The North Carolina
8-Hour Ozone Attainment Demonstration
for the
Charlotte-Gastonia-Rock Hill, NC-SC
8-Hour Ozone Nonattainment Area
(Cabarrus, Gaston, Lincoln,
Mecklenburg, Rowan, Union Counties and
Coddle Creek and Davidson Townships in Iredell County)

Prepared by:

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

June 15, 2007

PREFACE

This document contains North Carolina's modeling demonstration that the Charlotte-Gastonia-Rock Hill, North Carolina-South Carolina 8-hour ozone nonattainment area will meet the National Ambient Air Quality Standard for 8-hour ozone by June 15, 2010. This area includes the entire counties of Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan and Union Counties; Coddle Creek and Davidson Townships in Iredell County; and the Rock Hill Metropolitan Planning Organization boundary in York County, South Carolina.

EXECUTIVE SUMMARY

INTRODUCTION

Ozone, a strong chemical oxidant, adversely impacts human health through effects on respiratory function and can also damage forests and crops. Ozone is not emitted directly by the utilities, industrial sources or motor vehicles but instead, is formed in the lower atmosphere, the troposphere, by a complex series of chemical reactions involving nitrogen oxides (NOx), resulting from the utilities, combustion processes and motor vehicles, and reactive volatile organic compounds (VOCs). VOCs include many industrial solvents, such as toluene, xylene and hexane as well as the various hydrocarbons (HC) that are evaporated from the gasoline used by motor vehicles or emitted through the tailpipe following combustion. Additionally, VOCs are emitted by natural sources such as trees and crops.

Ozone formation is promoted by strong sunlight, warm temperatures and light winds. High concentrations tend to be a problem in the eastern United States only during the hot summer months when these conditions frequently occur. Therefore, the U. S. Environmental Protection Agency (USEPA) mandates seasonal monitoring of ambient ozone concentrations in North Carolina from April 1 through October 31 (40 CFR 58 App. D, 2.5).

NATIONAL AMBIENT AIR QUALITY STANDARD (NAAQS)

The USEPA promulgated a new 8-hour ozone NAAQS in July 1997, setting the standard at 0.08 parts per million (ppm) averaged over an 8-hour period. An exceedance of the 8-hour ozone NAAQS occurs when a monitor measures ozone above 0.084 ppm (per the rounding convention). A violation of the NAAQS occurs when the average of the annual fourth highest daily maximum 8-hour ozone values over three consecutive years is equal to or greater than 0.085 ppm. This three-year average is termed the design value for the monitor. The design value for a nonattainment area is the highest monitor's design value in the area.

NATURE OF PROBLEM IN NORTH CAROLINA

In April 2004, the USEPA designated areas as nonattainment for the 8-hour ozone NAAQS based upon air quality monitoring data measured during the 2001, 2002 and 2003 ozone seasons. These designations became effective on June 15, 2004. In North Carolina, there were seven areas designated as nonattainment (see Figure 1).

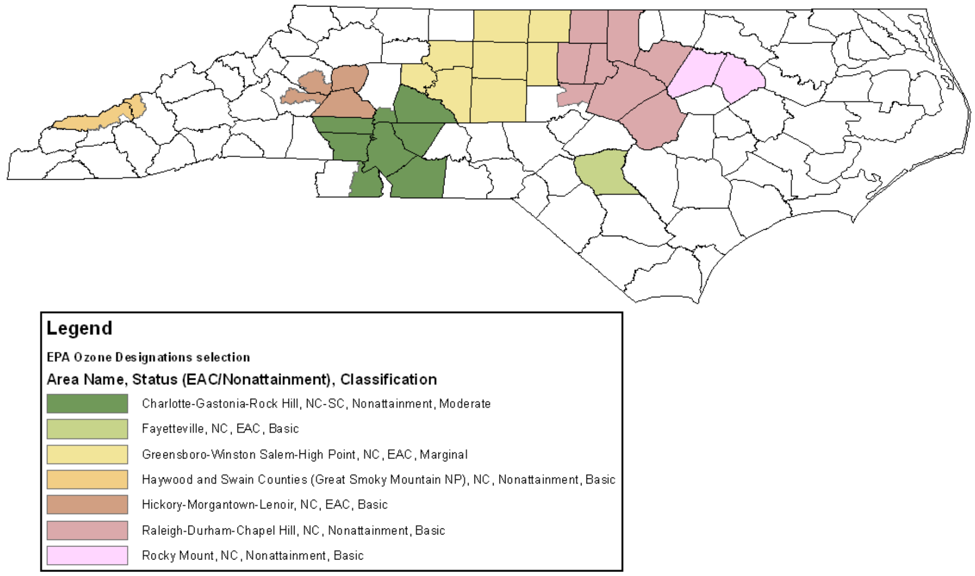

Figure 1. 8-hour Ozone Nonattainment Boundaries for North Carolina

This submittal covers the North Carolina portion of the Charlotte-Gastonia-Rock Hill, North Carolina-South Carolina (the Metrolina area) 8-hour ozone nonattainment area. This area was designated under subpart 2 since the area's 1-hour ozone design value was 0.129 ppm. Areas with 1-hour design values at 0.121 ppm or greater were designated under subpart 2, since this threshold was the low end of the classification table in Section 181(a)(1) of the Clean Air Act. The USEPA determined during the designation process that this was the appropriate treatment of the classification table under the 8-hour standard. With a regional 2001-2003 8-hour ozone design value of 0.100 ppm, the Metrolina area was classified as moderate. This nonattainment area includes the entire counties of Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan and Union Counties; Coddle Creek and Davidson Townships in Iredell County; and the Rock Hill Metropolitan Planning Organization boundary in York County, South Carolina.

CONTROLS APPLIED

Several control measures already in place or being implemented over the next few years will reduce stationary point, highway mobile, and nonroad mobile sources emissions. The expected Federal and State control measures were modeled for the attainment year of 2009.

The Federal control measures that were modeled included the Tier 2 vehicle standards; the heavy-duty gasoline and diesel highway vehicle standards; low sulfur gasoline and diesel fuels, large nonroad diesel engines standards; the nonroad spark-ignition engines and recreational engines standard; and the Clean Air Interstate Rule.

The State control measures that were modeled included the Clean Air Bill, in which the vehicle emissions inspection and maintenance program was expanded from 9 counties to 48; the NOx SIP Call Rule, which will reduce summertime NOx emissions from power plants and other industries; and the Clean Smokestacks Act, which will reduce NOx emissions beyond the requirements of the NOx SIP Call Rule and will require coal-fired power plants to meet an annual NOx emissions cap.

ATTAINMENT TEST RESULTS

The attainment test is not based on absolute modeling results, but rather relative reductions of ozone and is only applied at grid cells near the monitors. However, reviewing the modeling results of how the predicted ozone decreases in the future years and how wide spread the reductions are play an important role for the State in determining if additional controls should be considered.

The air quality modeling is used in a relative sense by determining what the relative reduction in ozone occurred between the baseline year (2002) and the attainment year (2009). Table 1 lists the attainment test results for the Metrolina area. The first two columns are the monitoring site and the county in which the site is located. The next three columns are the modeling base year design value (DVB), the relative response factor (RRF) and the future design value (DVF). According to the USEPA's guidance, areas with future design values between 0.082 and 0.087 ppm need to provide additional weight of evidence that the area will attain the 8-hour ozone NAAQS. Four of the monitors in the Metrolina area fall within the range requiring additional weight of evidence to demonstrate attainment.

Table 1 Attainment Test Results

Monitoring Site	County	DVB (ppm) 5-year weighted 2000-2004	2009	
			RRF	DVF (ppm)
Arrowood	Mecklenburg	0.0847	0.892	0.075
County Line	Mecklenburg	0.0973	0.874	**0.085**
Crouse	Lincoln	0.0907	0.868	0.078
Enochville	Rowan	0.0970	0.870	**0.084**
Garinger (Plaza)	Mecklenburg	0.0953	0.883	**0.084**
Monroe	Union	0.0870	0.884	0.076
Rockwell	Rowan	0.0973	0.862	**0.083**
York	York, SC	0.0830	0.861	0.071

The North Carolina Division of Air Quality (NCDAQ) provided strong weight of evidence that the Metrolina nonattainment area will attain the 8-hour ozone NAAQS by 2009. These included looking at alternative methods to calculate the future design values, air quality metrics, current air quality data and the emission reductions still to occur in 2007, 2008 and 2009, and additional measures that were not included in the air quality modeling.

The NCDAQ believes that the modeling attainment demonstration, in conjunction with the weight of evidence analyses, provides the necessary evidence that the Metrolina nonattainment area will attain the NAAQS by the prescribed attainment date.

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1.0 INTRODUCTION

1.1 What is tropospheric ozone?

Ozone, a strong chemical oxidant, adversely impacts human health through effects on respiratory function and can also damage forests and crops. Ozone is not emitted directly by the utilities, industrial sources or motor vehicles but instead, is formed in the lower atmosphere, the troposphere, by a complex series of chemical reactions involving nitrogen oxides (NOx), resulting from the utilities, combustion processes and motor vehicles, and reactive volatile organic compounds (VOCs). VOCs include many industrial solvents, such as toluene, xylene and hexane as well as the various hydrocarbons (HC) that are evaporated from the gasoline used by motor vehicles or emitted through the tailpipe following combustion. Additionally, VOCs are emitted by natural sources such as trees and crops.

Ozone formation is promoted by strong sunlight, warm temperatures and light winds. High concentrations tend to be a problem in the eastern United States only during the hot summer months when these conditions frequently occur. Therefore, the U. S. Environmental Protection Agency (USEPA) mandates seasonal monitoring of ambient ozone concentrations in North Carolina from April 1 through October 31 (40 CFR 58 App. D, 2.5).

1.2 What is the National Ambient Air Quality Standard?

In 1997 the USEPA revised the primary (health) and secondary (welfare) national ambient air quality standard (NAAQS) for ground-level ozone (40 CFR 50.9), setting the standard at 0.08 parts per million (ppm) averaged over an 8-hour period. The USEPA was sued on this action and in May 1999 the U. S. Court of Appeals for the D. C. Circuit remanded the 8-hour ozone standard back to the USEPA. In 2001, the USEPA proposed a response to the remand and reaffirmed the standard. Finally, in 2003 the 8-hour ozone standard became effective. The USEPA made nonattainment designations for the 8-hour ozone standard on April 30, 2004 with an effective date of June 15, 2004.

An exceedance of the 8-hour ozone NAAQS occurs when a monitor measures ozone above 0.084 ppm (per the rounding convention). A violation of the NAAQS occurs when the average of the annual fourth highest daily maximum 8-hour ozone values over three consecutive years is greater than or equal to 0.085 ppm. This three-year average is termed the design value for the monitor. The design value for a nonattainment area is the highest monitor’s design value in the area.

Since the 1977 amendments to the Clean Air Act (CAA), areas of the country that violated the ambient standard for a particular pollutant were formally designated as nonattainment for that pollutant. This formal designation concept was retained in the 1990 Amendments (CAAA), but additionally, areas designated as nonattainment for the 1-hour ozone standard were to be classified as to the degree of nonattainment. Five categories were created (section 181 of the 1990 CAAA). In increasing severity, these were marginal, moderate, serious, severe and extreme. The attainment dates for these areas were based upon this classification. The highest monitor design value in a nonattainment area was used to determine its classification.

With the implementation of the 8-hour ozone standard, an area could be designated under section 172 of the 1990 CAAA (subpart 1) as "basic" and would have 5 years from designation to attain the standard or could be designated under section 181 (subpart 2) and classified as one of the five categories listed above with attainment dates based on the classification (Table 1.2-1). Areas with an 1-hour ozone design value greater than 0.121 ppm were classified under subpart 2 and all other areas were classified under subpart 1.

Table 1.2-1 Subpart 2 Classifications and Attainment Dates

Classification	Design Value Range (ppm)	Attainment Date
Marginal	0.085 up to 0.092	June 15, 2007
Moderate	0.092 up to 0.107	June 15, 2010
Serious	0.107 up to 0.120	June 15, 2013
Severe 15	0.120 up to 0.127	June 15, 2019
Severe 17	0.127 up to 0.187	June 15, 2021
Extreme	0.187 and above	June 15, 2024

1.3 Nature of Problem in North Carolina

On April 15, 2004, the USEPA designated areas as nonattainment for the 8-hour ozone NAAQS based upon air quality monitoring data measured during the 2001, 2002 and 2003 ozone seasons. These designations became effective on June 15, 2004. In North Carolina, there were seven areas designated as nonattainment (Figure 1.3-1).

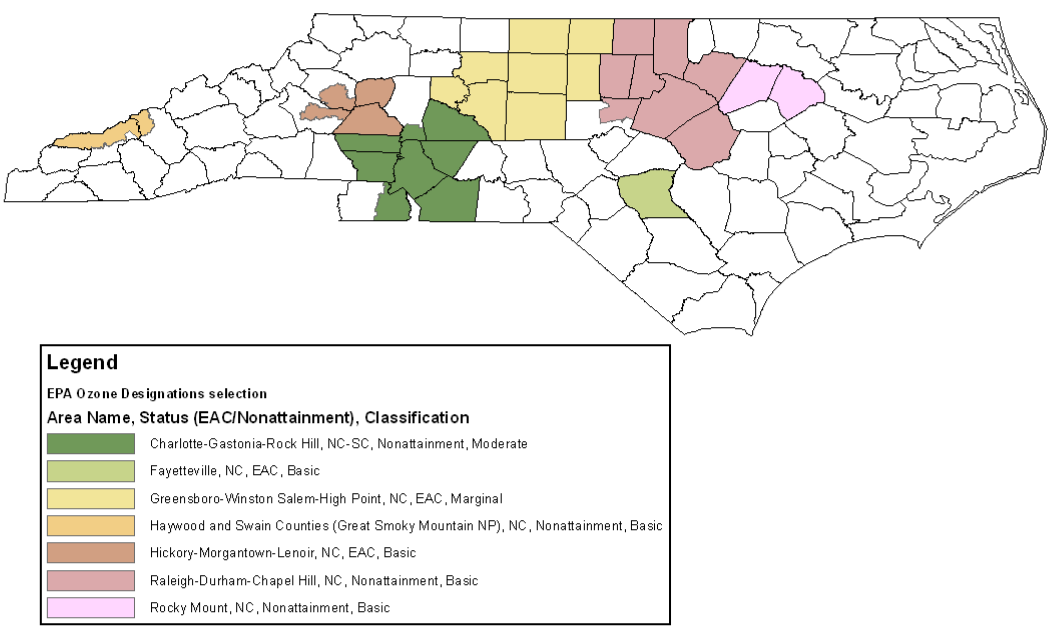


Figure 1.3-1 8-hour ozone nonattainment boundaries for North Carolina

The Charlotte-Gastonia-Rock Hill, North Carolina-South Carolina (referred to as the Metrolina area) 8-hour ozone nonattainment area was designated under subpart 2 since that area's 1-hour ozone design value was 0.129 ppm. With a regional 2001-2003 8-hour ozone design value of 0.100 ppm, the Metrolina area was classified as moderate. This nonattainment area includes the entire counties of Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan and Union Counties; Coddle Creek and Davidson Townships in Iredell County; and the Rock Hill Metropolitan Planning Organization boundary in York County, South Carolina.

Figure 1.3-2 displays where the monitors are located in the counties affected by the Metrolina nonattainment designation. The air quality data that the designations were based on is listed in Table 1.3-1. This table includes all of the monitors within the Metrolina nonattainment area and the York County monitor for completeness, even though it is located outside of the nonattainment boundary. The historic air quality data for the monitors in the Metrolina area is listed in Appendix C.

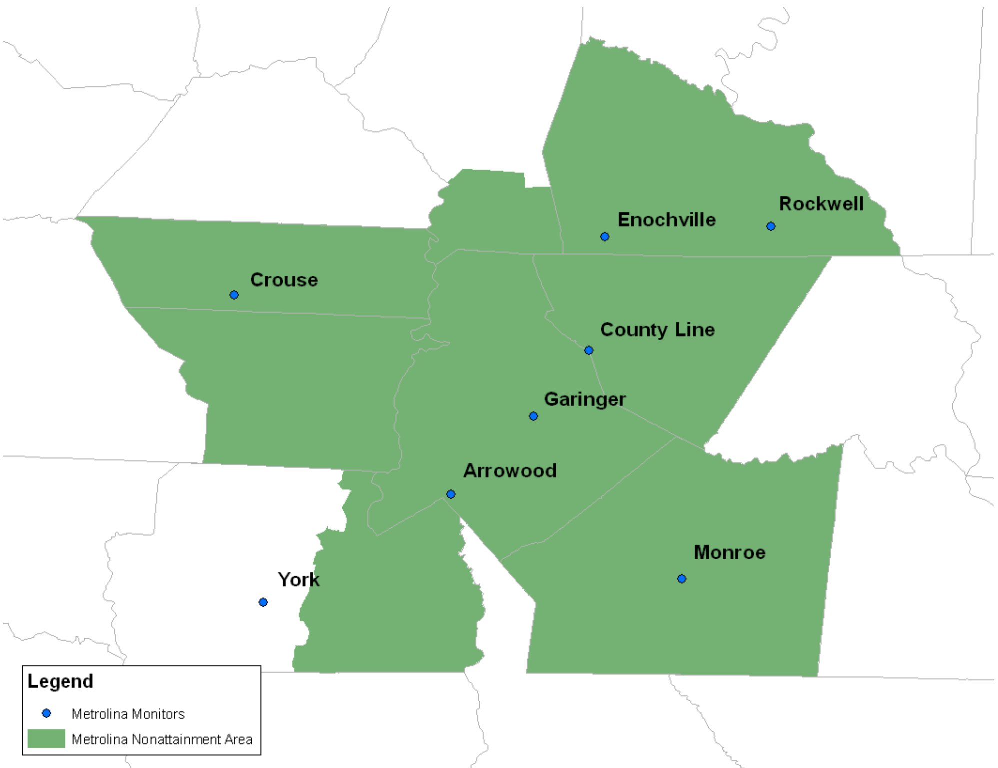


Figure 1.3-2 Monitor locations in the Metrolina area

Table 1.3-1 Metrolina Air Quality Data Designations were Based Upon

Monitor	County	4th Highest 8-hour Ozone Value			2001-2003 Design Value
		2001	2002	2003	
Crouse	Lincoln	0.094	0.095	0.089	**0.092**
County Line	Mecklenburg	0.099	0.107	0.088	**0.098**
Garinger (Plaza)	Mecklenburg	0.099	0.103	0.086	**0.096**
Arrowood	Mecklenburg	0.086	0.094	0.073	0.084
Enochville	Rowan	0.103	0.108	0.087	**0.099**
Rockwell	Rowan	0.097	0.106	0.098	**0.100**
Monroe	Union	0.081	0.100	0.083	**0.088**
York	York, SC	0.080	0.096	0.076	0.084

Bolded values represents violations of the 8-hour ozone NAAQS.

1.4 Conceptual Description of Ozone Formation in the Metrolina Area

The full conceptual description of ozone formation in North Carolina and the Metrolina nonattainment area is discussed in Appendix D. This section will focus on the conceptual description of ozone formation in the Metrolina area.

As stated earlier, ozone forms through the reaction of NOx and VOC emissions. Due to generally warm and moist climate of the Carolinas, vegetation abounds in many forms. The emissions from natural sources, such as vegetation, are referred to as biogenic emissions and account for approximately 90% of the total VOC emissions in the Carolinas. This results in the Carolinas being a NOx limited environment, which means that reductions in NOx emissions will have the greatest impact on reducing ozone formation in the Carolinas, including the Metrolina area.

North Carolina's most populous metropolitan regions are located in the central portions or the Piedmont of the state. The three largest cities (Charlotte, Greensboro, and Raleigh) form a partial crescent extending from the southwest to the northeast. This combination of metropolitan regions is often referred to as the Piedmont Crescent. A network of interstate and intrastate highways interconnects these three largest cities and further extends into adjoining states in a general southwest to northeast pattern. The mobile-based NOx emissions follow these highway networks with the highest emissions occurring in or near the city centers. The industrial point sources with both anthropogenic NOx and VOC emissions are also generally located in close proximity to the cities and the major road networks. Finally, North Carolina's largest NOx point sources are electric generating facilities, which are spatially scattered around state but are most heavily concentrated near the Piedmont Crescent. Figure 1.4-1 displays the location of the electric generating facilities in and near the Metrolina nonattainment area.

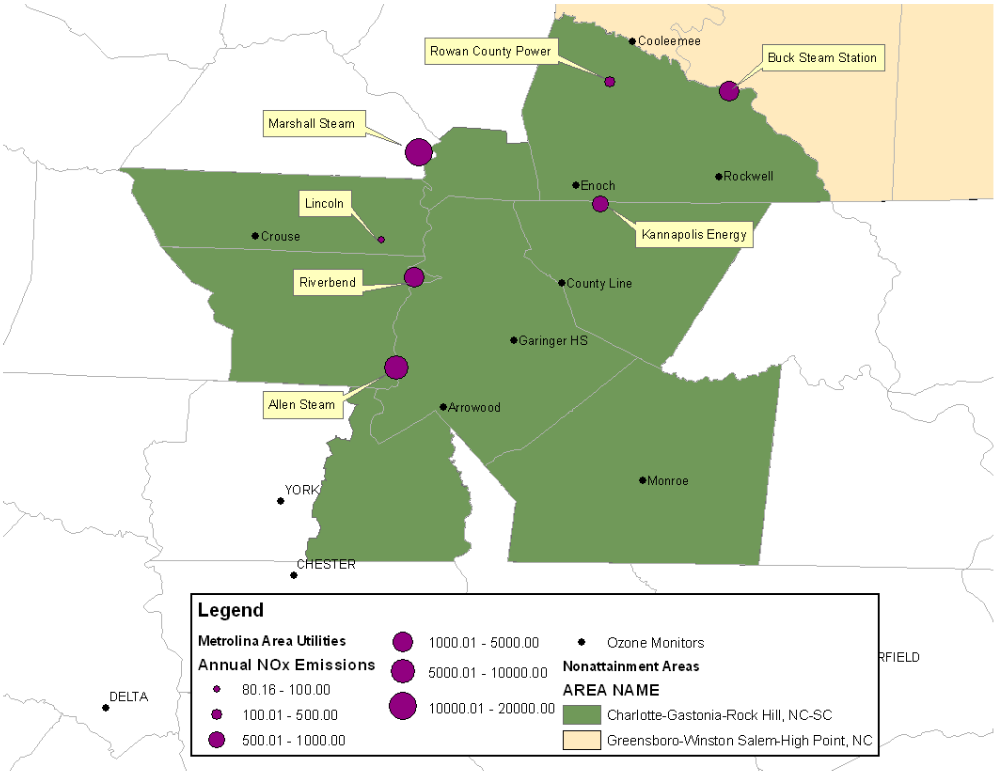


Figure 1.4-1 Location of electric generating facilities in and near the Metrolina nonattainment area.

By combining each of the major emission source categories (biogenic source VOC emissions and mobile sources (highway and non-road) and electric generating facilities NOx emissions), the highest concentrations of precursor pollutants for ozone formation are focused throughout the Piedmont Crescent, which includes the Metrolina area. Therefore, the greatest potential for ozone formation, with the right weather conditions, is also in this central portion of North Carolina.

Figure 1.4-2 displays the breakdown of man-made NOx emissions in and near the Metrolina nonattainment area. This figure shows that in the Metrolina area, including the counties that neighbor the nonattainment area, point source and highway mobile source NOx emissions account for over three quarters on the NOx emissions. The majority of the point source NOx emissions come from the electric generating facilities. Therefore, these sources that most impact ozone formation in the Metrolina region are highway mobile sources and electric generating facilities.

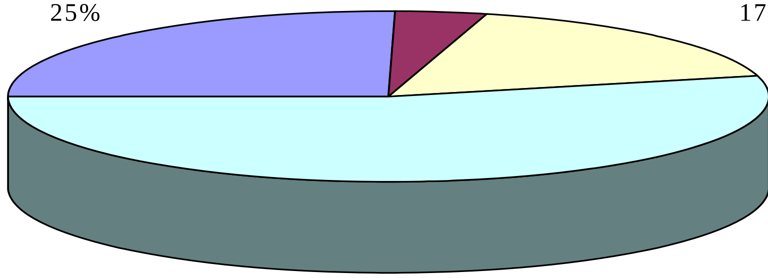


Figure 1.4-2 2002 NOx emissions for the Metrolina nonattainment area and neighboring counties

In addition to the emissions, meteorology plays an important role in ozone formation as well. Almost all high ozone episodes occurring in the Southeastern United States will have some common meteorological characteristics, including warm temperatures, lower relative humidity, little or no precipitation, and relatively light winds. These conditions are nearly universally indicative of regional high-pressure patterns causing large-scale sinking (subsiding) air at various levels of the atmosphere. The differences in the position, strength, and movement of these high pressure areas, along with differences in various mid-to-upper level wind patterns, allow staff to discern five meteorological scenarios, or “regimes”, in which high ozone episodes are likely to occur in the Carolinas. These meteorological regimes are discussed in detail in Appendix D.

