 2003a] recommends a simple formula to estimate aerosol extinction by using dry mass concentrations of individual aerosol components (ammonium sulfate, ammonium nitrate, OMC, EC, soil dust, and coarse mass (CM)), as follows:

$$\begin{aligned} b_{ext} &= 3f(RH)[(NH_4)_2SO_4] + 3f(RH)[NH_4NO_3] \\ &+ 4[OMC] + 10[EC] + [soil] + 0.6[CM] + 10 \end{aligned} , \qquad (3)$$

where b_{ext} is in units of Mm^{-1}, aerosol concentrations are in units of $\mu g\ m^{-3}$, and *f(RH)* is a correction factor for hygroscopic growth as a function of relative humidity (RH). The constant of 10 Mm^{-1} describes the scattering by air molecules and is such that an aerosol-free atmosphere would have a deciview index of zero. "Soil" in equation (3) is the fine component of soil dust (diameter < 2.5 μm) and "coarse mass" is the total mass of particles with diameter > 2.5 μm, mostly contributed by dust and sea salt. Recommended values of *f(RH)* for individual wilderness areas are given in the Regional Haze Rule document [*U.S. EPA*, 2003a]. In what follows we use typical *f(RH)* values of 2 and 3 for the west and east, respectively.

Applying equation (3) to aerosol concentrations given in Table 2, and assuming EPA natural default values for fine soil dust (0.5 $\mu g\ m^{-3}$) and coarse mass (3.0 $\mu g\ m^{-3}$), we compute deciview index values for baseline (present-day) conditions and for different definitions of the 2064 natural or background visibility endpoint. We use the results (Table 3) to estimate the implications of our results for phase 1 (2004-2018) implementation of the Regional Haze Rule. Under the EPA Regional Haze Rule, the linear improvement in visibility is to be applied to the 20% most impaired visibility days and at specific locations. Here we use visibility calculated from annual mean aerosol extinctions averaged over the western and eastern United States. Nevertheless, the results serve to illustrate the sensitivity of the required 2004-2018 emission controls to the choice of 2064 endpoint.

Table 3 gives a baseline (current) visibility degradation of 14 and 23 deciviews for the western and the eastern United States, respectively. The natural visibility degradation is 6.3 and 6.2 deciviews, respectively. Organic aerosols are the dominant contributors to natural visibility degradation. Our estimate for natural visibility degradation as expressed in deciviews is 37% higher in the west and 17% lower in the east than the values computed using the natural default aerosol concentrations recommended by EPA (4.6 and 7.5 deciviews). We have previously argued in *Park et al.* [2003] that the EPA natural default concentrations underestimate the influence of wildfires in the west.

Figure 13 shows the trajectories of linear visibility improvement towards a 2064 endpoint of natural visibility defined either from our results (dashed line) or from the EPA defaults (dotted line). Following these trajectories, we find that visibility degradation during the 2004-2018 phase 1 implementation of the Regional Haze Rule should be reduced by 1.8 deciviews (west) and 3.9 deciviews (east) if our estimate of the 2064 natural visibility endpoint is used, and by 2.2 deciviews (west) and 3.6 deciviews (east) if the EPA default endpoint is used. The corresponding reductions in light extinction are 6.7 Mm^{-1} (west) and 32.2 Mm^{-1} (east) if our estimate of the 2064 natural visibility endpoint is used, and 8.1 Mm^{-1} (west) and 30.1 Mm^{-1} (east) if the EPA default endpoint is used.

Let us now estimate the required percentage reductions in U.S. anthropogenic emissions needed to achieve such improvements in light extinction. We assume a linear correspondence between aerosol extinction, aerosol concentrations, and emissions. The current aerosol extinction from U.S. anthropogenic emissions can be calculated from the data in Table 2 by subtracting the background from the baseline aerosol concentrations, and applying equation (3). We obtain values of 18.1 Mm^{-1} in the west and 73 Mm^{-1} in the east. The resulting percentage decreases of U.S. anthropogenic emissions over 2004-2018 are shown in Figure 13. They are 37% and 44% for the western and eastern United States, respectively, using our natural visibility endpoint, and 44% and 41%, respectively, using the EPA natural visibility endpoint.

These differences are significant, but looking beyond the 2018 horizon exposes a more fundamental problem with the Regional Haze Rule. Continued linear decrease towards a 2064 natural visibility endpoint would require total shutdown of U.S. anthropogenic emissions by 2041-2049 (west) or 2053-2058 (east), as shown in Figure 13. Because of transboundary pollution (assumed here to be unchanged in the future), natural visibility cannot be achieved even with total suppression of U.S. anthropogenic emissions. It will be therefore necessary to either impose emission controls on an international level or to amend the 2064 endpoint to allow for uncontrollable transboundary pollution influences. Such an amendment should define the 2064 endpoint as a background rather than natural visibility. One would then have to make estimates of future trends in foreign emissions.

However, amendment of the Regional Haze Rule to target a background visibility endpoint has major implications for phase 1 (2004-2018) emission controls in the west. Using the background deciview values in Table 3 as 2064 endpoint, the required 2004-2018 decrease in visibility degradation is 1.4 deciviews (west) and 3.3 deciviews (east). The corresponding percentage decrease of U.S. anthropogenic emissions in the west is 29%, much lower than 37% if a natural visibility endpoint from our results is used or 44% if the natural visibility endpoint from the EPA defaults is used.

6. **Conclusions**

We used a global 3-D coupled oxidant-aerosol model (GEOS-CHEM) to quantify natural and transboundary pollution influences on sulfate-nitrate-ammonium aerosol concentrations in the United States. The U.S. EPA Regional Haze Rule requires immediate action to improve visibility in U.S. national parks and other wilderness areas along a linear trajectory towards an endpoint of "natural visibility conditions" by 2064. We need to better quantify the natural aerosol concentrations defining this natural visibility, and to determine if transboundary transport of pollution not amenable to domestic emission controls elevates background aerosol concentrations in the United States significantly above the natural values. If they do, then the Regional Haze Rule must either involve international emission controls or be amended to an endpoint of "background" as opposed to "natural" visibility. "Background" is defined here following *EPA* [2003b] as the aerosol concentrations that would be present in the absence of U.S. anthropogenic emissions, but allowing for contributions from transboundary pollution.

We conducted full-year simulations for 1998 and 2001. Results were evaluated with observations from surface networks in the United States and Europe (IMPROVE, CASTNET, NADP, EMEP) and with Asian outflow observations from the NASA TRACE-P aircraft mission over the northwest Pacific. The model reproduces well the spatial pattern and variability of sulfate observations in the United States and Europe across all seasons, with no systematic biases. Comparison with the TRACE-P observations indicates that Asian outflow of sulfate is if anything underestimated. Nitrate and ammonium aerosol concentrations in the model are highly correlated with observations but are too high in summer and fall, a problem that we attribute to seasonal overestimate of ammonia emissions [*Gilliland et al.*, 2003]. We find that the availability of ammonia limits the formation of ammonium nitrate in most of North America. The aerosol is typically 80-100% neutralized, both in the model and in the observations, with maximum acidity in summer.

We used a sequence of sensitivity simulations to quantify background sulfate-nitrate-ammonium aerosol concentrations in the United States, and to separate the contributions to this background from natural sources and from transboundary pollution. Our 2001 base simulation yields annual average concentrations of ammonium sulfate and ammonium nitrate of 1.52 and 1.53 $\mu g\ m^{-3}$, respectively, for the western United States and 4.11 and 3.26 $\mu g\ m^{-3}$, respectively, for the eastern United States. Our best estimates of mean annual natural concentrations are 0.11 $\mu g\ m^{-3}$ ammonium sulfate and 0.03 $\mu g\ m^{-3}$ ammonium nitrate for both the western and eastern United States. Our values are consistent with or lower than the default values recommended by EPA for natural visibility calculations in the context of the Regional Haze Rule.

Our best estimates of background concentrations for ammonium sulfate and ammonium nitrate are 0.43 and 0.27 μg m^{-3} for the west and 0.38 and 0.37 μg m^{-3} for the east. These values are considerably higher than the natural concentrations, pointing to the dominance of transboundary pollution in defining the background. Transpacific transport of Asian pollution is of comparable importance to transport from Canada and Mexico in contributing to the background sulfate enhancement over the United States. A significant enhancement of sulfate relative to other aerosols in the Asian outflow can occur as SO_2 partly escapes scavenging during wet lifting processes. In the case of ammonium nitrate, the transboundary pollution enhancement is mostly from Canada, and transpacific Asian pollution actually causes a slight depression (less than 0.1 μg m^{-3}) due to the added sulfate.

We assessed the implications of our results for implementation of the Regional Haze Rule. For this purpose we used our model to define the linear trend of visibility from present (2004) to natural or background (2064) conditions. We found that transboundary pollution prevents natural visibility from being achieved even with total suppression of U.S. anthropogenic emissions, implying the need for either international emission controls or for amendment of the 2064 endpoint to allow for uncontrollable transboundary pollution influences. The latter would require some estimates of future trends in transboundary pollution influences but these have large uncertainties. Projections by *IPCC* [2001] for 2060 anthropogenic sulfur emissions from Asia range from 30% to 160% of present-day levels depending on the socioeconomic scenario. Consideration of a background rather than natural visibility 2064 endpoint would have immediate implications for phase 1 implementation (2004-2018) of the Regional Haze Rule. It would imply, at least in the west, a significantly slower schedule of U.S. anthropogenic emission reductions.

Our results are only a first attempt to quantify natural and transboundary pollution influences in the United States using a global 3-D model analysis. In future work we plan to examine in more detail the observational constraints on aerosol background concentrations in the United States, including site-by-site analysis and frequency distributions of aerosol concentrations. Specification of natural and background aerosol concentrations for regulatory purposes will require formal uncertainty bounds to be placed on model estimates, and again this will require more extensive evaluation with observations as well as higher-resolution simulations with a nested regional model.

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Figures Captions

Figure 1. Monthly ammonia emissions in the contiguous United States. The values used in this work, broken down by source type (left bars), are compared to the values reported by *Gilliland et al.* [2003] (right bars) from inverse modeling of eight months of precipitation NH_4^+ data.

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Figure 9. Scatterplot of seasonal mean $[NH_4^+]$ vs. $(2[SO_4^{2-}]+[NO_3^-])$ at CASTNET sites in 2001, in the GEOS-CHEM model (top) and in observations (bottom). The reduced-major–axis regression slopes (given on the Figure) indicate the degree of acid neutralization.

Figure 10. Scatterplot of simulated versus observed sulfate (left), nitrate (middle) and ammonium (right) concentrations at 93 European EMEP sites. Values are annual means (top panels) and seasonal means for 1998. Thick solid lines are reduced major axis

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Figure 12a. Enhancements of sulfate-nitrate-ammonium aerosol concentrations in surface air due to anthropogenic emissions from Asia. Values are annual means for 2001 and were obtained by difference between the standard model simulation and a sensitivity simulation with Asian anthropogenic sources shut off.

Figure 12b. Same as in Figure 12a but for anthropogenic emissions from North America.

Figure 13. Illustrative example of required visibility improvements (top) and domestic emission reductions (bottom) over the 2004-2064 period for the western and the eastern United States (separated at 95^{o}W) under the EPA Regional Haze Rule [*U.S. EPA*, 2003a]. The visibility endpoints are as given in Table 3. The required percentage decrease in U.S. anthropogenic emissions corresponding to a given visibility improvement is computed by assuming a linear correspondence between aerosol extinction and emissions. Results are shown for different choices for the 2064 endpoint: (1) EPA natural default visibility (dotted lines), (2) our estimate of natural visibility (dashed lines), and (3) our estimate of background visibility (solid lines). Background includes contributions from both natural and transbounary pollution sources. Year 2018 (thin vertical line) is the target date for phase 1 implementation of the Regional Haze Rule.

