AUGUST 4, 2007
EXCEPTIONAL EVENT
DEMONSTRATION PACKAGE
FOR THE

LEXINGTON
FINE PARTICLE
FEDERAL REFERENCE METHOD MONITOR
(370570002-88101-1)

May 9, 2008

NCDENR

LEXINGTON FRM-PM2.5 MONITORING EXCEEDANCE REPORT

DATE OF EXCEEDANCE: AUGUST 4, 2007
EXCEEDANCE VALUE: 35.8 MICROGRAMS PER METER CUBED
FLAGGED IN AQS AS "RT" – WILDFIRE U.S.

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Executive Summary

The North Carolina Division of Air Quality believes the 35.8 μg/m^3 value measured on 8/4/07 at Lexington, NC was caused by wildfires in Idaho/Montana and should be excluded from regulatory decisions regarding attainment/non-attainment because:

1. The sulfates and organic carbon measured in the speciation samples on that day were high, and high sulfates and organic carbon can be associated with wood smoke and forest fires.
2. Forward trajectories starting from the wildfires show that air masses passed through Northern Kentucky, Pennsylvania, Ohio, and Lexington, NC before and on August 4, 2007. Multiple ground level hourly PM2.5 monitors read higher than 45 μg/m^3 on August 3, 2007 and August 4, 2007 in these States.
3. Backward trajectories from the monitor also show that air masses passed through Northern Kentucky, Pennsylvania, Ohio, and Lexington, NC before and on August 4, 2007.
4. The mixing height in North Carolina varied from 1-3km and most trajectories remained within the mixing height. Mixing heights allow vertical mixing within a deep layer of the atmosphere and good dispersion of pollutants.
5. The exceedance value of 35.8 μg/m^3 was higher than the 95th percentile recorded at the Lexington monitoring station for the month of August over a span of three years (2004-2006).
6. A statistical model indicates that the PM2.5 concentration value expected at Lexington on 8/4/07 should be 25.97 μg/m^3.

Proof of Event

The exceptional event consisted of a large grouping of forest fires in Idaho, Montana, and Canada. The fires are shown plotted on maps from the National Interagency Fire Center and the USDA (Figures 1,2,3,4, 5).

Fire activity in Idaho, Montana, and Canada lasted from 15 July 2007 to 1 September 2007. The smoke emissions from these large fires in Idaho, Montana, and Canada drifted east, and resulted in the exceedance of the daily PM2.5 NAAQS at site Lexington on 4 August 2007.

The Montana Department of Environmental Quality catalogued the fires at the following website: `http://www.deq.state.mt.us/fireupdates/`
or
`http://www.deq.state.mt.us/fireupdates/2007/Smoke_July%2026_2007.pdf`

Change the day in url to get updates for other days, e.g.,
`.../Smoke_July%2025_2007.pdf`.

Figure 1: Large fires in Idaho and Montana.
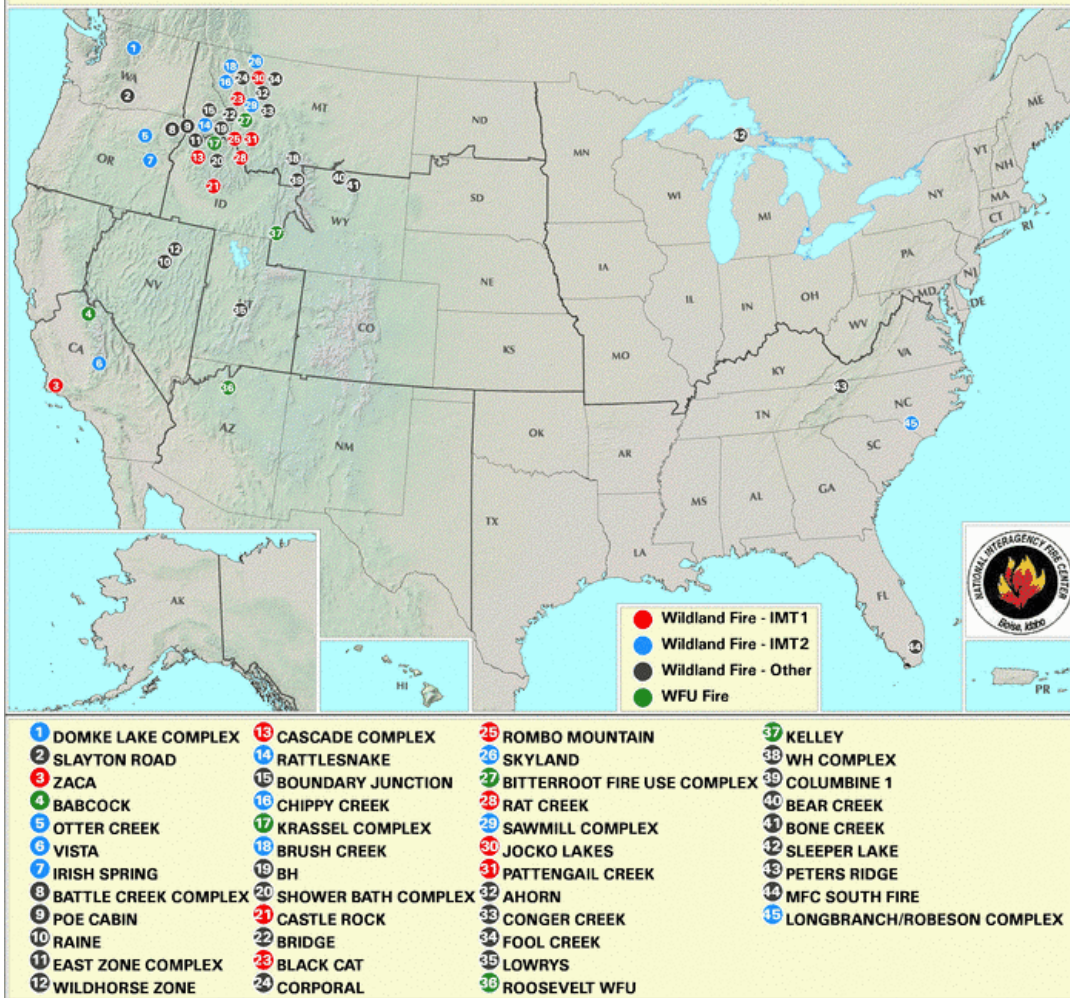
Figure 2: Large fires in Idaho and Montana.

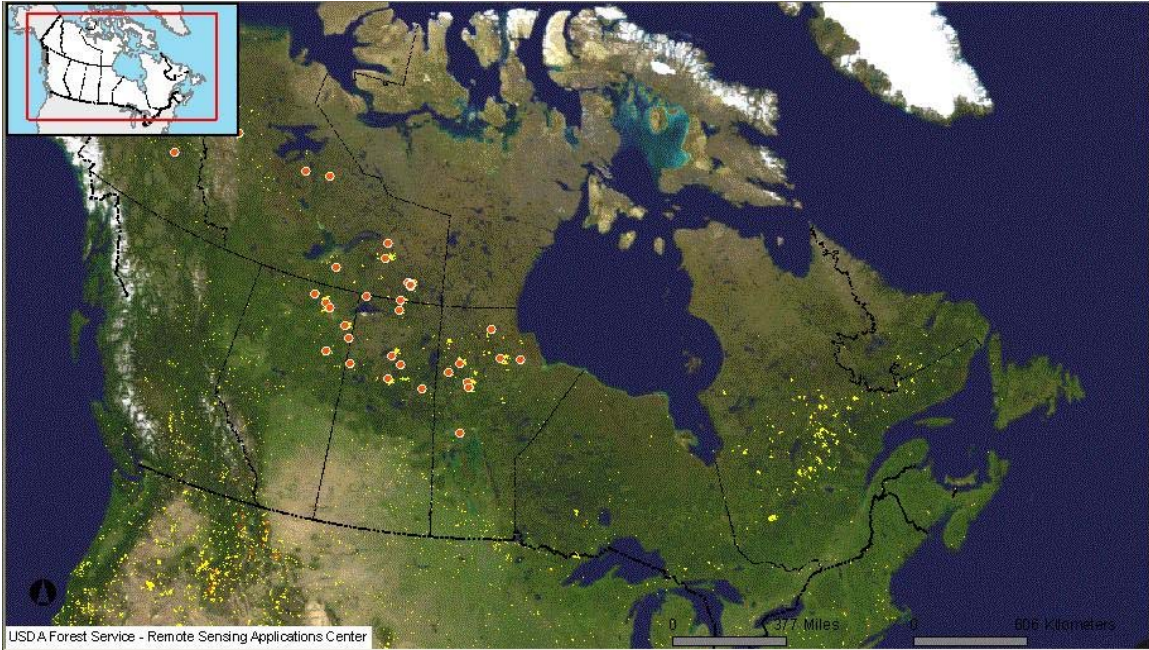**Figure 3: Large fires in Idaho and Montana.**

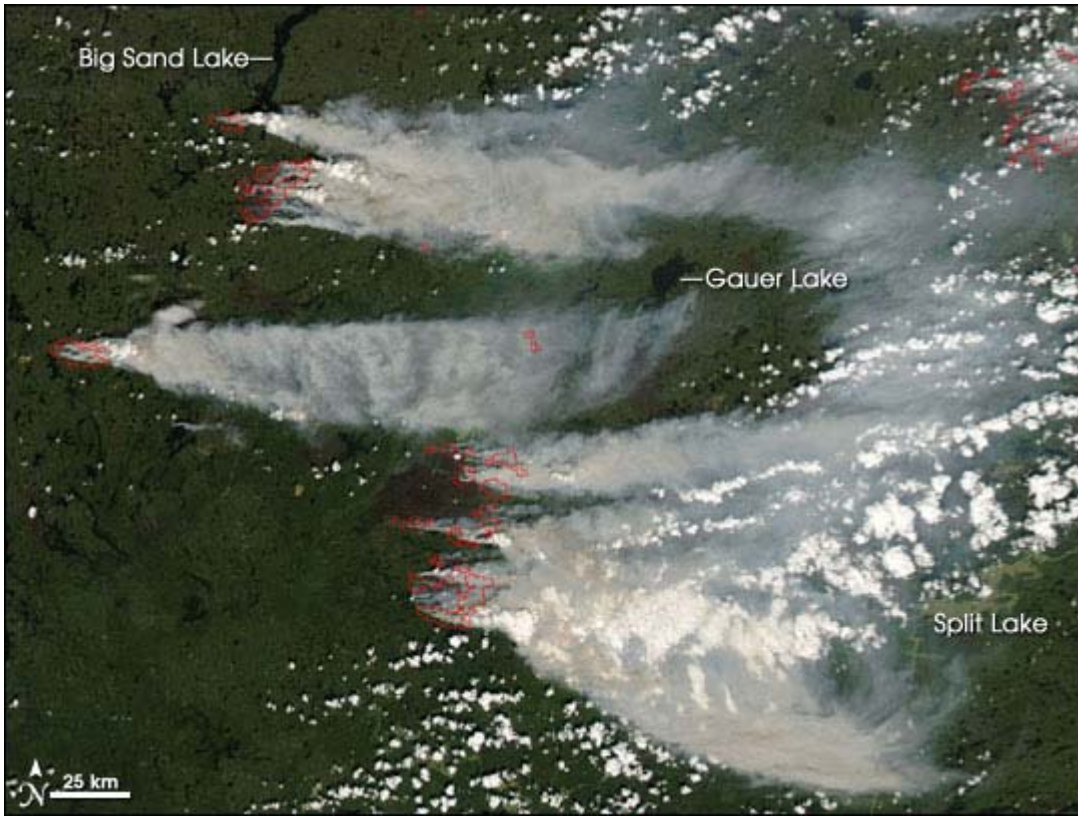**Figure** 4 Canadian Fires circa 8/1/07 (source: USDA).