The regional transport of ozone into the Metrolina area also contributes to the high ozone values observed in the Metrolina area. Just outside the borders of the Carolinas is a collection of large metropolitan regions. These metropolitan regions have similar emissions profiles and frequencies of high ozone concentrations leading to exceedances of the 8-hour ozone NAAQS. It is reasonable to conclude that precursor pollutants, as well as formed ozone, can be transported from any of these larger metropolitan regions into the Carolinas with an appropriate wind flow orientation from one or more of these regions. In recognition of the effects of regional transport of ozone, the USEPA has promulgated two rules to help reduce the effects of transported pollutants; the NOx SIP Call Rule and the Clean Air Interstate Rule.

In additional to regional transport, recirculated pollution around the Metrolina area affects high ozone events. Winds in the lower and middle atmosphere can shift around in a variety of directions. In the most frequent scenarios, winds transition from one direction to another in a clockwise fashion during the extent of the complete synoptic cycle or scenario. This clockwise shifting of the winds is a key characteristic of eastward-moving high pressure systems in the Northern Hemisphere. In a large recirculation pattern, plume(s) of precursor pollutants and formed ozone may leave the Metrolina area one day, travel across multiple regions, then return to the very air shed from where it started within a matter of days. Throughout the journey of air parcels in this type pattern, precursor pollutants and ozone are constantly being exchanged and added to the air parcels from each source sector and metropolitan region along the way, irrespective of any geo-political boundaries. In such smaller scale recirculation patterns, precursor pollutants and ozone from two neighboring metropolitan regions can exchange back and forth over a series of days, especially as a strong area of high-pressure moves from west to east across the region.

To summarize the conceptual description of ozone formation in the Metrolina area, various meteorological regimes in conjunction with biogenic VOC emissions and man-made NOx emissions can result in high ozone values in the Metrolina area. Reductions in highway mobile source and electric generating facility NOx emissions in and near the Metrolina area will have the greatest impact on reducing ozone formation.

1.5 Clean Air Act Requirements

Sections 172(c), 182(a) and 182 (b) of the CAA, as amended, contain the requirements for ozone nonattainment areas. As a subpart 2 moderate ozone nonattainment area, the Metrolina area must meet the requirements for both a marginal and moderate area, as well as the general requirements contained in Section 172(c). These requirements are listed below and are discussed in more details in Section 6.

Section 172(c) Nonattainment Plan Provisions

(1) Reasonable available control measures (RACM)
(2) Reasonable further progress (RFP)
(3) Actual emissions inventory and periodic emissions inventory
(4) New source review (NSR)
(5) Permit requirements for new and modified sources
(6) Other measures as may be necessary to provide attainment by specified attainment date
(7) Compliance with Section 110(a)(2)
(8) Equivalent techniques
(9) Contingency measures

Section 182(a) Plan Submissions and Requirements for Marginal Areas

(1) Actual emissions inventory in accordance with 172(c)(3)
(2) Corrections to SIP
    (A) Reasonably available control technology (RACT)
    (B) Motor vehicle inspection and maintenance (I/M)
    (C) Permit programs
(3) Periodic emissions inventory
    (A) General – emission inventory every three years until area is redesignated to attainment.
    (B) Annual emissions statement requirement for sources 25 tons per year or greater of VOC or NOx.

Section 182(b) Plan Submissions and Requirements for Moderate Areas

(1) Reasonable further progress

(2) Reasonable available control technology
(3) Gasoline vapor recovery
(4) Motor vehicle I/M
(5) Offset requirements of at least 1.15 to 1.

2.0 ATTAINMENT DEMONSTRATION METHODS AND INPUTS

The attainment modeling for the Metrolina nonattainment area was performed in conjunction with the regional haze modeling being done by the Southeast Regional Planning Organization, Visibility Improvement State and Tribal Association of the Southeast (VISTAS) and the fine particulate matter (PM2.5) and ozone modeling being done by the Association of Southeastern Integrated Planning (ASIP). VISTAS and ASIP are run by the ten Southeast states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia. Since the regional haze and PM2.5 modeling uses annual simulations and includes an intermediate year that is the attainment year required for the Metrolina nonattainment area, the North Carolina Division of Air Quality (NCDAQ) decided to use the this modeling for its attainment demonstration. The sections below outline the methods and inputs used by VISTAS/ASIP for the regional modeling.

2.1 Analysis Method

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system. VISTAS decided to use the following modeling system:

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

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

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

Additionally, an historical year is selected to model that represent typical meteorological conditions in the Southeast when high ozone, PM2.5 and poor visibility are observed throughout the Region. Once the historical year is selected, meteorological inputs are developed using the meteorological model. Emission inventories are also developed for the historical year and processed through the emissions model. These inputs are used in the air quality model to predict ozone, PM2.5 and visibility, with the results compared to the historic data. The model performance is evaluated by comparing the modeled predicted data to the historic air quality data.

Once model performance is deemed adequate, typical baseline and future year emissions are processed through the emissions model. For this demonstration, the baseline year was 2002, which corresponds with the same year as the historic meteorology used in the modeling. The attainment future year NCDAQ is using for this demonstration is 2009, since mandatory attainment date for the Metrolina area is June 15, 2010. The attainment date is set prior to the completion of the 2010 ozone season, therefore the attainment of the NAAQS would have to be met by the end of the 2009 ozone season. These emissions are processed through the air quality model with the meteorological inputs. The air quality modeling results are used to determine a relative reduction in future ozone, which is used in the attainment demonstration.

The complete modeling protocol used for this analysis can be found in Appendix D.

2.2 Model Selection

To ensure that a modeling study is defensible, care must be taken in the selection of the models to be used. The models selected must be scientifically appropriate for the intended application and be freely accessible to all stakeholders. Scientifically appropriate means that the models address important physical and chemical phenomena in sufficient detail, using peer-reviewed methods. Freely accessible means that model formulations and coding are freely available for review and that the models are available to stakeholders, and their consultants, for execution and verification at no or low cost.

The following sections outline the criteria for selecting a modeling system that is both defensible and capable of meeting the study's goals. These criteria were used in selecting the modeling system used for this modeling attainment demonstration.

2.2.1 Selection of Photochemical Grid Model

Criteria

For a photochemical grid model to qualify as a candidate for use in an attainment demonstration of the 8-hour ozone NAAQS, a State needs to show that it meets several general criteria:

- The model has received a scientific peer review
- The model can be demonstrated applicable to the problem on a theoretical basis
- Data bases needed to perform the analysis are available and adequate
- Available past appropriate performance evaluations have shown the model is not biased toward underestimates or overestimates
- A protocol on methods and procedures to be followed has been established
- The developer of the model must be willing to make the source code available to users for free or for a reasonable cost, and the model cannot otherwise be proprietary.

Overview of CMAQ

The photochemical model selected for this study was CMAQ version 4.4. For more than a decade, the USEPA has been developing the Models-3 CMAQ modeling system with the overarching aim of producing a ‘One-Atmosphere’ air quality modeling system capable of addressing ozone, fine particulate matter, visibility and acid deposition within a common platform. The original justification for the Models-3 development emerged from the challenges posed by the 1990 CAAA and the USEPA’s desire to develop an advanced modeling framework for ‘holistic’ environmental modeling utilizing state-of-science representations of atmospheric processes in a high performance computing environment. The USEPA completed the initial stage of development with Models-3 and released the CMAQ model in mid 1999 as the initial operating science model under the Models-3 framework. The most recent rendition is CMAQ version 4.4, which was released in October 2004.

Another reason for choosing CMAQ as the atmospheric model is the ability to do one-atmospheric modeling. Since NCDAQ will be using the same modeling exercise for the ozone and $PM_{2.5}$ attainment demonstrations SIPs, as well as the regional haze SIP, having a model that can handle both ozone and particulate matter is essential. A number of features in CMAQ’s theoretical formulation and technical implementation make the model well suited for annual PM modeling.

The configuration used for this modeling demonstration, as well as a more detailed description of the CMAQ model, can be found in the Modeling Protocol (Appendix D).

2.2.2 Selection of Meteorological Model

Criteria

Meteorological models, either through objective, diagnostic, or prognostic analysis, extend available information about the state of the atmosphere to the grid upon which photochemical grid modeling is to be carried out. The criteria for selecting a meteorological model are based on both the models ability to accurately replicate important meteorological phenomena in the region of study, and the model's ability to interface with the rest of the modeling systems -- particularly the photochemical grid model. With these issues in mind, the following criteria were established for the meteorological model to be used in this study:

- Non-Hydrostatic Formulation
- Reasonably current, peer reviewed formulation
- Simulates Cloud Physics
- Publicly available on no or low cost
- Output available in I/O API format
- Supports Four Dimensional Data Assimilation (FDDA)
- Enhanced treatment of Planetary Boundary Layer heights for AQ modeling

Overview of MM5

The non-hydrostatic MM5 model is a three-dimensional, limited-area, primitive equation, prognostic model that has been used widely in regional air quality model applications. The basic model has been under continuous development, improvement, testing and open peer-review for more than 20 years and has been used worldwide by hundreds of scientists for a variety of mesoscale studies.

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

Distinct planetary boundary layer (PBL) parameterizations are available for air-quality applications, both of which represent sub-grid-scale turbulent fluxes of heat, moisture and momentum. One scheme uses a first-order eddy diffusivity formulation for stable and neutral environments and a modified first-order scheme for unstable regimes. The other scheme uses a prognostic equation for the second-order turbulent kinetic energy, while diagnosing the other key boundary layer terms.

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

Results of detailed performance evaluations of the MM5 modeling system in regulatory air quality application studies have been widely reported in the literature (e.g., Emery et al., 1999; Tesche et al., 2000, 2003) and many have involved comparisons with other prognostic models such as the Regional Atmospheric Modeling System (RAMS) and the Systems Application International Mesoscale Model. The MM5 enjoys a far richer application history in regulatory modeling studies compared with RAMS or other models. Furthermore, in evaluations of these models in over 60 recent regional scale air quality application studies since 1995, it has generally been found that the MM5 model tends to produce somewhat better photochemical model inputs than alternative models.

The configuration used for this modeling demonstration, as well as a more detailed description of the MM5 model, can be found in the Modeling Protocol (Appendix D).

2.2.3 Selection of Emissions Processing System

Criteria

The principal criterion for an emissions processing system is that it accurately prepares emissions files in a format suitable for the photochemical grid model being used. The following list includes clarification of this criterion and additional desirable criteria for effective use of the system.

- File System Compatibility with the I/O API
- File Portability
- Ability to grid emissions on a Lambert Conformal projection
- Report Capability
- Graphical Analysis Capability
- MOBILE6 Mobile Source Emissions
- Biogenic Emissions Inventory System version 2 (BEIS-3)
- Ability to process emissions for the proposed domain in a reasonable amount of time.
- Ability to process control strategies
- No or low cost for acquisition and maintenance
- Expandable to support other species and mechanisms

Overview of SMOKE

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

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

SMOKE contains a number of major features that make it an attractive component of the modeling system. The model supports a variety of input formats from other emissions processing systems and models. It supports both gridded and county total land use scheme for biogenic emissions modeling. SMOKE can accommodate emissions files from up to 10 countries and any pollutant can be processed by the system.

For additional information about eh SMOKE model please refer to Modeling Protocol (Appendix D).

2.3 Episode Selection

A crucial step to SIP modeling is the selection of episodes to model. Several considerations need to be weighed before settling on not only which days to model, but how many days for each episode. This section details the guidance and process by which episodes were selected for the 8-hour Ozone SIP modeling package.

2.3.1 Overview of USEPA Guidance on Ozone

The USEPA's September 2006 draft final guidance, *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze*, (*referred to as Attainment Guidance)* sets out specific criteria for the selection of episodes to model for attainment of the 8-hour ozone NAAQS. First, episodes should include days encompassing a variety of meteorological conditions, including varying wind directions, for days exceeding 0.084 ppm. Additionally, episodes should be selected that contain days close (within ± 0.010 ppm) to the current design value (DVC). Episodes should also be chosen around days for which there are extensive air quality and meteorology measurements, including measurements aloft, measurements of indicator species and/or precursor measurements. Finally, a sufficient number of days should be selected to ensure robust attainment tests at violating monitoring sites.

In addition to these primary criteria, the USEPA also suggests a set of secondary criteria that may be used in the selection of episodes. This set of criteria allows states to give preference to previously modeled episodes. This is a very valuable consideration, as the USEPA points out, since it can save modeling resources and effort. Additional considerations include selecting episodes maximizing the number of days and sites observing a violation, selecting episodes which include weekends, and the selection of episodes meeting primary and secondary criteria in other nonattainment areas, when participating in regional modeling. Using these criteria laid out by the USEPA, the data available was systematically examined to determine the best episodes for modeling.

2.3.2 Episode Selection

With the advances in computing and storage technologies, and aided by regional modeling efforts, NCDAQ intends to move toward the modeling of the peak ozone season for the 8-hour ozone attainment demonstration SIP. By modeling the peak season, several criteria are covered, including the modeling of weekends and a sufficient number of days to ensure a robust modeled attainment test. Modeling the peak ozone season will also accomplish the goal of encompassing a myriad of meteorological conditions that influence ozone concentrations.

Efforts were made to determine an appropriate period to model. The selection process started with an examination of the 8-hour ozone maxima for the 1997 through 2004 seasons to determine which season may yield the most days to be included for study. Following the second primary criteria, the number of days each monitoring site observed a value within 0.010 ppm of the design value was tabulated using the recently suggested 5 year average (the 3 year average design value).

It was found that, overall, 2002 had the most days within 0.010 ppm of the design values, and generally had the most exceedance days for the individual monitoring sites. When 2002 was not the highest year, it was generally either the second or third highest, for either design value convention. Since 2002 was the base year for the VISTAS modeling as well, choosing the 2002 ozone season for the episode allowed the NCDAQ and the other States involved in ASIP to use the VISTAS modeling for the attainment demonstration for ozone.

The months of May through September 2002 were typical of the meteorology one would expect for an active ozone season, namely warmer and drier than average. Temperatures were 1-2 ºF warmer than average across the state and throughout the Mid-Atlantic States and the precipitation values were 4-6 inches below normal for most of North Carolina. The dry conditions were also present for much of the coastal Mid-Atlantic States. The warmer and drier conditions led to lower soil moisture throughout much of the East coast, which would reduce the evaporation of moisture into the air, thus lowering dewpoint temperatures. With less available moisture in the atmosphere, cloud cover was decreased, which lead to more sunlight, increased photochemistry, and higher levels of ozone across the state.

Additionally, the episode classification further verifies that the 2002 ozone season is a representative year for use in attainment demonstration modeling. The 2002 ozone season encompass all five meteorological scenarios: eastern stacked highs, frontal approaches, Canadian highs, modified Canadian highs, progressive Canadian highs and the subcategory of tropical influence. Thus, the 2002 season provides an excellent case to evaluate various control strategies for maintaining the NAAQS for ozone.

For these reasons, the 2002 ozone season was selected for the episode to model for the attainment demonstration. Further details of the episode selection process, episode classification procedures, as well as the episodes classifications for the 2002 ozone season can be found in the Modeling Protocol (Appendix D).

2.4 Modeling Domains

2.4.1 Horizontal Modeling Domain

The CMAQ model was run in one-way nested grid mode. This allowed the larger outer domains to feed concentration data to the inner nested domain. One-way nesting is believed to be appropriate for the generally stagnant conditions experienced during North Carolina ozone episodes. Two-way nesting was not considered due to numerical and computational uncertainty associated with the technique.

The horizontal coarse grid modeling domain boundaries were determined through a national effort to develop a common grid projection and boundary. Since this national modeling domain was used in the VISTAS regional haze modeling, it was used for the attainment demonstration as well. A smaller 12-km grid, modeling domain was selected in an attempt to balance location of areas of interest, such as ozone and fine particulate matter nonattainment areas, as well as Class 1 and wilderness areas for regional haze. Processing time was also a factor in choosing a smaller 12-km grid, modeling domain.

The coarse 36-km horizontal grid domain covers the continental United States. This domain was used as the outer grid domain for MM5 modeling with the CMAQ domain nested within the MM5 domain. Figure 2.4.1-1 shows the MM5 horizontal domain as the outer most, blue grid with the CMAQ 36-km domain nested in the MM5 domain.

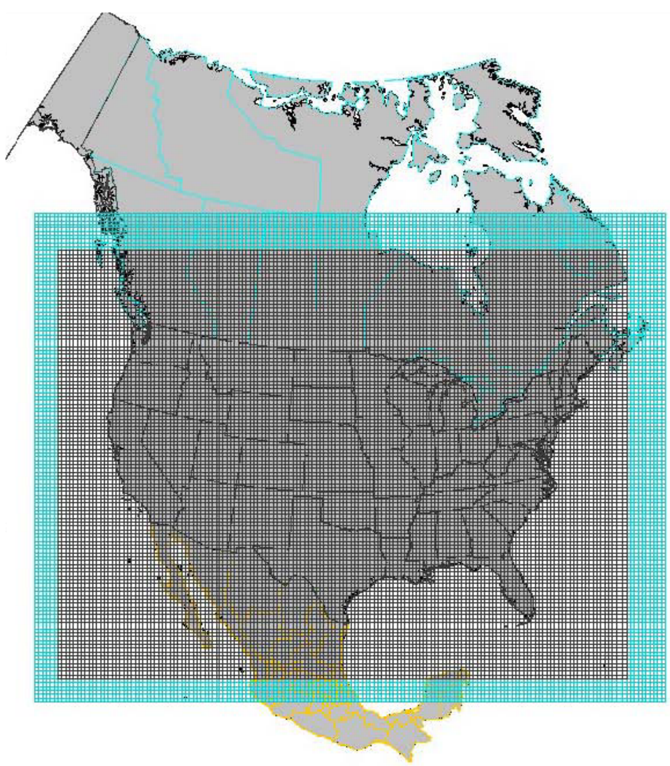


Figure 2.4.1-1: The MM5 horizontal domain is the outer most, blue grid, with the CMAQ 36-km domain nested in the MM5 domain.

To achieve finer spatial resolution in the VISTAS states, a one-way nested high resolution (12-km grid resolution) was used. Figure 2.4.1-2 shows the 12-km grid, modeling domain for the VISTAS region. This is the modeling domain on which the attainment test results are based. The NCDAQ did a study to determine if using a finer grid resolution provided different modeling results. Since the USEPA's attainment test uses the modeling results to determine the relative reductions in ozone between the base year and the future year, the NCDAQ determined that effectively the same attainment test results are obtained from 12-km grid modeling or 4-km grid modeling. Since 4-km grid modeling takes significantly more time and resources to run, the NCDAQ decided to use the VISTAS 12-km grid modeling results for this attainment demonstration. A copy of a journal article describing the results of the grid resolution study can be found in Appendix N.

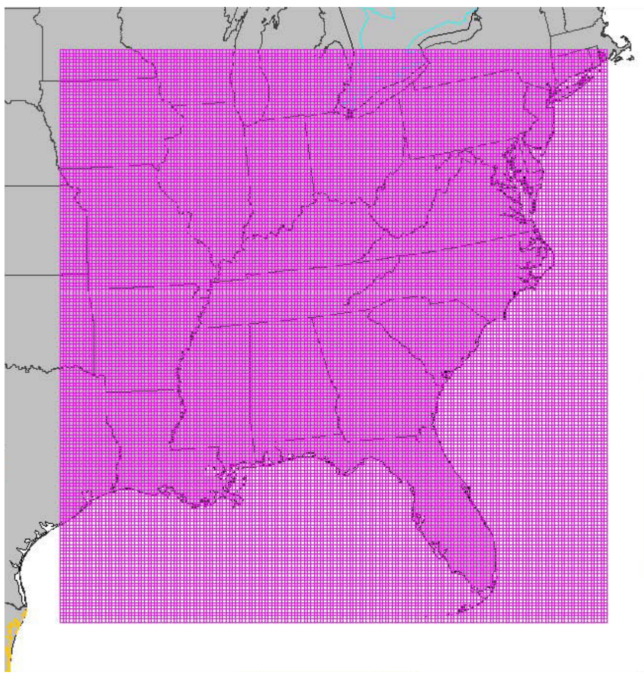


Figure 2.4.1-2: A more detailed view of the 12-km grid over the VISTAS region.

2.4.2 Vertical Modeling Domain

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employed a terrain following coordinate system defined by pressure, using 34 layers that extend from the surface to the 100 mb. Table 2.4.2-1 lists the layer definitions for both MM5 and for CMAQ. A layer-averaging scheme is adopted for CMAQ to reduce the computational cost of the CMAQ simulations. The effects of layer averaging were evaluated in conjunction with the VISTAS modeling effort and was found to have a relatively minor effect on the model performance metrics when both the 34 layer and a 19 layer CMAQ models were compared to ambient monitoring data.

Table 2.4.2-1: Vertical Layer Definition For MM5 and CMAQ

MM5 Simulation					CMAQ 19 Layers				
Layer	Sigma	Pressure (mb)	Height (m)	Depth (m)	Layer	Sigma	Pressure (mb)	Height (m)	Depth (m)
34	**0.000**	**100**	**14662**	**1841**	**19**	**0.000**	**100**	**14662**	**6536**
33	0.050	145	12822	1466		0.050	145		
32	0.100	190	11356	1228		0.100	190		
31	0.150	235	10127	1062		0.150	235		
30	0.200	280	9066	939		0.200	280		
29	**0.250**	**325**	**8127**	**843**	**18**	**0.250**	**325**	**8127**	**2966**
28	0.300	370	7284	767		0.300	370		
27	0.350	415	6517	704		0.350	415		
26	0.400	460	5812	652		0.400	460		
25	**0.450**	**505**	**5160**	**607**	**17**	**0.450**	**505**	**5160**	**1712**
24	0.500	550	4553	569		0.500	550		
23	0.550	595	3984	536		0.550	595		
22	**0.600**	**640**	**3448**	**506**	**16**	**0.600**	**640**	**3448**	**986**
21	0.650	685	2942	480		0.650	685		
20	**0.700**	**730**	**2462**	**367**	**15**	**0.700**	**730**	**2462**	**633**
19	0.740	766	2095	266		0.740	766		
18	**0.770**	**793**	**1828**	**259**	**14**	**0.770**	**793**	**1828**	**428**
17	0.800	820	1569	169		0.800	820		
16	**0.820**	**838**	**1400**	**166**	**13**	**0.820**	**838**	**1400**	**329**
15	0.840	856	1235	163		0.840	856		
14	**0.860**	**874**	**1071**	**160**	**12**	**0.860**	**874**	**1071**	**160**
13	0.880	892	911	158	**11**	**0.880**	**892**	**911**	**158**
12	**0.900**	**910**	**753**	**78**	**10**	**0.900**	**910**	**753**	**155**
11	0.910	919	675	77		0.910	919		
10	**0.920**	**928**	**598**	**77**	**9**	**0.920**	**928**	**598**	**153**
9	0.930	937	521	76		0.930	937		
8	**0.940**	**946**	**445**	**76**	**8**	**0.940**	**946**	**445**	**76**
7	**0.950**	**955**	**369**	**75**	**7**	**0.950**	**955**	**369**	**75**
6	**0.960**	**964**	**294**	**74**	**6**	**0.960**	**964**	**294**	**74**
5	**0.970**	**973**	**220**	**74**	**5**	**0.970**	**973**	**220**	**74**
4	**0.980**	**982**	**146**	**37**	**4**	**0.980**	**982**	**146**	**37**
3	**0.985**	**986.5**	**109**	**37**	**3**	**0.985**	**986.5**	**109**	**37**
2	**0.990**	**991**	**73**	**36**	**2**	**0.990**	**991**	**73**	**36**
1	**0.995**	**995.5**	**36**	**36**	**1**	**0.995**	**995.5**	**36**	**36**
0	**1.000**	**1000**	**0**	**0**	**0**	**1.000**	**1000**	**0**	**0**

2.5 Emission Inventory

There are five different emission inventory source classifications, stationary point and area sources, off-road and on-road mobile sources, and biogenic sources. Stationary point sources are those sources that emit greater than a specified tonage per year and the data is provided at the facility level. Stationary area sources are those sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (i.e., dry cleaners, service stations, etc.). These types of emissions are estimated on the county level. Off-road mobile sources include equipment that can move, but do not use the roadways, i.e., lawn mowers, construction equipment, railroad locomotives, aircraft, etc. The emissions from these sources, like stationary area sources, are estimated on the county level. On-road mobile sources are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type and are summed to the county level. Biogenic sources are the natural sources like trees, crops, grasses and natural decay of plants. The emissions from these sources are estimated on a county level.