Tables

Table 1a. Sulfur emissions for 2001 (Tg S yr^{-1}).

Source type	Globe	Contiguous United States
Total	78	8.3
Anthropogenic source total	**57**	**8.3**
Industrial activity	56	8.3
Biofuel use	0.27	< 0.01
Aircraft	0.07	0.02
Natural source total	**21**	**0.01**
Ocean (DMS)	15	0
Volcanoes	4.8	0
Biomass burning	1.3	0.01

Table 1b. Ammonia emissions for 2001 (Tg N yr^{-1}).

Source type	Globe	Contiguous United States
Total	55	2.8
Anthropogenic source total	**35**	**2.2**
Domesticated animals	21	1.3
Fertilizers	9.0	0.49
Human bodies	2.6	0.13
Biofuel use	1.6	0.18
Industry	0.2	0.03
Fossil fuel use	0.1	0.06
Natural source total	**20**	**0.59**
Ocean	8.2	0
Biomass burning	5.9	0.04
Crop	3.5	0.44
Soil	2.4	0.1
Wild animals	0.1	0.01

Table 1c. NO_x emissions for 2001 ($Tg\ N\ yr^{-1}$).

Source type	Globe	Contiguous United States
Total	43	7.4
Anthropogenic source total	**27**	**6.8**
Fossil fuel use	24	6.7
Biofuel use	2.2	0.02
Fertilizer	0.47	0.07
Natural source total	**17**	**0.66**
Biomass burning	6.5	0.05
Natural soil	5.3	0.36
Lightning	4.7	0.25

Table 2. Background aerosol concentrations ($\mu g\ m^{-3}$) in the United States[a].

	Ammonium sulfate		Ammonium nitrate		Elemental carbon		Organic carbon mass	
	West	East	West	East	West	East	West	East
Baseline (2001)	1.52	4.11	1.53	3.26	0.27	0.66	1.77	3.07
Background	0.43	0.38	0.27	0.37	0.08	0.06	1.30	1.22
Natural	0.11	0.11	0.03	0.03	0.06	0.04	1.25	1.17
Transboundary pollution	0.28	0.26	0.18	0.23	0.02	0.02	0.05	0.05
Canada and Mexico	0.15	0.14	0.2	0.25	0.02	0.02	0.04	0.04
Asia	0.13	0.12	-0.02	-0.02	<0.01	<0.01	0.01	<0.01
EPA natural defaults[b]	0.12	0.23	0.1	0.1	0.02	0.02	0.47	1.40

[a]Values are annual and spatial means from the standard 2001 simulation (baseline) and from the sensitivity simulations described in section 2.1. Partitioning between west and east is at 95°W. Background and natural concentrations are obtained from the sensitivity simulations without U.S. and global anthropogenic emissions, respectively. Transboundary pollution influences from Canada and Mexico are determined by difference between two sensitivity simulations with anthropogenic emissions shut off in the United States versus in all of North America. Transpacific pollution influences from Asia are determined by difference between the standard simulation and the sensitivity simulation with anthropogenic sources shut off in Asia. Results for elemental carbon (EC) and organic carbon mass (OMC) are from our previous work [*Park et al.*, 2003] in a simulation using climatological emissions from wildfires.

[b]"Default average natural concentrations" recommended by *U.S. EPA* [2003a] for estimating natural visibility conditions as 2064 endpoint in the application of the EPA Regional Haze Rule.

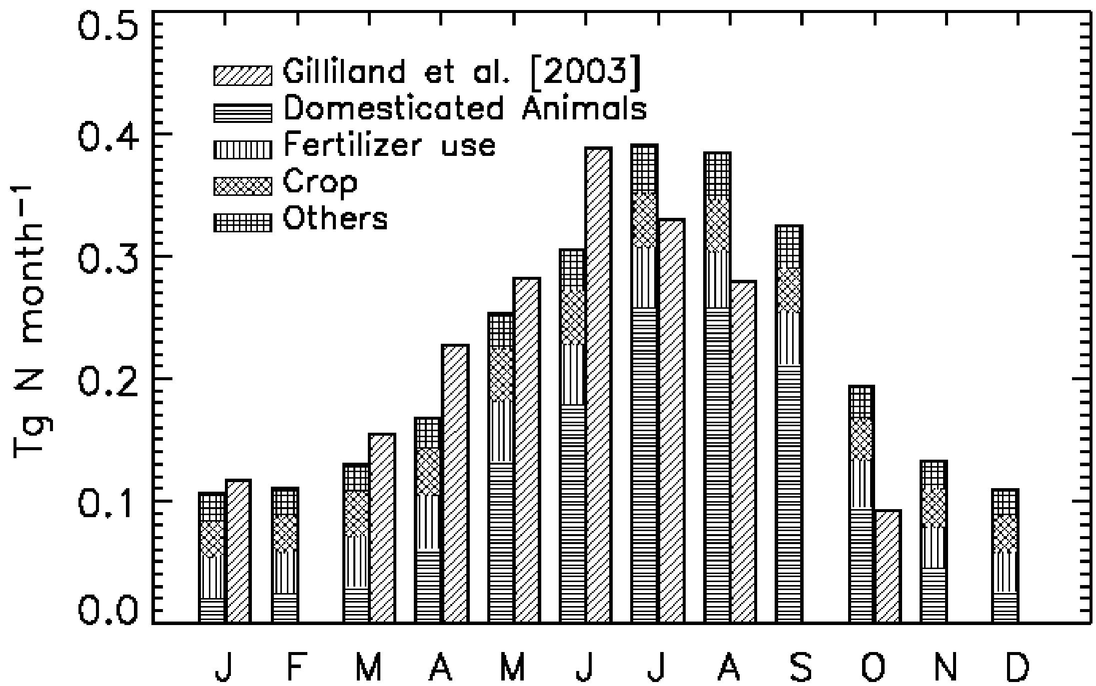
Table 3. Visibility degradation (deciviews) in the United States[a].

	West	East
Baseline (2001)	14	23
Background[b]	8.1	9.0
Natural		
This work	6.3	6.2
EPA default	4.6	7.5

[a]Visibility degradation in deciviews (equation (2)) calculated from mean annual aerosol extinction as given by equation (3). Aerosol concentrations for use in equation (3) are from Table 2, with in addition EPA default natural values for soil (0.5 $\mu g\ m^{-3}$) and coarse mass (CM) (3.0 $\mu g\ m^{-3}$). Values of *f(RH)* in equation (3) are 2 in the west and 3 in the east.

[b]Including contributions to visibility degradation from both natural and transboundary pollution sources.

Figures



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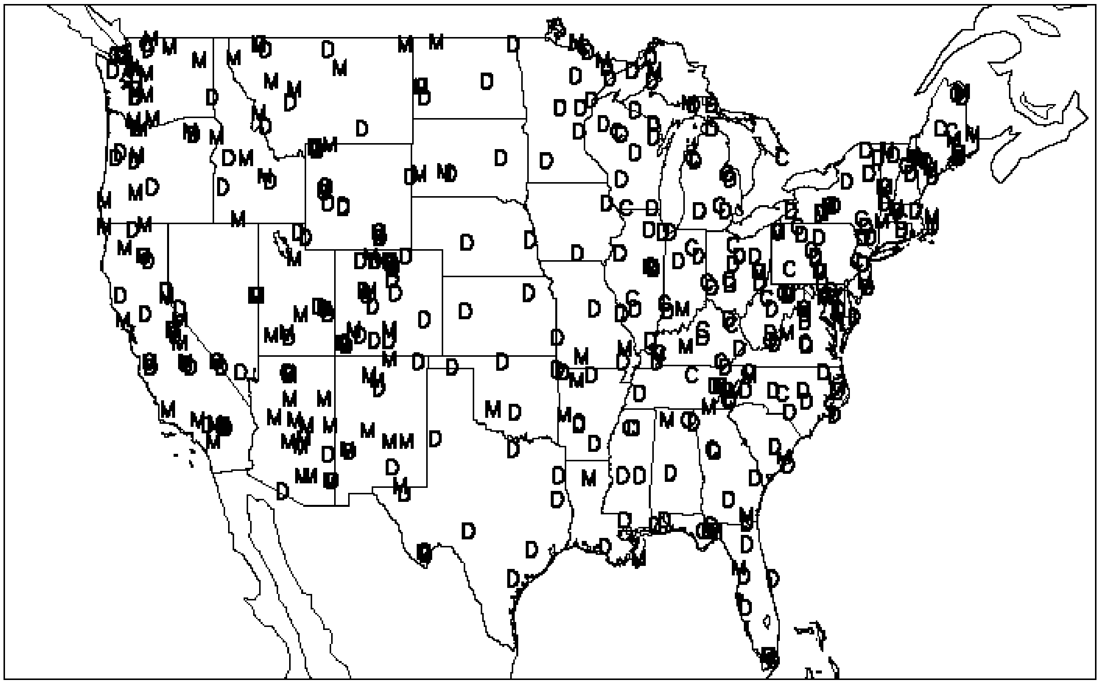

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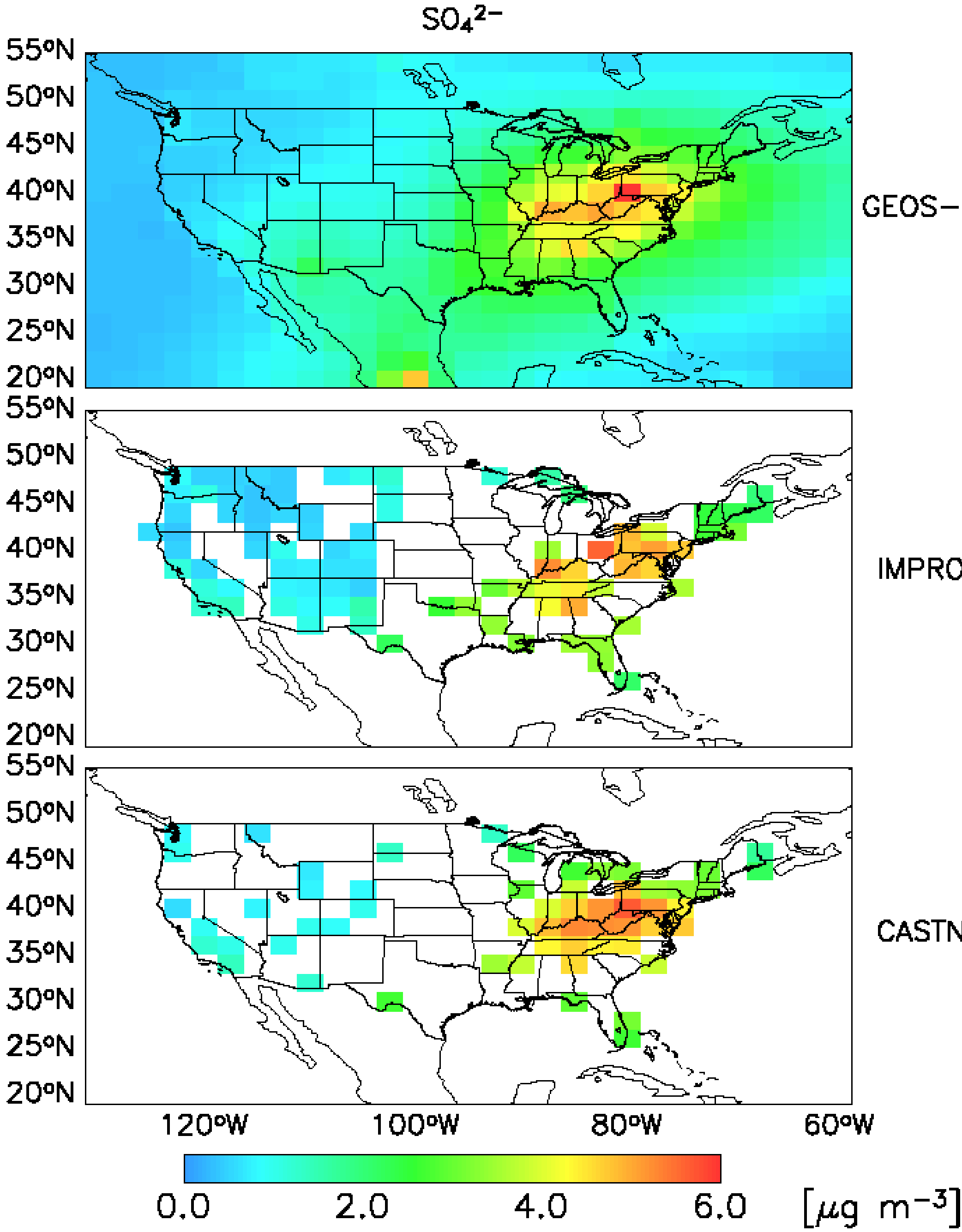