Figure 5 Fires in Manitoba : In Manitoba, Canada, north of Lake Winnipeg, several massive fires were burning on July 23, 2007, when the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite captured this photo-like image. Places where the sensor detected actively burning fires are outlined in red. Thick plumes of smoke spread east from the forest fires. In previous days, smoke from fires degraded the air quality enough that people in communities near Southern Indian Lake (hidden by smoke to the west of Gauer Lake) had to evacuate.
The large image provided above has a spatial resolution (level of detail) of 250 meters per pixel and shows a slightly wider area, including part of Saskatchewan. The MODIS Rapid Response Team provides this image in additional resolutions. NASA image by Jeff Schmaltz, MODIS Rapid Response Team, Goddard Space Flight Center.

Chemical analysis of Lexington filter

The Lexington FRM-PM2.5 is an every three-day monitor that sampled on 4 August 2007 and measured 35.833 μg/m^3 which is an exceedance of the recently lowered PM2.5 daily standard (35 μg/m^3) that went into affect on 12/18/2006. The hourly PM2.5 data obtained with the TEOM at Lexington rose sharply (11.4 ug/m3 to 55.8 ug/m3) on 8/4/07. This steep rise in the hourly PM2.5 at Lexington on 8/4/07 is perhaps indicative of an exceptional event impact.

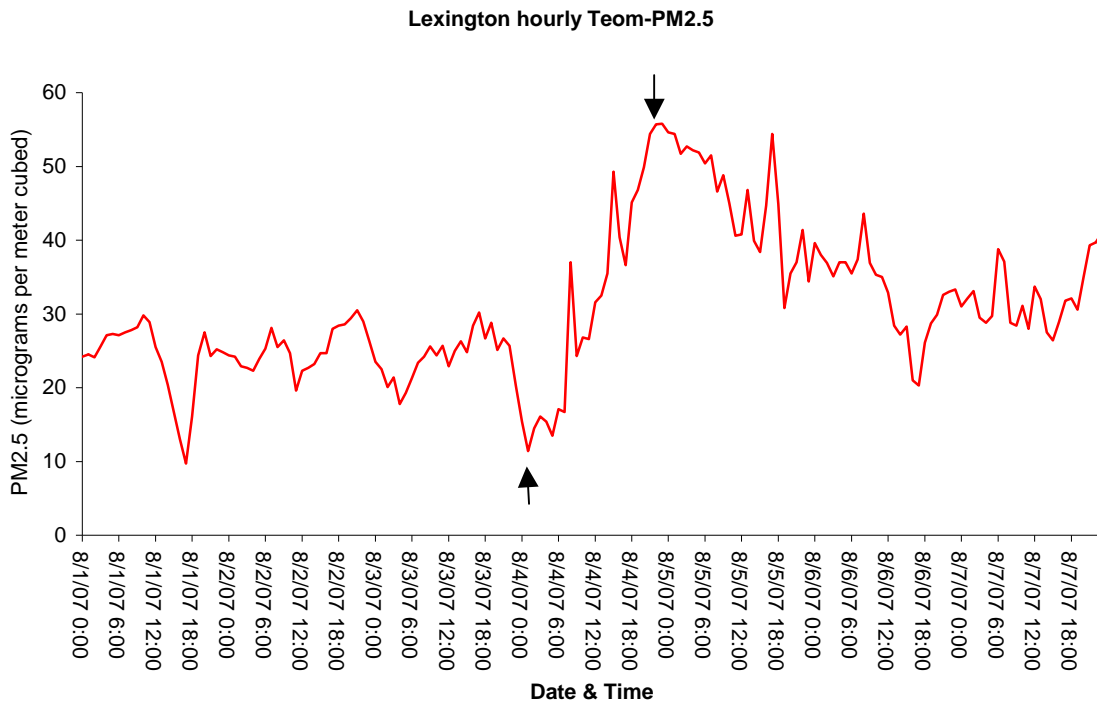**Lexington hourly Teom-PM2.5**

Figure 6: Lexington hourly Teom-PM2.5

The FRM-PM2.5 teflon filter (46.2 mm diameter) for Lexington and two from a background site were analyzed for elemental carbon with optical reflectance, cation/anions with Ion Chromotography, and crustal material with the alumina silica method. In lieu of elemental carbon data, the optical reflectance testing can provide a qualitative test for elemental carbon. However, Lexington, where the exceedance occurred, and Millbrook, the chosen background site, both contain a collocated speciated monitor (MetOne SASS). The elemental and organic carbon for the FRM-PM2.5 filters were assumed to be the same as the amount collected on the collocated speciated monitor at both Lexington, the site where the exceedance occurred, and Millbrook, the background site.

The speciated data is higher than the FRM data perhaps due to transportation and storage issues and because FRM Teflon filters have lower nitrate. Nevertheless, the results of the three tests on the FRM-PM2.5 teflon filter (optical reflectance, Ion Chromatography, and crustal mass test) produced data that compared well with the data collected by the speciation monitor (MetOne SASS) at both Lexington and Millbrook as seen in Table 1.

Table 1: Speciated mass via Ion Chromatography and/or MetOne SASS

Sample	Total Mass FRM, μg / Total Mass SP‡, μg	Speciated Mass via Ion Chromatography of the FRM-PM2.5 teflon filters (micrograms) / Speciated Mass via Met One SASS (micrograms)							
		EC	OC	K	Na	NO3	SO4	NH4	Other
LX 8/4	860	**	**	2.75	2.75	<0.88	390.91	89.9	unknown
	899	23	195	2.36	2.86	9.32	402.9	101.7	
ML 4/30	225	**	**	0.58	0.192	<0.88	67.07	26.6	
	292	17.83	116.45	1.38	6.05	13.27	88.6	43.7	
ML 9/29	145	**	**	0.3	0.203	<0.88	41.43	16.28	
	NA	NA	NA	NA	NA	NA	NA	NA	

‡ SP = Speciated Data from MetOne SASS
**The elemental and organic carbon for the FRM-PM2.5 filters were assumed to be the same as the amount collected on the collocated speciated monitor at both Lexington and Millbrook. For example, at Lexington on 8/4/07, the elemental carbon (EC) and organic carbon (OC) was assumed to be 23 and 195 micrograms. The crustal mass on the FRM-PM2.5 teflon filters was negligible.

The sulfates were six times higher for the FRM-PM2.5 exceedance filter (390.91 micrograms) than the Millbrook background FRM-PM2.5 filters. The study by Buzcu has shown that sulfates were higher during woodsmoke episodes than non-woodsmoke episodes in Texas. (**Citation:** Buzcu, B., Z. W. Yue, M. P. Fraser, U. Nopmongcol, and D. T. Allen (2006), Secondary particle formation and evidence of heterogeneous chemistry during a wood smoke episode in Texas, *J. Geophys. Res.*, 111, D10S13, doi:10.1029/2005JD006143).

The exceedance filter also contained approximately a twice as much organic carbon as the background filters. Organic carbon is also considered a compound that indicates woodsmoke impact.

The higher sulfates are perhaps due to the longer residence time available for chemical reactions in the plume. The organic carbon is either a product of the combustion of woodsmoke, combustion of diesel, or tree emissions. Both the sulfates and the organic carbon were higher at Lexington on 8-4-07 (the day of the exceedance) than the other days when the speciated monitor collected data (Figure 7).
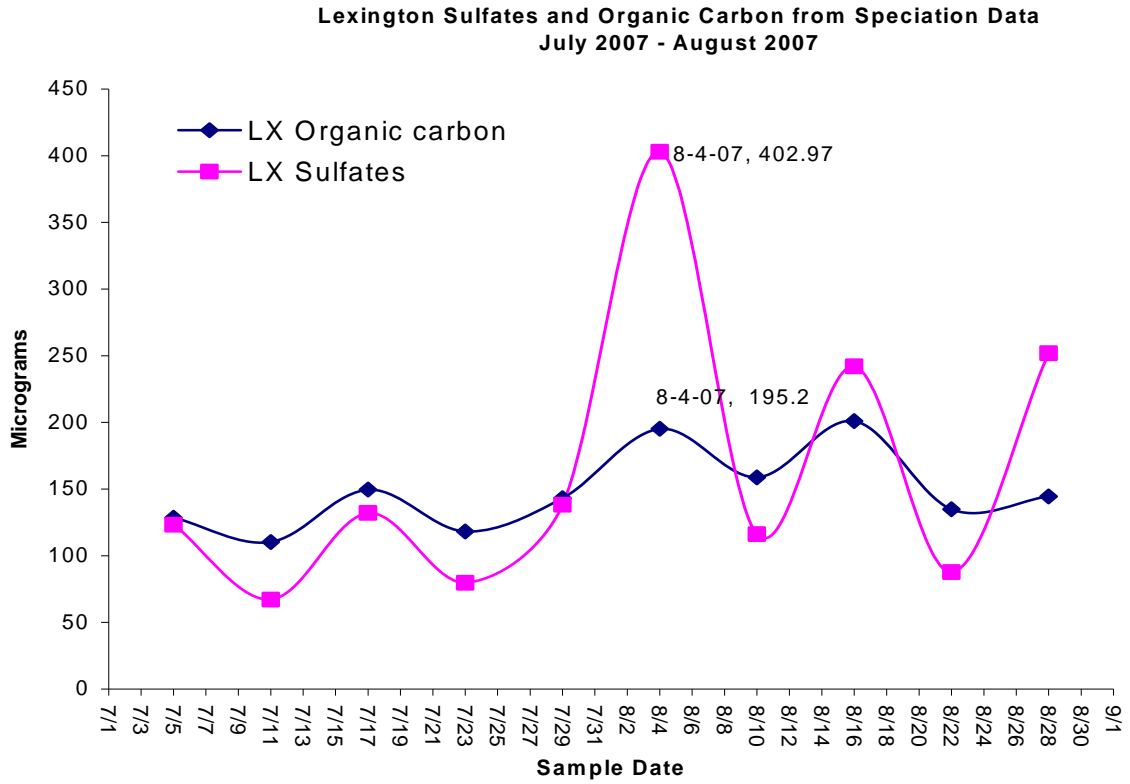
**Lexington Sulfates and Organic Carbon from Speciation Data
July 2007 - August 2007**

Legend:
- LX Organic carbon
- LX Sulfates

Data labels: 8-4-07, 402.97 and 8-4-07, 195.2

X-axis: Sample Date
Y-axis: Micrograms

Figure 7: Organic carbon and sulfates collected by the MetONE SASS monitor at the Lexington site.

Note that we did not chose a background site from August because NOAA smoke maps, which are located at the following website: http://map.ngdc.noaa.gov/website/firedetects/viewer.htm, indicate the entire State of North Carolina was covered with smoke during August 2007. The Millbrook monitoring station in Wake County was chosen as the background site because it is a central site that runs an everyday FRM-PM2.5 monitor which allowed flexibility in choosing our dates. The dates that satisfied the criteria for background filters were 4/30/07 and 9/29/07. The speciated MetOne SASS monitor at Millbrook ran on 4/30/07, but not on 9/29/07.

The criteria for selecting the background filters was that there was very little fire activity across the country and the back trajectories showed that air arrived from Idaho, Montana, and Canada and took a similar path as the back trajectories on Lexington on 8/4/07.