In addition to the various source classifications, there are also various types of emission inventories. The first is the actual base year inventory. This inventory is the base year emissions that correspond to the meteorological data, for this modeling effort is 2002. These emissions are used for evaluating the air quality model performance.

The second type of inventory is the typical base year inventory. This inventory is similar to the actual base year, however for sources that may have significant changes from year-to-year, a more typical emission value is used. In this modeling effort, typical emissions were developed for the electric generating units (EGUs) and the wildland fire emissions. The air quality modeling results using these emissions are used in calculating the relative reresponse factors used in the attainment demonstration test.

The future year base inventory is an inventory developed for some future year for which attainment of the ozone standard is needed. For this modeling project, the future year inventory will be 2009, the last complete year for which the standard must be attained. It is the future base year inventory that control strategies and sensitivities are applied to determine what controls beyond those measures already included in the future year base inventory, to which source classifications must be made in order to attain and maintain the ozone standard.

In the sections that follow, a synopsis of the inventories used for each source classifications are discussed. The detail discussions of the emissions inventory development can be found in Appendix F and emission summaries by county for the Metrolina nonattainment area, as well as for the State are in Appendix E.

2.5.1 Stationary Point Sources

Point source emissions are emissions from individual sources having a fixed location. Generally, these sources must have permits to operate and their emissions are inventoried on a regular schedule. Large sources having emissions of 100 tons per year (tpy) of a criteria pollutant, 10 tpy of a single hazardous air pollutant (HAP), or 25 tpy total HAP are inventoried annually. Smaller sources have been inventoried less frequently. The point source emissions data can be grouped into the EGU sources and the other point sources, i.e., non-EGUs. Appendix F.1 documents the point source modeling inventory development in more details. Appendix E provides tables of the point sources in the Metrolina nonattainment area and the average daily peak ozone season emissions.

Electric Generating Units

The actual base year inventory for the EGU sources used 2002 continuous emissions monitoring (CEM) data reported to the USEPA's Acid Rain program or 2002 hourly emissions data provided by stakeholders. This data provides hourly emissions profiles that can be used in the modeling of these large sources of NOx and helps to provide more accurate modeling of these sources.

Since the NOx emissions from EGU sources are a significant part of the emissions inventory, a typical base year emissions inventory was developed for these sources to avoid anomalies in emissions due to variability in meteorology, economic and outage factors in 2002. This approach is consistent with the USEPA's modeling guidance. To develop a typical year 2002 emissions inventory for EGU sources, for each unit the average CEM heat input for 2000 through 2004 was divided by the 2002 actual heat input to generate a unit specific normalizing factor. This normalizing factor was then multiplied by the 2002 actual emissions. The heat inputs for the period 2000 through 2004 were used since the modeling current design values use monitoring data from this same 5-year period. If a unit was shutdown for an entire year during the 2000 through 2004 period, the average of the years the unit was operational was used. If a unit was shutdown in 2002, but not permanently shutdown, the emissions and heat inputs for 2001 (or 2000) were used in the normalizing calculations.

As part of the VISTAS modeling, VISTAS and the Midwest Regional Planning Organization contracted with ICF Resources, L.L.C., to generate future year emission inventory for the electric generating sector of the contiguous United States using the Integrated Planning Model (IPM). IPM is a dynamic linear optimization model that can be used to examine air pollution control policies for various pollutants throughout the contiguous United States for the entire electric power system. The dynamic nature of IPM enables the projection of the behavior of the power system over a specified future period. The optimization logic determines the least-cost means of meeting electric generation and capacity requirements while complying with specified constraints including air pollution regulations, transmission bottlenecks, and plant-specific operational constraints. The versatility of IPM allows users to specify which constraints to exercise and populate IPM with their own datasets.

The IPM modeling runs took into consideration the USEPA's Clean Air Interstate Rule (CAIR) implementation and North Carolina's Clean Smokestacks Act compliance plans for Duke Power and Progress Energy.

Other Point Sources

For the non-EGU sources, the same inventory will be used for both the actual and typical base year emissions inventories. The non-EGU category will use annual emissions as reported for the Consolidated Emissions Reporting Rule (CERR) for the year 2002. These emissions were temporally allocated to month, day, and hour using source category code (SCC) based allocation factors using the SMOKE emissions model.

The general approach for assembling future year data was to use recently updated growth and control data consistent with USEPA's CAIR analyses. This data was supplemented with state specific growth factors and stakeholder input on growth assumptions.

2.5.2 Stationary Area Sources

Stationary area sources include sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (i.e., combustion of fuels for heating, structure fires, service stations, etc.). Emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such as fuel usage, number of household or population. Stationary area source emissions are estimated on the county level.

A portion of the area source 2002 base year inventory for North Carolina was developed by the NCDAQ and provided to the VISTAS/ASIP contractor. The VISTAS/ASIP contractor calculated the remaining portion of the area source inventory. The sources estimated by the contractor include emissions from animal husbandry, wildland fires, and particulate matter from paved and unpaved roads. For the other states within the modeling domain, the state supplied data or the CERR data for 2002 was used.

The actual base year inventory will serve as the typical base year inventory for all area source categories except for wildland fires. For this source category, development of a typical year fire inventory provided the capability of using a comparable data set for both the base year and future years. Thus, fire emissions would remain the same for air quality modeling in both the base and any future years. The VISTAS Fire Special Interest Work Group was consulted and decided to use State level ratios of acres over a longer term record (three or more years) developed for each fire type relative to 2002. The 2002 acreage was then scaled up or down based on these ratios to develop a typical year inventory.

For categories other than wildland fires, the VISTAS/ASIP contractor generated the future base year emissions inventory used in the attainment demonstration modeling. Growth factors supplied from the states or the USEPA's CAIR emission projections were applied to project the controlled emissions to the appropriate year. In some cases, the USEPA's Economic Growth and Analysis System Version 5 growth factors were used if no growth factor was available from either the states or the CAIR growth factor files.

Appendix F.2 provides a detailed discussion of the area source inventory. Appendix E provides emission summaries by area source category for average peak ozone season day.

2.5.3 Off-Road Mobile Sources

Non-road mobile sources include equipment that can move, but do not use the roadways, such as construction equipment, aircraft, railroad locomotives, lawn and garden equipment, etc. For the majority of the non-road mobile sources, the emissions were estimated using the USEPA's NONROAD2005c model. For the three source categories not included in the NONROAD model, i.e., aircraft engines, railroad locomotives and commercial marine, more traditional methods of estimating the emissions were used. The same inventory will be used for both the actual and typical base year emissions inventories for the non-road mobile sources.

For the source categories estimated using the USEPA's NONROAD model, the model was used to create a future base year inventory. The NONROAD model takes into consideration rules that are in effect that could impact the emissions from these source categories. For the four largest airports in North Carolina, the FAA's Terminal Area Forecast was used to project growth in aircraft emissions. For the commercial marine, railroad locomotives and the remaining airport emissions, the VISTAS/ASIP contractor calculated the future base year emissions using detailed inventory data (both before and after controls) for 1996 and 2010 obtained from the USEPA's Clean Air Interstate Rule Technical Support Document. When available, state specific growth factors were used.

Appendix F.2 provides a detailed discussion of the nonroad mobile source inventory. Average daily emission summaries by nonroad source category can be found in Appendix E.

2.5.4 Highway Mobile Sources

In order to accurately model the mobile source emissions in the Metrolina nonattainment area, the newest version of the MOBILE model, MOBILE6.2, was used. Key inputs for the MOBILE model include information on the age of vehicles on the roads, the average speed on the roads, the mix of vehicles on the roads, any control technologies in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and temperature. The MOBILE model inputs were developed through interagency consultation with the transportation partners for this area.

The MOBILE model takes into consideration rules that are in effect that impact the emissions from this source sector. For highway mobile sources, the actual and typical year emissions were the same and the MOBILE model was run using input data reflective of 2002. The same model then is run for the future year emissions inventory using input data reflective of 2009. The 2002 and 2009 vehicle miles traveled (VMT), speeds, vehicle age and vehicle mix data was obtained from the North Carolina Department of Transportation (NCDOT). For urban areas in North Carolina that run travel demand models (TDMs), VMT and speed data from TDMs were used. The Metrolina area is one of the areas that run a TDM, and the TDM domain covers the entire nonattainment area.

For a detailed discussion about the mobile source inventory development used in the attainment demonstration modeling, please refer to Appendix F.3. Emission summaries by county for the mobile source sector can be found in Appendix E.

2.5.5 Biogenic Emission Sources

Biogenic emissions were prepared with the SMOKE-BEIS3 (Biogenic Emission Inventory System 3 version 0.9) preprocessor. SMOKE-BEIS3 is basically the Urban Airshed Model (UAM)-BEIS3 model, but also includes modifications to use MM5 data, gridded land use data, and science updates. The emission factors that are used in SMOKE-BEIS3 are the same as the emission factors in UAM-BEIS3.

The basis for the gridded land use data used by BEIS3 is the county land use data in the Biogenic Emissions Landcover Database version 3 (BELD3) provided by the USEPA. A separate land classification scheme, based upon satellite (AVHRR, 1 km spatial resolution) and census information, aided in defining the forest, agriculture and urban portions of each county.

3.0 Model Performance Evaluation

There are many aspects of model performance. This section will focus primarily on the methods and techniques recommended by the USEPA for evaluating the performance of the air quality model. Before the air quality model can be fully evaluated, an understanding of the meteorological modeling performance is needed to understand potential biases and errors that may be passed from the meteorological model directly into the air quality model. The meteorological modeling evaluation is fully documented in Appendix I and is briefly summarized in the next few paragraphs.

Generally speaking, the meteorological modeling performance was quite good at both the 36-km and 12-km grid resolutions. Synoptic features were routinely accurately predicted and the meteorological model showed considerable skill in replicating the state variables (e.g. temperature, mixing ratio, relative humidity, wind speed and direction, cloud cover, and precipitation). The meteorological modeling performance statistics fell within expected and acceptable ranges of error during the majority of the 2002 modeled year.

The meteorological modeling performance for North Carolina was very similar to the performance for the VISTAS/ASIP region for the 12-km modeling domain. Again, large-scale meteorological patterns were accurately predicted. The meteorological model demonstrated substantial skill throughout the entire year and was especially skillful during the summertime season from May through September.

For the North Carolina portion of the 12km modeling domain, the temperature bias was near zero in May, June, and August. July had a slight negative temperature bias near –0.25 Kelvin (K), and September had a negative temperature bias of –0.1 K. The mixing ratio bias was near 0 gram/kilogram (g/kg) in May through July and then fell to –0.2 g/kg in August and to -0.6 in September. The relative humidity bias generally hovered around ± 3% throughout the summer. Cloud coverage bias peaked near 10% in July and was biased less than 5% during the other summertime months. Wind direction was the most erratic of the measurements. The direction bias in North Carolina was more pronounced than for the full 12-km domain, being more negative May through July, and more positive in August and September. When considering all wind measurements, the wind speed was 0.8 to 1.0 meters per second (m/s) too strong. When omitting calm observations, the bias falls to 0.2 to 0.5 m/s. Additionally, the meteorological model noticeably overestimated the amount of summertime precipitation but not the spatial coverage of measurable precipitation.

Overall, excess wind speeds, increased relative humidity, more daytime cloud cover, and precipitation overestimations will likely contribute to slight under predictions of the daily maximum peak ozone concentration in the air quality model. The NCDAQ believes that the meteorological model performance is adequate for this modeling exercise and should produce credible inputs for the air quality modeling for the attainment demonstration for the Metrolina area.

With the meteorological modeling performance summarized, the first step in the air quality modeling process is to verify the model's performance in terms of its ability to predict the ozone in the right locations and at the right levels. To do this, the actual base year model predictions are compared to the ambient data observed in the historical season. This verification is a combination of statistical and graphical evaluations. If the model appears to be producing ozone in the right locations for the right reasons, then the model can be used as a predictive tool to evaluate various control strategies and their effects on ozone. The purpose of the model performance evaluation is to assess how accurately the model predicts ozone levels observed in the historical season. The key statistical measures that were used to evaluate model performance are as follows:

1. Comparison of modeled mean of ozone to the observed mean of ozone. This metric is an evaluation of how, on average across the modeling period, the model compares to the observed values.
2. Bias in the model is calculated by taking the difference between the modeled mean and the observed mean.

3. Normalized bias is calculated by taking the bias for each observation/prediction pair, and then dividing by the number of pairs that are used in the calculations. The USEPA recommends that normalized bias fall between ± 5 – 15 percent.

4. Gross error. For the entire modeling domain, gross error for all pairs above 60 parts per billion (ppb) of ozone was calculated. For the Metrolina nonattainment area, the gross error was calculated on the daily 8-hour ozone maximums. The USEPA guidance suggests that gross error can be interpreted as precision of the model. This metric is typically used to compare various modeling applications. The USEPA recommends that the gross error of all pairs >60 ppb be less than 30-35 percent.

These statistics will be presented in the sections that follow for the entire 12-km modeling domain and for the Metrolina nonattainment area.

Another method of evaluating model performance is reviewing spatial plots and time series plots of the modeled versus observed data. These graphical plots aid in getting a better understanding of how the model is performing over the whole domain.

Only the model performance evaluation for the 12-km grid domain will be discussed in the subsections to follow. For the full model performance evaluation for both the 36-km and 12-km grid domains, please refer to Appendix J.

3.1 Domain-Wide Performance

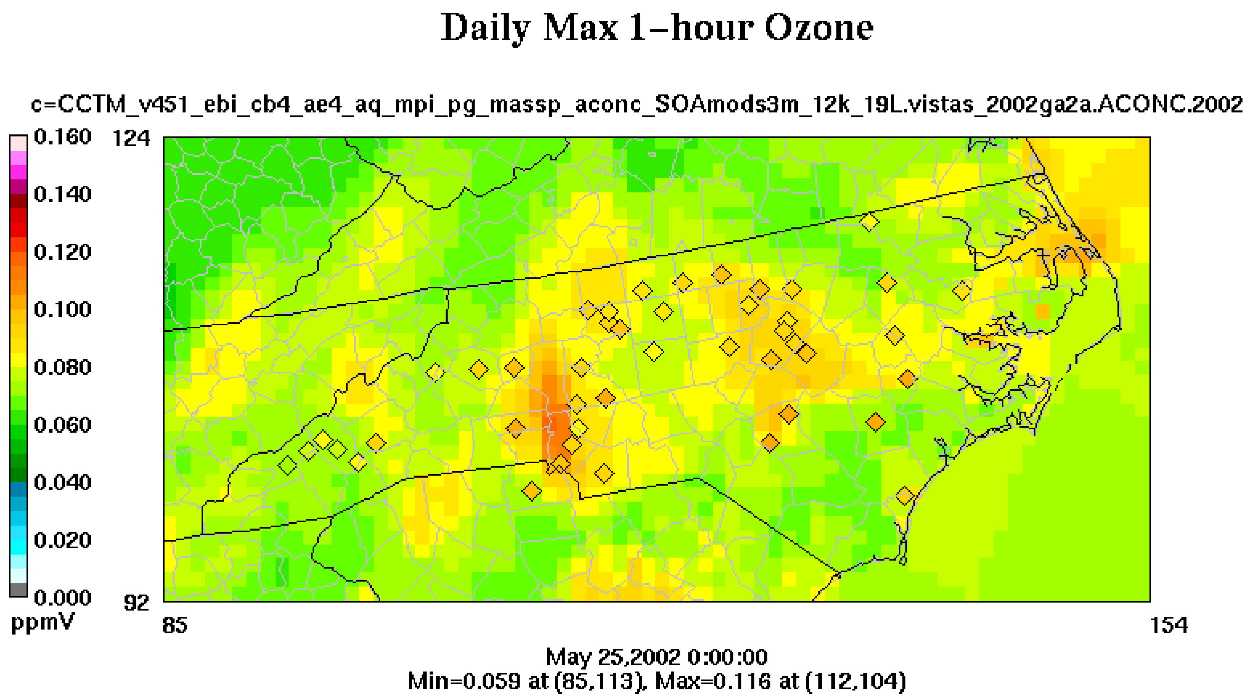
The 8-hour ozone statistical data was calculated for the 12-km domain for the ASIP states, North Carolina and South Carolina and is presented in Tables 3.1-1. The mean normalized bias was well within the recommended ± 5-15 percent for the entire season (May through September). When looking at the individual monthly statistics for August and September in North Carolina and South Carolina, the mean normalized bias was slightly outside the suggested range. This suggests an under prediction of ozone toward the end of the summer, however the NCDAQ does not believe this slight under prediction for August and September impacts the overall modeling results. The mean normalized gross error was significantly below the 30-35 percent range at the 60 ppb threshold for all regions. These statistical metrics were used as a first screening of the model performance.

Table 3.1-1. 12-km Domain Model Statistics for 8-Hour Ozone

Region/Month	Modeled Mean (ppb)	Observed Mean (ppb)	Mean Bias (ppb)	Mean Normalized Bias (%)	Mean Normalized Gross Error (%)
ASIP States combined					
May	61.26	67.69	-6.44	-8.96	12.47
June	62.62	70.99	-8.37	-11.37	14.02
July	62.73	70.85	-8.12	-10.90	14.74
August	61.33	72.57	-11.24	-14.92	16.98
September	60.81	71.98	-11.17	-14.98	17.07
Mean (May-September)	***61.75***	***70.82***	***-9.07***	***-12.23***	***15.06***
North Carolina					
May	64.06	69.05	-5	-6.86	10.76
June	62.21	71.82	-9.62	-13.03	14.47
July	62.94	72.10	-9.16	-12.09	14.63
August	60.60	73.92	-13.33	-17.40	18.34
September	57.90	69.37	-11.46	-16.11	17.68
Mean (May-September)	***61.54***	***71.25***	***-9.71***	***-13.10***	***15.18***
South Carolina					
May	63.87	67.71	-3.85	-5.31	9.66
June	61.95	70.92	-8.97	-12.10	13.52
July	60.89	70.24	-9.35	-12.73	14.75
August	59.77	71.39	-11.62	-16.03	16.64
September	61.18	72.62	-11.44	-15.22	16.32
Mean (May-September)	***61.53***	***70.58***	***-9.05***	***-12.28***	***14.18***

3.1.1 Spatial Plots

Appendix J has all of the domain-wide spatial plots of modeled 1-hour and 8-hour maximum ozone with the observations overlaid for the days used in the relative response factor calculations. In this section, only representative days will be displayed (Figures 3.1.1-1 and 3.1.1-7). Overall the model does well with the spatial extent of the higher ozone concentrations. There is a slight under prediction of the ozone in the model, most notably in the 1-hour ozone plots. Higher ozone concentrations are seen in the urban areas, where it would be expected. In general, the NCDAQ believes the model does an acceptable job capturing the spatial distribution and concentration of ozone in the Metrolina region.



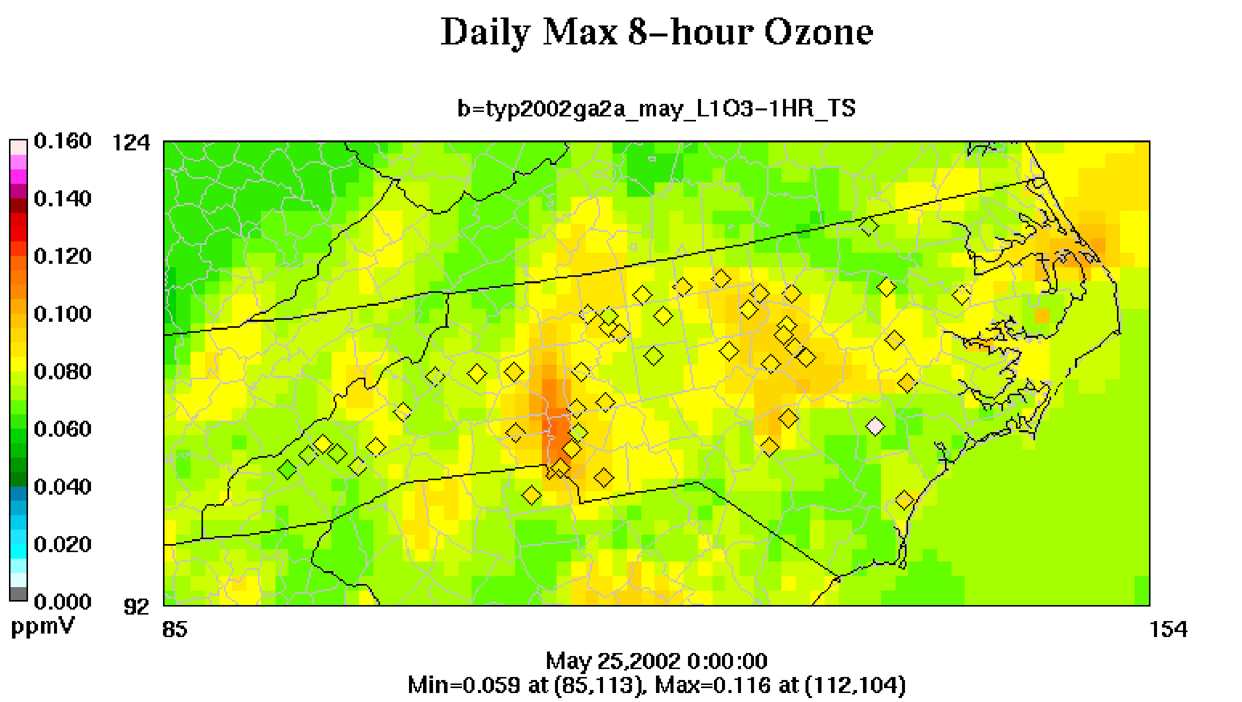
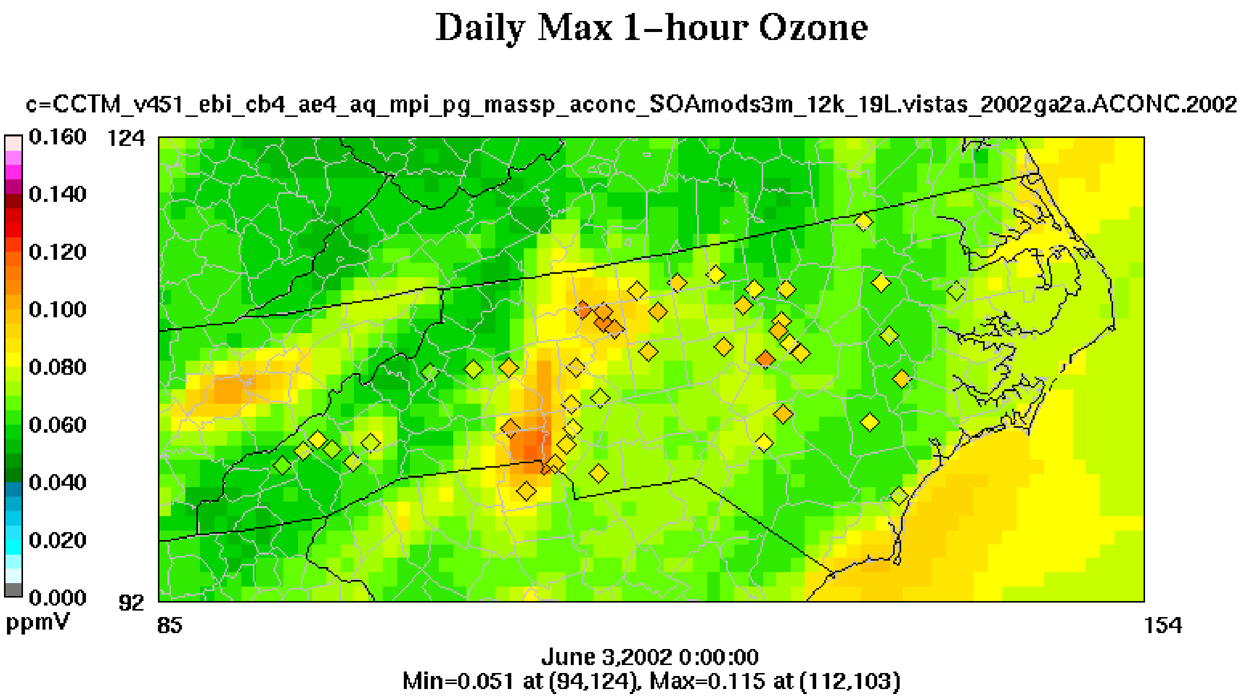


Figure 3.1.1-1 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for May 25, 2002.