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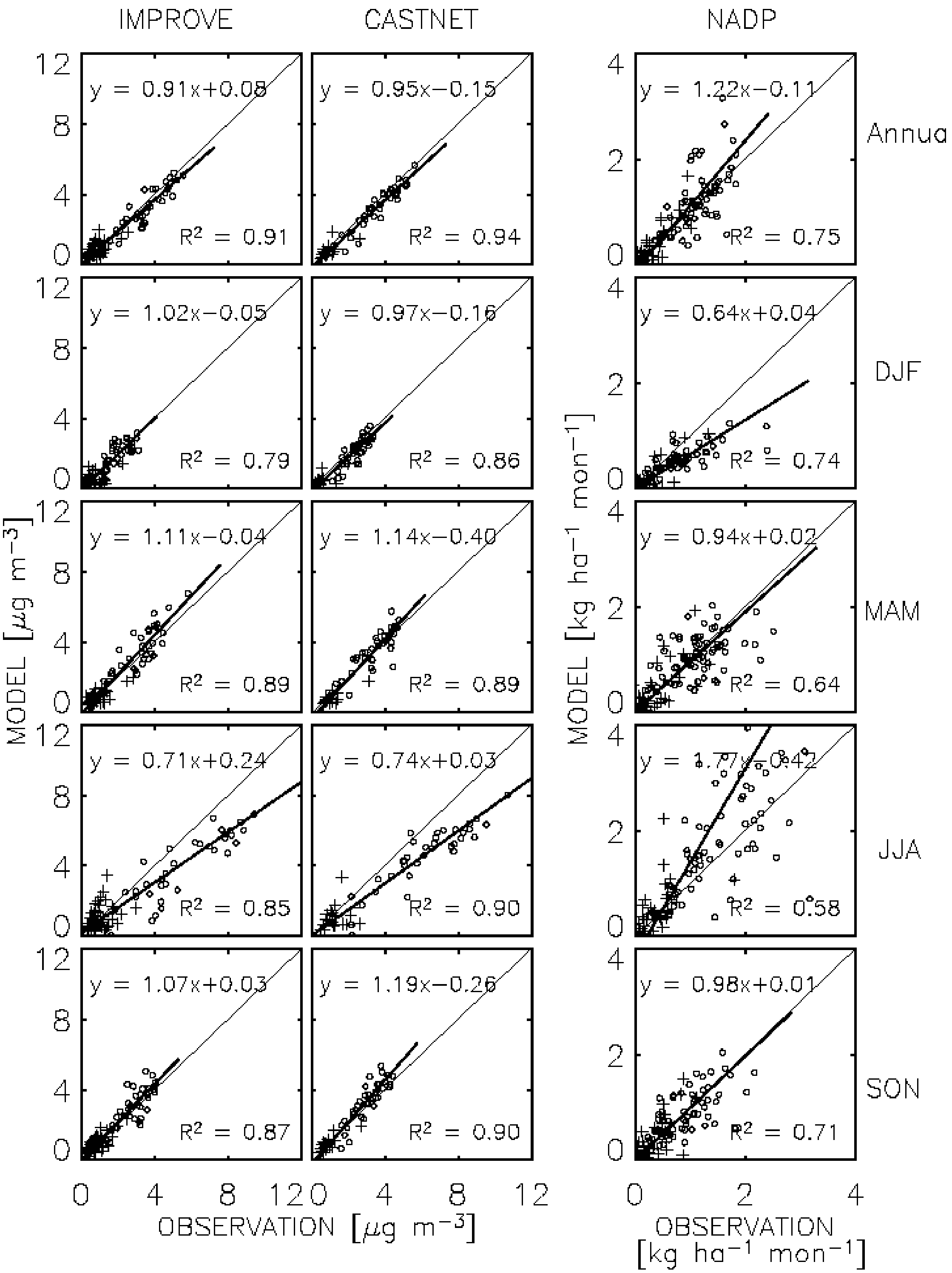

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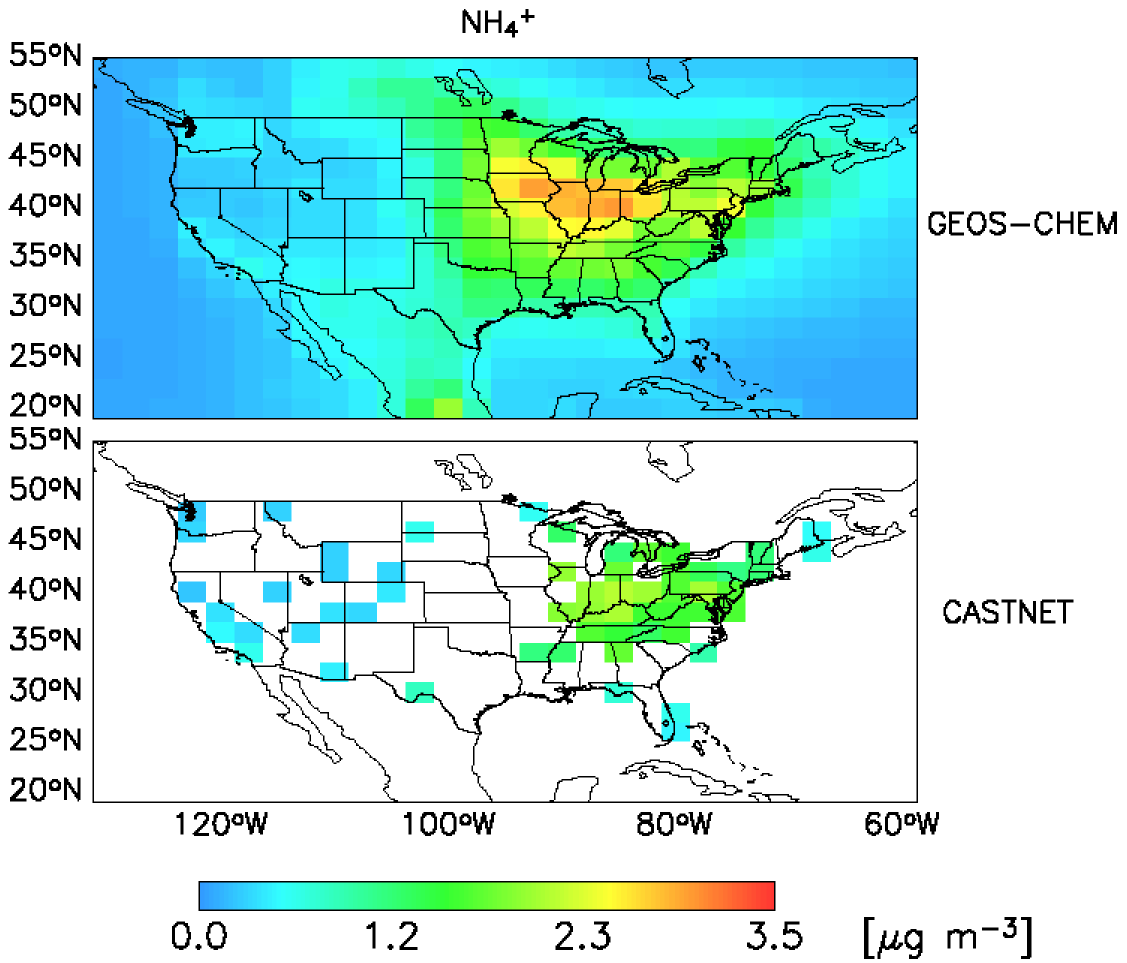

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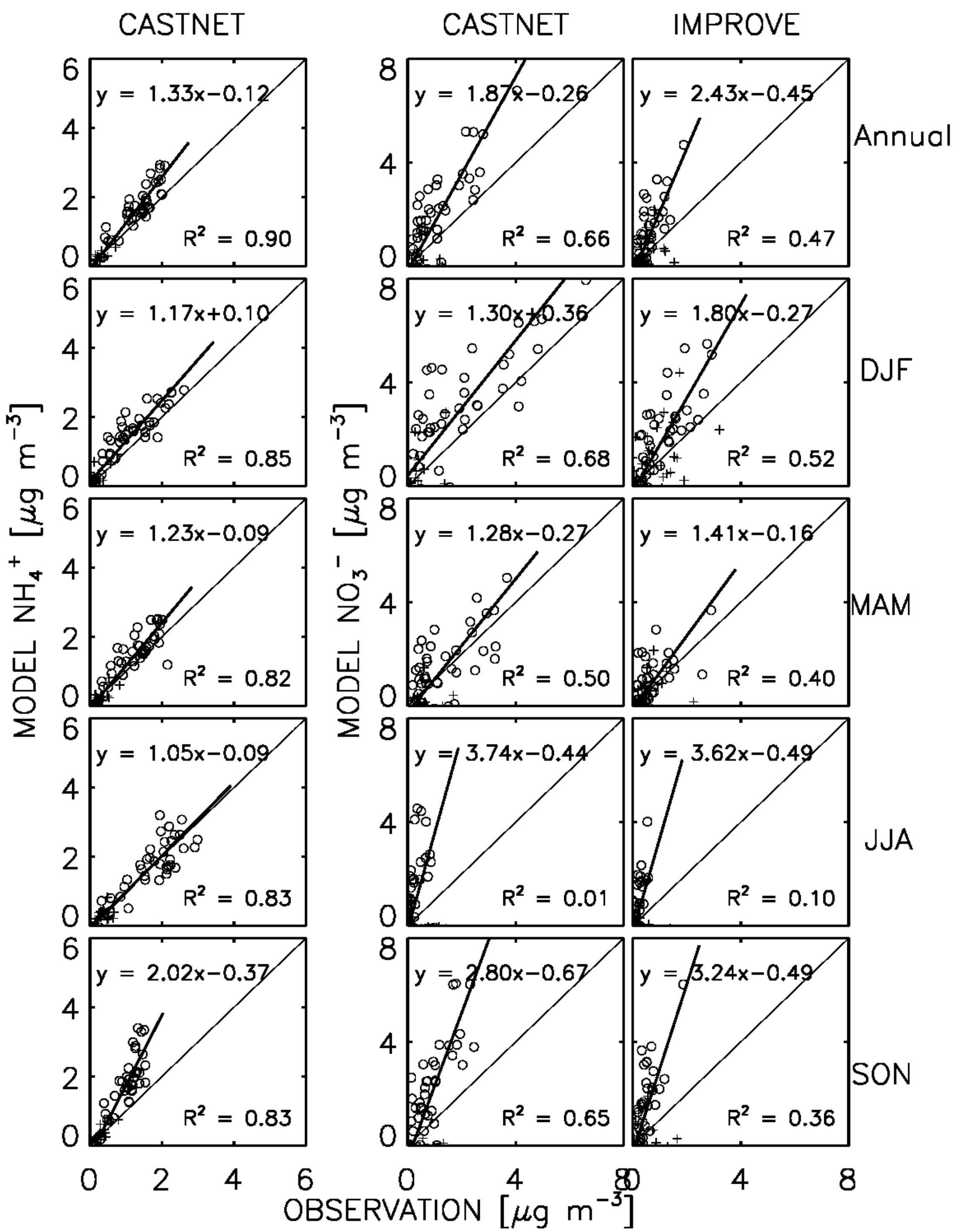