Fire activity across the country is shown in Figures 8 and 9. (You can access the previous large fire incident location maps at http://activefiremaps.fs.fed.us/modules/lg_fire/data/. If you are looking for 2007 maps, look in the 2007 sub directory. The maps are named by date (e.g. lg_fire_nifc_2007-09-15.png). You will find 3 map files for each date in png or pdf format).
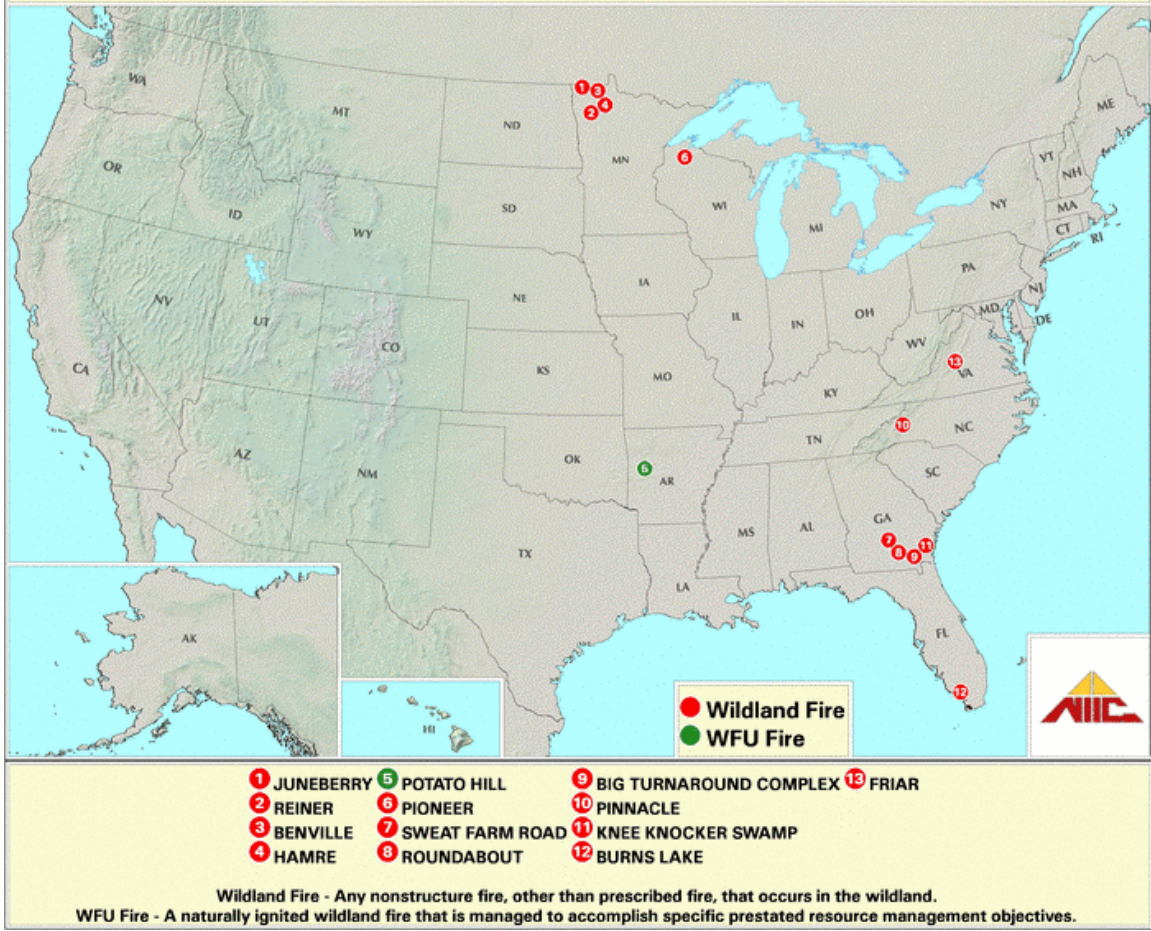
The back trajectories from Millbrook are shown in Figures 10 and 11.

Figure 8: Low fire activity on 4-30-07. A background sample from Millbrook was selected on 4-30-07.
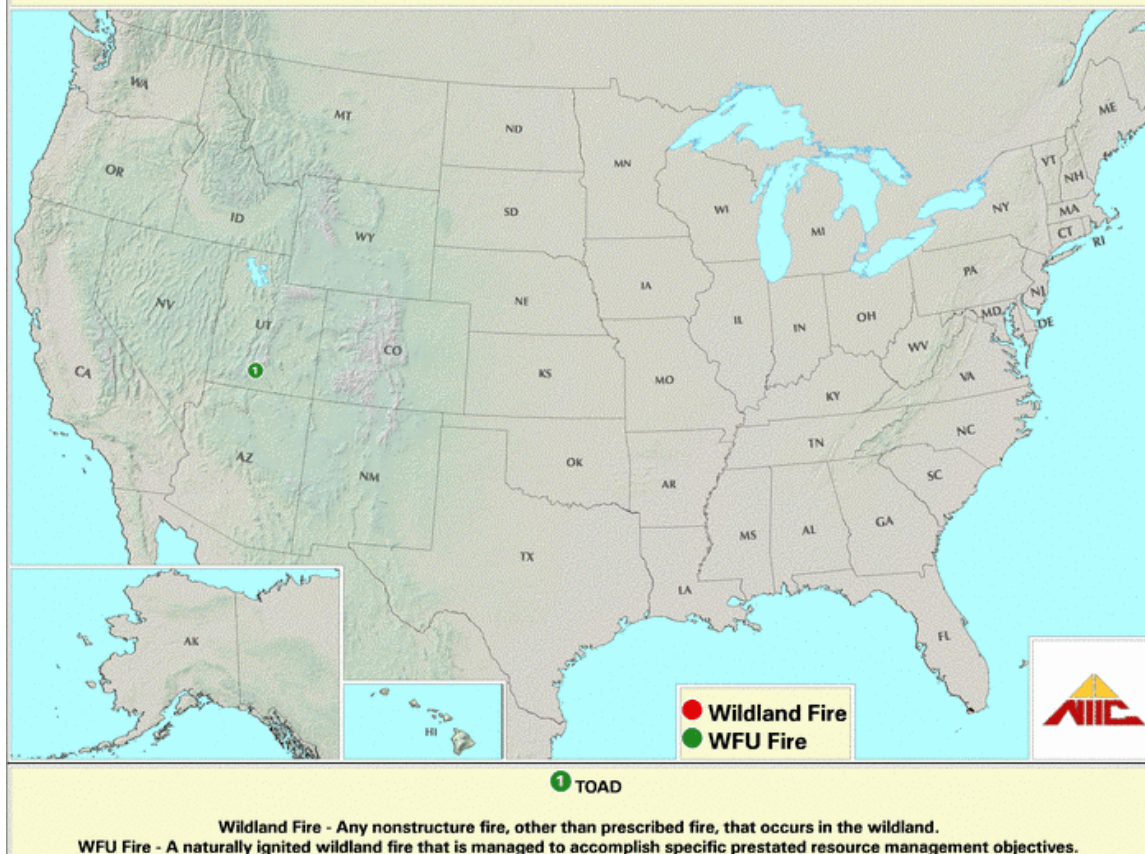
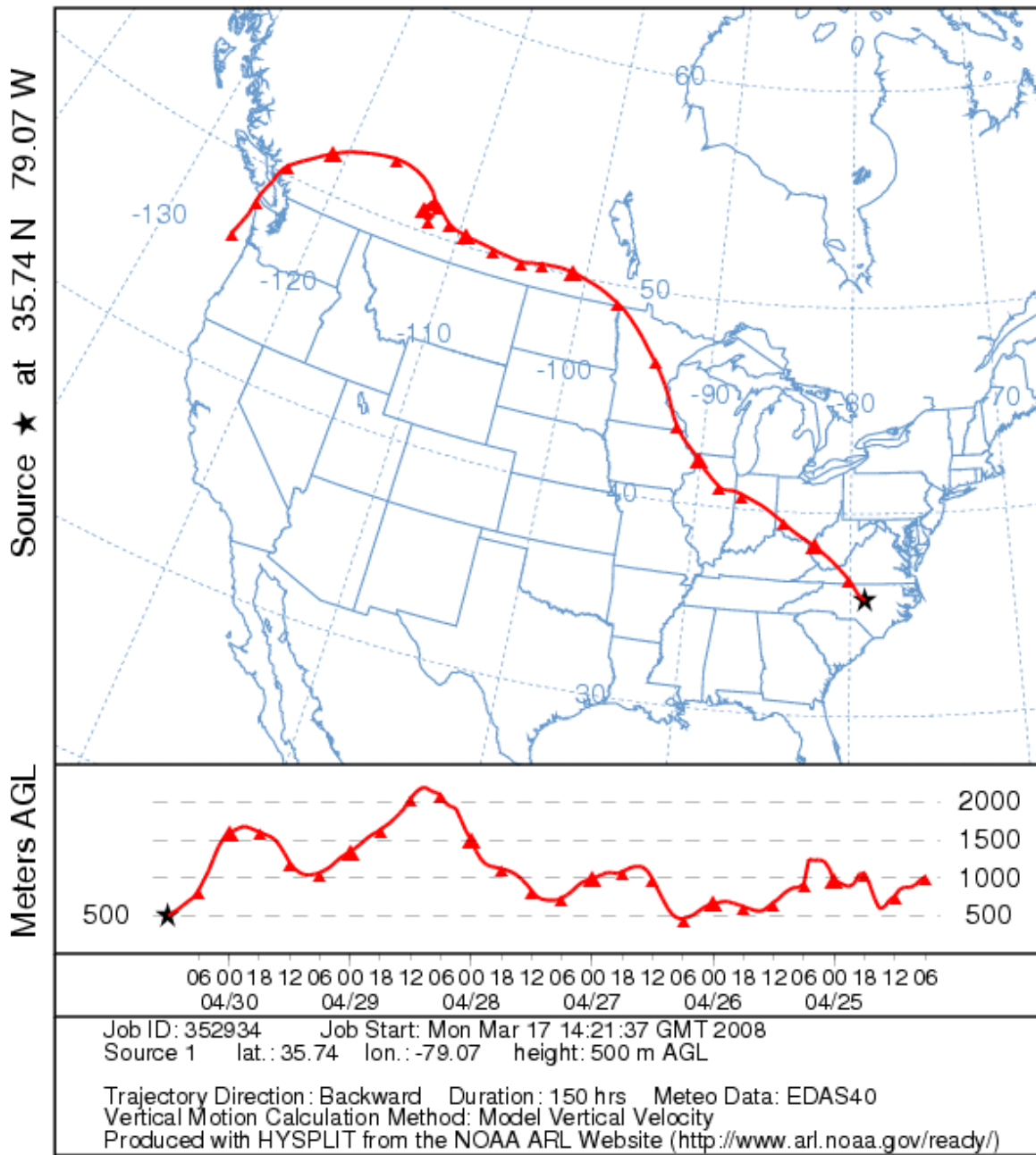**Figure 9: Low fire activity on 9-29-07. A background sample from Millbrook was selected on 9-29-07.**