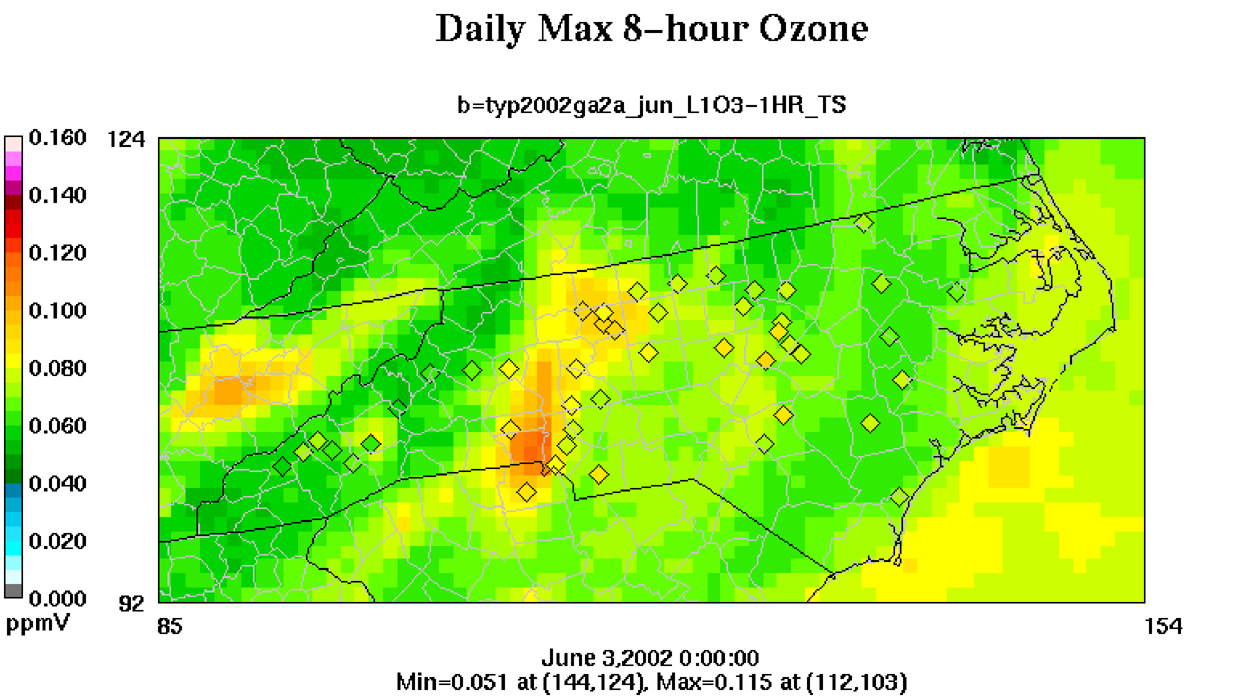
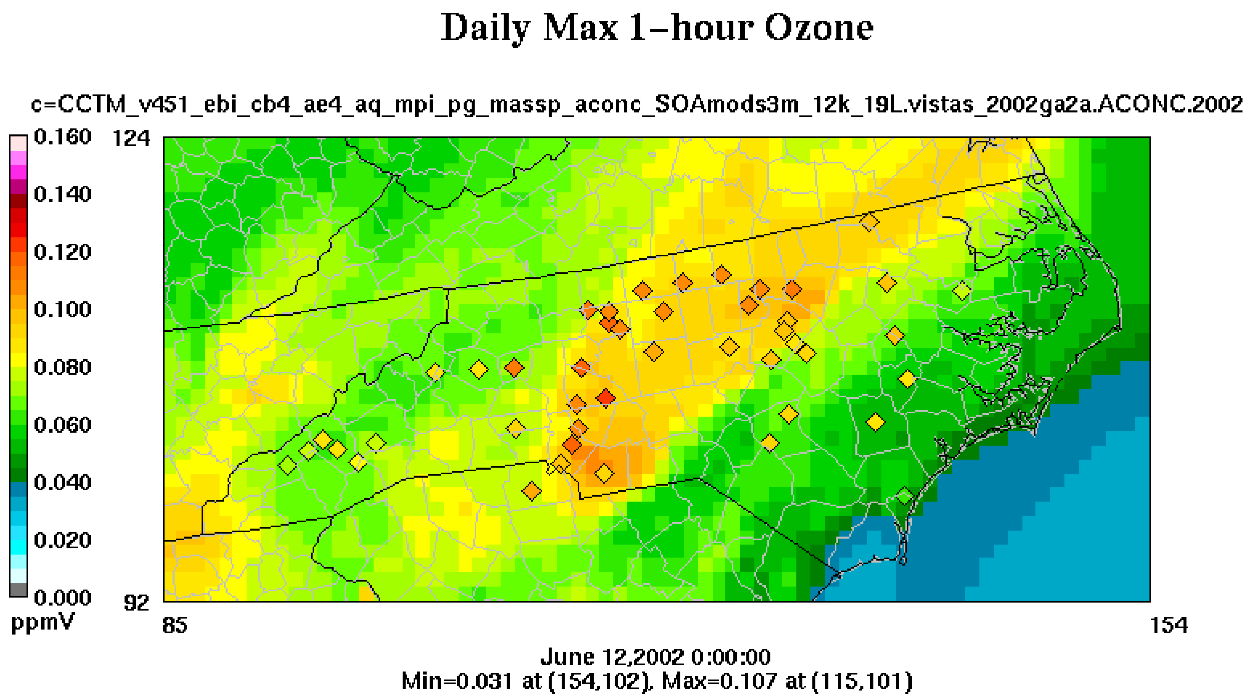


Figure 3.1.1-2 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for June 3, 2002.



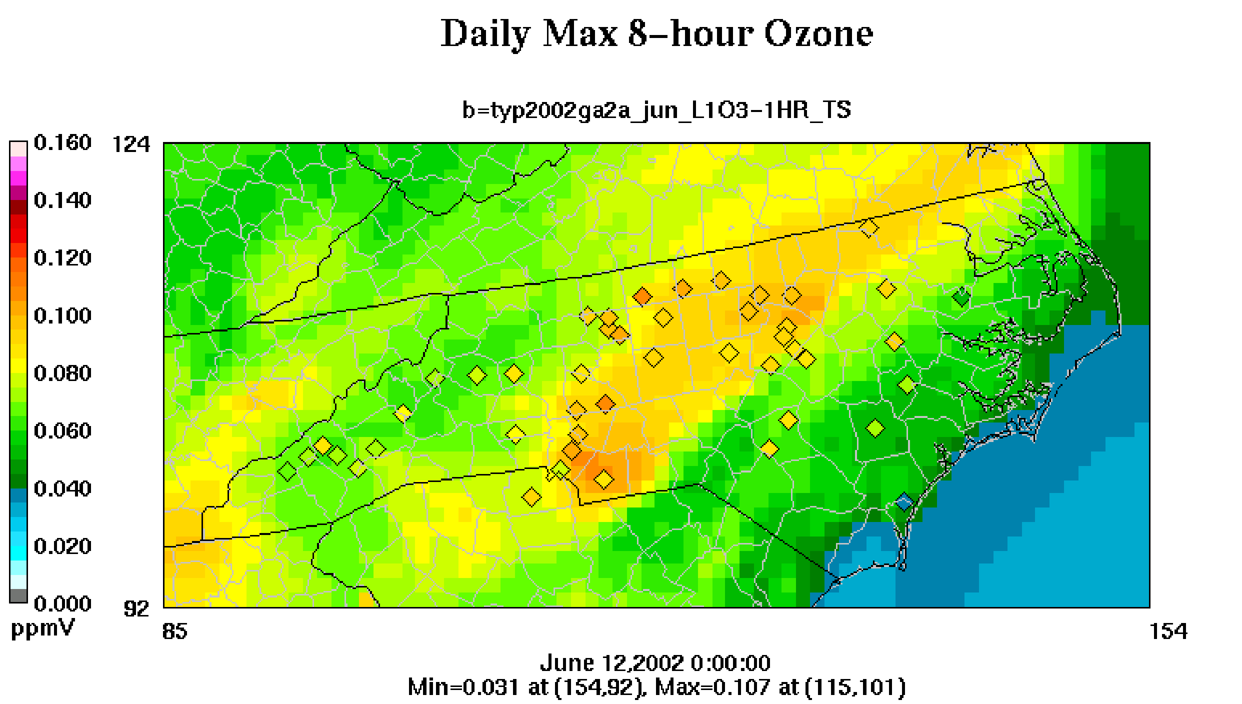


Figure 3.1.1-3 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for June 12, 2002.

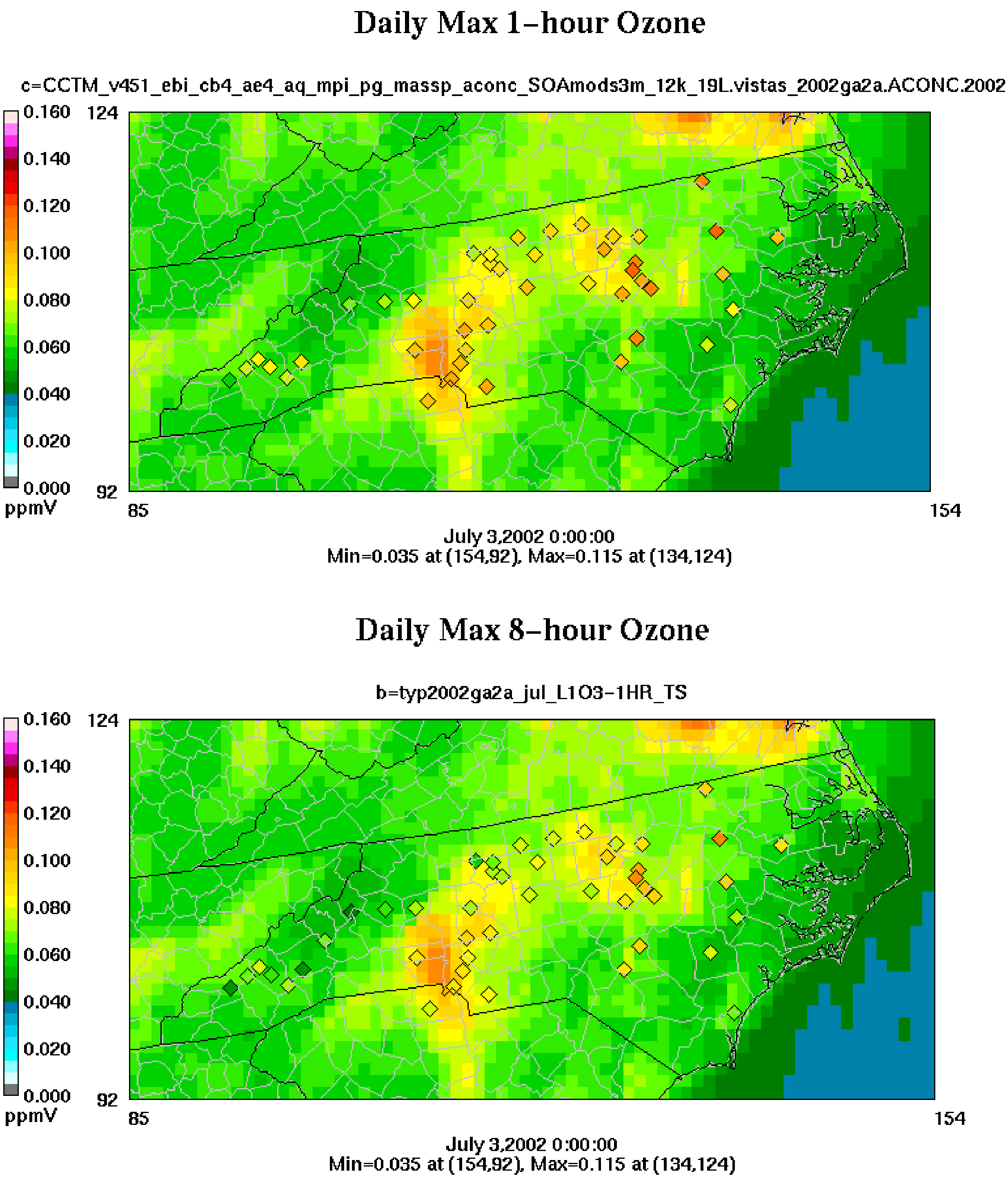


Figure 3.1.1-4 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for July 3, 2002.

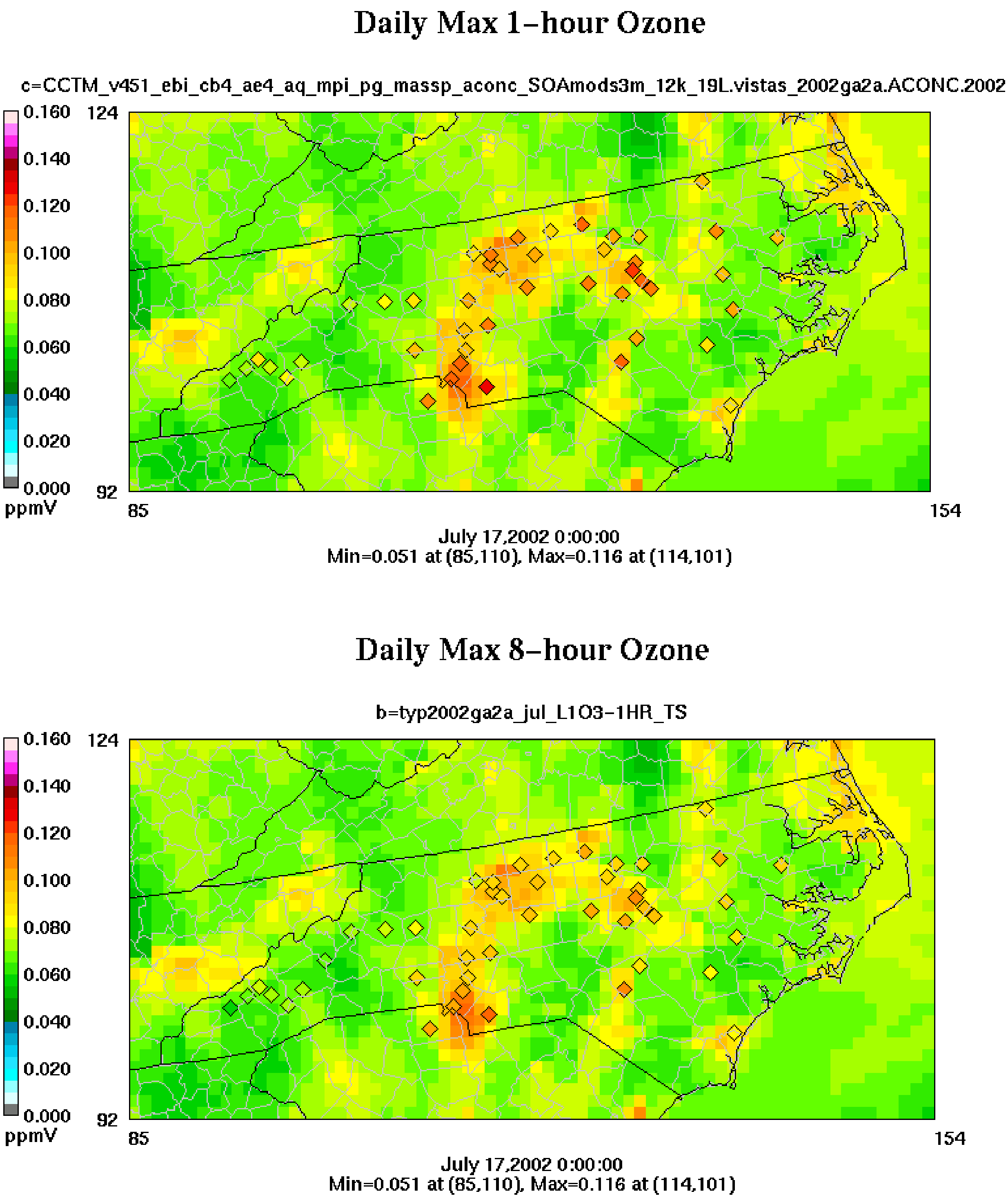
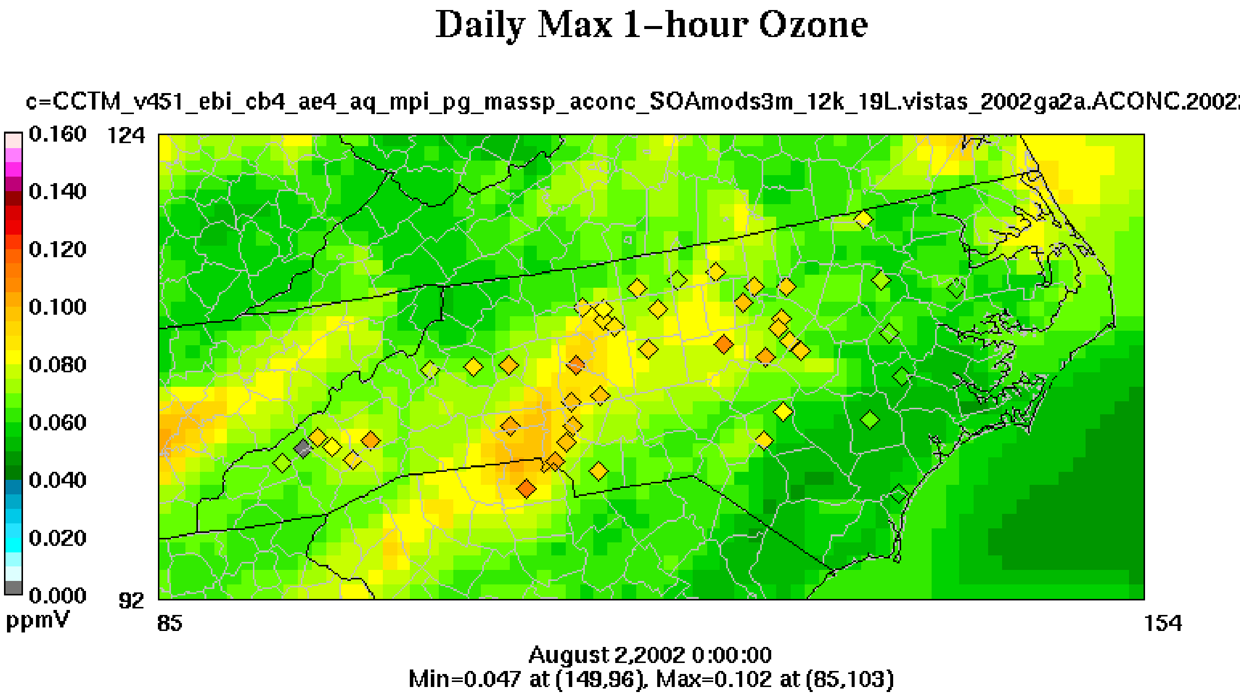


Figure 3.1.1-5 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for July 17, 2002.



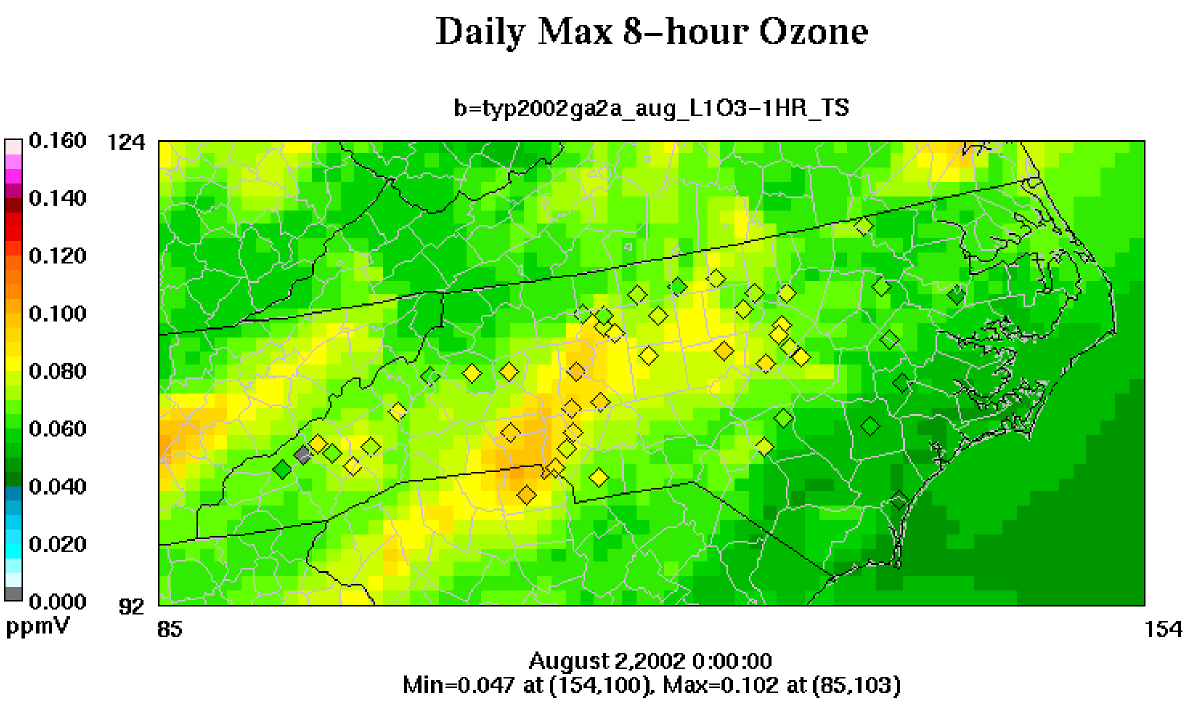
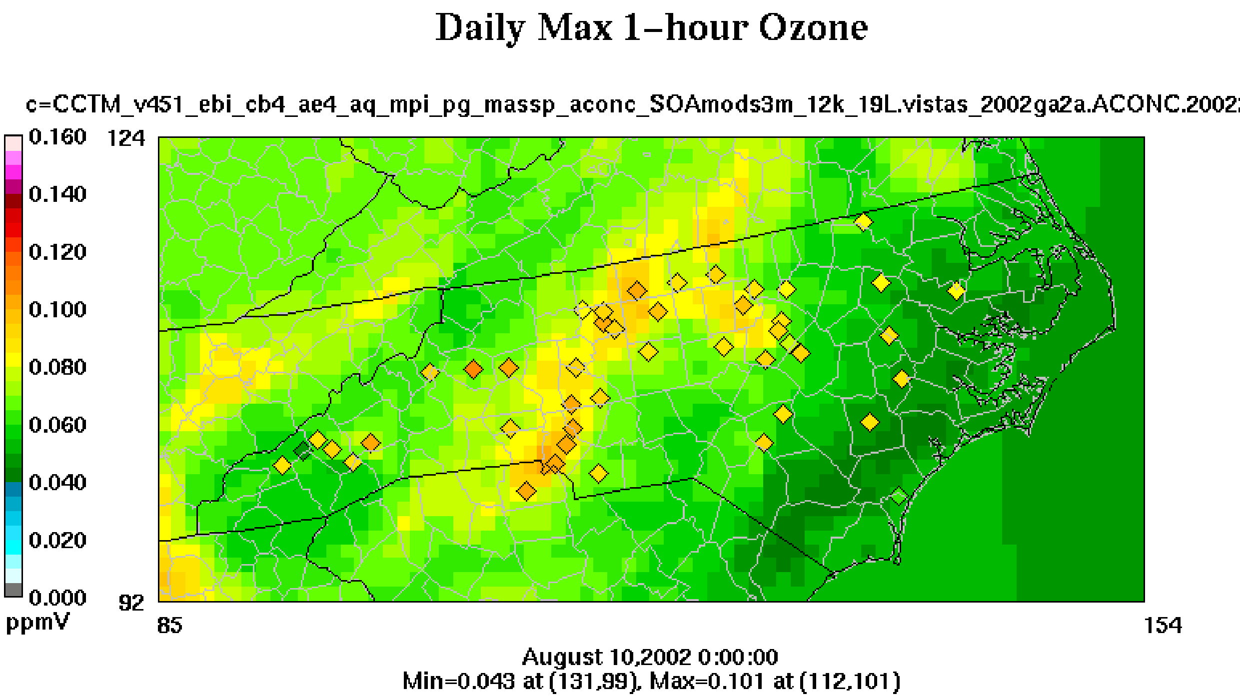


Figure 3.1.1-6 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for August 2, 2002.