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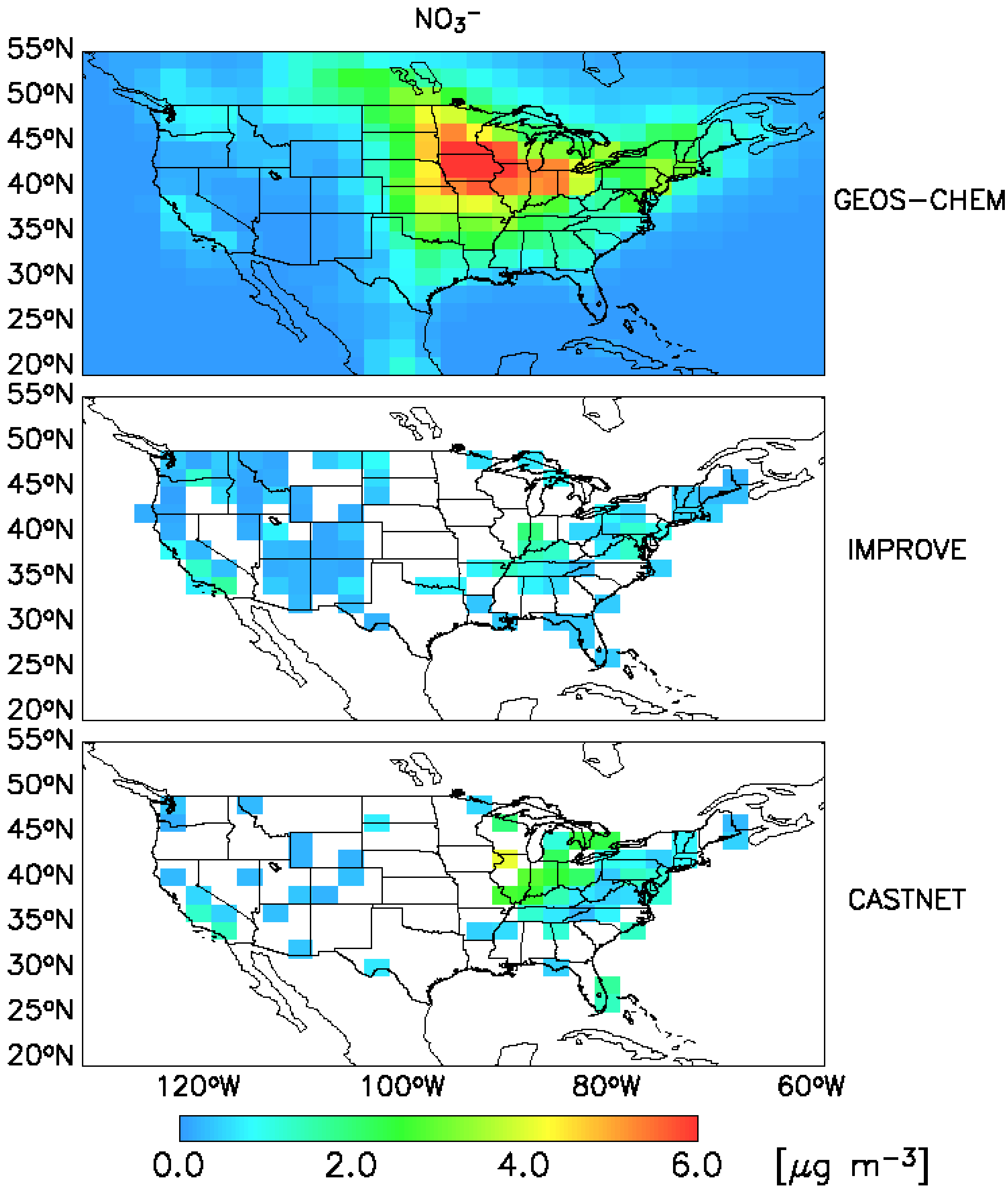

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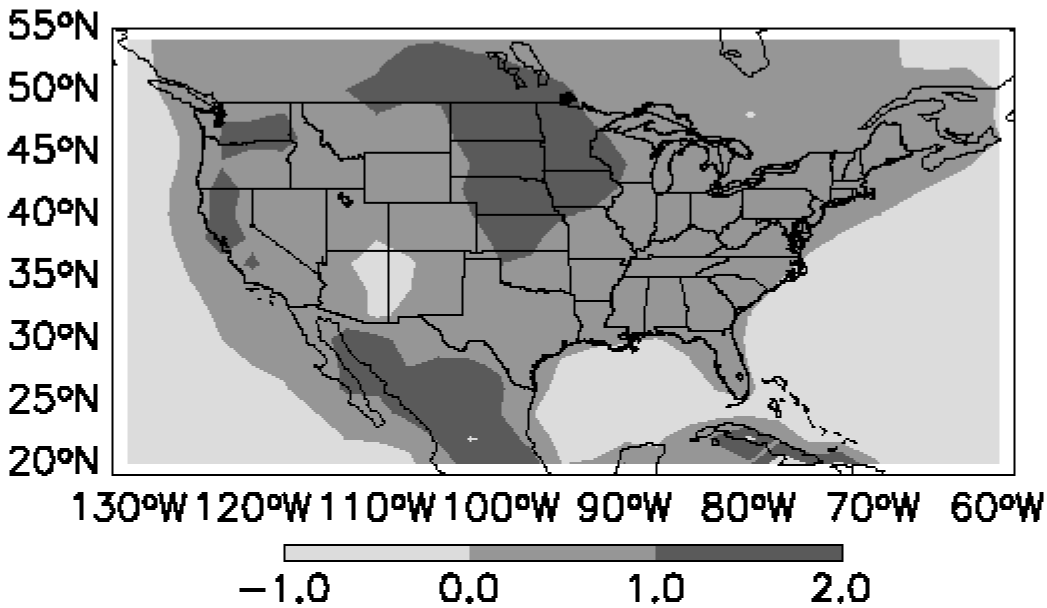

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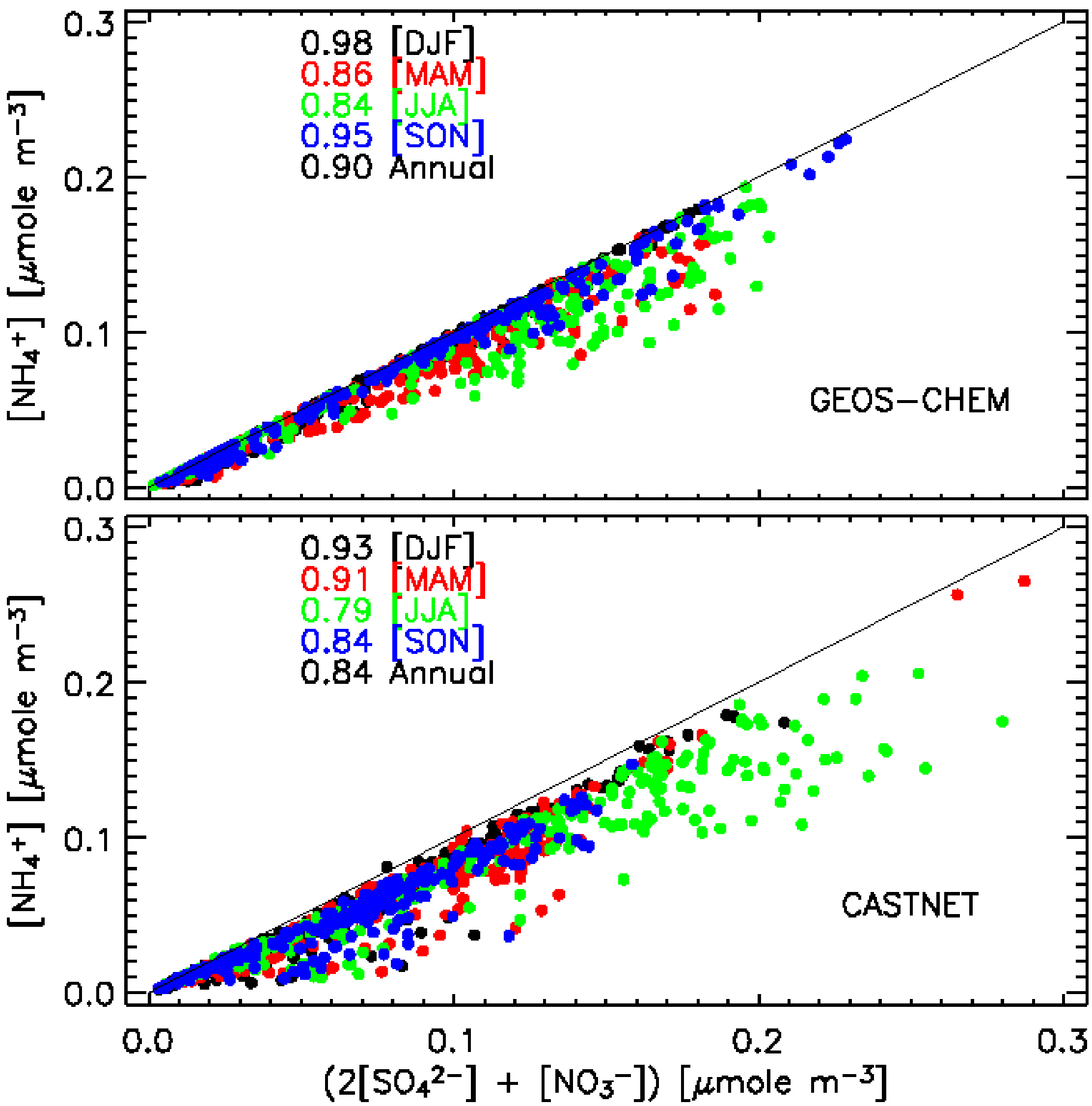