Figure 10: A back trajectory on 4-30-07 at Millbrook. Millbrook was selected to serve as the background site for the Lexington exceedance on 8-4-2007.
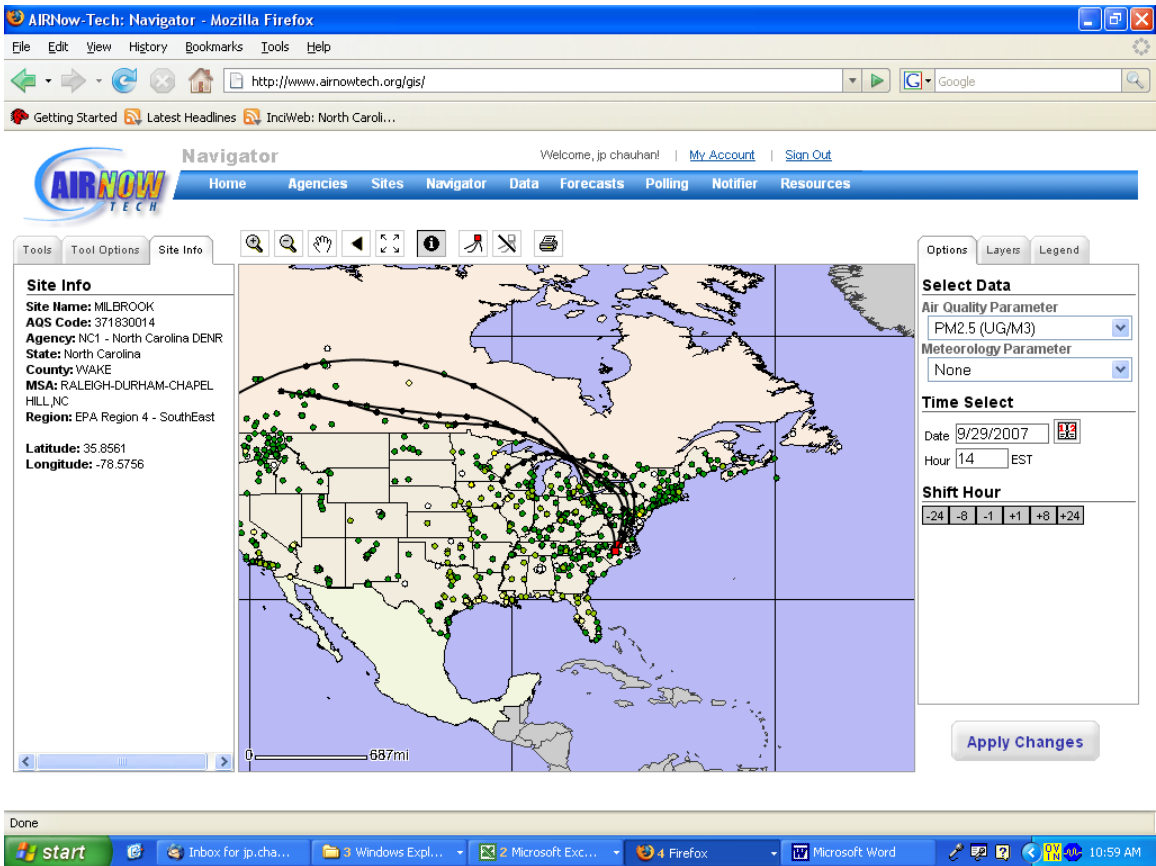
Figure 11: Backward trajectories at Milbrook on 9-29-2007. Back trajectories to Millbrook come out of Canada very close to the area where the Montana/Idaho smoke dispersed. Furthermore, Millbrook contains an everyday sampler making background sample day selection convenient.

The transport of Smoke from Idaho and Montana

As the smoke drifted east from Idaho/Montana/Canada, it spread to cover a range from Maryland to the Mid-Atlantic States by 4 August 2007. Further, the smoke resided or accumulated as seen with the thin smoke layer hovering over the Eastern US in the satellite image (satellite image in Figure 12).
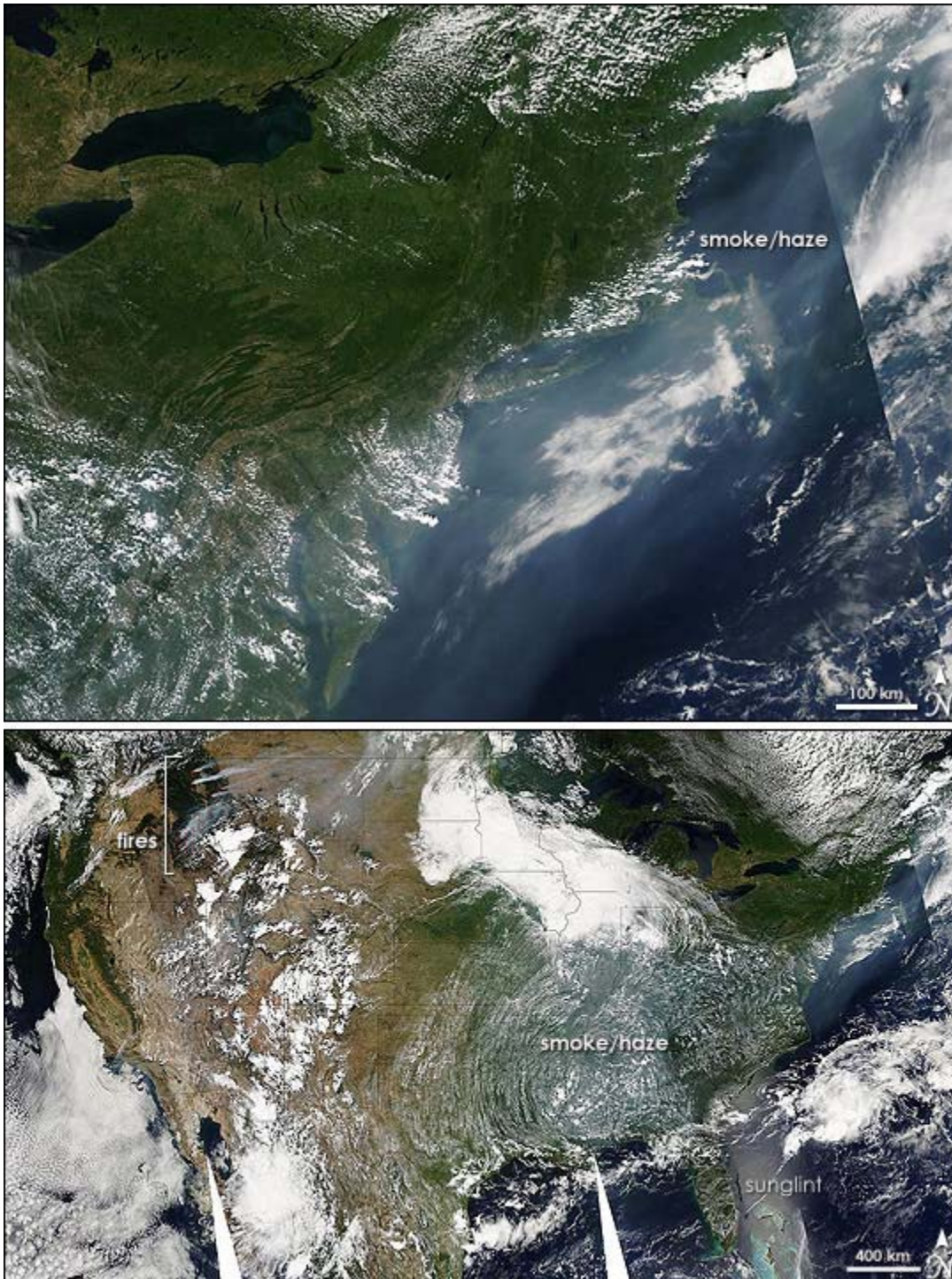
Figure 12 Smoke from fires in Idaho and Montana : Some things are so large that the perspective from space is necessary to appreciate them. One of those things is the long-distance impact that pollutants like smoke or dust can have on air quality. On August 4, 2007, for example, fires raging in Montana and Idaho polluted the air over much of the United States. The Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Aqua satellite captured this image of the smoke and fires on the afternoon of August 4. The lower image is a mosaic of four separate flyovers (separated by faint diagonal lines), while the top image is a close-up view of the smoke and haze along the northeastern seaboard.

Strong winds on August 4 created uncontrollable firestorms that forced the evacuation of at least two communities in Montana, reported the *Missoulian.* Fires in Montana and Idaho are marked with red dots in the lower image and are more clearly visible in the large image. In addition to fueling the flames, the winds blew dense plumes of smoke northeast. The thickest plumes rise from the fires in northwestern Montana. By the time the smoke reached eastern Montana, the plumes were no longer distinct. The air was clouded with a soupy, gray haze that curves north into Canada. High-level winds pushed the smoke south over the western Great Lakes, and into the central and southern United States. From the bank of clouds over Illinois to the Gulf of Mexico, the air was white-gray with haze. From the central United States, the plume of pollution snaked over the Mid-Atlantic States and the Chesapeake Bay to the Atlantic Ocean, where it turned north and flowed along the coast. Some additional haze may line the coast south of Cape Hatteras, but reflected sunlight has turned the ocean's surface into a mirror, effectively masking the presence of any haze.

The top image provides a closer view of the haze over the Atlantic Ocean from the Delmarva Peninsula along the eastern shore of the Chesapeake Bay, to the Gulf of Maine, north of Cape Cod. By this point, smoke from the western wildfires is probably only one component of the haze. High temperatures and stagnant air also amplified the impact of urban pollution, creating Code Orange air quality conditions, which are unhealthy for sensitive groups such as active children or adults or individuals with respiratory ailments. The jetstream—the fast-moving, high-level winds that steer weather systems—is defined by the stark boundary between the hazy air over the Mid-Atlantic and the clear air over New England. Jetstream winds are clearly blocking the smoke from traveling north.

NASA image courtesy the MODIS Rapid Response Team at NASA GSFC, which provides daily images of the United States in a clickable map.

The forward trajectories reveal where the smoke would have gone from Idaho and Montana (the trajectories are shown individually in a later section of this report). The forward trajectories start on 26 July 2007 from the fire location. The individual forward trajectories are also shown in Figure 3 using the NOAA Hysplit format. These forward trajectories indicate smoke from the fires dispersed east and south, and took residency in the Mid-Atlantic area of the U.S.
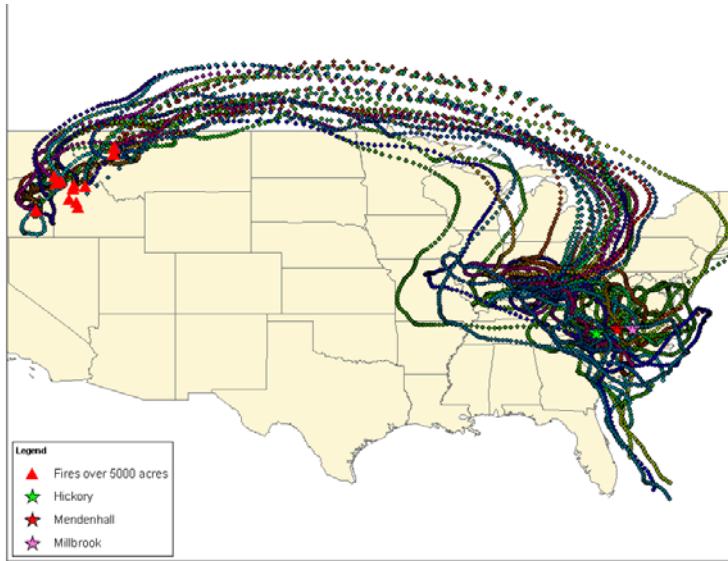

Figure 13 August 4th 2007 fire impacts from all fires over 5000 arces. The various stars denote the location of the monitors. The Lexington monitor is very close (approximately 35 miles) Southwest of the Mendenhall monitor. The air mass seems to congregate or accumulate at the mid-atlantic states.
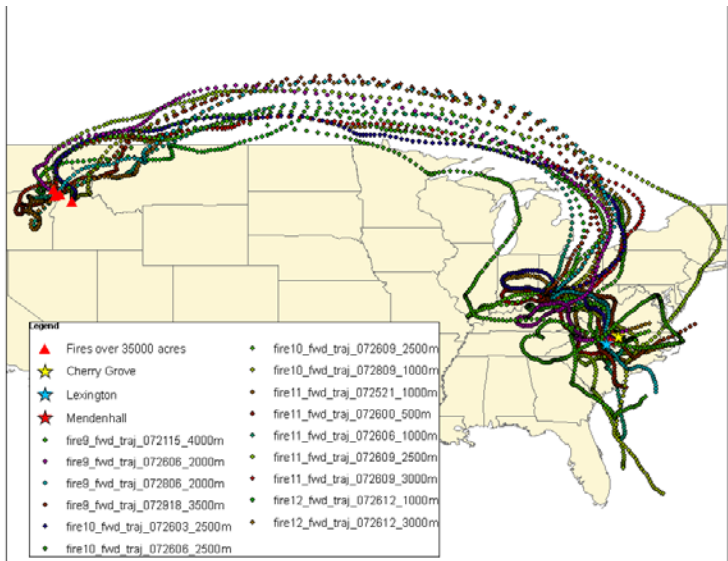

Figure 14 August 4th 2007 fire impacts from all fires over 35000 arces. The various stars denote the location of the monitors. The Lexington monitor is approximately 35 miles Southwest of the Mendenhall monitor. The air mass seems to congregate or accumulate at the mid-atlantic states.