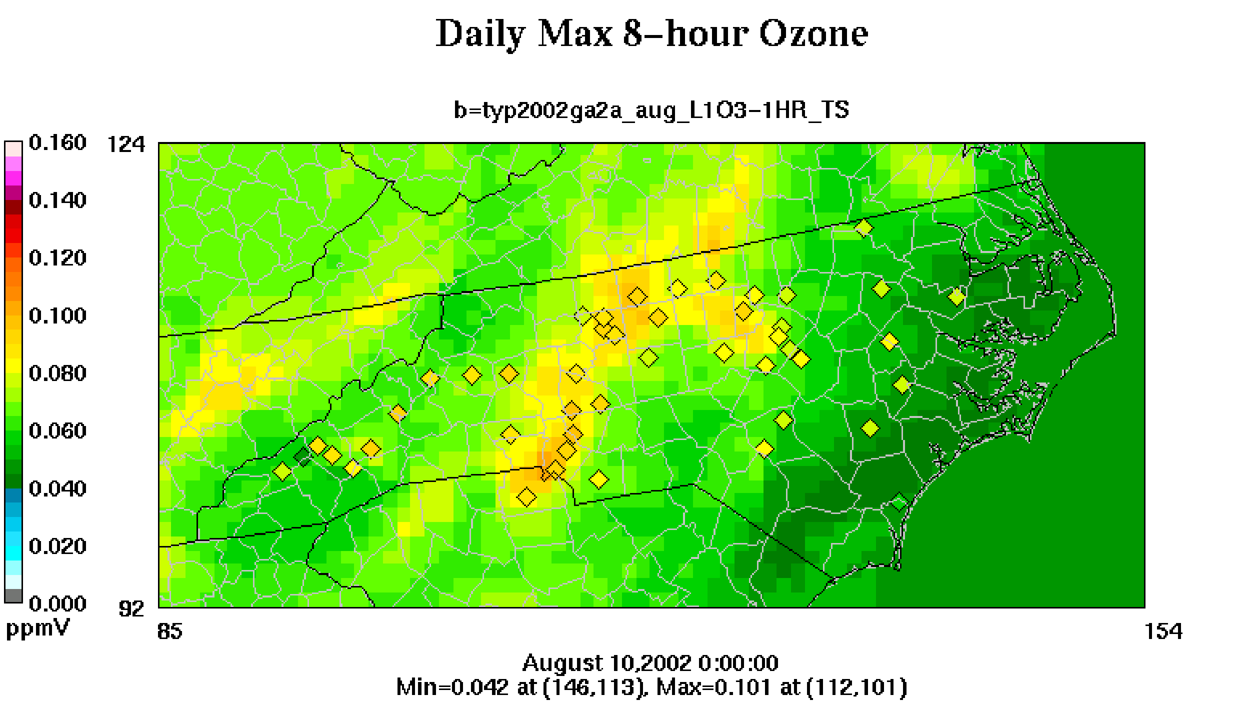


Figure 3.1.1-7 Spatial plots for modeled predicted and observed peak 1-hour (top) and 8-hour (bottom) ozone concentrations for August 10, 2002.

3.1.2 Scatter Plots

The NCDAQ is most concerned about how the model performed for North and South Carolina and secondarily for the whole 12-km domain. For this reason, the scatter plots below are for the two states and the domain-wide scatter plots can be found in Appendix J. The model performance scatter plots of modeled predicted versus observed for 1-hour and 8-hour ozone has been compiled for each month used in the attainment test (May through September). Only the 8-hour ozone scatter plots for the three months (June through August) in which the majority of the modeled days used in the relative response factor are shown. Although there are some outliers, the overall performance is good for the 2002 ozone season. The majority of the points fall within the acceptable limits of good model performance.

North Carolina scatter plots

Figure 3.1.2-1 through 3.1.2-3 displays the scatter plots for 8-hour ozone for June, July and August for all of the monitoring sites in North Carolina. The 1-hour ozone scatter plots and the remaining 8-hour ozone scatter plots can be found in Appendix J. Overall, for the North Carolina monitoring sites the model performance is good. Although there are some days where over predictions and under predictions are observed, in general most days fall within acceptable ranges of the 1:1 line.

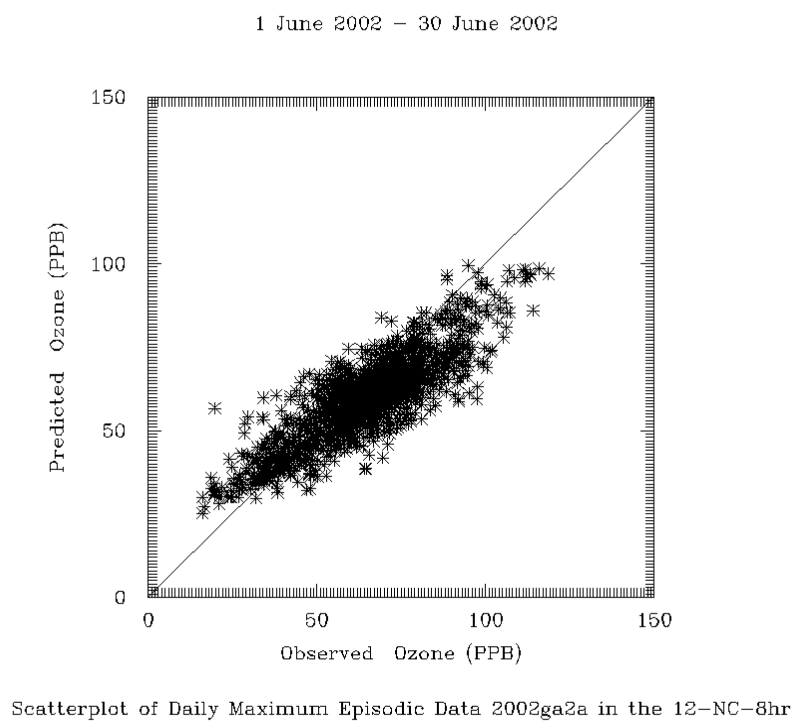


Figure 3.1.2-1 8-hour ozone scatter plot for North Carolina 12-km grid for June 2002

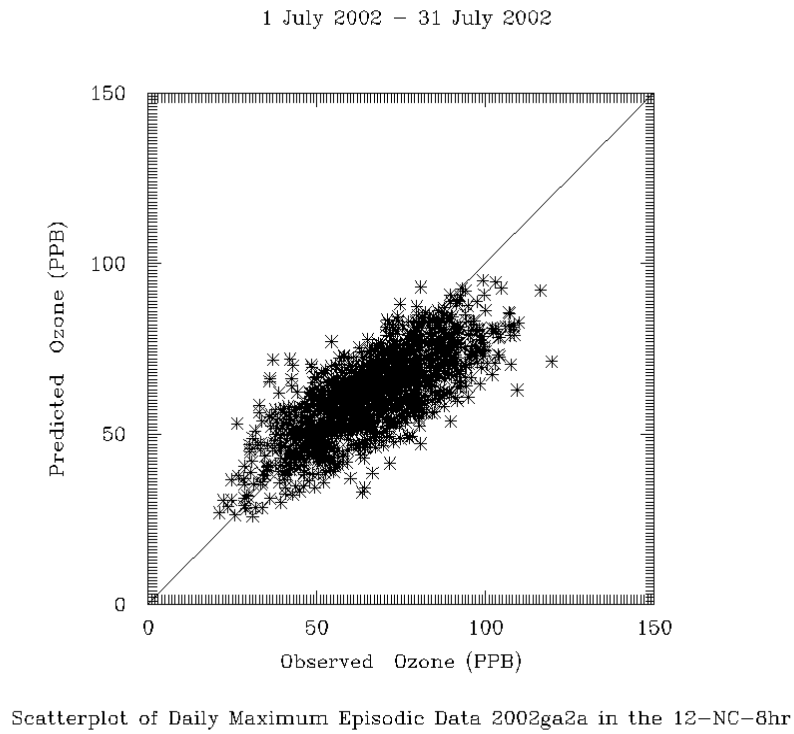


Figure 3.1.2-2 8-hour ozone scatter plots for North Carolina 12-km grid for July 2002

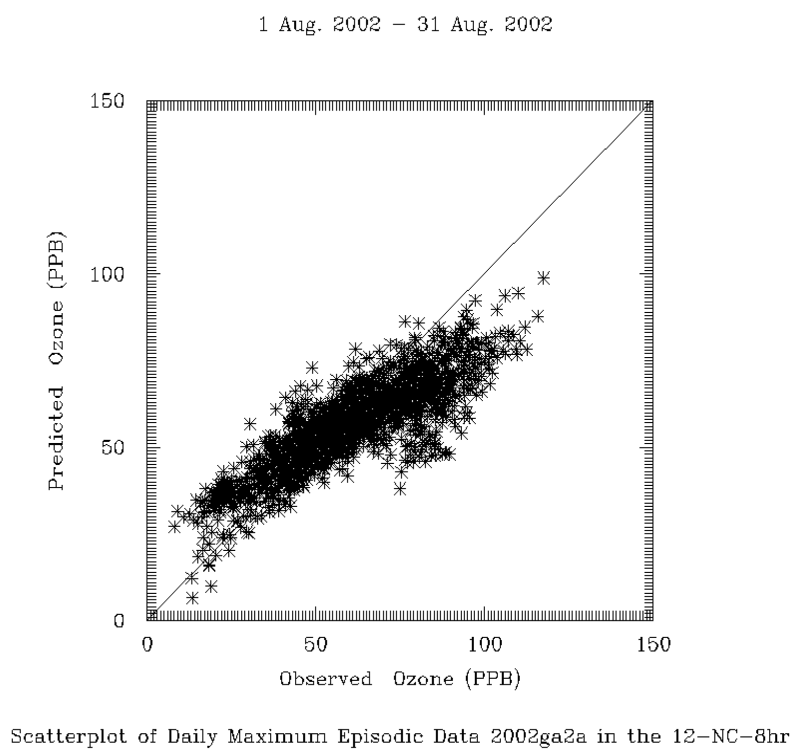


Figure 3.1.2-3 8-hour ozone scatter plots for North Carolina 12-km grid for August 2002

South Carolina scatter plots

Figure 3.1.2-4 through 3.1.2-6 displays the scatter plots for 8-hour ozone for June, July and August for all of the monitoring sites in South Carolina. The 1-hour ozone scatter plots and the remaining 8-hour ozone scatter plots can be found in Appendix J. Overall, the model performance is good for the South Carolina monitoring sites. Again, although there are some days where over predictions and under predictions are observed, in general most days fall within acceptable ranges of the 1:1 line.

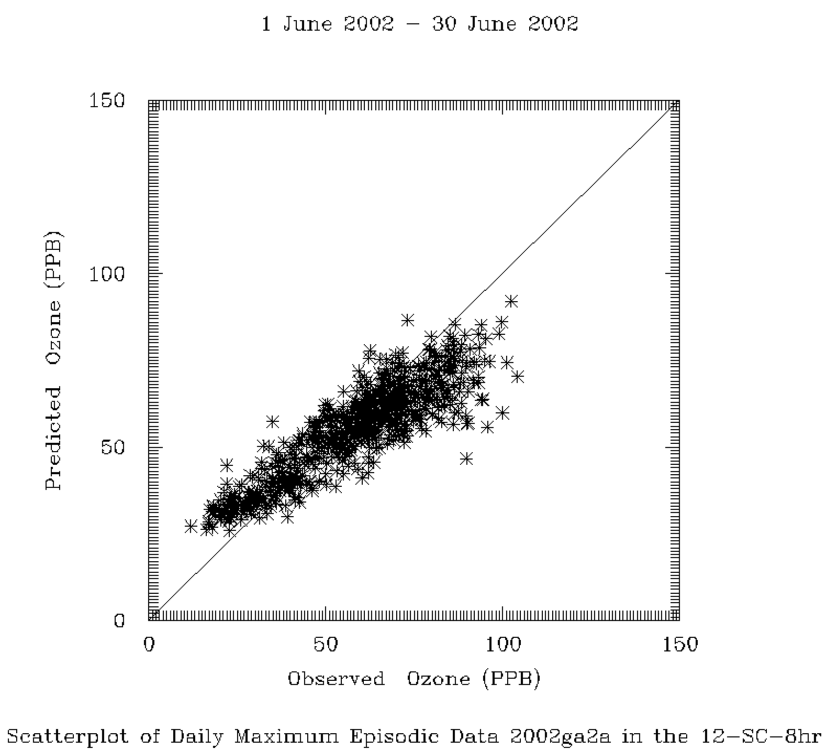


Figure 3.1.2-4 8-hour ozone scatter plots for South Carolina 12-km grid for June 2002

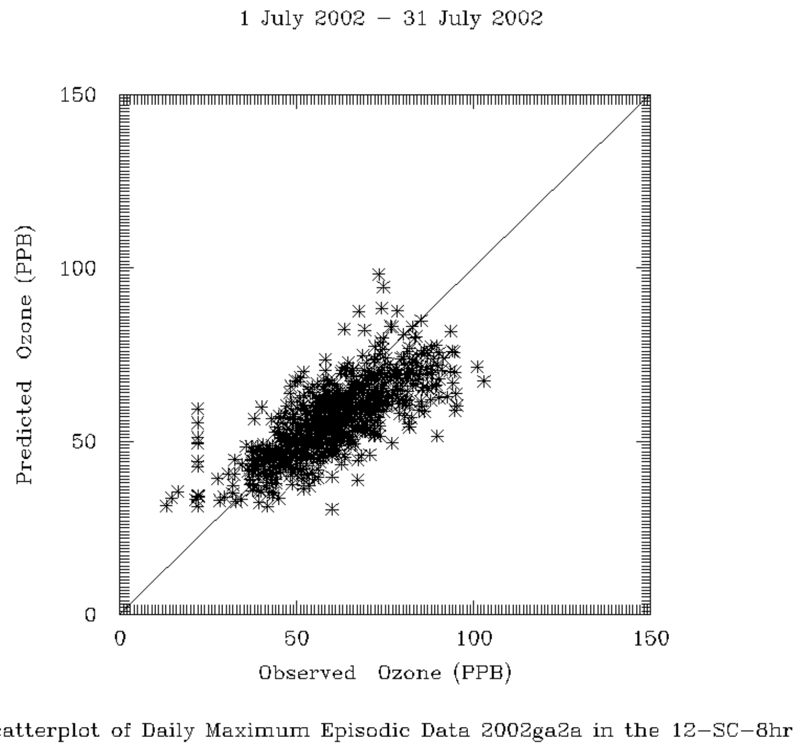


Figure 3.1.2-5 8-hour ozone scatter plots for South Carolina 12-km grid for July 2002

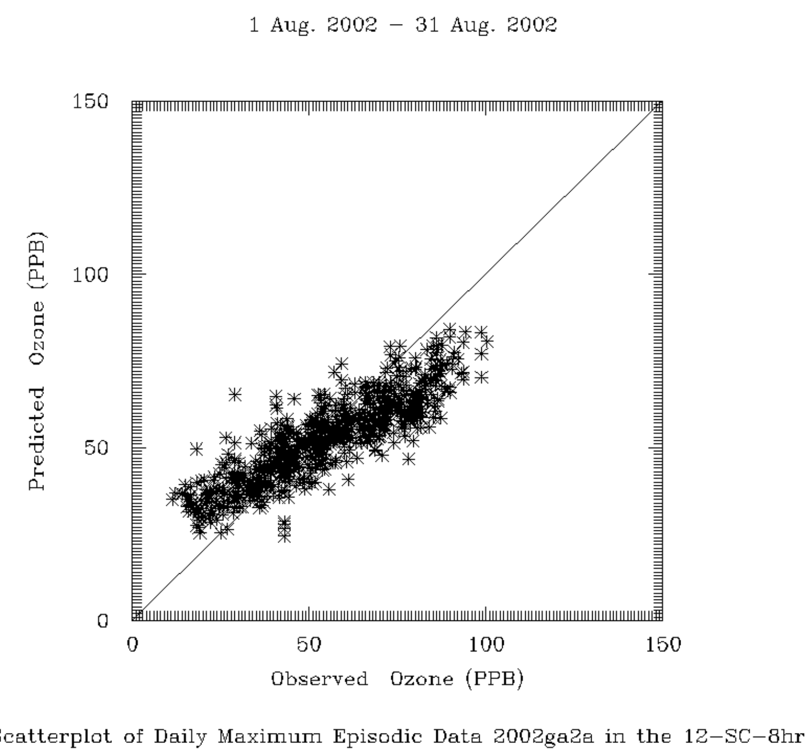


Figure 3.1.2-6 8-hour ozone scatter plots for South Carolina 12-km grid for August 2002

3.1.3 Time Series Plots

Following are 8-hour time series plots from the 12 km domain for the North Carolina monitors for June through August. The time series presents the observed values (black *'s) and the predicted values (green lines) by month. The 1-hour and 8-hour ozone time series plots for the ASIP region, North Carolina and South Carolina can be found in Appendix J.

The model predicts the overall diurnal pattern well, however it tends to under predict peak values and over predict minimum values. In particular the last few days of August shows the model not handling the prediction of the absolute value of ozone well. Overall, the model is within acceptable tolerances for model performance.

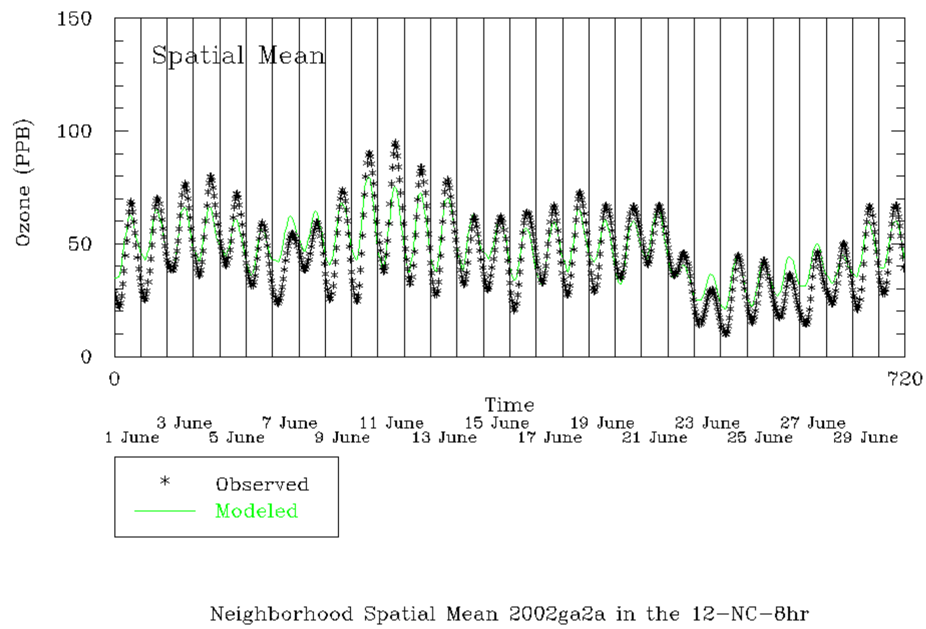


Figure 3.1.3-1 Time series plot of model predicted versus mean 8-hour observed for North Carolina monitors for June 2002.

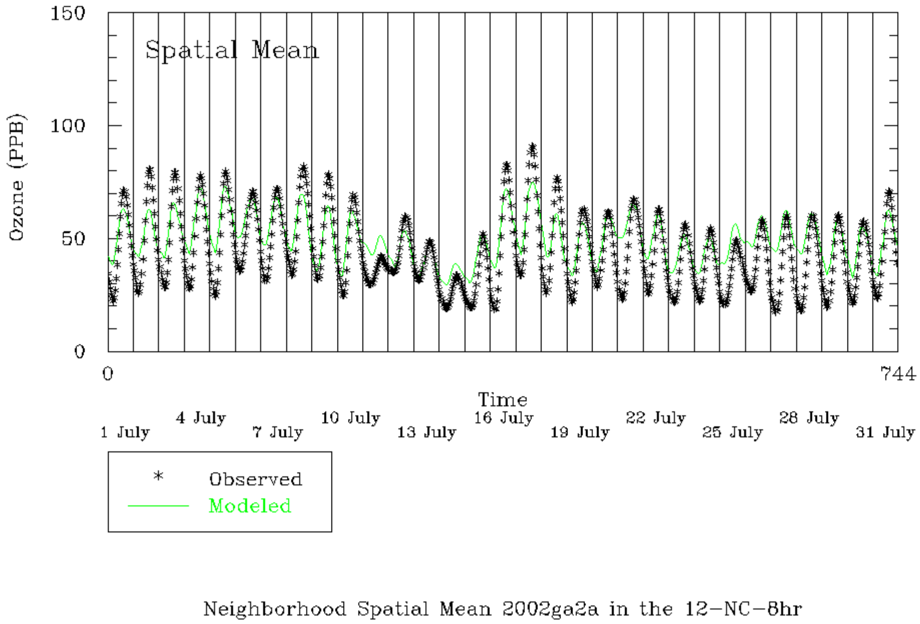


Figure 3.1.3-2 Time series plot of model predicted versus mean 8-hour observed for North Carolina monitors for July 2002.

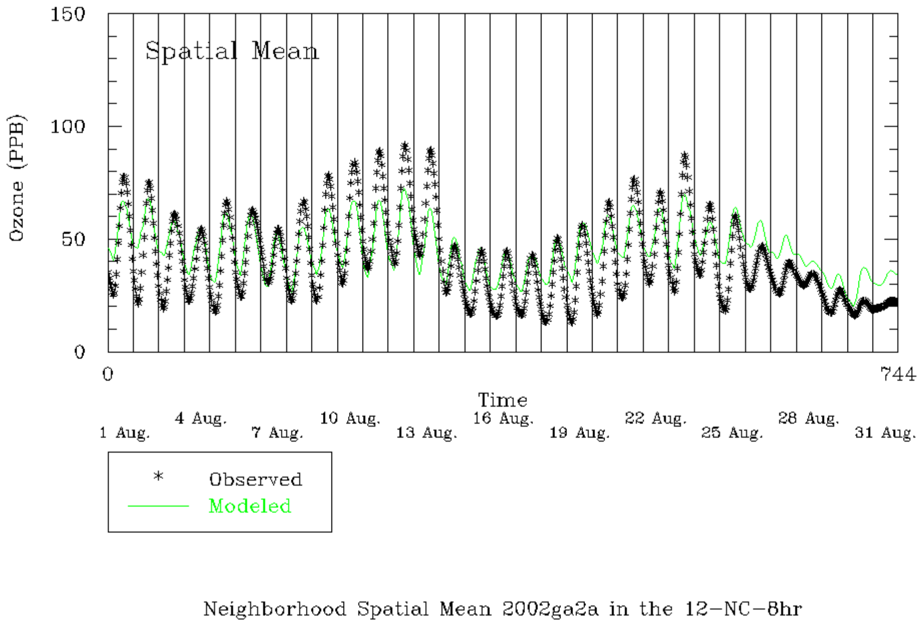


Figure 3.1.3-3 Times series plot of model predicted versus mean 8-hour observed for North Carolina monitors for August 2002

3.1.4 Domain-Wide Summary

Overall, the model performance for North Carolina and South Carolina throughout the ozone season is good. For the most part, mean normalized bias and mean normalized gross error are within the recommended limits for good model performance. The model seems to do a good job capturing ozone concentrations through various episode-clean out cycles. There are some instances of under and over predictions, but for the majority of the time the model does well simulating the afternoon ozone peak throughout North Carolina and South Carolina. The scatter plots show that the model did well. The NCDAQ believes that the model performance is well within the limits of acceptable performance established in the USEPA's Guidance On The Use Of Models And Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze ("*Attainment Guidance*").