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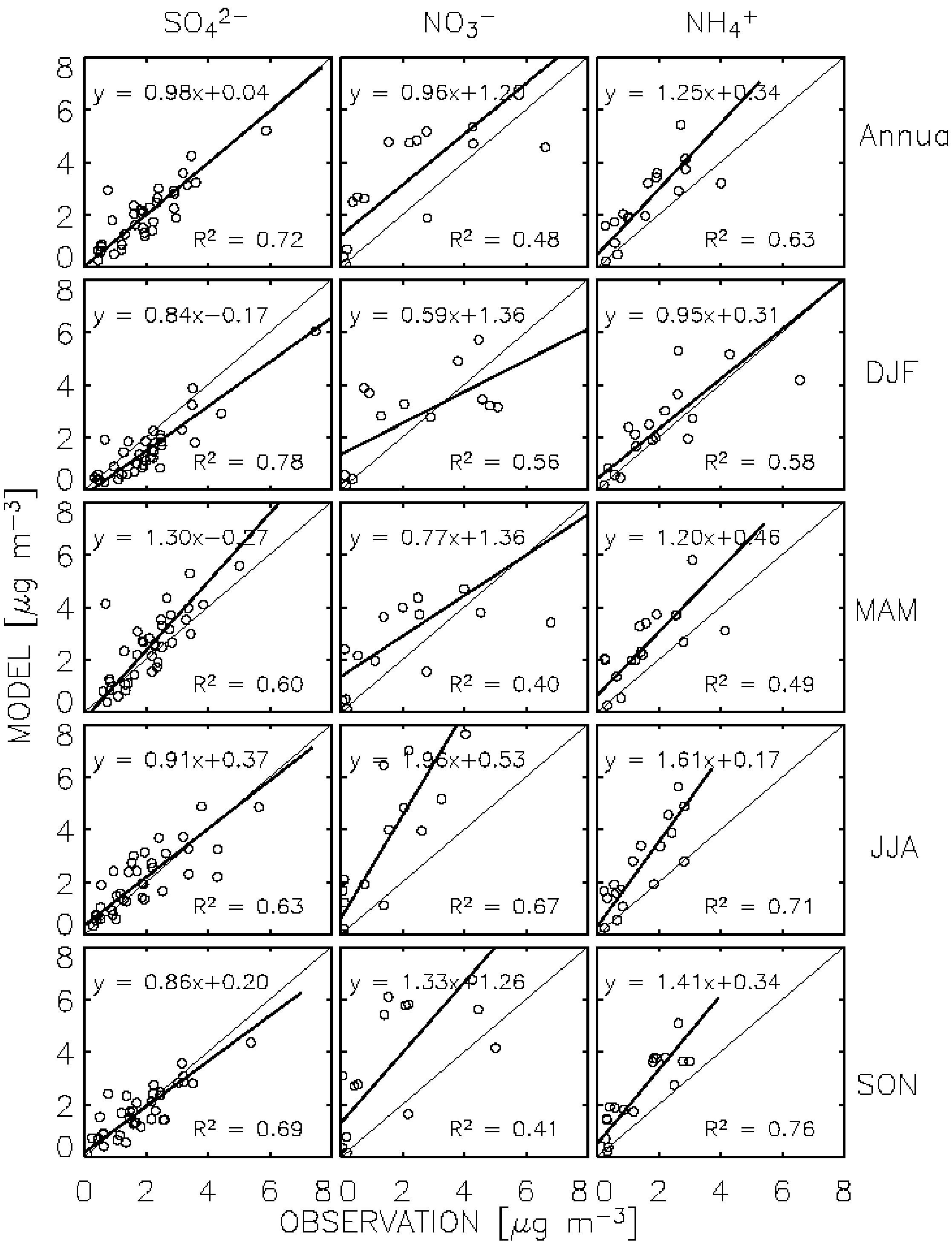

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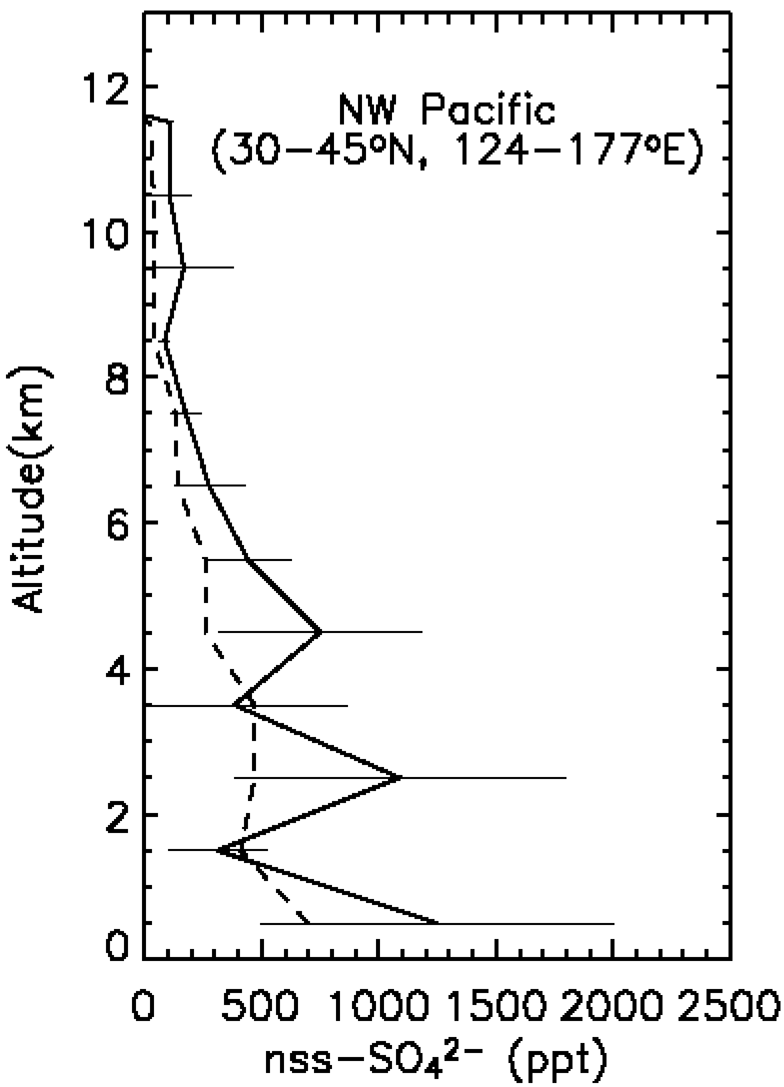

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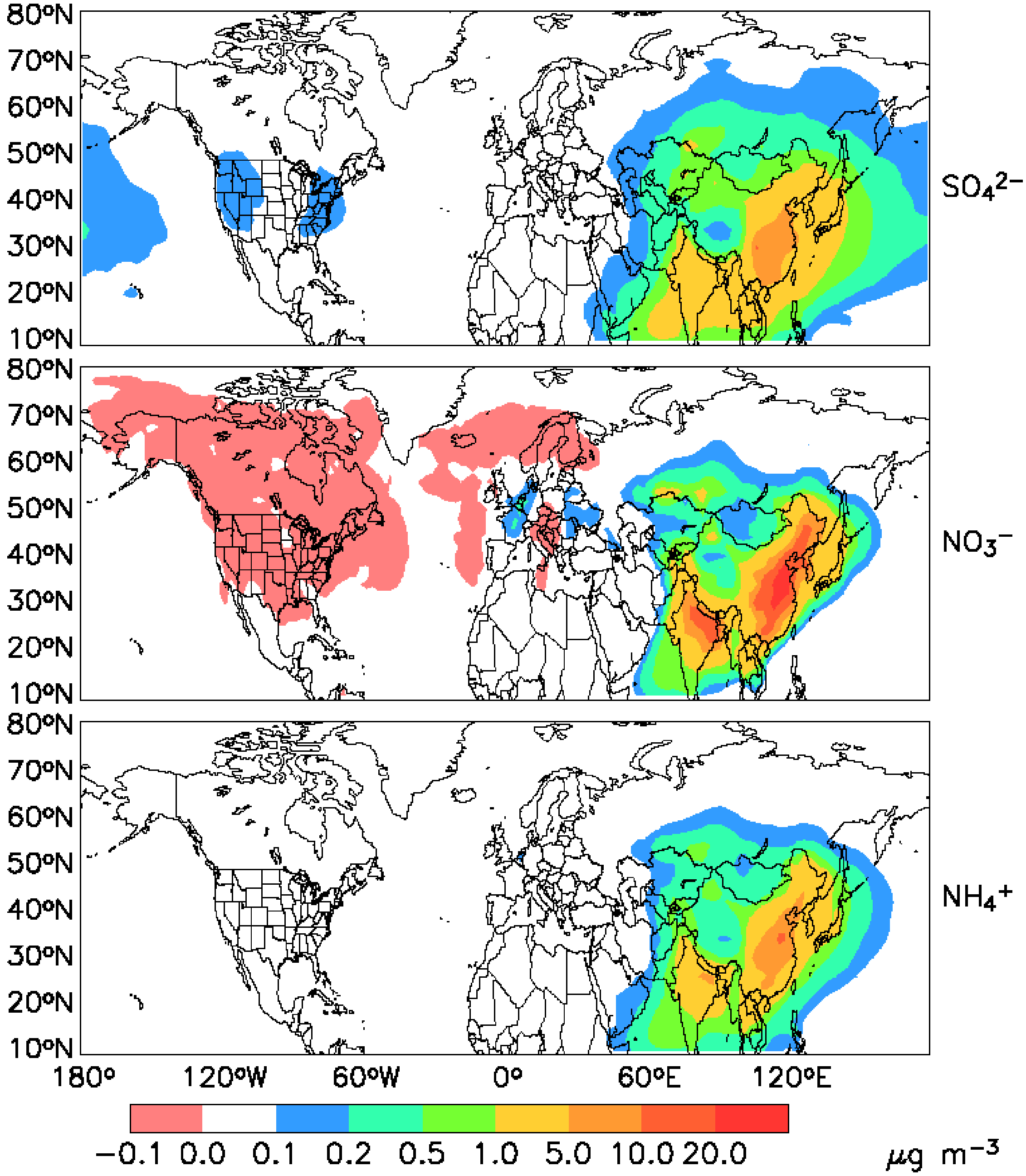