Individual Forward Trajectories

The height of the air mass along its journey to North Carolina is plotted for the individual forward trajectory images in the next several pages. Forward trajectories indicate where the smoke would have gone. The star in North Carolina denotes the Lexington monitor in these images. The star in Idaho denotes a fire that was greater than 10,000 acres. The trajectories were stopped on 5 August 2007 at midnight.
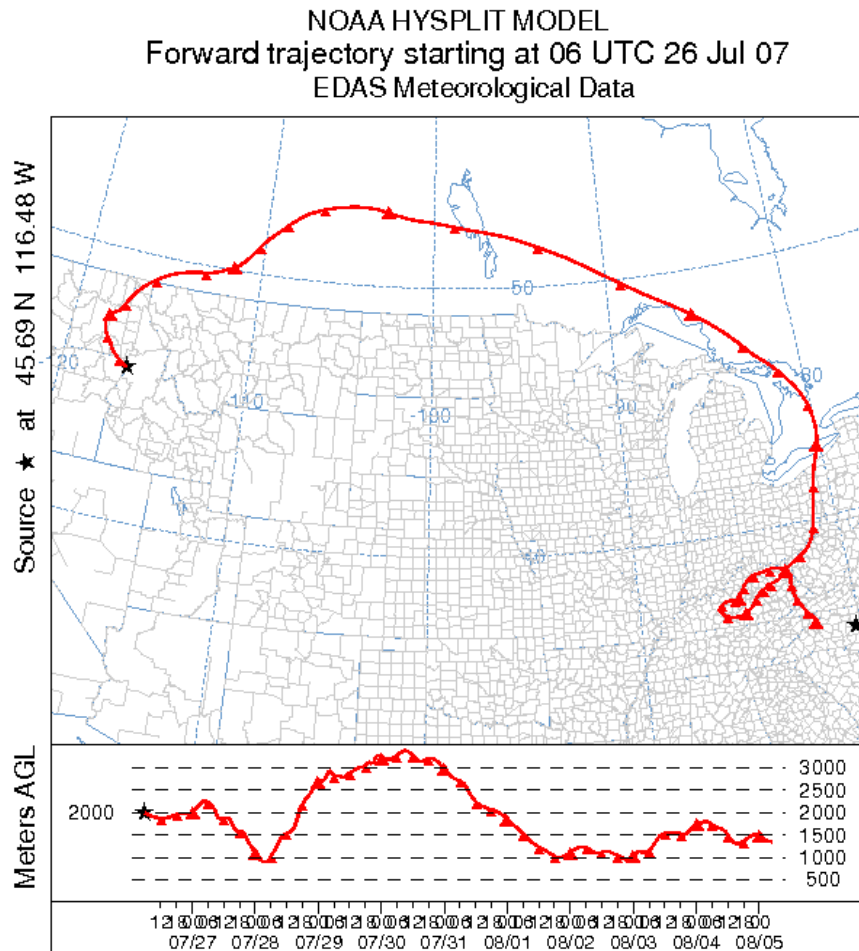
NOAA HYSPLIT MODEL
Forward trajectory starting at 06 UTC 26 Jul 07
EDAS Meteorological Data

Figure 15: Individual Forward Trajectory
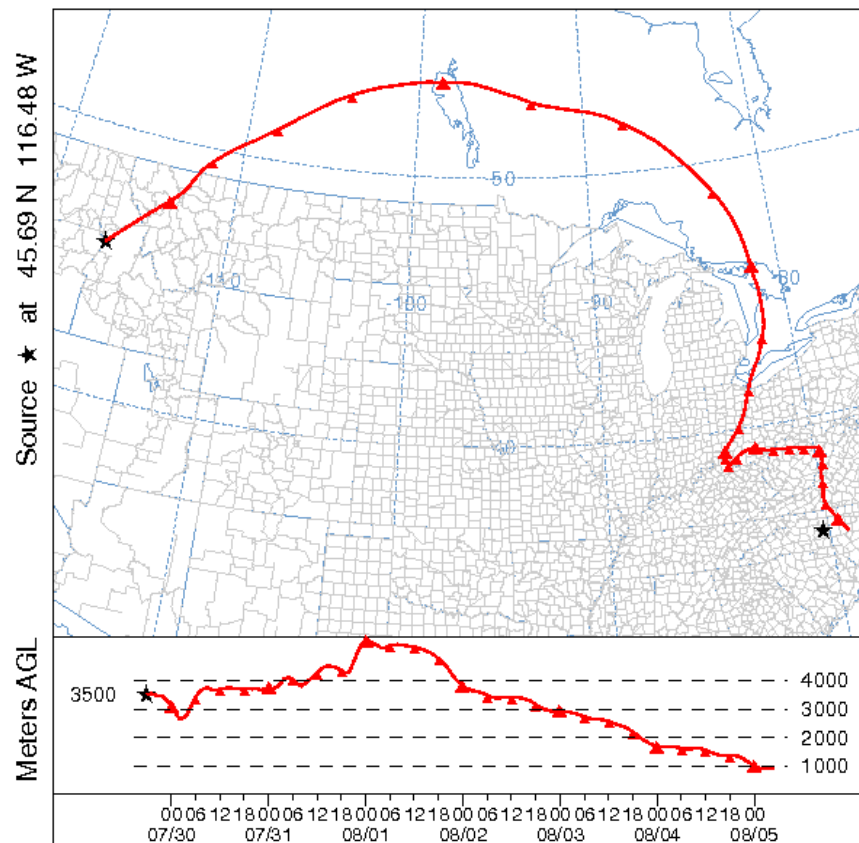
Figure 16: Individual Forward Trajectory

Figure 17: Individual Forward Trajectory

NOAA HYSPLIT MODEL
Forward trajectory starting at 03 UTC 26 Jul 07
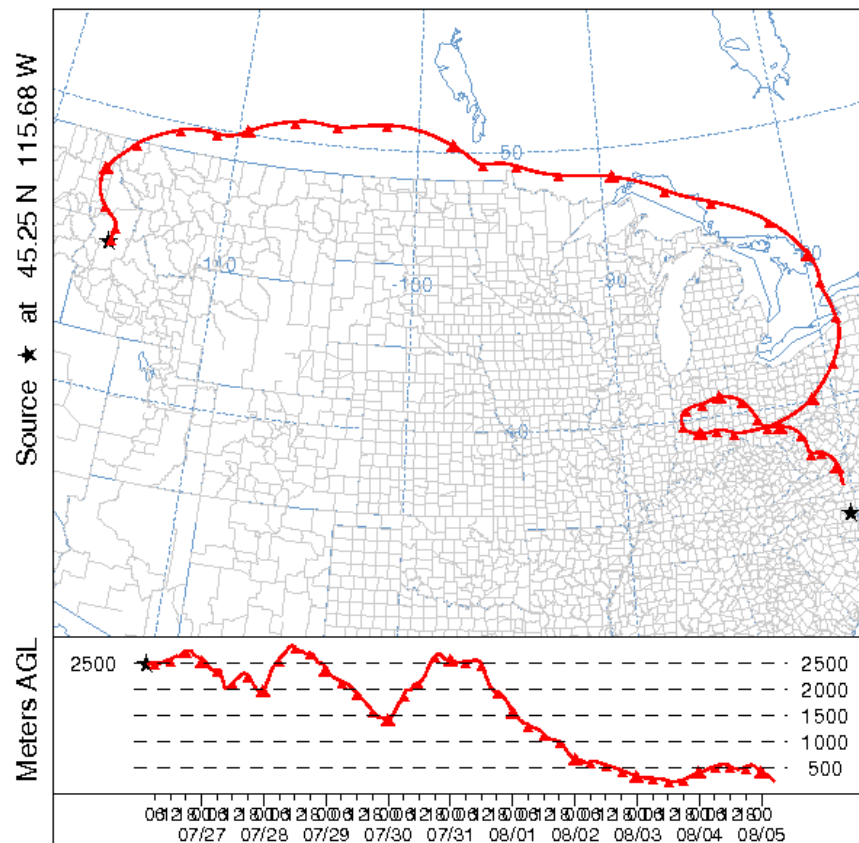EDAS Meteorological Data