3.2 Metrolina Nonattainment Area Model Performance Evaluation

Below is the model performance evaluation for the Metrolina nonattainment area. Included are visual (e.g. time series) and statistical measures. These evaluation products include:

1. Time series plots showing how the model's predicted ozone compares to the observed ozone at the monitor within the same grid cell. This is considered the most stringent of the model performance evaluation procedures since it requires the evaluation of the model's ability to predict the observed ozone in the location where it was observed over all hours of the episode.

2. Statistical measures for entire nonattainment area and by monitor in the region. Statistical measures include mean bias, mean normalized bias, and mean normalized gross error. Like the time series, the statistics compare the observed ozone at the monitor to the grid cell where the monitor is located.

3.2.1 Time Series Plots

The following are the June through August time series plots for the 12km grid domain for the County Line and Enochville monitors located in Mecklenburg and Rowan Counties, respectively. The time series presents the observed values (green line) and the predicted values (red line). Presented here are just the 8-hour ozone plots for these two monitors, all of the May through September, 1-hour and 8-hour ozone time series plots for the monitors in the nonattainment area can be found in Appendix J.

As with the larger domain time series plots, the air quality model tends to slightly under predict peak 8-hour ozone values. The over prediction of the nighttime minimum issue is more noticeable in the individual monitoring site time series, especially these more urbanized sites due to the higher night time nitrogen oxide (NOx) environment found in such a urban area. The NOx emissions titrate the ozone after sunset and the ozone levels decrease dramatically. The air quality model does not replicate this type of phenomenon very well. The nighttime minimum over prediction is not an issue with respect to the modeled attainment test and is therefore not of significant concern in this modeling exercise. The ability of the air quality model to accurately capture the synoptic cycles from high ozone episodes to very clean periods is best demonstrated in these individual monitor time series. Despite the under prediction of some of the 8-hour ozone daily maximum and the over night over predictions, the NCDAQ concludes that the air quality modeling continues to meet all requirements for further application in the modeled attainment test.

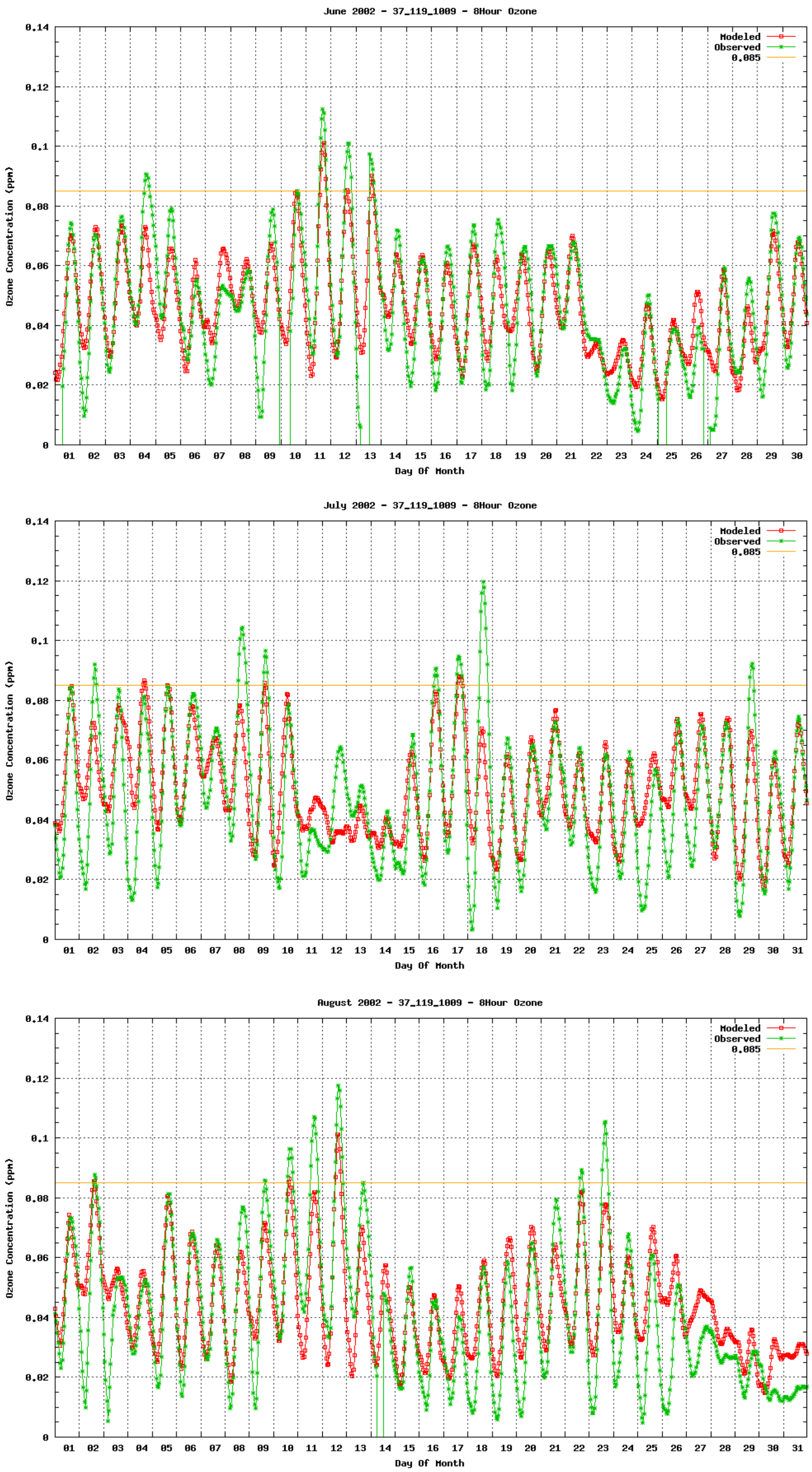


Figure 3.2.1-1 Time series plots of model predicted versus 8-hour ozone concentrations for County Line monitor for June (top), July (middle) and August (bottom).

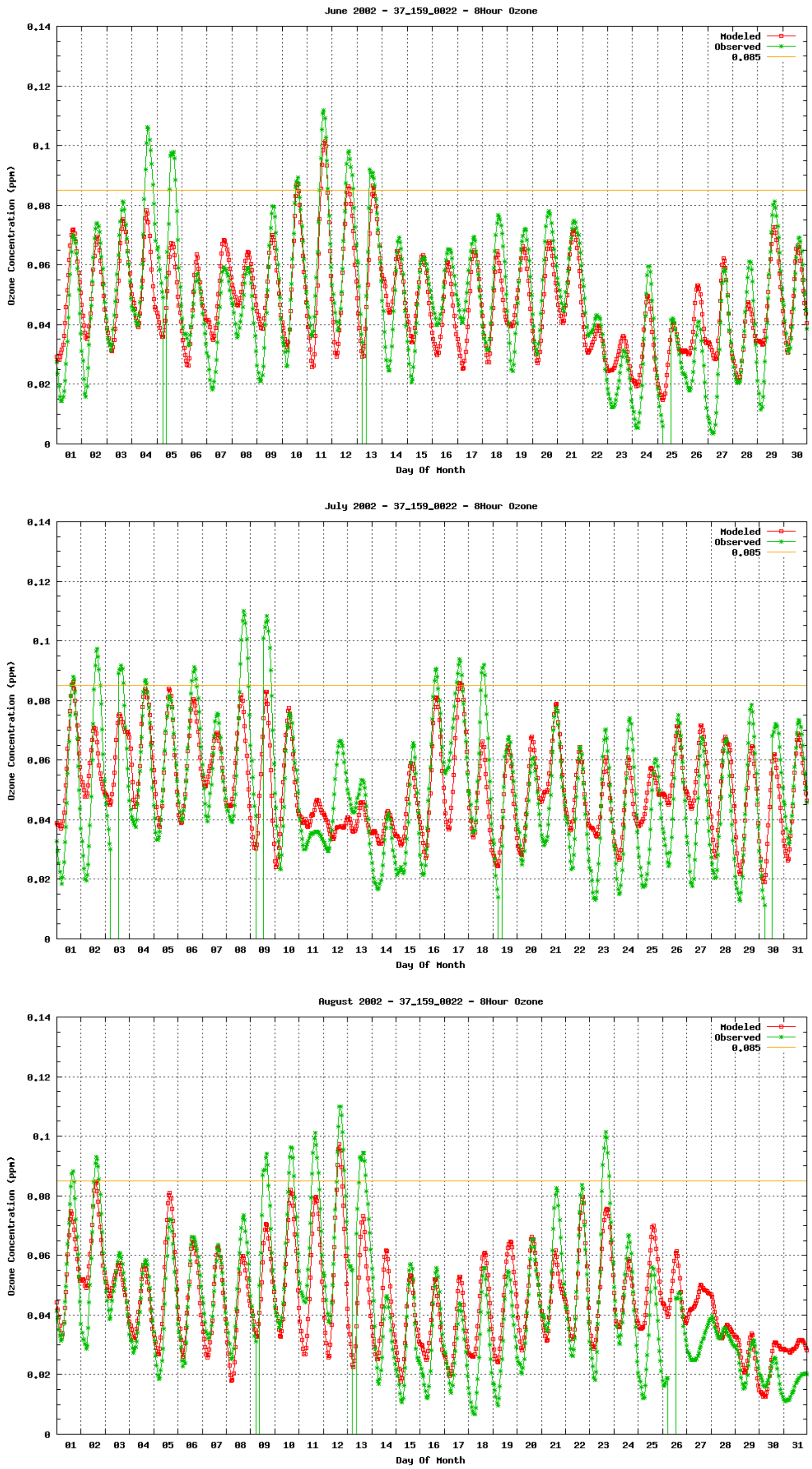


Figure 3.2.1-2 Time series plots of model predicted versus 8-hour ozone concentrations for Enochville monitor for June (top), July (middle) and August (bottom).

3.2.2 Area and Monitor Statistics

Table 3.2.2-1 displays the model performance statistics comparing the modeled 8-hour ozone mean and the observed 8-hour ozone mean at each monitor in the Metrolina area, as well as the combined statistics for all of the monitors in the Metrolina area. The statistics represent the May through September time period.

Table 3.2.2-1. Metrolina Nonattainment Area Monitor Statistics

Monitor	Modeled Mean (ppb)	Observed Mean (ppb)	Mean Bias (ppb)	Mean Normalized Bias (%)	Mean Normalized Gross Error (%)
Metrolina Area	**66.87**	**75.75**	**-8.75**	**-10.72**	**15.04**
Crouse	69.0	76.0	-6.0	-7.232	12.050
County Line	66.0	76.0	-11.0	-13.777	17.861
Garinger (Plaza)	69.0	74.0	-5.0	-5.872	14.354
Arrowood	69.0	77.0	-8.0	-9.248	13.835
Enochville	66.0	76.0	-10.0	-12.223	14.812
Rockwell	68.0	77.0	-9.0	-11.230	14.767
Monroe	63.0	75.0	-12.0	-14.677	17.048
York County, SC	65.0	75.0	-9.0	-11.471	15.549

It is recommended that the combined mean normalized bias fall within ± 5-15 percent and the combined mean normalized gross error not exceed the 30-35 percent range. For a specific monitor, it is recommended that the mean normalized bias fall within ± 20 percent. From the table above it is demonstrated that the mean bias, mean normalized bias, and mean normalized gross error were all within recommended and accepted ranges.

A slight under prediction of 8-hour ozone was also observed at this more refined level of analysis and was similar to what was seen at the larger state and VISTAS/ASIP region levels. Individual monthly statistics are not presented here due to the very limited number of modeled and observed data pairs at just the eight Metrolina ozone monitoring sites. Whole season statistics are more representative of how this air quality modeling will be applied in the modeled attainment test discussed in Appendix L. Across the whole season, the Metrolina region as a whole, as well as the individual ozone monitoring sites, had mean normalized bias statistics in the suggested ± 5-15 percent range and mean normalized gross error statistics in the suggested 30-35 percent range given a 60 ppb threshold.

4.0 CONTROLS APPLIED

Several control measures already in place or being implemented over the next few years will reduce stationary point, highway mobile, and nonroad mobile sources emissions. The Federal and State control measures were modeled for all of the future years and are discussed in the sections below.

4.1 Federal Control Measures

4.1.1 Tier 2 Vehicle Standards

Federal Tier 2 vehicle standards will require all passenger vehicles in a manufacturer's fleet, including light-duty trucks and Sport Utility Vehicles (SUVs), to meet an average standard of 0.07 grams of NOx per mile. Implementation began in 2004, and should be completely phased in by 2007. The Tier 2 standards will also cover passenger vehicles over 8,500 pounds gross vehicle weight rating (the larger pickup trucks and SUVs), which are not covered by the current Tier 1 regulations. For these vehicles, the standards will be phased in beginning in 2008, with full compliance in 2009. The new standards require vehicles to be 77% to 95% cleaner than those on the road today. The Tier 2 rule also reduced the sulfur content of gasoline to 30 ppm starting in January of 2006. Most gasoline sold in North Carolina prior to January 2006 had a sulfur content of about 300 ppm. Sulfur occurs naturally in gasoline, but interferes with the operation of catalytic converters on vehicles resulting in higher NOx emissions. Lower-sulfur gasoline is necessary to achieve the Tier 2 vehicle emission standards.

4.1.2 Heavy-Duty Gasoline and Diesel Highway Vehicles Standards

New USEPA standards designed to reduce NOx and VOC emissions from heavy-duty gasoline and diesel highway vehicles began to take effect in 2004. A second phase of standards and testing procedures, beginning in 2007, will reduce particulate matter from heavy-duty highway engines, and will also reduce highway diesel fuel sulfur content to 15 ppm since the sulfur damages emission control devices. The total program is expected to achieve a 90% reduction in particulate matter (PM) emissions and a 95% reduction in NOx emissions for these new engines using low sulfur diesel, compared to existing engines using higher-content sulfur diesel.

4.1.3 Large Nonroad Diesel Engines Rule

In May 2004, the USEPA promulgated new rules for large nonroad diesel engines, such as those used in construction, agricultural, and industrial equipment, to be phased in between 2008 and 2014. The nonroad diesel rules also reduce the allowable sulfur in nonroad diesel fuel by over 99%. Nonroad diesel fuel currently averages about 3,400 ppm sulfur. The rule limits nonroad diesel sulfur content to 500 ppm in 2006 and 15 ppm in 2010. The combined engine and fuel rules would reduce NOx and PM emissions from large nonroad diesel engines by over 90%, compared to current nonroad engines using higher-content sulfur diesel.

4.1.4 Nonroad Spark-Ignition Engines and Recreational Engines Standard

The new standard, effective in July 2003, regulates NOx, HC and CO for groups of previously unregulated nonroad engines. The new standard will apply to all new engines sold in the United States and imported after these standards begin and will apply to large spark-ignition engines (forklifts and airport ground service equipment), recreational vehicles (off-highway motorcycles and all-terrain-vehicles), and recreational marine diesel engines. The regulation varies based upon the type of engine or vehicle.

The large spark-ignition engines contribute to ozone formation and ambient CO and PM levels in urban areas. Tier 1 of this standard was implemented in 2004 and Tier 2 is scheduled to start in 2007. Like the large spark-ignition, recreational vehicles contribute to ozone formation and ambient CO and PM levels. For the off-highway motorcycles and all-terrain-vehicles, model year 2006, the new exhaust emissions standard was phased-in by 50% and for model years 2007 and later at 100%. Recreational marine diesel engines over 37 kilowatts are used in yachts, cruisers, and other types of pleasure craft. Recreational marine engines contribute to ozone formation and PM levels, especially in marinas. Depending on the size of the engine, the standard began phasing-in in 2006.

When all of the nonroad spark-ignition engines and recreational engines standards are fully implemented, an overall 72% reduction in HC, 80% reduction in NOx, and 56% reduction in CO emissions are expected by 2020. These controls will help reduce ambient concentrations of ozone, CO, and fine PM.

4.1.5 NOx SIP Call in Surrounding States

In October 1998, the USEPA made a finding of significant contribution of NOx emissions from certain states and published a rule that set ozone season NOx budgets for the purpose of reducing regional transport of ozone (63 FR 57356). This rule, referred to as the NOx SIP Call, called for ozone season controls to be put on utility and industrial boilers, as well as internal combustion engines in 22 states in the Eastern United States. A NOx emissions budget was set for each state and the states were required to develop rules that would allow the state to meet their budget. A NOx trading program was established, allowing sources to buy credits to meet their NOx budget as opposed to actually installing controls. The emission budgets were to be met by the beginning of 2004. Even with the trading program, the amount of ozone season NOx emissions has decreased significantly in and around North Carolina.

4.1.6 Clean Air Interstate Rule

On May 12, 2005, the USEPA promulgated the "Rule To Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule); Revisions to Acid Rain Program; Revisions to the NOx SIP Call", referred to as CAIR. This rule established the requirement for States to adopt rules limiting the emissions of NOx and sulfur dioxide (SO_2) and a model rule for the states to use in developing their rules. The purpose of the CAIR is to reduce interstate transport of precursors to fine particulate and ozone.

The CAIR applies to (1) any stationary, fossil-fuel-fired boiler or stationary, fossil-fuel-fired combustion turbine serving at any time, since the start-up of a unit's combustion chamber, a generator with nameplate capacity of more than 25 MWe producing electricity for sale and (2) for a unit that qualifies as a cogeneration unit during the 12-month period starting on the date that the unit first produces electricity and continues to qualify as a cogeneration unit, a cogeneration unit serving at any time a generator with nameplate capacity of more than 25 MWe and supplying in any calendar year more than one-third of the unit's potential electric output capacity or 219,000 MWh, whichever is greater, to any utility power distribution system for sale

This rule provide annual state caps for NOx and SO2 in two phases, with the Phase I caps for NOx and SO2 starting in 2009 and 2010, respectively. Phase II caps become effective in 2015. The USEPA is allowing the caps to be met through a cap and trade program if a state so chooses to participate in the program.

4.2 State Control Measures

North Carolina has adopted a number of regulations and legislation to address pollution issues across the State. These include the Clean Air Bill, the NOx SIP Call Rule, the Clean Smokestacks Act and the Open Burning Rule. All of these regulations were modeled in the attainment demonstration. These regulations are summarized below and the actual regulations and legislation can be viewed in Appendix M.

4.2.1 Clean Air Bill

The 1999 Clean Air Bill expanded the vehicle emissions inspection and maintenance program in North Carolina from 9 counties to 48 counties between July 1, 2002 and January 1, 2006 (Figure 4.2.1-1). Vehicles are tested using the onboard diagnostic system (OBDII), an improved method of testing, which indicates NOx emissions, among other pollutants. The previously used tailpipe test (i.e., idle test) did not measure NOx. Mecklenburg and Gaston Counties were required to have the idle test inspection and maintenance program due to the 1-hour ozone nonattainment/maintenance status of those counties. The idle test only tested VOC and CO emissions. Starting in 2006, the idle test was replaced with the OBDII test in these two counties.

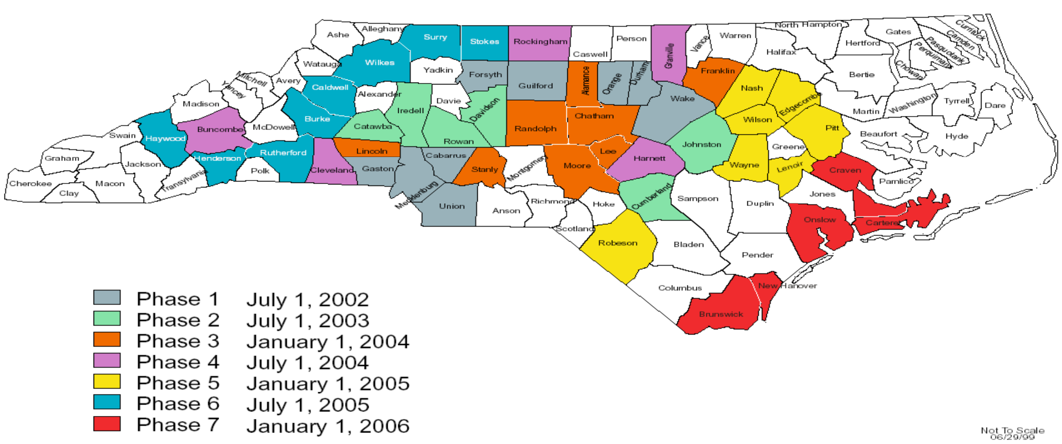


Figure 4.2.1-1 North Carolina's NOx Inspection and maintenance phase-in map

The effective dates for the counties in the Metrolina nonattainment area are listed below.

County	Date	County	Date
Cabarrus	July 1, 2002	Mecklenburg	July 1, 2002
Gaston	July 1, 2002	Rowan	July 1, 2003
Iredell	July 1, 2003	Union	July 1, 2002
Lincoln	January 1, 2004		

4.2.2 NOx SIP Call Rule

In response to the USEPA's NOx SIP call, North Carolina adopted rules to control the emissions of NOx from large stationary combustion sources. These rules cover (1) fossil fuel-fired stationary boilers, combustion turbines, and combined cycle systems serving a generator with a nameplate capacity greater than 25 megawatts and selling any amount of electricity, (2) fossil fuel-fired stationary boilers, combustion turbines, and combined cycle systems having a maximum design heat input greater than 250 million British thermal units per hour, and (3) reciprocating stationary internal combustion engines rated at equal or greater than 2400 brake horsepower (3000 brake horsepower for diesel engines and 4400 brake horsepower for dual fuel engines). As part of the NOx SIP call, the USEPA rules established a NOx budget for sources in North Carolina and other states.

Besides amending existing NOx rules and adopting new NOx rules specifically to address the USEPA NOx SIP call, the North Carolina rules also require new sources to control emissions of NOx. The objective of this requirement is (1) to aid in meeting the NOx budget for North Carolina for minor sources and (2) to aid in attaining and maintaining the ambient air quality standard for ozone in North Carolina.

North Carolina's NOx SIP Call rule was predicted to reduce summertime NOx emissions from power plants and other industries by 68% by 2006. In October 2000, the North Carolina Environmental Management Commission adopted rules requiring the reductions.

4.2.3 Clean Smokestacks Act

In June 2002, the North Carolina General Assembly enacted the Clean Smokestacks Act, requiring coal-fired power plants to reduce annual NOx emissions by 78% by 2009. These power plants must also reduce annual sulfur dioxide emissions by 49% by 2009 and by 74% by 2013. The Clean Smokestacks Act reduces NOx emissions beyond the requirements of the NOx SIP Call Rule. One of the first state laws of its kind in the nation, this legislation provides a model for other states in controlling multiple air pollutants from older coal-fired power plants.

4.2.4 Open Burning Bans

The North Carolina Environmental Management Commission (EMC) approved revisions to the open burning regulation banning open burning on forecasted code orange and higher air quality action days for those counties that the NCDAQ forecasts ozone and fine particulate matter. The

NCDAQ has forecasted ozone for the Metrolina area since 1998, and in 2002 started forecasting fine particulate matter year round. Therefore, the following counties in the Metrolina area are subject to this rule: Cabarrus, Gaston, southern Iredell, Lincoln, Mecklenburg, Rowan, and Union.

4.2.5 Clean Air Interstate Rule

In response to the USEPA's CAIR, the NCDAQ developed a state CAIR. Under the USEPA's rule, North Carolina has caps as follows:

- Annual NOx: 62,183 tons for 2009-2014 and
  51,819 tons for 2015 and each year thereafter;

- Ozone season NOx: 28,392 tons for 2009-2014 and
  23,660 tons for 2015 and each year thereafter;

- Annual SO_2: 137,342 tons for 2010-2014 and
  96,139 tons for 2015 and each year thereafter.

The State's NOx allocations have been distributed among the covered facilities. The USEPA will determine the SO_2 allocations, which are based on the acid rain program. For the most part the proposed rules incorporate the USEPA's model rule. The USEPA's model rule for definitions; permitting; monitoring, reporting, and recordkeeping; trading and banking; designated representative; opt-in provision, and new source growth are incorporated by reference.

The rule requires the EMC to periodically review the allocations in 2010 and every five years thereafter and to decide whether to reallocate. This rule does not preclude the EMC from adopting additional emission reduction requirements for covered sources if necessary to attain or maintain an ambient air quality standard.

The EMC adopted North Carolina's CAIR on March 9, 2006 and the rule became effective July 1, 2006.