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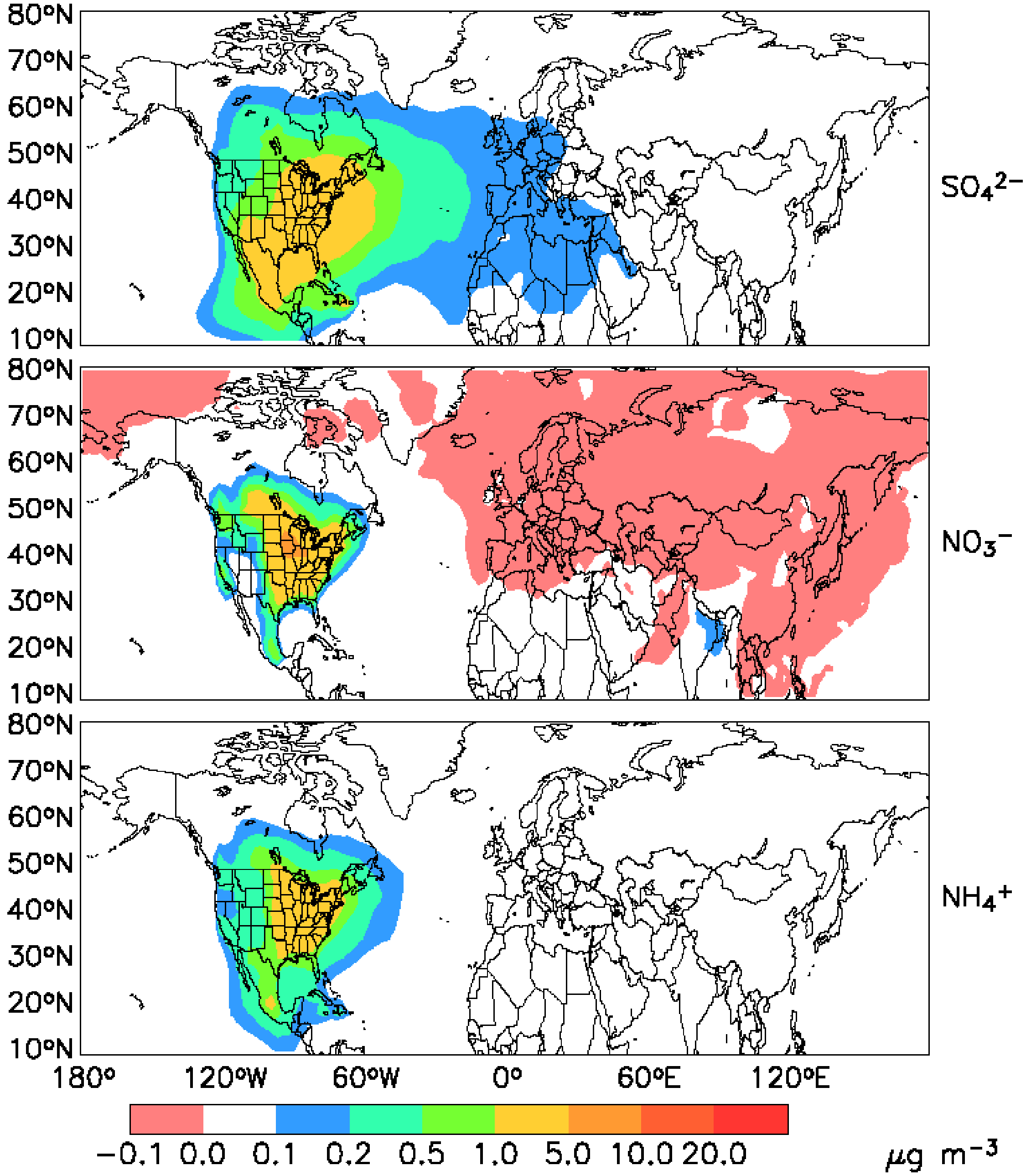

Figure 12b. Same as in Figure 12a but for anthropogenic emissions from North America.

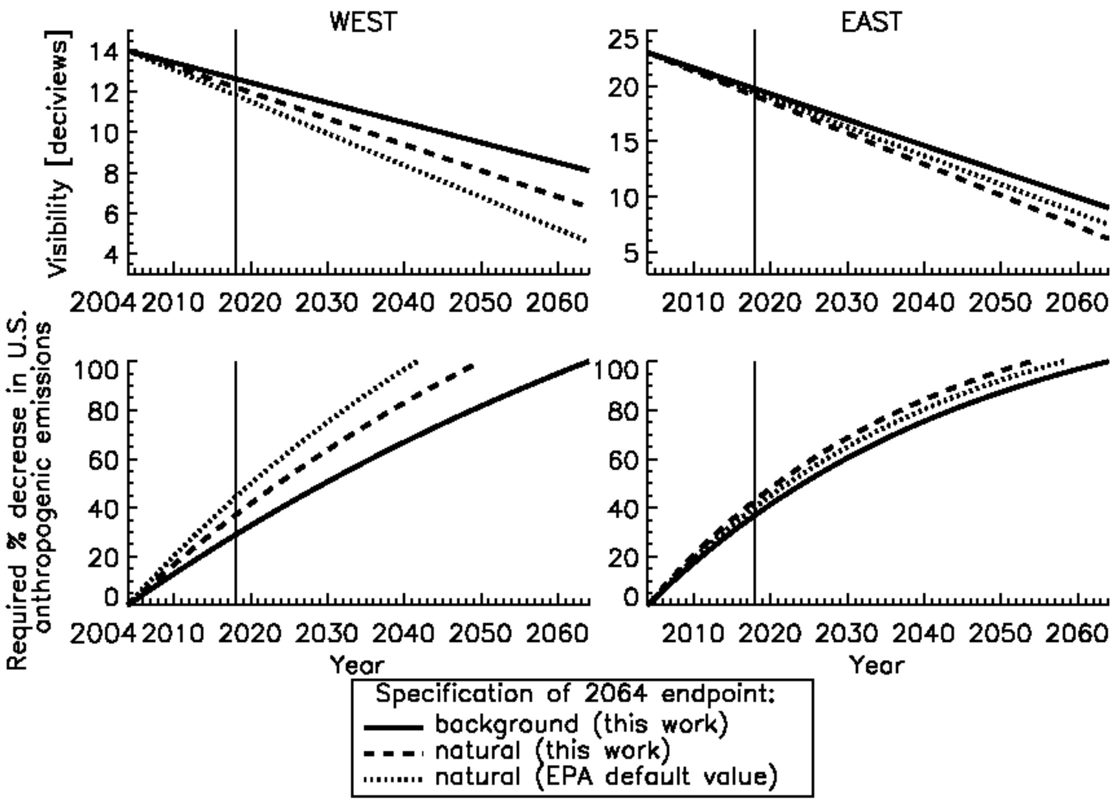

Figure 13. Illustrative example of required visibility improvements (top) and domestic emission reductions (bottom) over the 2004-2064 period for the western and the eastern United States (separated at 95°W) under the EPA Regional Haze Rule [*U.S. EPA*, 2003a]. The visibility endpoints are as given in Table 3. The required percentage decrease in U.S. anthropogenic emissions corresponding to a given visibility improvement is computed by assuming a linear correspondence between aerosol extinction and emissions. Results are shown for different choices for the 2064 endpoint: (1) EPA natural default visibility (dotted lines), (2) our estimate of natural visibility (dashed lines), and (3) our estimate of background visibility (solid lines). Background includes contributions from both natural and transbounary pollution sources. Year 2018 (thin vertical line) is the target date for phase 1 implementation of the Regional Haze Rule.

Appendix Q

Public Notice Report,

Comments Received and Responses

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Table of Contents

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Public Notice Report
For
The North Carolina Fine Particulate Matter Attainment Demonstration for the Hickory and Greensboro/Winston-Salem/High Point Fine Particulate Matter Nonattainment Areas (Catawba, Davidson, and Guilford Counties)

On April 1, 2009, a draft version of The North Carolina Fine Particulate Matter Attainment Demonstration for the Hickory and Greensboro/Winston-Salem/High Point Fine Particulate Matter Nonattainment Areas for the 1997 $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS) was submitted to the U. S. Environmental Protection Agency (USEPA). A request for public hearing, in accordance with 40 CFR 51.102, and the public comment period were noticed on the North Carolina Division of Air Quality (NCDAQ) web site on April 1, 2009 and in the local newspapers on April 2, 2009. The public comment period was open from April 1, 2009, through May 11, 2009, with a tentative hearing scheduled for May 7, 2009. No requests for public hearing were received and the hearing was cancelled. A hearing cancellation notice was posted on the NCDAQ web site on May 4, 2009. The public comment period elicited comments from only the USEPA. These comments and our response are included later in this Appendix.

Background

The USEPA promulgated a new $PM_{2.5}$ NAAQS (40 CFR 50.7) in 1997, setting the standard at a 15.0 micrograms per cubic meter (µg/m3) annual average and at a 65 µg/m3 daily or 24-hour average. A violation of the annual $PM_{2.5}$ NAAQS occurs when the annual average $PM_{2.5}$ concentration averaged over a three consecutive year period is equal to or greater than 15.1 µg/m3. A violation of the daily $PM_{2.5}$ NAAQS occurs when the annual 98th percentile of daily $PM_{2.5}$ concentration averaged over a three consecutive year period is equal to or greater than 66 µg/m3. The annual or daily $PM_{2.5}$ design value for a nonattainment area is the highest monitor's design value in that area.

The USEPA designated areas as nonattainment for the annual and daily $PM_{2.5}$ NAAQSs based upon air quality monitoring data measured during 2001, 2002 and 2003. The effective date of nonattainment designations was April 5, 2005. In North Carolina, there were two areas designated as nonattainment for violating the annual $PM_{2.5}$ standard. These two areas include the Hickory $PM_{2.5}$ nonattainment area (Catawba County) and Greensboro/Winston-Salem/High Point $PM_{2.5}$ nonattainment area (Davidson and Guilford Counties). All areas of North Carolina met the daily $PM_{2.5}$ standard.

Several control measures already in place or being implemented over the next few years will reduce stationary point, highway mobile, and nonroad mobile sources emissions. The expected Federal and State control measures were modeled for the attainment year of 2009.

The Federal control measures that were modeled included the Tier 2 vehicle standards; the heavy-duty gasoline and diesel highway vehicle standards; low sulfur gasoline and diesel fuels, large nonroad diesel engines standards; the nonroad spark-ignition engines and recreational engines standard; and the Clean Air Interstate Rule.

The State control measures that were modeled included the Clean Air Bill, in which the vehicle emissions inspection and maintenance program was expanded from 9 counties to 48; the NO_x SIP Call Rule, the North Carolina Clean Air Interstate Rule and the Clean Smokestacks Act, which will significantly reduce SO_2 emissions from the large electrical generation units with implementation beginning prior to the 2009 attainment year and well in advance of the Federal Clean Air Interstate Rule. The Clean Smokestacks Act further requires the coal-fired power plants to meet an annual SO_2 emissions cap without an option of emissions trading from outside of North Carolina.

Summary of Public Notice and Comment Period

Please reference page 3 of this Appendix for the full listing of the USEPA's public comments received.

Please reference page 7 of this Appendix for the NCDAQ response letter addressing the USEPA's public comments.

Conclusions

The NCDAQ firmly believes that it has prepared an adequate attainment demonstration package to address and resolve the nonattainment issues in the Hickory and Greensboro/Winston-Salem/ High Point $PM_{2.5}$ nonattainment area and demonstrates that both of these areas will meet the National Ambient Air Quality Standards for fine particulate matter by the April 5, 2010 attainment date. In a testament to the implemented control measures modeled in this attainment demonstration, $PM_{2.5}$ concentrations have already decreased significantly and all the monitoring sites in both nonattainment areas have attained the annual $PM_{2.5}$ NAAQS with the 2006-2008 monitoring data. Furthermore, the NCDAQ has adequately addressed the USEPA public comments received and made all appropriate modifications to the attainment demonstration. As a result, the NCDAQ will be moving forward with the final submittal to the USEPA of The North Carolina Fine Particulate Matter Attainment Demonstration for the Hickory and Greensboro/Winston-Salem/High Point Fine Particulate Matter Nonattainment Areas.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

MAY 1 9 2009

Mr. B. Keith Overcash, P.E., Director
North Carolina Department of Environment
And Natural Resources
Division of Air Quality
1641 Mail Service Center
Raleigh, NC 27699-1641

Dear Mr. Overcash:

Thank you for your letter dated April 1, 2009, transmitting a prehearing package regarding the attainment demonstrations for the Hickory and Greensboro-Winston-Salem-High Point (Triad) nonattainment areas for the1997 $PM_{2.5}$ national ambient air quality standard. We have completed our review of your submittals and have included comments in the enclosure.

If you have questions regarding our comments, please contact Lynorae Benjamin at (404) 562-9040 or have your staff contact Nacosta Ward at (404) 562-9140 of the EPA Region 4 office.