Figure 18: Individual Forward Trajectory

NOAA HYSPLIT MODEL
Forward trajectory starting at 06 UTC 26 Jul 07
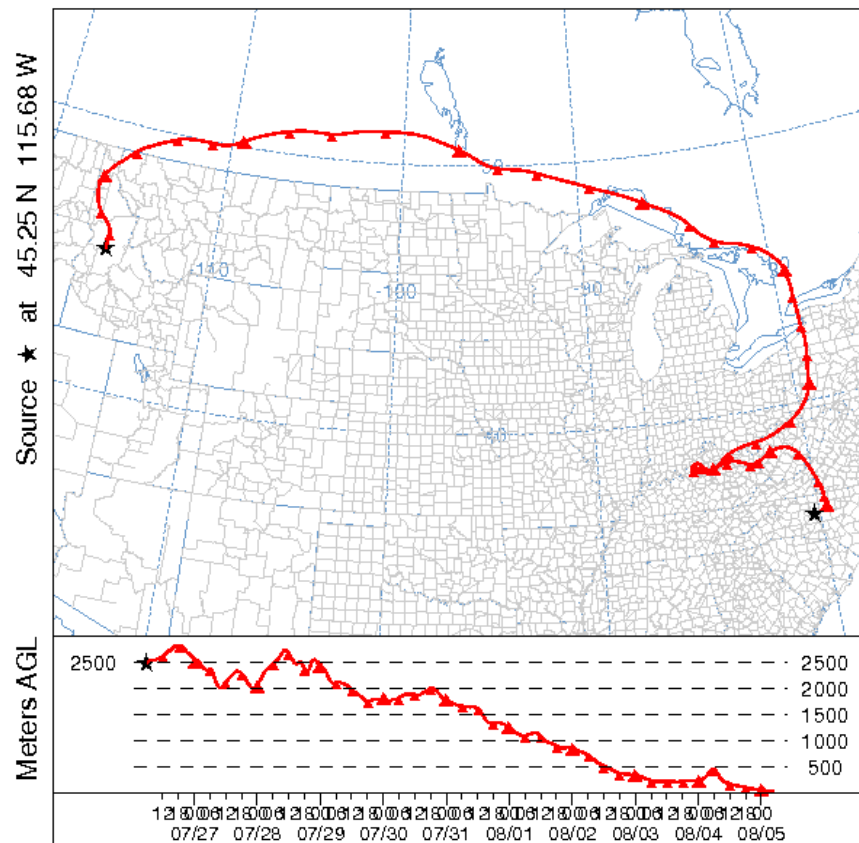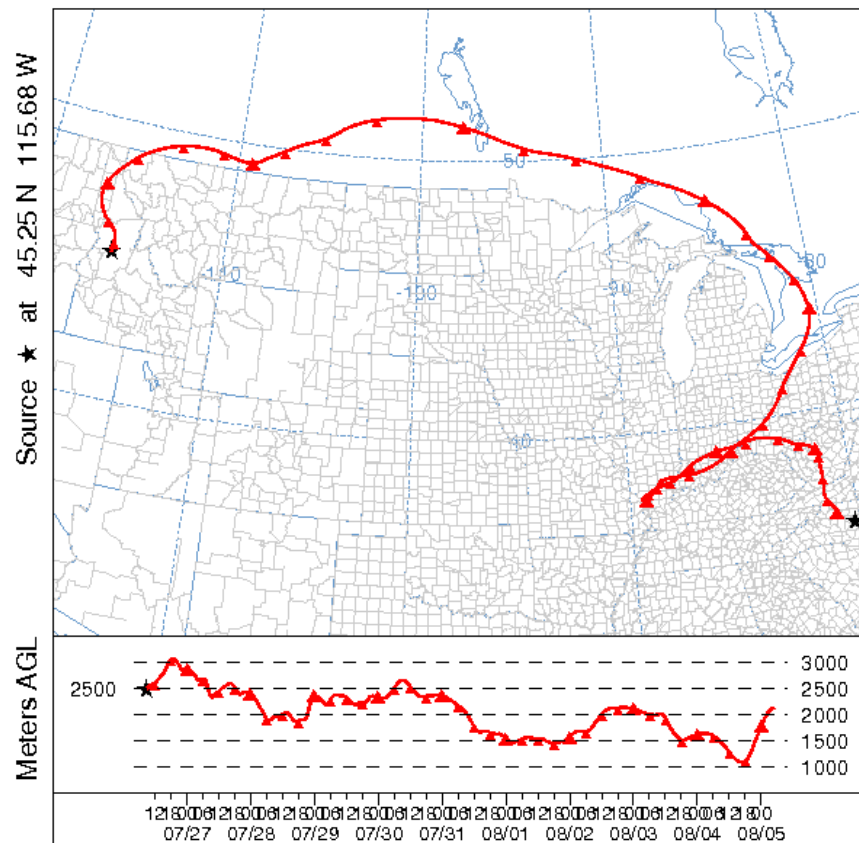EDAS Meteorological Data

Figure 19: Individual Forward Trajectory

23

NOAA HYSPLIT MODEL
Forward trajectory starting at 09 UTC 26 Jul 07
EDAS Meteorological Data

Figure 20: Individual Forward Trajectory

Figure 21: Individual Forward Trajectory

NOAA HYSPLIT MODEL
Forward trajectory starting at 15 UTC 21 Jul 07
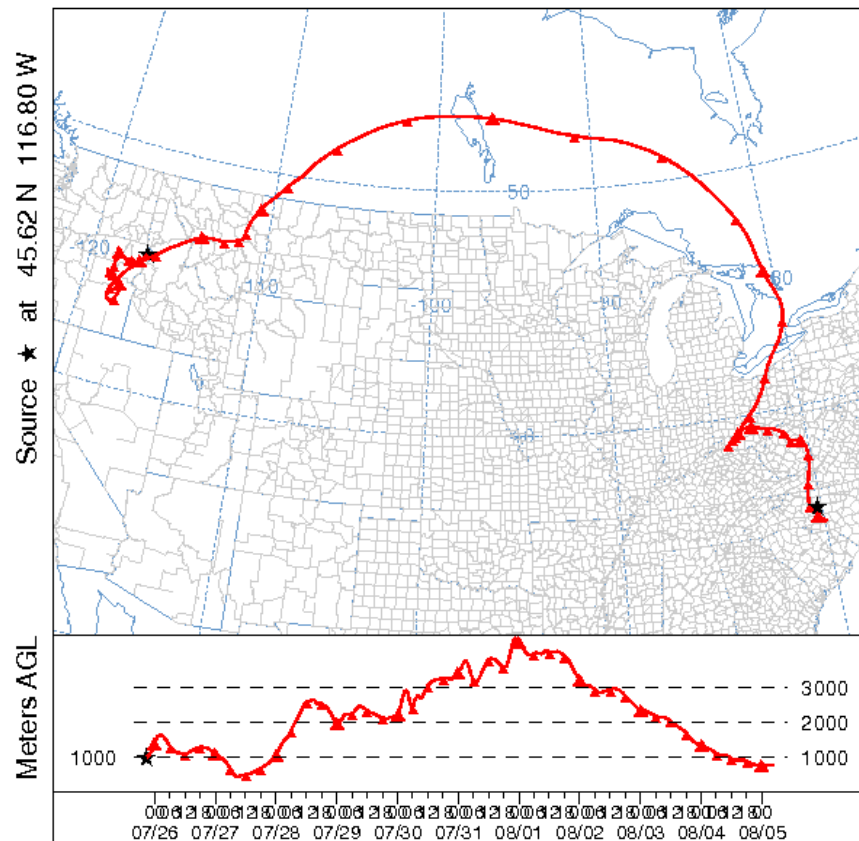EDAS Meteorological Data

Figure 22: Individual Forward Trajectory

NOAA HYSPLIT MODEL
Forward trajectory starting at 12 UTC 26 Jul 07
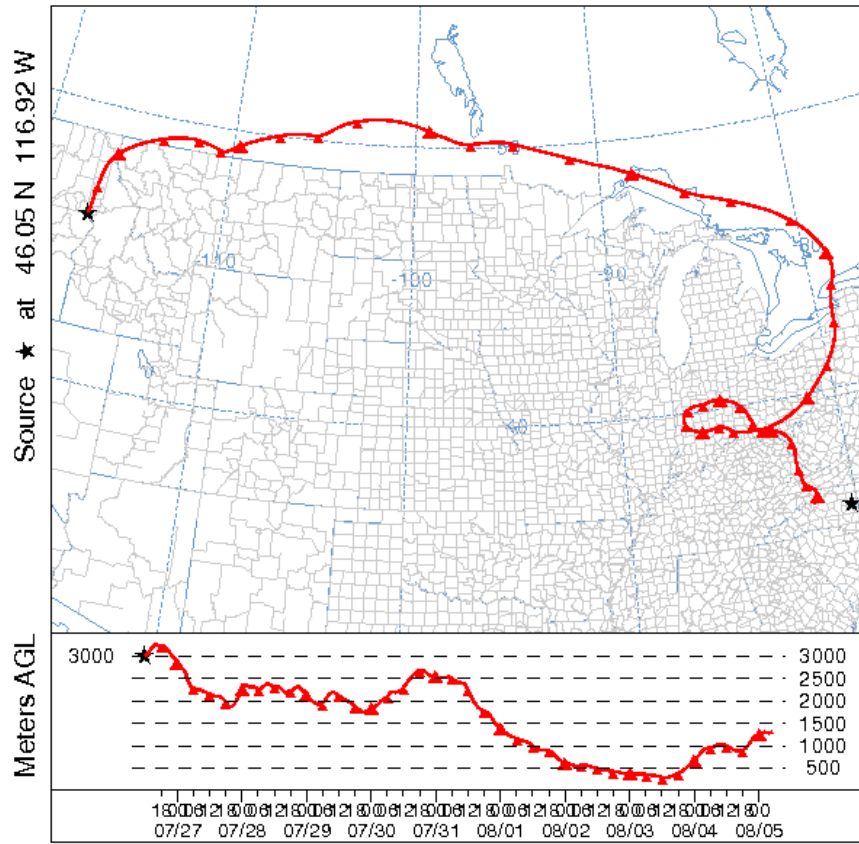EDAS Meteorological Data

Figure 23: Individual Forward Trajectory

Backward trajectories reveal from where several air masses arrived in North Carolina on 4 August 2007 (individual trajectories are shown after this section).
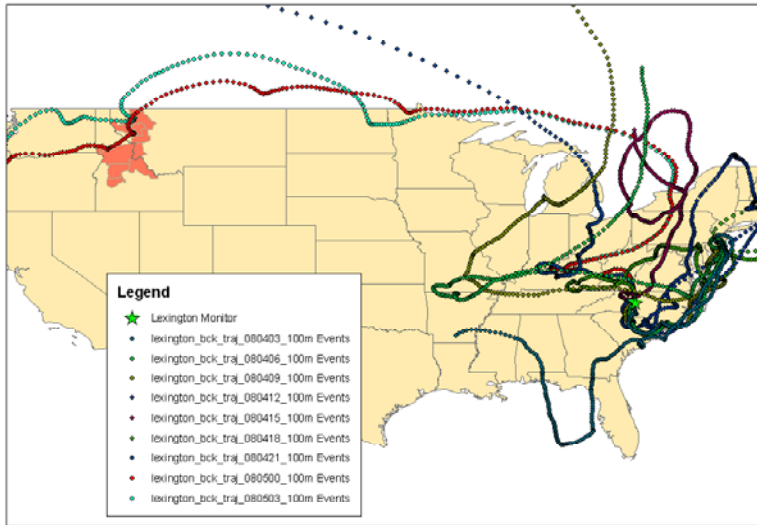

Figure 24 :HYSPLIT backward trajectories at Lexington at various times at 100m on 08/04/07. Legend indicates date/time(zulu)_trajectory level. HYSPLIT trajectories use Zulu Time or Coordinated Universal Time (UTC) as their time reference. The trajectory images that appear above are stamped in Zulu time. [Eastern Daylight time(EDT)(Mar to Nov 2007) = Zulu – 4, e.g. 5pm (EDT) = 21z – 4]. The counties in Red contain large fires identified by NIFC during the period of July 20-Aug 5. The green star denotes the location of the monitor.
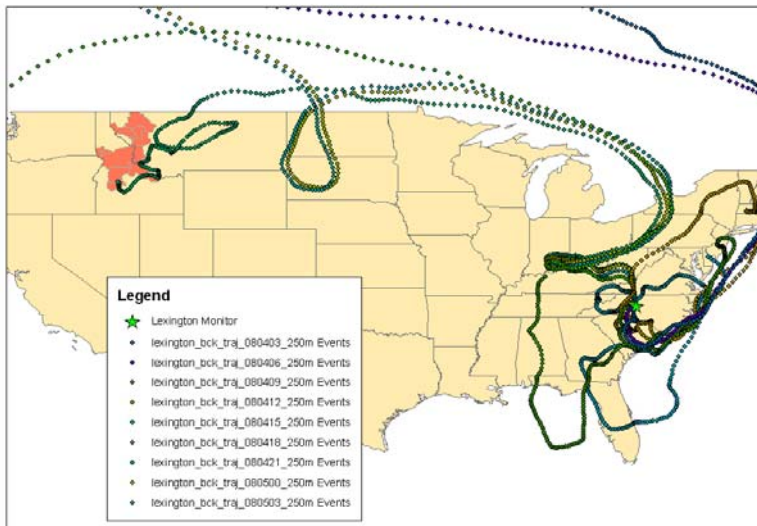

Figure 25 HYSPLIT backward trajectories at Lexington at various times at 250m on 08/04/07. Legend is same as in Figure 5, except at 250 meters.