5.0 ATTAINMENT DEMONSTRATION

5.1 Attainment Test Introduction

The modeled attainment test is the practice of using air quality modeling results for baseline and future years to determine if an area is expected to attain the NAAQS. For the 8-hour ozone NAAQS, the baseline and future model estimates are used in a “relative” rather than “absolute” sense. Specifically, the ratio of the air quality model’s future to current predictions is calculated at each ozone monitoring site. These monitoring site-specific ratios are called relative response factors (RRFs). Future ozone design values (DVFs) are then estimated at each monitor by multiplying the monitor-specific baseline ozone design value (DVB) by the modeled RRF for each monitor. If all of the predicted monitor-specific DVFs in a given area are less than or equal to 0.084 ppm, the attainment test is passed and the area is said to demonstrate attainment. Equation 5.1-1 presents the modeled attainment test, applied at monitoring site “x” as described in Section 4.0 of the USEPA’s *Attainment Guidance*.

$$(DVF) = (RRF) \times (DVB) \quad \text{Equation 5.1-1}$$

Where (DVB) = the baseline design value monitored at site "x", ppm
= the average (of the three) design value periods which include the baseline inventory year (i.e. the average of the 2000-2002, 2001-2003, and 2002-2004 design vales periods for the 2002 baseline inventory year).

(RRF) = the ratio of the future 8-hr daily maximum concentration predicted "nearby" a monitor (averaged over each day of the episode) to the current 8-hr daily maximum concentration predicted "nearby" the monitor (averaged over each day of the episode).

(DVF) = the estimated future design value, ppm.

It is important to consider an array of cells “nearby” a monitor rather than focusing on the individual cell containing the monitor. This allows for variations in the model performance where the peak ozone may not occur in the grid cell that contains the monitor but rather nearby the monitor.

The RRF is calculated by taking the ratio of the future year modeling 8-hour ozone daily maximum to the current year modeling 8-hour ozone daily maximum “near” the monitor averaged over all of the episode days (Equations 5.1-2).

$$RRF = \frac{\text{mean future yr. 8-hr daily max “near” monitor “x”}}{\text{mean current yr. 8-hr daily max “near” monitor “x”}} \quad \text{Equation 5.1-2}$$

The DVC, for purposes of the modeled attainment test, is defined in the USEPA’s *Attainment Guidance* the average of the three design value periods that straddle the baseline inventory year (e.g., the average of the 2000-2002, 2001-2003, and 2002-2004 design value periods for a 2002 baseline inventory year).

5.2 Attainment Test Results

As stated above, the attainment test is not based on absolute modeling results but rather relative reductions of ozone and is only applied at the monitors. However, reviewing the modeling results of how the predicted ozone decreases in the future years and how wide spread the reductions are plays an import role for the State in determining if additional controls should be considered. The modeling results for each day used in the RRF calculations are available in Appendix K. Additionally, discussions about how this modeling demonstration meets the screening test for areas away from the monitoring sites and additional matrices performed to support the attainment test results are in Appendix L.

The USEPA's *Attainment Guidance* states that future design values (DVFs) that fall below 0.082 ppm demonstrate attainment and little weight of evidence is needed. For monitors with DVFs between 0.082 ppm and 0.087 ppm, a weight of evidence demonstration must be submitted that supports a demonstration of attainment. For DVFs greater than 0.087 ppm, the *Attainment Guidance* states that more qualitative results are less likely to support a conclusion differing from the outcome of the modeled attainment test.

Table 5.3-1 lists the attainment test results for the Metrolina nonattainment . The first column is the monitoring site, followed by the base year design value discussed in Section 5.1. The next series of columns are the calculated RRF and the resulting DVF for the attainment year 2009. Monitors with DVFs that fall in the additional weight of evidence requirement are bolded.

Table 5.3-1 Attainment Test Results

Monitoring Site	County	DVB (ppm) 5-year weighted 2000-2004	2009	
			RRF	DVF (ppm)
Arrowood	Mecklenburg	0.0847	0.892	0.075
County Line	Mecklenburg	0.0973	0.874	**0.085**
Crouse	Lincoln	0.0907	0.868	0.078
Enochville	Rowan	0.0970	0.870	**0.084**
Garinger (Plaza)	Mecklenburg	0.0953	0.883	**0.084**
Monroe	Union	0.0870	0.884	0.076
Rockwell	Rowan	0.0973	0.862	**0.083**
York	York, SC	0.0830	0.861	0.071

5.3 Supporting Weight of Evidence

As part of the weight of evidence determination, the following analyses will be evaluated: alternative DVFs calculations, metrics of air quality modeling results, air quality modeling results from other studies, observed air quality trends and additional reductions in emissions, and local measures not modeled. The weight of evidence determination is a supplement to the modeled attainment test and further supports that the area will attain the NAAQS for 8-hour ozone by June 15, 2010.

The NCDAQ believes that the weight of evidence provided in the sections below is strong evidence that the Metrolina nonattainment area will attain the 8-hour ozone NAAQS by 2009.

5.3.1 Alternative DVF Calculation

The NCDAQ uses the USEPA recommended method of calculating the DVB in its modeled attainment test. However, the NCDAQ has commented several times on various draft versions of the attainment guidance that we do not believe that a weighted DVB is appropriate and that a DVB calculated using a straight average minimizes the impacts of any abnormally hot/dry or cool/wet meteorological conditions. As part of the weight of evidence demonstration, the NCDAQ proposes an alternative method to calculate the DVB and presents the modeled attainment test results with this alternative DVB.

The USEPA recommends calculating the DVB by averaging the three design value periods that straddle the baseline inventory year. This methodology results in a center weighting of annual 4^{th} highest ozone concentrations around the baseline inventory year because the three design value periods averaged contain overlapping data. A weighted DVB can be significantly affected by an abnormally hot/dry or cool/wet year, if the year happens to be the center weighted year. To minimize potential impacts of any abnormal meteorological conditions while still considering ozone conditions across a 5-year span, an alternative DVB calculation that does not weight any of the years more than another, but is the straight average of annual 4^{th} highest ozone concentrations for the 5-year span centered on the baseline inventory year was considered.

The 5-year straight average DVB is applied to the remainder of the modeled attainment test equations and the resulting DVFs are shown in Table 5.3.1-1 at each monitoring site in the Metrolina region.

Table 5.3.1-1 5-Year Average Alternative Attainment Test Results for 2009

Monitoring Site	County	Alternative DVB 2000-2004 (ppm)	RRF	DVF (ppm)
Arrowood	Mecklenburg	0.0834	0.892	0.074
County Line	Mecklenburg	0.0956	0.874	**0.083**
Crouse	Lincoln	0.0892	0.868	0.077
Enochville	Rowan	0.0944	0.870	**0.082**
Garinger (Plaza)	Mecklenburg	0.0938	0.883	**0.082**
Monroe	Union	0.0846	0.884	0.074
Rockwell	Rowan	0.0946	0.862	0.081
York	York, SC	0.0798	0.861	0.068

The alternative DVFs are slightly lower at each monitoring site compared to the attainment test DVFs. These differences were expected as 2002 was an abnormally hot and dry year throughout the Southeast resulting ozone concentrations that were much higher than in the surrounding years of 2000, 2001, 2003, and 2004. Thus, the recommended DVB calculation weighted these high air quality conditions several times more than in the NCDAQ alternative DVB calculations. The NCDAQ firmly believes that the straight five-year average approach to the DVB calculation is more appropriate and minimizes dramatic fluctuations in meteorological and air quality conditions from year to year. This would be true whether the center weighted year was an abnormally hot/dry year or a cool/wet year.

While none of the monitoring sites in the Metrolina region had DVF values at or above 0.085 ppm using the NCDAQ alternative DVB calculation, there are still three monitors that have DVFs that fall between 0.082 and 0.087 ppm. This continues to indicate that some additional weight of evidence should still be included to demonstrate attainment.

5.3.2 Air Quality Modeling Metrics

A series of five additional air quality modeling outputs or metrics is recommended to provide assurance the modeled attainment demonstration indicates attainment. These metrics look at the relative change between the baseline and future years modeling and help to demonstrate how widespread the improvement in air quality is expected in the future. These metrics include:

- The relative change in surface grid-hours greater than 0.084ppm. This is the number of grid cells in a Metrolina region with predicted hourly 8-hour ozone concentrations greater than 0.084 ppm. The relative change is the percent reduction from the baseline year to the future year.
- The relative change in the number of grid cells with predicted 8-hour daily maximums greater than 0.084 ppm. This metric uses the modeled daily maximum 8-hour ozone concentrations greater than 0.084 ppm. The relative change is the percent reduction from the baseline year to the future year.
- The relative change in the sum of hourly predictions greater than 0.084 ppm. This metric is the sum of all grid cells with predicted hourly 8-hour ozone concentrations greater than 0.084 ppm. The relative change is the percent reduction from the baseline year to the future year.
- The relative change in the sum of the predicted 8-hour daily maximums greater than 0.084 ppm. This metric uses the modeled daily maximum 8-hour ozone concentrations greater than 0.084 ppm. The relative change is the percent reduction from the baseline year to the future year.
- The change in the Air Quality Index (AQI) counts. The AQI counts metric is a count of the number of grid cells with predicted maximum 8-hour ozone concentrations sorted within each of the color codes as defined by the USEPA's AQI.

The USEPA recommended that these metrics should be at least 80% or higher in order to provide weight of evidence that an area would attain the ozone NAAQS. The air quality modeling metric analyses demonstrated significant reductions of greater than 85%, in all metrics, in the 2009 attainment year of modeled days above the NAAQS in the Metrolina nonattainment area. A full discussion of the metrics and the results can be found in Appendix L.

5.3.3 Air Quality Modeling Results From Other Studies

Another recommended weight of evidence analysis is to review other air quality modeling results that included the Metrolina nonattainment area to determine how other modeling results compare to the attainment demonstration. There are two air quality modeling studies to which results are available for the Metrolina area.

The first is the Early Action Compact (EAC) modeling that the NCDAQ performed for the EAC areas within North Carolina. Since the modeling domain for this analysis covered the majority of North Carolina, including the Metrolina nonattainment area, the modeling results can be easily compared to the attainment demonstration. Although there are some differences between the two modeling exercises, the modeling results for 2012 show all of the monitors well below the 8-hour ozone NAAQS, with the highest monitor having a DVF of 0.081 ppm.

Table 5.3.3-1 Metrolina DVFs based on EAC Modeling

Monitoring Site	County	DVB (ppm)	2012	
			RRF	DVF (ppm)
Arrowood	Mecklenburg	0.092	0.848	0.078
County Line	Mecklenburg	0.101	0.802	0.081
Crouse	Lincoln	0.092	0.826	0.076
Enochville	Rowan	0.099	0.818	0.081
Garinger (Plaza)	Mecklenburg	0.098	0.816	0.080
Monroe	Union	0.088	0.795	0.070
Rockwell	Rowan	0.100	0.800	0.080

It should be noted that for the Greensboro/Winston-Salem/High Point EAC area, the EAC attainment test results predicted the highest monitor in the area to be at 83 ppb in 2007. However the current 2004-2006 design value for that area is 80 ppb, below what was projected and a year earlier.

Another air quality modeling exercise that contained results for the Metrolina nonattainment area is the USEPA's modeling for the Clean Air Interstate Rule (CAIR). The Technical Support Document for the final CAIR, March 2005, provided modeling results with and without the implementation for the CAIR. These modeling results are listed in the table below.

Table 5.3.3-2 Metrolina DVFs based on the USEPA's CAIR Modeling

County	DVB (ppb)	DVF (ppb)	
		2010 Base	2010 CAIR
Lincoln	92.3	76.1	74.5
Mecklenburg	100.3	82.5	81.4
Rowan	99.7	81.3	80.1
Union	87.7	71.9	71.1
York, SC	83.3	70.0	68.5

The USEPA's modeling results predicts that the Metrolina nonattainment area should be below the 8-hour ozone standard by 2010. Although this is one year later than the attainment year for the Metrolina area, the USEPA's 2010 CAIR DVFs are 3 to 4 ppb lower than what the NCDAQ is showing in the attainment demonstration, and supports weight of evidence that the Metrolina area will attain the 8-hour ozone standard by its attainment year of 2009.

5.3.4 Air Quality Trends and Additional Reductions in Emissions

Since the 8-hour ozone designation for the Metrolina area, the 8-hour ozone design values have improved significantly. The 2001-2003 design value period had values as high as 0.100 ppm and six out of the seven North Carolina monitors in the area were violating the NAAQS. Each year since, the design values have decreased and/or the number of violating monitors in the region has decreased. With the latest design value period, 2004-2006, the highest violating monitor has a value of 88 ppb and there are only three monitors that exceed the NAAQS (See Table 5.3.4-1)

Table 5.3.4-1 Design Values (ppm) for the North Carolina Monitors in the Metrolina Area

Monitoring Site	County	2001-2003	2002-2004	2003-2005	2004-2006
Arrowood	Mecklenburg	0.084	0.081	0.078	0.080
County Line	Mecklenburg	**0.098**	**0.092**	**0.087**	**0.088**
Crouse	Lincoln	**0.092**	**0.086**	0.081	0.079
Enochville	Rowan	**0.099**	**0.091**	**0.085**	**0.085**
Garinger (Plaza)	Mecklenburg	**0.096**	**0.091**	**0.086**	**0.088**
Monroe	Union	**0.088**	**0.085**	0.079	0.078
Rockwell	Rowan	**0.100**	**0.094**	**0.088**	0.083
York	York, SC	0.084	0.081	0.075	0.076

The current ozone design values are very close to the predicted attainment year design values, however, there are still significant nitrogen oxides (NOx) emission reductions that are expected between now and the attainment year. Although most of these expected NOx emission reductions have been included in the attainment demonstration modeling, it does not appear the model is responsive enough to expected emission reductions.

As mentioned in Section 1.4, the Metrolina area is a NOx limited area and the major sources of NOx emissions in the region comes from mobile sources and electric generating facilities. Reduction of emissions from these two source sectors can significantly influence the ozone formation in this region. The NCDAQ has estimated that there will be approximately 7.6 tons per day of NOx emissions reduced each year from the mobile sector. These reductions are the result of Federal motor vehicle and equipment standards for both highway vehicles and off-road equipment.

Another source of NOx emission reductions that are expected to occur between now and the attainment year are from the electric generating facilities located in and near the Metrolina nonattainment area. Several of the Duke Energy units are still expected to have controls installed over the next two years. Figure 5.3.4-1 displays the location and size of the Duke Energy facilities located in the vicinity of the Metrolina nonattainment area. Table 5.3.4-2 lists the units that are in and around the Metrolina area and shows the year the controls are expected to come on line and the estimated amount of NOx emissions reductions for the ozone season.

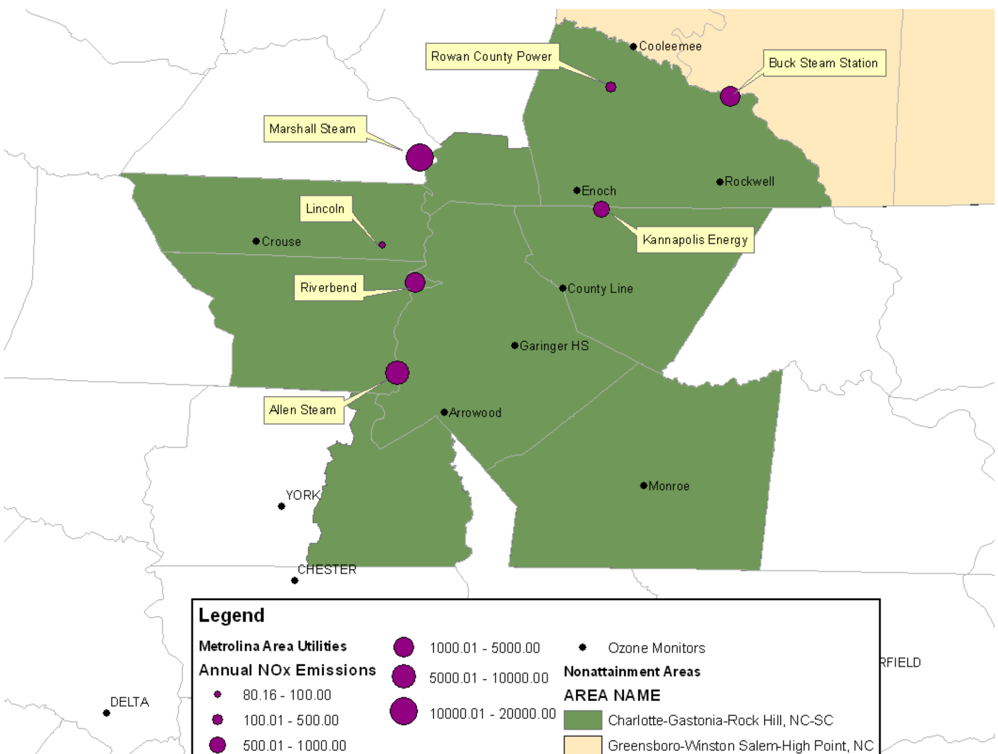


Figure 5.3.4-1 Location and size of the Duke Energy facilities located in the vicinity of the Metrolina nonattainment area.

Table 5.3.4-2 Utility NOx Emission Reductions since 2006 Ozone Season

Facility	County	Technology	Operational Date	Ozone Season Reductions (tons/season)
Allen Steam Station Unit 2 Unit 3	Gaston	SNCR SNCR	Spring 2007 Fall 2007	~300
Buck Steam Station Units 3 & 4 Units 5 & 6	Rowan	Low NOx Burners SNCR	Spring 2007 Fall 2006	~350
Riverbend Unit 4 Unit 5 Unit 6 Unit 7	Gaston	SNCR SNCR & Burners SNCR & Burners SNCR	Spring 2007 Spring 2007 Fall 2006 Fall 2006	~325
Marshall Steam Station Unit 2 Unit 3 Unit 4	Catawba	SNCR SCR SNCR	Spring 2007 Fall 2008 Fall 2006	~2,300
Total expected reduction = 3,275 tons/ozone season				

SNCR = Selective Non-Catalytic Reduction
SCR = Selective Catalytic Reduction

The combination of the mobile source and utility NOx emission reductions that are expected in the Metrolina area between the end of the 2006 ozone season and before the beginning of the attainment year 2009 is significant. Since the 2004-2006 design values are just above the standard, the additional NOx emission reductions in the area should ensure that the Metrolina area would attain the NAAQS by the prescribed attainment year.

5.3.5 Local Measures not Modeled

A significant source of NOx emission reductions that has not been included in the modeling is the addition of a SCR unit at Marshall Unit 3. As can be seen in Figure 5.3.4-1 in the previous section, the Marshall Steam Station is located directly north and adjacent to the Metrolina nonattainment area. The additional NOx emission reductions expected at this facility will have an impact on the ozone formation in the Metrolina area on days when the winds are coming from the North/Northwest and on days when there is recirculation occurring. This SCR unit should be installed the Fall of 2008 and will be operational before the beginning of 2009.

In addition to the Marshall NOx emission reductions, the Metrolina area has a number of groups that are working towards decreasing emissions. These measures are voluntary measures that although may not account for large emission reductions, they are directionally correct. A few of the known measures that are under way in the Metrolina area include: I-77 High Occupancy Vehicle (HOV) lane in Mecklenburg County, truck stop electrification in Rowan County, express bus routes, pedestrian walkways and bikeways projects, idle reduction policies, biodiesel use and diesel retrofit projects. Discussions of these measures can be found in Appendix L.

5.4 Unmonitored Area Analysis

The modeled attainment test does not address future air quality at locations where there is not an ozone monitor nearby. To guard against the possibility that air quality levels could exceed the standard in areas with limited monitoring, Section 3.4 of the *Attainment Guidance* suggest that additional review is "necessary, particularly in nonattainment areas where the ozone or $PM_{2.5}$ monitoring network just meets or minimally exceeds the size of the network required to report data to Air Quality System (AQS)." This review is intended to ensure that a control strategy leads to reductions in ozone at other locations that could have baseline (and future) design values exceeding the NAAQS were a monitor deployed there. The test is called an "unmonitored area analysis". The purpose of the analysis is to use a combination of model output and ambient data to identify areas that might exceed the NAAQS if monitors were located there.

NCDAQ believes that the density of its' monitoring network relieves the necessity of applying this additional analysis. With an average of one monitor per 3,077 km^2, this is one of the densest statewide ozone monitoring networks in the nation. Additionally, the monitor density across the Metrolina nonattainment area is more than twice that of the statewide monitor density (on average a monitor every 1,278 km^2).

The Modeled Attainment Test Software (MATS) tool has been developed by the USEPA to spatially interpolate data, adjust the spatial fields based on model output gradients, and multiply the fields by model calculated RRFs for analysis of unmonitored areas. However, this tool has just recently been released with documentation, June 2007, and the NCDAQ has not had sufficient time to review documentation and fully understand the output from this tool, nor has the tool been peer reviewed. The NCDAQ is committed to evaluate the MATS tool output and any peer review comments that are submitted to determine if additional monitoring or further NOx controls may be needed to ensure attainment of the NAAQS throughout the Metrolina region.

5.4 Data Access

The modeling input and output files are very large and it would not be reasonable to submit all of these files with the SIP attainment demonstration. These include all files used to process the emissions, meteorology and air quality models and any other files used to develop the modeling. To request access to these files please contact the Division of Air Quality, Attainment Planning Branch Chief at 919.733.3340.

6.0 OTHER CLEAN AIR ACT REQUIREMENTS

Sections 172(c), 182(a) and 182 (b) of the CAA, as amended, contain the requirements for ozone nonattainment areas. As a subpart 2 moderate ozone nonattainment area, the Metrolina area must meet the requirements for both a marginal and moderate area, as well as the general requirements contained in Section 172(c). These requirements are listed below and are discussed in more detail in the following chapter, although it should be noted that they have been grouped to avoid duplication of the discussion.

<u>Section 172(c) Nonattainment Plan Provisions</u>

(1) Reasonable available control measures (RACM)
(2) Reasonable further progress (RFP)
(3) Actual emissions inventory and periodic emissions inventory
(4) New source review (NSR)
(5) Permit requirements for new and modified sources
(6) Other measures as may be necessary to provide attainment by specified attainment date
(7) Compliance with Section 110(a)(2)
(8) Equivalent techniques
(9) Contingency measures

<u>Section 182(a) Plan Submissions and Requirements for Marginal Areas</u>

(1) Actual emissions inventory in accordance with 172(c)(3)
(2) Corrections to SIP
    (A) Reasonably available control technology (RACT)
    (B) Motor vehicle inspection and maintenance (I/M)
    (C) Permit programs
(3) Periodic emissions inventory
    (A) General – emission inventory every three years until area is redesignated to attainment.
    (B) Annual emissions statement requirement for sources 25 tons per year or greater of VOC or NOx.

<u>Section 182(b) Plan Submissions and Requirements for Moderate Areas</u>

(1) Reasonable further progress
(2) Reasonable available control technology
(3) Gasoline vapor recovery
(4) Motor vehicle I/M
(5) Offset requirements of at least 1.15 to 1.

6.1 RACT/RACM Requirements

Section 172(c)(1) of the CAA requires SIPs to provide for the implementation of all reasonably available control measures (RACM) to demonstrate attainment as expeditiously as practicable. A subset of RACM is RACT, which relates specifically to stationary point sources. Section 182(b)(2) of the CAA requires RACT rules be adopted for all point sources of VOC and NOx with potential to emit at least 100 tons per year or greater. The RACT rules were due on September 15, 2006. The NCDAQ was unable to complete the rule adoption process by that date. However, a public hearing was held on the RACT rules on October 4, 2006, and the EMC officially adopted the rules on January 11, 2007. The rules became effective on March 1, 2007. Sources subject to the rule must submit a permit application and compliance schedule by August 1, 2007, with final compliance no later than April 1, 2009. The RACT rules are contained in 15A NCAC 02D.0902, .0909, .1402 and .1403 and are provided in Appendix M.

In the mid 1990s, the NCDAQ completed a technical analysis and determined that the entire state is NOx limited and that the control program for reducing ozone should be focused on NOx emission reductions, since roughly 90 percent of the VOC emissions in North Carolina originate from biogenic sources, and not man-made sources. When the 8-hour ozone standard was promulgated in 1997, the NCDAQ evaluated the 8-hour ozone levels in North Carolina and realized at that time that attainment of the new standard was going to be a significant challenge for the state. The NCDAQ began the process of legislative and rulemaking changes that were deemed necessary for the state to attain the 8-hour ozone standard in late 1997, which addressed many of the RACM available. As such, work began to demonstrate the need for an aggressive inspection and maintenance program. This resulted in the 1999 session of the General Assembly passing the Clean Air Bill, which required the testing of vehicles in 48 counties across the state. The EMC adopted the NOx SIP Call rule in 2000 and the open burning rule in 2004. The 2002 session of the General Assembly passed the Clean Smokestacks Act. Details of these control measures are discussed in Section 4.2 of this document.