Sincerely,

Lynorae Benjamin for

Richard A. Schutt,
Chief
Air Planning Branch

Enclosure

Region 4 EPA Comments for Hickory and Greensboro PM2.5 Attainment Demonstrations
May 19, 2009

Note: Unless otherwise indicated, the sections, tables, and page numbers referenced in these comments are from the narrative portion of the State Implementation Plan (SIP) submittal.

Key Comments

1. On December 23, 2008, the United States Court of Appeals for the District of Columbia Circuit remanded the Clean Air Interstate Rule (CAIR) to EPA without vacatur, directing the Agency to remedy the rule's flaws in accordance with the Court's July 11, 2008, opinion in the case of *North Carolina v. EPA*, 531 F.3d 896, 901 (D.C. Cir. 2008). If the submission relies upon anticipated CAIR reductions, it may need to be revised consistent with EPA's new final action when the Agency responds to the Court's remand.

2. It is unclear how the controls and emissions reductions, from the power plants as part of the Clean Smokestacks Act (CSA) that appear to be needed for attainment are federally enforceable. To the extent that these emission reductions are being relied on for attainment for Hickory and Greensboro for the 1997 $PM_{2.5}$ standard, this discussion will be needed in the SIP submittals to support the demonstrations. Potential options for providing for federal enforceability of CSA emission reductions that may be relied on for attainment in Hickory and/or Greensboro are as follows:

    a. One option is for relevant portions of the North Carolina CSA could be submitted to the EPA as a regulation. We recognize that the entire CSA should not be submitted because it includes actions related to mercury and other parts that are not specifically related to the requirements for emission limitations and permitting conditions.

    b. The other option involves the submittal of the emissions limitations for those power plants that were explicitly modeled and affect the attainment areas as source-specific SIP revisions. The 50 kilometer circle that was used to determine the sources from which contingency measure reductions was obtained could be used to identify the sources that are subject to a source-specific SIP revision.

3. The CSA appears to have a Director's discretion prohibition relating to the North Carolina Commission and revisions to the Title IV permit. The following is from the CSA:

    > "Section 2(c) The Commission shall have the power: (1) To grant and renew a permit with such any conditions attached as that the Commission believes necessary to achieve the purposes of this

2

> section Article or the requirements of the Clean Air Act and implementing regulations adopted by the United States Environmental Protection Agency."

The highlighted portion appears to be in conflict with delegations that might be for the EPA Administration only. We are highlighting this consideration in the event that portions of CSA are submitted for approval in the North Carolina SIP.

4. The contingency measures also need to be federally enforceable. Since the CSA has not been submitted to EPA for incorporation into the SIP you would either need to submit CSA, or submit the individual permits adopted under CSA for incorporation into the SIP, or show that the adopted permit limits are enforceable under CAIR. The incorporation of measures into title V permits does not satisfy the necessity that they originate from a federally enforceable requirement.

Other Comments

1. The SIP narrative states on page 40 that the Clean Air Bill, the Nitrogen Oxide (NOx) SIP Call Rule, the CSA, and the Open Burning Rule were modeled in the attainment demonstration. However, the summary of these regulations that follows in sections 5.2.1 through 5.2.5 includes CAIR. For consistency of paragraph 5.2 State Control Measures, please add "Clean Air Interstate Rule" to sentence two, which will clarify that CAIR was a modeled regulation in the attainment demonstration.

2. In the SIP narrative, air quality data up to 2006 are presented. We recommend that the air quality trend analyses for the annual averages and design values at each monitor also include data from 2007 and 2008. Section 6.3.3 mentions the use of preliminary 2007 data. This data should be officially submitted to EPA and preliminary 2008 data should be available to use in the SIP. It is important to see how air quality is responding to emissions controls in these more recent years, especially since it already is the 2009 attainment year being requested.

3. The SIP narrative does not include a discussion of the changes in emissions and reductions that are associated with air quality improvement in the 2007 to 2009 period. We recommend that a table and/or chart with accompanying discussions of the emissions trends and implementation dates of controls related to the attainment of the areas by the proposed 2009 attainment year be included in the final submittal.

4. EPA guidance requires states to adopt "contingency measures equal to approximately one year's worth of reductions necessary to achieve reasonable further progress for the area." The purpose is to provide a one year of reductions if the area does not attain. Attainment

demonstrations are based on modeling of sulfur dioxide reductions from sources outside the nonattainment area, the inventory based assessment in the guidance does not make sense for this area. We do not believe reliance on the ozone guidance meets the intent of this requirement. Please provide tangible evidence that the emission reductions attributable to CSA will contribute to attainment if these are being relied upon as a contingency measure.

We recommend modeling the facilities with 2009-2010 reductions planned or reviewing existing modeling to develop sensitivity data that demonstrates the impact controlling these units will have on the ambient levels at the monitoring sites. Since the baseline design value for the Triad area is 15.8 ug/m^3, and the baseline design value for the Hickory area is 15.5 ug/m^3, one years' progress would be about 0.1 ug/m^3 ((15.8 – 15.0)/7) for the Triad area and also about 0.1 ug/m^3 ((15.5 – 15.0)/7) for the Hickory area.

5. 110(a)(2) Submittal. For Section 7.7 please clarify that the discussion in this submission is related to the 1997 PM2.5 standard and not the 2006 standard. It is our understanding that North Carolina is in the process of developing a submission for 110(a)(2) infrastructure elements for the 2006 standard and that this submission will be submitted later this year.

6. Page 1970 of the Adobe Acrobat file containing Appendices A-Q appears to be the location of a new document which we believe may be the North Carolina "Clean Smokestacks Act." If this is correct, we recommend adding a title page identifying the document and adding it to the bookmark index.

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Air Quality
Beverly Eaves Perdue, Governor
B. Keith Overcash, P.E., Director
Dee Freeman, Secretary

August 21, 2009

Richard A. Schutt
Air Planning Branch Chief
USEPA Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303-8960

Subject: Region 4 EPA Comments for Hickory and Greensboro/Winston-Salem/High Point $PM_{2.5}$ Attainment Demonstration

Dear Mr. Schutt:

Thank you for your letter dated May 19, 2009, transmitting the Environmental Protection Agency (EPA) Region 4's comments on the pre-hearing draft of the attainment demonstration for the Greensboro/Winston-Salem/High Point (referred to as the Triad) and Hickory fine particulate matter ($PM_{2.5}$) nonattainment areas. This letter is to provide the North Carolina Division of Air Quality (NCDAQ) response to those comments.

Key Comments:

1. EPA Comment: On December 23, 2008, the United States Court of Appeals for the District of Columbia Circuit remanded the Clean Air Interstate Rule (CAIR) to EPA without vacatur, directing the Agency to remedy the rule's flaws in accordance with the Court's July 11, 2008, opinion in the case of North Carolina v. EPA, 531 F.3d 896, 901 (D.C. Cir. 2008). If the submission relies upon anticipated CAIR reductions, it may need to be revised consistent with EPA's new final action when the Agency responds to the Court's remand.

NCDAQ Response: The $PM_{2.5}$ attainment demonstration relied on emission reductions achieved through the North Carolina Clean Smokestacks Act (CSA) that reduced both nitrogen oxides and sulfur dioxide (SO_2) emissions from the coal-fire utilities in North Carolina. The CAIR Phase I caps for SO_2 do not start until 2010, and since both regions have already attained the standard with the 2006-2008 ambient data, the NCDAQ does not believe our attainment demonstration is reliant upon CAIR.

2. EPA Comment: It is unclear how the controls and emissions reductions, from the power plants as part of the CSA, that appear to be needed for attainment are federally enforceable. To the extent that these emission reductions are being relied on for attainment for Hickory and Greensboro for the 1997 $PM_{2.5}$ standard, this discussion will be needed in the SIP submittals to support the demonstrations.

1641 Mail Service Center, Raleigh, North Carolina 27699-1641
2728 Capital Blvd., Raleigh, NC 27604
Phone: 919-733-3340 \ FAX: 919-715-7175 \ Internet: www.daq.state.nc.us/

NCDAQ Response: As part the final attainment demonstration State Implementation Plan (SIP) submittal, the NCDAQ will request that the portion of the CSA that establishes the system-wide emission caps be incorporated into the North Carolina federally approved SIP.

3. EPA Comment: The CSA appears to have a Director's discretion prohibition relating to the North Carolina Commission and revisions to the Title IV permit. The following is from the CSA:

> *"Section 2(c) The Commission shall have the power: (1) To grant and renew a permit with such any conditions attached as that the Commission believes necessary to achieve the purposes of this section Article or the requirements of the Clean Air Act and implementing regulations adopted by the United States Environmental Protection Agency."*

The highlighted portion appears to be in conflict with delegations that might be for the EPA Administration only. We are highlighting this consideration in the event that portions of CSA are submitted for approval in the North Carolina SIP.

NCDAQ Response: The NCDAQ believes that EPA has misinterpreted the CSA language. It is through the North Carolina Environmental Management Commission (referred to in the CSA as the Commission) that the NCDAQ has the authority to issue Title V permits and to adopt and implement rules. This section of the CSA was added so that the NCDAQ could go beyond the CSA emission reductions if they were required to meet a national ambient air quality standard or meet requirements in regulations promulgated by the EPA. The NCDAQ does not intend to request this section of the CSA be incorporated into the North Carolina federally approved SIP.

4. EPA Comment: The contingency measures also need to be federally enforceable. Since the CSA has not been submitted to EPA for incorporation into the SIP you would either need to submit CSA, or submit the individual permits adopted under CSA for incorporation into the SIP, or show that the adopted permit limits are enforceable under CAIR. The incorporation of measures into title V permits does not satisfy the necessity that they originate from a federally enforceable requirement.

NCDAQ Response: As part of the final attainment demonstration SIP submittal, the NCDAQ will request that the portion of the CSA that establishes the system-wide emission caps be incorporated into the North Carolina federally approved SIP.

Other Comments:

1. EPA Comment: The SIP narrative states on page 40 that the Clean Air Bill, the NOx SIP Call Rule, the CSA, and the Open Burning Rule were modeled in the attainment demonstration. However, the summary of these regulations that follows in sections 5.2.1 through 5.2.5 includes CAIR. For consistency of paragraph 5.2 State Control Measures, please add "Clean Air Interstate Rule".

NCDAQ Response: The appropriate language has been added in the SIP Narrative.

2. EPA Comment: In the SIP narrative, air quality data up to 2006 are presented. We recommend that the air quality trend analyses for the annual averages and design values at each monitor also include data from 2007 and 2008. Section 6.3.3 mentions the use of preliminary 2007 data. This data should be officially submitted to EPA and preliminary 2008 data should be available to use in the SIP. It is important to see how air quality is responding to emissions controls in these more recent years, especially since it already is the 2009 attainment year being requested.

NCDAQ Response: The appropriate tables have been updated in the SIP Narrative and the corresponding appendix.

3. EPA Comment: The SIP narrative does not include a discussion of the changes in emissions and reductions that are associated with air quality improvement in the 2007 to 2009 period. We recommend that a table and/or chart with accompanying discussions of the emissions trends and implementation dates of controls related to the attainment of the areas by the proposed 2009 attainment year be included in the final submittal.

NCDAQ Response: The appropriate language has been added in the SIP Narrative.

4. EPA Comment: EPA guidance requires states to adopt "contingency measures equal to approximately one year's worth of reductions necessary to achieve reasonable further progress for the area." The purpose is to provide a one year of reductions if the area does not attain. Attainment demonstrations are based on modeling of sulfur dioxide reductions from sources outside the nonattainment area, the inventory based assessment in the guidance does not make this requirement. We do not believe reliance on the ozone guidance meets the intent of this requirement. Please provide tangible evidence that the emission reductions attributable to CSA will contribute to attainment if these are being relied upon as a contingency measure.