Individual Backward Trajectories

NOAA HYSPLIT MODEL
Backward trajectory ending at 21 UTC 04 Aug 07
EDAS Meteorological Data

Figure 26: Individual Backward Trajectory

NOAA HYSPLIT MODEL
Backward trajectory ending at 03 UTC 05 Aug 07
EDAS Meteorological Data

Figure 27: Individual Backward Trajectory

NOAA HYSPLIT MODEL
Backward trajectory ending at 06 UTC 04 Aug 07
EDAS Meteorological Data

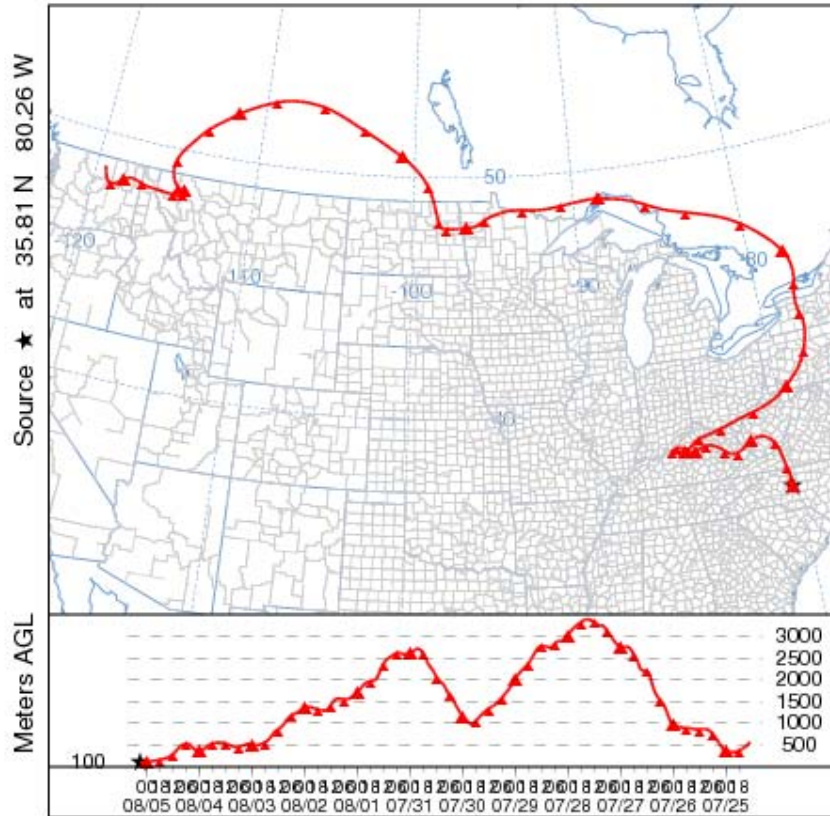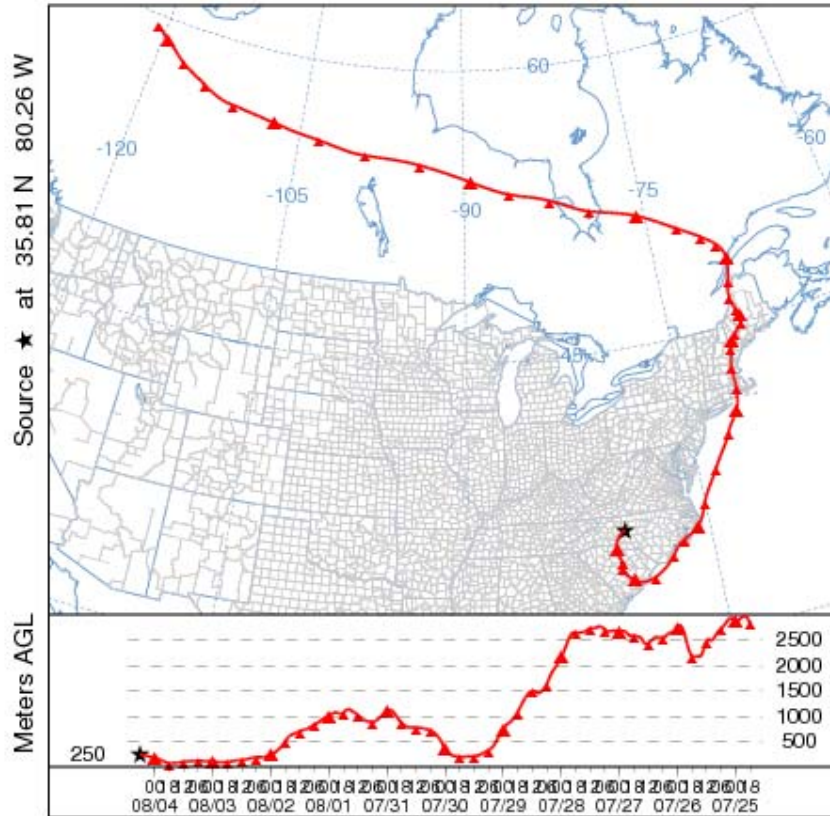**Figure 28: Individual Backward Trajectory**

Figure 29: Individual Backward Trajectory

NOAA HYSPLIT MODEL
Backward trajectory ending at 21 UTC 04 Aug 07
EDAS Meteorological Data

Figure 30: Individual Backward Trajectory

Figure 31: Individual Backward Trajectory

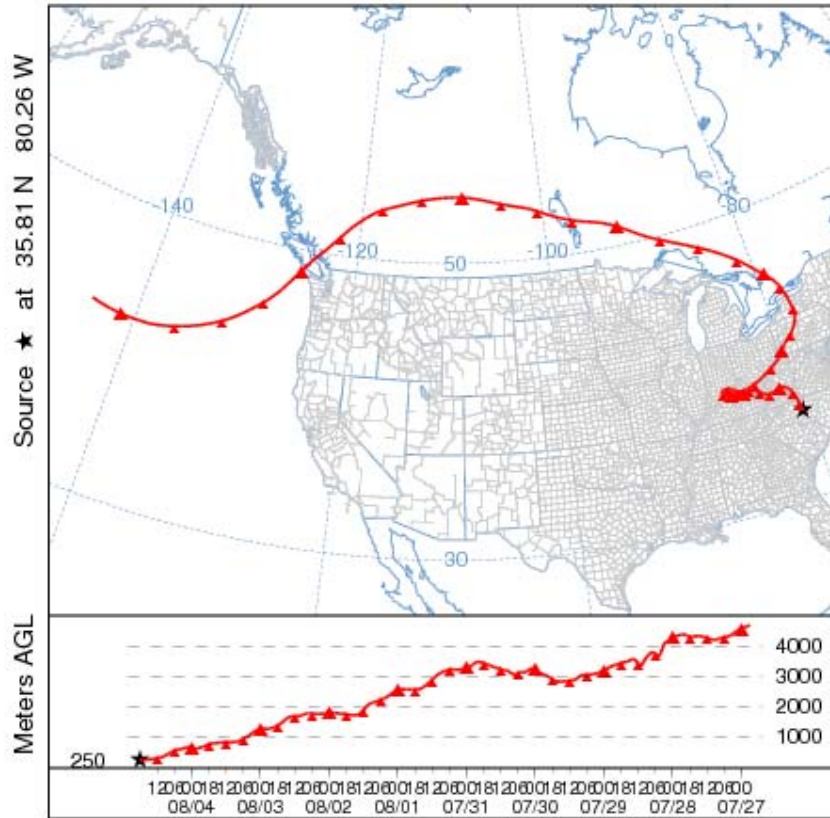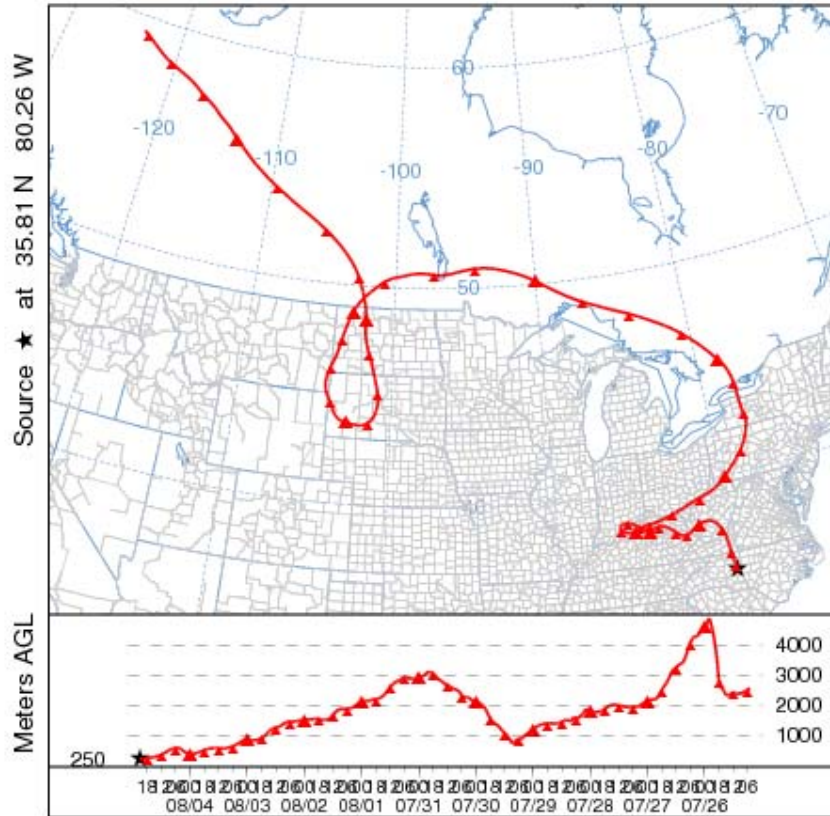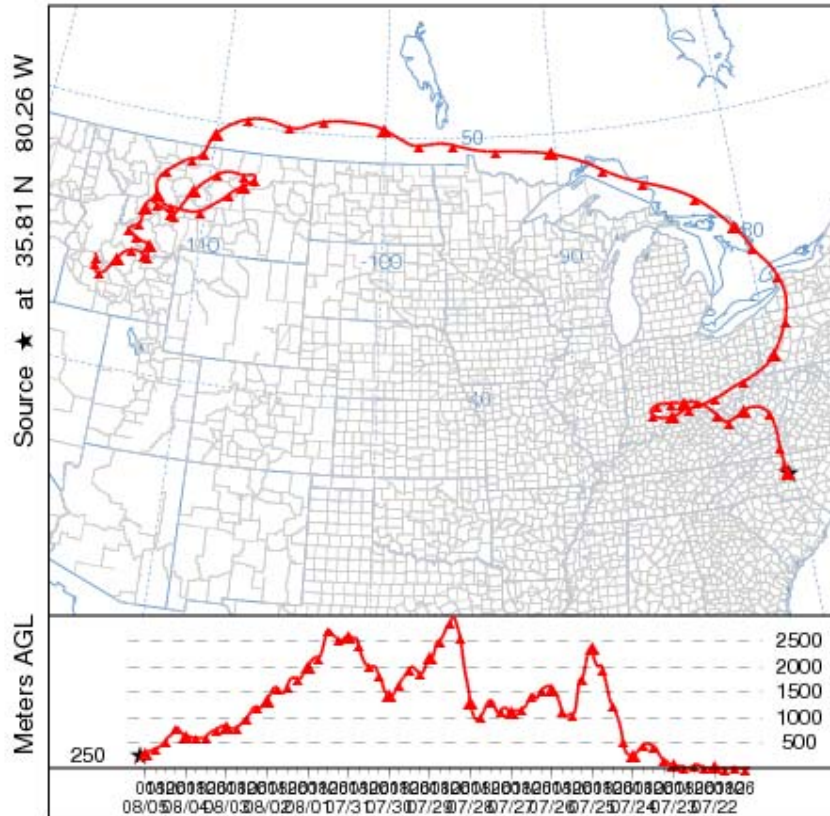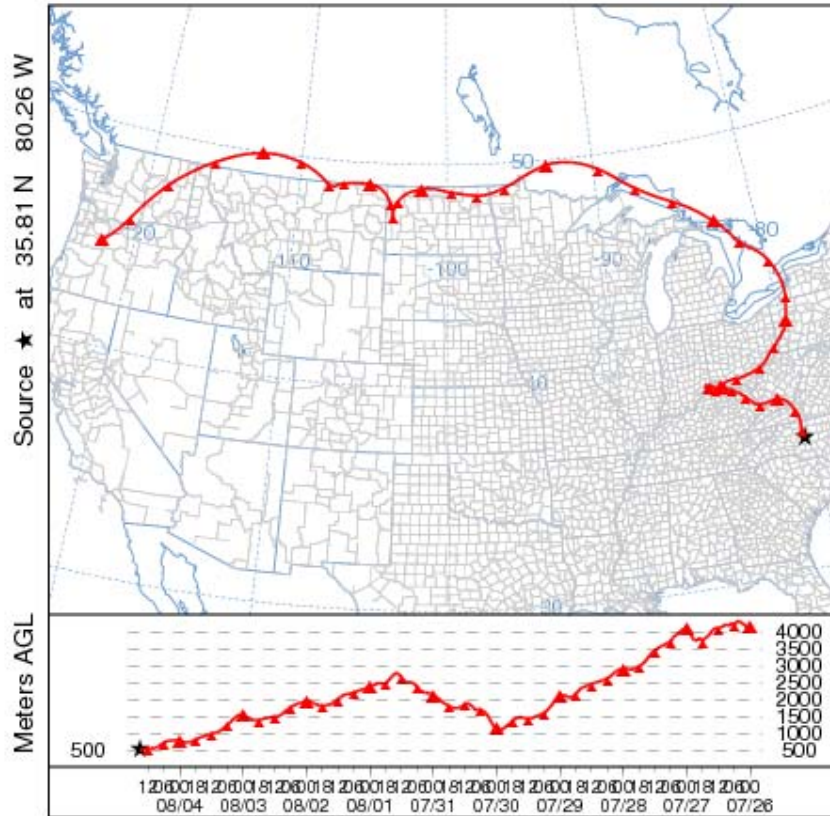**Figure 32: Individual Backward Trajectory**