Since the Clean Smokestacks Act, the NOx SIP Call rule and the RACT rule address the implementation of RACM for point sources, the remaining source sectors were examined for potential control measures that would expedite attainment of the NAAQS. Area source NOx emissions are a very small fraction of the NOx emissions in the Metrolina area, accounting for only four percent of the total NOx. The only reasonably controlled area source is open burning, since the remaining NOx sources include structure fires and forest fires, which cannot be controlled. With the adoption of the open burning rule in 2004, RACM for area sources is addressed.

This left the focus of the RACM evaluation on the nonroad and on-road mobile sectors. The NCDAQ considered the following measures:

- An I/M program for on-road heavy-duty diesel engines
- An I/M program for on-road light-duty diesel engines
- Requirements for clean diesel technology for all construction equipment on large construction projects
- Mandatory VMT reduction program on ozone episode days
- Anti-idling program for heavy-duty engines (on-road and non-road)

The first two measures, I/M programs for diesel engines, is not viable at this time since the technology is not yet available on heavy-duty diesel engines and is just beginning to be available for some light-duty diesel vehicles, but not all. For the remaining measures, the NCDAQ concluded that these measures would require significant stakeholder involvement, and additional time to study the cost-benefit of these measures. An estimated timeline for implementation of the remaining control measures is outlined below.

June 2007 – December 2007	Research and perform the cost-benefit analysis of these measures
January 2008 – September 2008	Draft rules for viable measures, organize a list of stakeholders and hold several stakeholder meetings to address concerns in draft rules
July 2008	Take concept of draft rules to the Air Quality Committee (AQC)
September 2008	Present draft rules to AQC and request permission to take draft rules to the EMC.
November 2008	Present draft rules to the EMC and request permission to take the rules to public hearing.
January 2009	Take rules to public hearing and provide 30 days to public comments.
February 2009 – April 2009	Address comments received at public hearing and prepare hearing report for AQC and EMC.
May 2009	Take final rules to EMC and request adoption of final rules.
July 2009	If 10 letters requesting legislative review are not received, rules become effective and time for implementation outlined in rule (6 months to 2 years depending on rule)
May 2010	If 10 letters received requesting legislative review received, legislative review process would begin.

As outlined above, these measures cannot be implemented by May 1, 2009 and measures implemented after this date cannot advance the June 2010 attainment date. However, these measures will continue to be studied as the NCDAQ considers what additional emission reductions may be needed in the Metrolina area to show maintenance of the 8-hour ozone standard.

6.2 Reasonable Further Progress

Section 182(b)(1) of the CAA mandates a 15 percent VOC emission reduction, accounting for growth, in the first 6 years after the baseline year (2002) for moderate and above ozone nonattainment areas. Thus for the Metrolina nonattainment area, a reasonable further progress (RFP) analysis between 2002 and 2008 is required. Although the Charlotte-Gastonia 1-hour ozone nonattainment area (comprised of Mecklenburg and Gaston Counties) was classified as moderate following the 1990 CAAA, the area had measured attainment of the 1-hour standard prior to the 15 percent Rate of Progress (ROP) requirement coming due on November 15, 1993. Therefore, this area did not implement a 15 percent ROP plan under the 1-hour standard, and the RFP requirement must be met through VOC reductions only, consistent with the CAA.

The methodology the NCDAQ used to calculate the RFP target levels of VOC emissions is based on the method developed in the CAAA, while taking into account the restrictions on creditable emissions and the need to use the 2002 inventory as a baseline. The CAAA of 1990 specified four types of measures that were not creditable toward the 15 percent RFP requirement. These were:

(1) Any measure relating to motor vehicle exhaust or evaporative emissions promulgated by the Administrator by January 1, 1990.

(2) Regulations concerning Reid Vapor Pressure (RVP) promulgated after 1990 or required under section 211(h).

(3) Measures required under section 182(a)(2)(A) to correct deficiencies in SIPs regarding VOC RACT regulations required prior to enactment of the CAA Amendments of 1990.

(4) State regulations submitted to correct deficiencies in I/M existing or required programs.

These four types of measures were all expected to result in a decrease in emissions between 1990 and 1996. Of these four types of measures, RACT and I/M program corrections and the 1992 RVP requirements were completely in place by 1996 and therefore are already accounted for in the 2002 baseline. As a result, they would produce no additional reductions between 2002 and 2008 or later milestone years.

However, the pre-1990 Federal Motor Vehicle Control Program (FMVCP) will continue to provide additional benefits during the first two decades of the 21st century as remaining vehicles meeting pre-1990 standards are removed from the vehicle fleet. Because these benefits are not creditable for RFP purposes, in order to calculate the target level of emissions for future RFP milestone years, you must first calculate the reductions that would occur over these future years as a result of the pre-1990 FMVCP. The NCDAQ used Method 1 to account for non-creditable reductions when calculating RFP targets for the 2008 milestone year. They are consistent with requirements of sections 182(b)(1)(C) and (D) and 182(c)(2)(B) of the CAAA. The NCDAQ did not have VOC RACT regulations in the Metrolina region prior to the enactment of the 1990

CAAA, thus only the on-road mobile source sector required an estimation of non-creditable emissions.

Method 1: For areas that must meet a 15 percent VOC reduction requirement by 2008:

(A) Estimate the actual anthropogenic base year VOC inventory in 2002 with all 2002 control programs in place for all sources.

(B) Using the same highway vehicle activity inputs used to calculate the actual 2002 inventory, run the appropriate motor vehicle emissions model for 2002 and for 2008 with all post-1990 CAA measures turned off. Any other local inputs for vehicle I/M programs should be set according to the program that was required to be in place in 1990. Fuel RVP should be set at 9.0 or 7.8 depending on the RVP required in the local area as a result of fuel RVP regulations promulgated in June, 1990.

(C) Calculate the difference between the 2002 and 2008 VOC emission factors calculated in Step B and multiply by 2002 vehicle miles traveled (VMT). The result is the VOC emissions reductions that will occur between 2002 and 2008 without the benefits of any post-1990 CAA measures. These are the non-creditable reductions that occur over this period.

(D) Subtract the non-creditable reductions calculated in Step C from the actual anthropogenic 2002 inventory estimated in Step A. This adjusted VOC inventory is the basis for calculating the target level of emissions in 2008.

(E) Reduce the adjusted VOC inventory calculated in Step D by 15 percent. The result is the target level of VOC emissions in 2008 in order to meet the 2008 RFP requirement. The actual projected 2008 inventory for all sources with all control measures in place and including projected 2008 growth in activity must be at or lower than this target level of emissions.

The NCDAQ's 2002 baseline VOC emissions for the Metrolina area are presented in Table 6.2-1. The 2008 VOC emission estimates are included in Table 6.2-2. Table 6.2-3 below provides the summary 15% RFP analysis showing the projected 2008 VOC emissions for the area, 188.1 tons/day are well below the target level of emissions, 263.9 tons/day, as calculated using Method 1. Further details about the RFP calculation can be found in Appendix O.

Table 6.2-1 Metrolina Nonattainment Area 2002 Baseline VOC Emissions (tons/day)

County	Point	Area	Non-Road	Highway Mobile	Total
Cabarrus	2.2	6.0	2.7	21.5	32.4
Gaston	2.5	8.9	2.9	13.5	27.8
Iredell (partial)	0.9	1.9	0.9	5.1	8.8
Lincoln	2.1	3.1	1.3	7.1	13.6
Mecklenburg	5.7	29.4	24.1	68.0	127.2
Rowan	6.3	5.6	2.3	14.8	29.0
Union	1.0	6.4	4.7	13.0	25.1
Total	20.7	61.3	38.9	143.0	263.9

Table 6.2-2 Metrolina Nonattainment Area 2008 Baseline VOC Emissions (tons/day)

County	Point	Area	Non-Road	Highway Mobile	Total
Cabarrus	2.3	5.9	1.5	12.5	22.2
Gaston	2.7	9.4	2.0	9.0	23.1
Iredell (partial)	0.7	1.8	0.5	4.2	7.2
Lincoln	2.1	2.9	0.8	4.8	10.6
Mecklenburg	5.9	30.1	13.0	35.4	84.4
Rowan	6.0	5.6	1.5	9.7	22.8
Union	1.2	5.7	1.7	9.2	17.8
Total	20.9	61.4	21.0	84.8	188.1

Table 6.2-3 Metrolina Nonattainment Area 15% RFP Analysis

Metrolina 15% RFP Analysis	VOC (tons/day)	Step from Method 1
Total 2002 Base year anthropogenic VOC emissions	263.9	Step A
Non-creditable VOC reductions	11.3	Step C
2002 base year minus the non-creditable emissions	252.6	Step D
2008 target level of VOC emissions	214.7	Step E
2008 projected VOC emissions	188.1	Projection < Target RFP goal met

* See Appendix O for details on the development of these numbers.

The NCDAQ must show continued progress from 2008 through the attainment date (June 15, 2010). To do so, the NCDAQ calculated the expected benefits from the fleet turnover for the on-road and off-road mobile sectors. In 2009 and 2010, the NCDAQ expects approximately 7.6 tons per day of NOx emissions reductions from this fleet turnover. The NCDAQ did not calculate future expected VOC emissions reductions in 2009 and 2010 since the area is NOx limited, but additional VOC emission reductions are expected from the fleet turnover of the on-road mobile sector. The NCDAQ believes these additional reductions demonstrate continued reasonable further progress toward attainment beyond 2008.

Another requirement of RFP is that VOC motor vehicle emission budgets for transportation conformity need to be set for the RFP year 2008. The NCDAQ has determined that mobile source VOC emissions are insignificant to ozone formation in the Metrolina nonattainment area (see Appendix F.3). Therefore, the RFP motor vehicle emission budgets are not required.

6.3 Actual Emissions Inventory

Section 182(a)(1) and Section 172(c)(3) require the development of a comprehensive, accurate current inventory of actual emissions from all sources of VOC and NOx in the nonattainment area. Such inventory was due two years after designation of the 8-hour ozone nonattainment areas, or by June 15, 2006. The NCDAQ met this requirement through the submittal of the 2002 emission inventories under the Consolidated Emission Reporting Rule (CERR) for the North Carolina counties in this nonattainment area.

The NCDAQ submitted statewide emissions for area, nonroad mobile and highway mobiles sources. For stationary point sources, The NCDAQ submitted inventories for those counties without a local program. The Mecklenburg County Land Use and Environmental Services Agency - Air Quality submitted an emission inventory for stationary point sources located within Mecklenburg County.

The final 2002 emission inventories used in the attainment demonstration will go through the public hearing process with the full attainment demonstration, which will include any updates or revisions that are necessary since the CERR submittal.

6.4 Emissions Inventory Statement

Section 182(a)(3)(B) requires the SIP to contain a requirement for all owners or operators of stationary sources located in the nonattainment area and that emit either VOC or NOx to submit a statement of actual emissions annually. The State may waive the requirement for sources that emit less than 25 tons per year of NOx or VOC emissions. The requirement for such emissions statements has been in place in the old 1-hour ozone nonattainment areas including Charlotte-Gastonia (Mecklenburg and Gaston Counties) under 15A NCAC 02Q .0207 since July 1, 1994. The NCDAQ took an amendment to this rule to public hearing on March 14, 2007 to add the new 8-hour ozone counties in the Charlotte-Gastonia-Rock Hill nonattainment area. The NCDAQ anticipates that the EMC will adopt this amended rule at its May 10, 2007 meeting, and that the rule will become effective on August 1, 2007. The NCDAQ will submit the amended rule to the USEPA as soon as it becomes effective.

6.5 Periodic Emissions Inventory

Section 172(c)(3) and 182(a)(3)(A) require periodic inventory submittals. Specifically, Section 182(a)(3)(A) requires the inventory be submitted every three years until the area is redesignated to attainment. The NCDAQ plans to meet this requirement through the CERR submittal. As such, The NCDAQ will submit the 2005 emissions inventory on or before June 1, 2007.

6.6 Permit Program Requirements

Sections 172(c)(5) and 182(a)(2)(C) require a permit program consistent with the requirements of Section 173. Additionally, Section 182(b)(5) requires an offset requirement of 1.15 to 1. On November 30, 2005, the NCDAQ submitted amendments to the nonattainment new source review (NNSR) rules contained in 15A NCAC 2D .0531 to the USEPA for review and approval. These rules adopted the new offset requirement. Further, on March 16, 2007, the NCDAQ submitted amendments to 15A NCAC 2D .0530 Prevention of Significant Deterioration (PSD) permitting rules to the USEPA. The NCDAQ believes that the adoption and submittal of the NNSR and the PSD rules meet the "prevention of significant deterioration" requirement of Section 110(a)(2)(D)(i) since major sources in North Carolina are subject to PSD and NNSR programs. Finally, the NCDAQ adopted an Emissions Banking Rule, 15A NCAC 2D .2300 to establish a bank where sources could place their shutdown credits, as well as credits achieved through installing controls that go above and beyond what is required. The NCDAQ believes it has met the permit program requirements for a moderate nonattainment area.

6.7 Gasoline Vapor Recovery

Section 182(b)(3) of the CAA requires moderate and above ozone nonattainment areas to implement Stage II vapor recovery programs. However, Section 202(a)(6) of the CAA states that the section 182(b)(3) Stage II requirement shall not apply in moderate areas after onboard refueling vapor recovery (ORVR) rules are promulgated. The USEPA promulgated the ORVR regulations on April 16, 1994. Therefore, 8-hour ozone moderate areas designated in 2004 are not subject to the Stage II vapor recovery program requirements.

As such, the NCDAQ removed the pre-piping requirements that were contained in the 1-hour maintenance plan for the Charlotte-Gastonia area. The attainment plan and contingency plan contained in this submittal addresses the necessary controls to attain the 8-hour standard in the Metrolina region. Since the area is NOx-limited and the Stage II program is not required, the NCDAQ believes removing the pre-piping requirement is appropriate. The removal of the pre-piping requirement was done through a separate SIP revision. The public hearing was held on October 4, 2006, the EMC approved the rule change on January 11, 2007 and the rule became effective on March 1, 2007. No emission changes are expected from this rule change since the pre-piping for Stage II does not result in any emission reductions.

6.8 Inspection and Maintenance Program

Section 182(b)(4) requires moderate and above ozone nonattainment areas to implement a vehicle I/M program. To meet this requirement for the Charlotte-Gastonia 1-hour ozone nonattainment area, a decentralized idle test was implemented in Mecklenburg County on April 1, 1991, and in Gaston County on July 1, 1992. Additionally, the State required the program to also be implemented in Cabarrus and Union Counties, and the program became effective on July 1, 1993. The program required testing for CO and VOC emissions. Following the promulgation of the new 8-hour standard in 1997, the North Carolina General Assembly passed the Clean Air Bill in the 1999 session. The Clean Air Bill required that the I/M test be changed to be the Acceleration Simulation Mode (ASM) or dynamometer testing for both NOx and VOC emissions. The Clean Air Bill also mandated that the program be phased in 48 counties across the state between 2002 and 2006, and that the idle test be phased out in 2006 in the nine counties in which the program was required. In the 2000 session of the General Assembly, the testing was changed again to be On-Board Diagnostics (OBD-II) since this equipment was significantly cheaper and also allowed testing for NOx and VOC emissions from automobiles. The following rules were amended to reflect the legislative requirements of the Clean Air Bill: 15A NCAC 02D .1001, .1002, .1004, .1005. The NCDAQ believes that the Clean Air Bill and associated rule changes meet the requirements of Section 182(b)(4).

6.9 Other Measures

Section 1729(c)(6) requires the nonattainment SIPs to include enforceable limitation and other control measures, along with schedules for compliance as needed to demonstrate attainment. Section 4.0 of this document discusses in detail the Federal and State measures that are necessary for attainment. Appendix M contains the rules and compliance schedules.

6.10 Compliance with Section 110(a)(2)

Section 172(c)(7) requires nonattainment SIPs to meet the applicable provisions of Section 110(a)(2). The NCDAQ has reviewed the requirements of Section 110(a)(2) and has concluded that the prior rule submittals, along with this attainment demonstration plan address the relevant requirements.

6.11 Equivalent Techniques

The NCDAQ believes that the procedures for modeling, emissions inventory and planning follow the USEPA guidance and is not requesting approval for equivalent techniques, as envisioned under Section 172(c)(8).

6.12 Contingency Measures

Section 172(c)(9) requires that the nonattainment SIPs contain specific measures that would take effect upon a State’s failure to attain the ozone standard in a given area, without further action by the State or the USEPA. Guidance from the USEPA indicates that the measures should be approximately three percent of the baseline emissions, so that reasonable progress level of reduction could be expected to occur in the year following the failure to attain. The NCDAQ elected to adopt NOx only contingency measures since the area is NOx limited. The contingency plan consists of Federal and State measures. The Federal measures result from the fleet turnover of the light and heavy-duty engine standards from the on-road mobile sector and the non-road engine standards. These measures are already adopted and the fleet turnover will occur without further action by either the State or the USEPA. The fleet turnover will result in approximately 7.6 tons/day NOx emission reductions, or about 2.7% of the base emissions. The analysis of these emission reductions is included in Appendix P.

The State measure is lowering the NOx RACT applicability level from 100 tons per year potential emissions to 50 tons per year potential emissions. The NCDAQ took this rule to public hearing on March 14, 2007. The NCDAQ anticipates that the EMC will adopt this amended rule at its May 10, 2007 meeting, and that the rule will become effective on July 1, 2007. The NCDAQ will submit the amended rule to the USEPA as soon as it becomes effective. The draft rule is included in Appendix M.

7.0 MOTOR VEHICLE EMISSION BUDGETS

7.1 Transportation Conformity

The purpose of transportation conformity is to ensure that Federal transportation actions occurring in nonattainment and maintenance areas do not hinder the area from attaining and maintaining the 8-hour ozone standard. This means that the level of emissions estimated by the NCDOT or the metropolitan planning organizations for the Transportation Implementation Plan (TIP) and Long Range Transportation Plan must not exceed the motor vehicle emission budgets (MVEBs) as defined in this attainment demonstration.

7.2 Highway Mobile Source VOC Insignificance

Section 93.109(k) in the Transportation Conformity Rule Amendments for the new 8-hour ozone and fine particulate matter NAAQS addresses areas with insignificant motor vehicle emissions. The rule suggests that such a finding would be based on a number of factors, including the percentage of motor vehicle emissions in the context of the total SIP inventory, the current state of air quality as determined by monitoring data for that NAAQS, the absence of SIP motor vehicle control measures, and historical trends and future projections of the growth of motor vehicle emissions. Although there is a vehicle control measure in place in the Metrolina area, an inspection and maintenance program, the current program was established for additional reductions in NOx emissions. There are incidental VOC emission reductions as a result of this program (~ 8%), however it is not believed the reduction of VOC emissions resulted in decreased ozone levels.

The NCDAQ has examined the sources of VOC emissions and their contribution to ozone formation in North Carolina. Due to the generally warm and moist climate of North Carolina, vegetation abounds in many forms, and forested lands naturally cover much of the state. The biogenic sector is the most abundant source of VOC emissions in North Carolina and accounts for approximately 90% of the total VOC emissions statewide. The overwhelming abundance of biogenic VOC emissions makes the majority of North Carolina a NO_x limited environment for the formation of ozone. This holds true in the Metrolina area.

Additionally, the NCDAQ has performed a number of modeling sensitivities to determine the impact of highway mobile source VOCs on ozone formation in the Metrolina area. The results of these sensitivities indicate no change in future ozone concentrations in the Metrolina area when highway mobile VOC emissions are significantly changed (e.g., 50% decrease). These sensitivities are discussed in more detail in Appendix F.3.

The NCDAQ believes highway mobile VOCs are insignificant contributors to ozone formation in the Metrolina nonattainment area. Emission estimates indicate highway mobile VOC is a small percentage of the total VOC emissions inventory. Highway mobile VOC emissions are projected to decrease into the future, notwithstanding VMT increases. Emission sensitivity modeling indicates no change in future ozone concentrations when VOC emissions are significantly changed. For these reasons, the NCDAQ presented the VOC insignificance concept to the transportation partners and all agreed through the interagency consultation that VOC emissions were insignificant. Therefore, the NCDAQ will not be setting MVEB for VOC for the North Carolina portion of the Metrolina nonattainment area. The NCDAQ will revisit the setting of MVEB for VOC if there is indication that the Metrolina area has become VOC sensitive for ozone formation.

An affirmative insignificance finding from the USEPA only relieves the transportation partners from a regional emissions analysis for VOC emissions for this area and does not relieve them of the other transportation conformity requirements. The transportation partners will need to note the VOC insignificance finding (if found adequate and approved by the USEPA) in future conformity determinations.

7.3 Motor Vehicle Emission Budgets

As part of the consultation process on setting MVEBs, the NCDAQ sent out a request for comment on setting the geographic extent of the MVEBs to all of the transportation partners. A copy of the letter can be found in Appendix B. In the letter, the NCDAQ expressed its preference for setting county level budgets and some of the reasons why the NCDAQ believed county level budgets were appropriate.

The NCDAQ received comments from several of the transportation partners regarding the geographic extent of the MVEBs. Some of the partners wanted county-by-county budgets; others wanted regional budgets. Copies of the letters received can be found in Appendix B. Upon careful consideration of all arguments, the NCDAQ decided to move forward with setting county level MVEBs. The NCDAQ believes that since mobile source NOx emissions play a significant role in the ozone formation in the Metrolina area, it is important that the large counties in the area meet the county level NOx MVEBs that closely represents the emissions that were modeled for the attainment demonstration.

A requirement of RFP is that VOC motor vehicle emission budgets for transportation conformity need to be set for the RFP year 2008. Since the NCDAQ has determined that mobile source VOC emissions are insignificant to ozone formation in the Metrolina nonattainment area (see Appendix F.3), the 2008 RFP motor vehicle emission budgets are not required.

The MVEBs will be set for the attainment year 2009. By the time the MVEBs are approved by the USEPA, the next transportation conformity regional emissions analysis should be for years 2009 and beyond. Therefore, MVEBs will not be set for the baseline year 2002.

Although the emissions are usually expressed in terms of tons per day, the MVEBs will be set in terms of kilograms (kg) per day. The reason for the change is because the MOBILE model generates the emissions factors in grams per mile. In past conformity exercises, there have been some issues with conversion to tons per day, as well as concerns with how the MVEBs were rounded to the hundredth place. Setting MVEBs in kilograms per day will avoid these issues in future conformity determinations.

The mobile inputs used to develop the MVEBs were developed through interagency consultation with the transportation partners for this area. These inputs were consistent with what was used in the attainment demonstration modeling, and do not represent a significant change to the emissions. These changes include:

- Time of day speeds and vehicle miles traveled for Iredell, Mecklenburg and Union Counties were used in response to comments.
- Vehicle age distribution and vehicle mix were revised to reflect new data available, in response to comments.
- Temperature, relative humidity and barometric pressure assumptions were developed using the average 2002 July meteorological data for the region.

The table below shows the North Carolina counties with their highway mobile NOx emissions expressed in tons per day and the corresponding kilograms per day values for 2009.

Table 7.3-1 Highway Mobile Source NOx Emissions Metrolina Nonattainment Area

County	2009	
	Tons/day	Kg/day
Cabarrus	8.57	7,788
Gaston	9.48	8,602
Iredell*	5.61	5,094
Lincoln	3.65	3,317
Mecklenburg	32.27	29,270
Rowan	8.45	7,675
Union	5.57	5,070
Total	73.09	66,353

* Iredell County emissions for nonattainment area only.

The NCDAQ will set MVEB, for transportation conformity purposes, as county budgets within the Metrolina nonattainment area for 2009. Tables 7.3-2 below list out the NOx MVEBs in kilograms per day, for transportation conformity purposes, by county. Upon the USEPA's affirmative adequacy finding for these county level sub-area MVEBs, these MVEBs will become the applicable MVEBs for each county.

Table.7.3-2 County Level NOx MVEB for 2009

County	MVEB (Kilograms/day)
Cabarrus	7,788
Gaston	8,602
Iredell*	5,094
Lincoln	3,317
Mecklenburg	29,270
Rowan	7,675
Union	5,070

* Iredell County MVEB for nonattainment area only