We recommend modeling the facilities with 2009-2010 reductions planned or reviewing existing modeling to develop sensitivity data that demonstrates the impact controlling these units will have on the ambient levels at the monitoring sites. Since the baseline design value for the Triad area is 15.8 ug/m3, and the baseline design value for the Hickory area is 15.5 ug/m3, one years' progress would be about 0.1 ug/m3 ((15.8 – 15.0)/7) for the Triad area and also about 0.1 ug/m3 ((15.5 – 15.0)/7) for the Hickory area.

NCDAQ Response: The purpose of contingency measures is to provide further reductions in the event that an area does not attain the standard by the prescribed attainment date. Since both nonattainment areas in North Carolina have already attained the 1997 annual $PM_{2.5}$ *standard with the 2006-2008 ambient data, one year earlier than required, the necessity of contingency measures is unlikely. However, for the purposes of this submittal, the NCDAQ has added to the documentation back trajectories and current ambient air quality data to demonstrate that reductions in* SO_2 *emissions from the power plants in North Carolina have an impact on the monitors in the nonattainment areas.*

5. EPA Comment: 110(a)(2) Submittal. For Section 7.7 please clarify that the discussion in this submission is related to the 1997 PM2.5 standard and not the 2006 standard. It is our understanding that North Carolina is in the process of developing a submission for 110(a)(2) infrastructure elements for the 2006 standard and that this submission will be submitted later this year.

NCDAQ Response: The appropriate language has been added in the SIP Narrative.

6. EPA Comment: Page 1970 of the Adobe Acrobat file containing Appendices A-Q appears to be the location of a new document which we believe may be the North Carolina "Clean Smokestacks Act." If this is correct, we recommend adding a title page identifying the document and adding it to the bookmark index.

NCDAQ Response: The Clean Smokestacks Act is part of Appendix M and is properly identified in the Table of Contents for Appendix M. The NCDAQ does not believe that this section of Appendix M requires its own title page.

Thank you for your review of our pre-hearing draft. We look forward to working with EPA Region 4 during your review of our official SIP submittal for this area. If you have questions, please contact Laura Boothe of my staff at (919) 733-1488.

Sincerely,

B. Keith Overcash, P.E.

BKO:lab

cc: Lynorae Benjamin, USEPA
Nacosta Ward, USEPA
Donnie Redmond, NCDAQ
Laura Boothe, NCDAQ

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES

PUBLIC NOTICE

PURPOSE:	The North Carolina Department of Environment and Natural Resources, Division of Air Quality (NCDAQ) hereby gives notice regarding its Pre-Hearing Draft of The North Carolina Fine Particulate Matter Attainment Demonstration for the Hickory and Triad Fine Particulate Matter Nonattainment Areas. Persons wishing to submit written requests for a public hearing or comments regarding the "PM2.5 Attainment Demonstration Package" are invited to do so.
REQUESTS FOR A PUBLIC HEARING:	Requests for a public hearing must be in writing and include a statement supporting the need for such a hearing, an indication of your interest in the subject, and a brief summary of the information intended to be offered at such hearing. Written requests for a public hearing should be received by no later than Friday, May 1, 2009. If a public hearing is requested, the hearing will be held at 2:00pm on Thursday, May 7, 2009, at the Winston-Salem Region Office of the NCDAQ, located at 585 Waughtown Street, Winston-Salem, NC 27107. If a public hearing is not requested, a cancellation notice will be posted on Monday, May 4, 2009 on the NCDAQ web site by selecting May 7, 2009, on the Events Calendar, http://www.ncair.org/calendar/ or by calling 919-733-1115.
COMMENT PROCEDURES:	Any person wishing to comment may submit a written statement for inclusion in the record of proceedings regarding the PM2.5 Attainment Demonstration Package. Written comments should be received by no later than Monday, May 11, 2009.

INFORMATION: Written requests for a public hearing or comments can be electronically submitted or sent to the following:

daq.publiccomments@ncmail.net
(Please type "PM2.5 Attainment Demonstration Package" in the subject line)

George Bridgers
NC Division of Air Quality
1641 Mail Service Center
Raleigh, NC 27699-1641
Phone: (919) 715-6287
Fax: (919) 715-7476

Copies of the PM2.5 Attainment Demonstration Package may be downloaded from the NCDAQ web site at
http://www.ncair.org/planning/nc_sip.shtml

The PM2.5 Attainment Demonstration Package may be reviewed in person during normal business hours at the following offices:

NCDAQ, Raleigh Central Office, Planning Section	919-733-1115
NCDAQ, Mooresville Regional Office	704-663-1699
NCDAQ, Winston-Salem Regional Office	336-771-5000
Western Piedmont Council of Governments	828-322-9191

Date: 3/31/09

B. Keith Overcash, P.E., Director

North Carolina Community Newspapers Order Confirmation for Ad #0001346506-01

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCE

PUBLIC NOTICE

PURPOSE: The North Carolina Department of Environr sources, Division of Air Quality (NCDAQ) hereby gives Pre-Hearing Draft of The North Carolina Fine Particula Demonstration for the Hickory and Triad Fine Nonattainment Areas. Persons wishing to submit writt lic hearing or comments regarding the "PM2.5 Attai Package" are invited to do so.

REQUESTS FOR A PUBLIC HEARING: Requests for a pub writing and include a statement supporting the need indication of your interest in the subject, and a brief sur tion intended to be offered at such hearing. Written hearing should be received by no later than Friday, May

If a public hearing is requested, the hearing will be hel day, May 7, 2009, at the Winston-Salem Region Office at 585 Waughtown Street, Winston-Salem, NC 27107. not requested, a cancellation notice will be posted on on the NCDAQ web site by selecting May 7, 2009, on http://www.ncair.org/calendar/ or by calling 919-733-11

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INFORMATION: Written requests for a public hearing electronically submitted or sent to the following:
daq.publiccomments@ncmail.net
(Please type "PM2.5 Attainment Demonstration Package"

George Bridgers
NC Division of Air Quality
1641 Mail Service Center
Raleigh, NC 27699-1641
Phone: (919) 715-6287
Fax: (919) 715-7476

Copies of the PM2.5 Attainment Demonstration Packag from the NCDAQ web site at http://www.ncair.org/planning/nc_sip.shtml

The PM2.5 Attainment Demonstration Package may b during normal business hours at the following offices:

NCDAQ, Raleigh Central Office, Planning Section
NCDAQ, Mooresville Regional Office
NCDAQ, Winston-Salem Regional Office
Western Piedmont Council of Governments

Date:

B. Keith O

Publish: April 2, 2009.

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704-663-1699
336-771-5000
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vercash, P.E., Director

News & Record

Published by
News & Record, Inc.
Greensboro, North Carolina

North Carolina, Guilford County

AFFIDAVIT OF PUBLICATION

Before the undersigned, a Notary Public of said County and State, duly commissioned, qualified and authorized by law to administer oaths, personally appeared the Publisher's Representative who being first duly sworn, deposed and says:

1. That he/she is the Publisher's Representative of the Greensboro News & Record, Inc. a corporation, engaged in the publication of newspapers known as "News & Record", published, issued and entered as second class mail in the City of Greensboro in said County and State.

2. That he/she is authorized to make this affidavit and sworn statement; that the notice or other legal advertisement, a copy of which is attached hereto, was published in the News & Record on the dates listed below.

3. That the said newspaper (or newspapers) in which such notice, paper, document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina.

Publisher's Representative Shannon Weston

Sworn to and subscribed before me, this 2nd day of April, 2009.

Valerie McNeil
Notary Public

My commission expires: August 23, 2010

NOTARY PUBLIC
VALERIE McNEIL
GUILFORD COUNTY, NC
My Commission Expires August 23, 2010

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NORTH CAROLINA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES

PUBLIC NOTICE

PURPOSE: The North Carolina Department of Environment and Natural Resources, Division of Air Quality (NCDAQ) hereby gives notice regarding its Pre-Hearing Draft of The North Carolina Fine Particulate Matter Attainment Demonstration for the Hickory and Triad Fine Particulate Matter Nonattainment Areas. Persons wishing to submit written requests for a public hearing or comments regarding the "PM2.5 Attainment Demonstration Package" are invited to do so.

REQUESTS FOR A PUBLIC HEARING: Requests for a public hearing must be in writing and include a statement supporting the need for such a hearing, an indication of your interest in the subject, and a brief summary of the information intended to be offered at such hearing. Written requests for a public hearing should be received by no later than Friday, May 1, 2009.

If a public hearing is requested, the hearing will be held at 2:00pm on Thursday, May 7, 2009, at the Winston-Salem Region Office of the NCDAQ, located at 585 Waughtown Street, Winston-Salem, NC 27107. If a public hearing is not requested, a cancellation notice will be posted on Monday, May 4, 2009 on the NCDAQ web site by selecting May 7, 2009, on the Events Calendar, http://www.ncair.org/calendar/ or by calling 919-733-1115.

COMMENT PROCEDURES: Any person wishing to comment may submit a written statement for inclusion in the record of proceedings regarding the PM2.5 Attainment Demonstration Package. Written comments should be received by no later than Monday, May 11, 2009.

INFORMATION: Written requests for a public hearing or comments can be electronically submitted or sent to the following:

daq.publiccomments@ncmail.net
(Please type "PM2.5 Attainment Demonstration Package" in the subject line)

George Bridgers
NC Division of Air Quality
1641 Mail Service Center
Raleigh, NC 27699-1641
Phone: (919) 715-6287
Fax (919) 715-7476

Copies of the PM2.5 Attainment Demonstration Package may be downloaded from the NCDAQ web site at http://www.ncair.org/planning/nc_sip.shtml

The PM2.5 Attainment Demonstration Package may be reviewed in person during normal business hours at the following offices:

NCDAQ, Raleigh Central Office, Planning Section 919-733-1115
NCDAQ, Mooresville Regional Office 704-663-1699
NCDAQ, Winston-Salem Regional Office 336-771-5000
Western Piedmont Council of Governments 828-322-9191

Date: 3/31/09
B. Keith Overcash, P.E., Director

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PUBLIC NOTICE

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT & NATURAL RESOURCES

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Date: 3/31/09
B. Keith Overcash, P.E., Director

WSJ: April 2, 2009

Media General Operations, Inc.
Publisher of the
Winston-Salem Journal
Forsyth County

Before the undersigned, a Notary Public of Forsyth County, North Carolina, duly commissioned, qualified, and authorized by law to administer oaths, personally appeared D.H. Stanfield, who by being duly sworn deposes and says: that he is Controller of the Winston-Salem Journal, engaged in the publishing of a newspaper known as Winston-Salem Journal, published, issued and entered as second class mail in the City of Winston-Salem, in said County and State: that he is authorized to make this affidavit and sworn statement: that the notice or other legal advertisement, a true copy of which is attached hereto, was published in the Winston-Salem Journal on the following dates:

04/02/2009

and that the said newspaper in which such notice, paper document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina.

This 2th day of April, 2009

D.H. Stanfield
(signature of person making affidavit)

Sworn to and subscribed before me, this 2th day of April, 2009

Kimaley Johnson
(Notary Public)

KIMALEY JOHNSON
NOTARY PUBLIC
FORSYTH COUNTY
STATE OF NORTH CAROLINA
MY COMMISSION EXPIRES 9-28-2010

My Commission expires Sept. 28, 2010

THIS IS NOT A BILL. PLEASE PAY FROM INVOICE. THANK YOU