NOAA HYSPLIT MODEL
Backward trajectory ending at 21 UTC 04 Aug 07
EDAS Meteorological Data
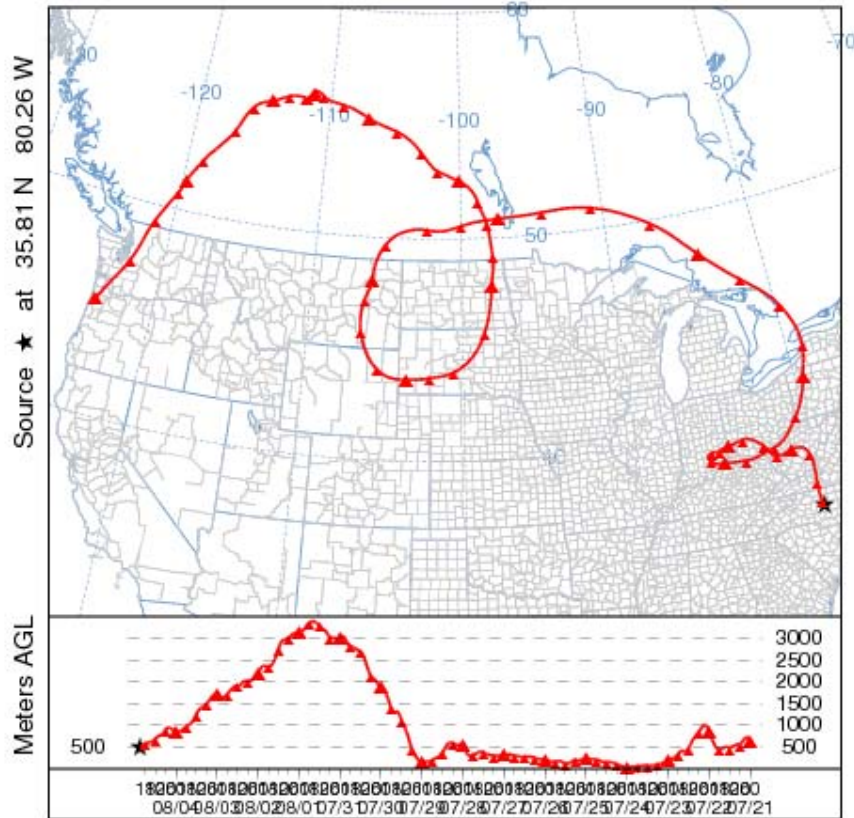
Figure 33: Individual Backward Trajectory

Figure 34: Individual Backward Trajectory

The mixing height in North Carolina on August 4, 2007 ranged from 1-3km (Figure 35 and 36). Most forward trajectories enter North Carolina below the mixing height on 4 August 2007 over North Carolina. The vertical mixing occurring in the mixing height would have likely brought the smoke down to ground level, especially over 2000 miles of travel from Idaho/Montana/Canada to North Carolina. Upwind monitors in Pennsylvania, Ohio, and Kentucky were reading hourly PM2.5 in excess of 50 μg/m^3 the day before the exceedance at the Lexington, NC monitor (See Figure 37).
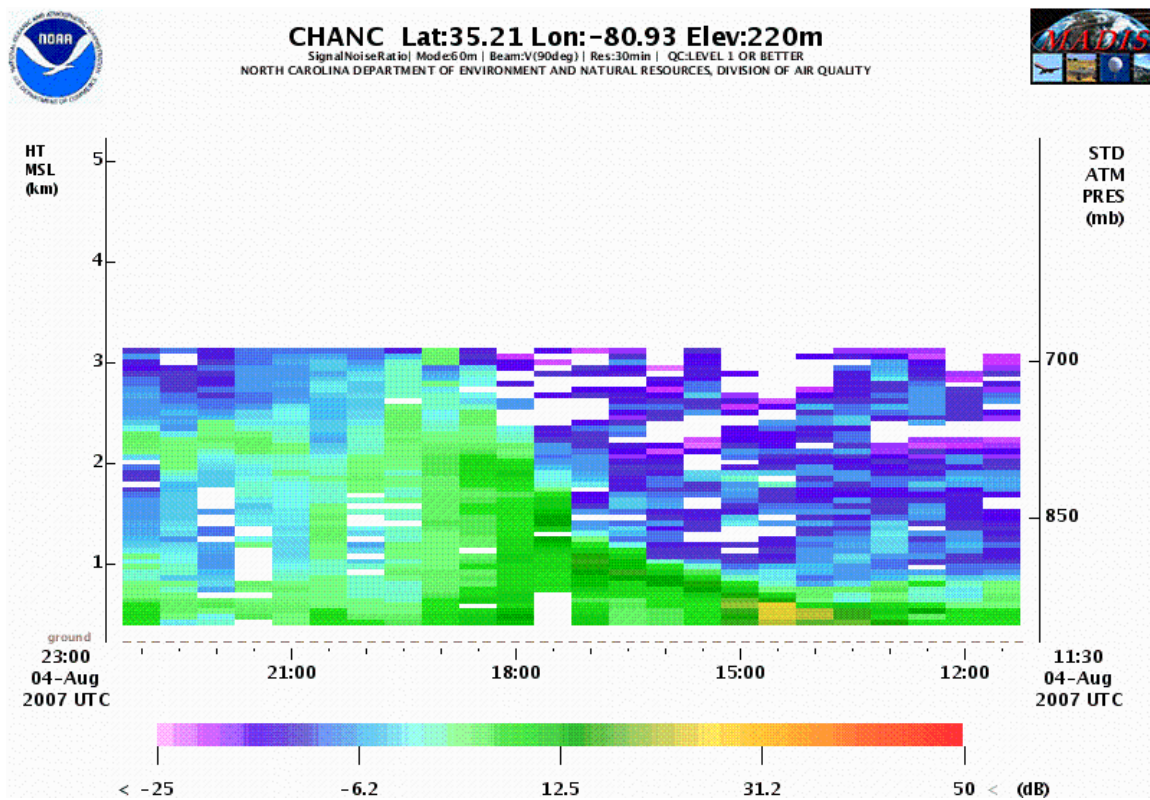
Figure 35: The mixing height over Charlotte on 04-Aug 2007 UTC is indicated by the green and indicates mixing height increases from 1 km (½ mile) to 3 km (2 miles) in the afternoon. Mixing heights peak at approximately the same time as the temperature peak is expected.
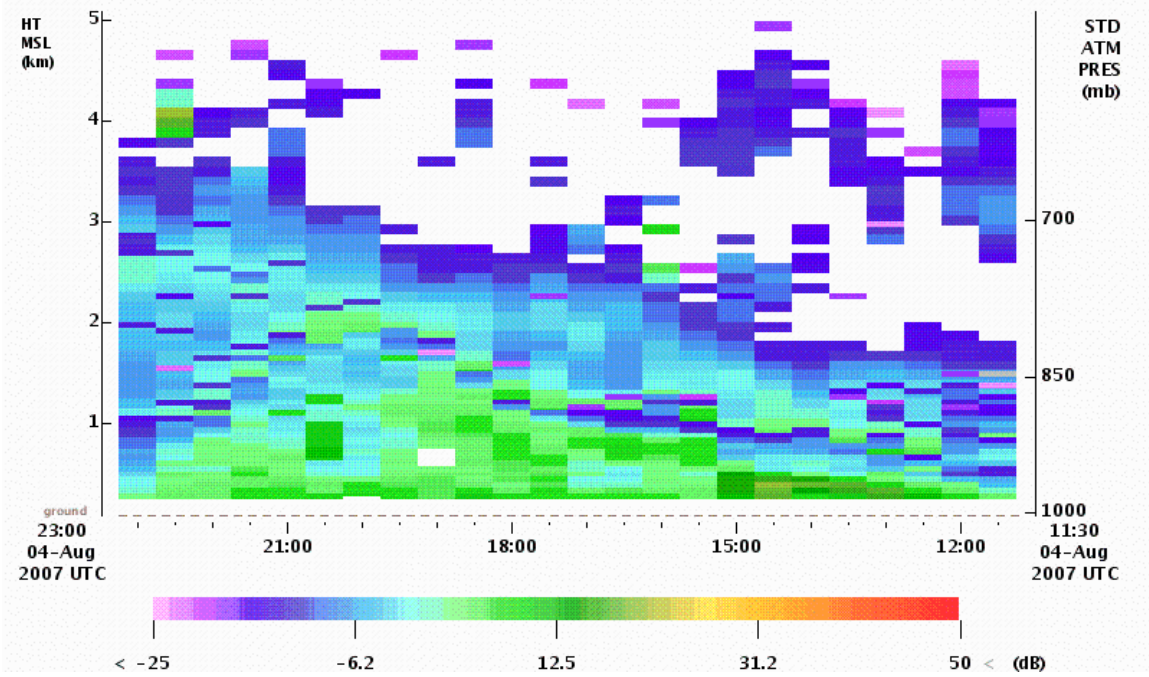
Figure 36: The mixing height over Raleigh on 04-Aug 2007 UTC is indicated by the green and indicates mixing height increases from 1 km (½ mile) to 2 km (1 mile) in the afternoon. Mixing heights peak at approximately the same time as the temperature peak is expected.
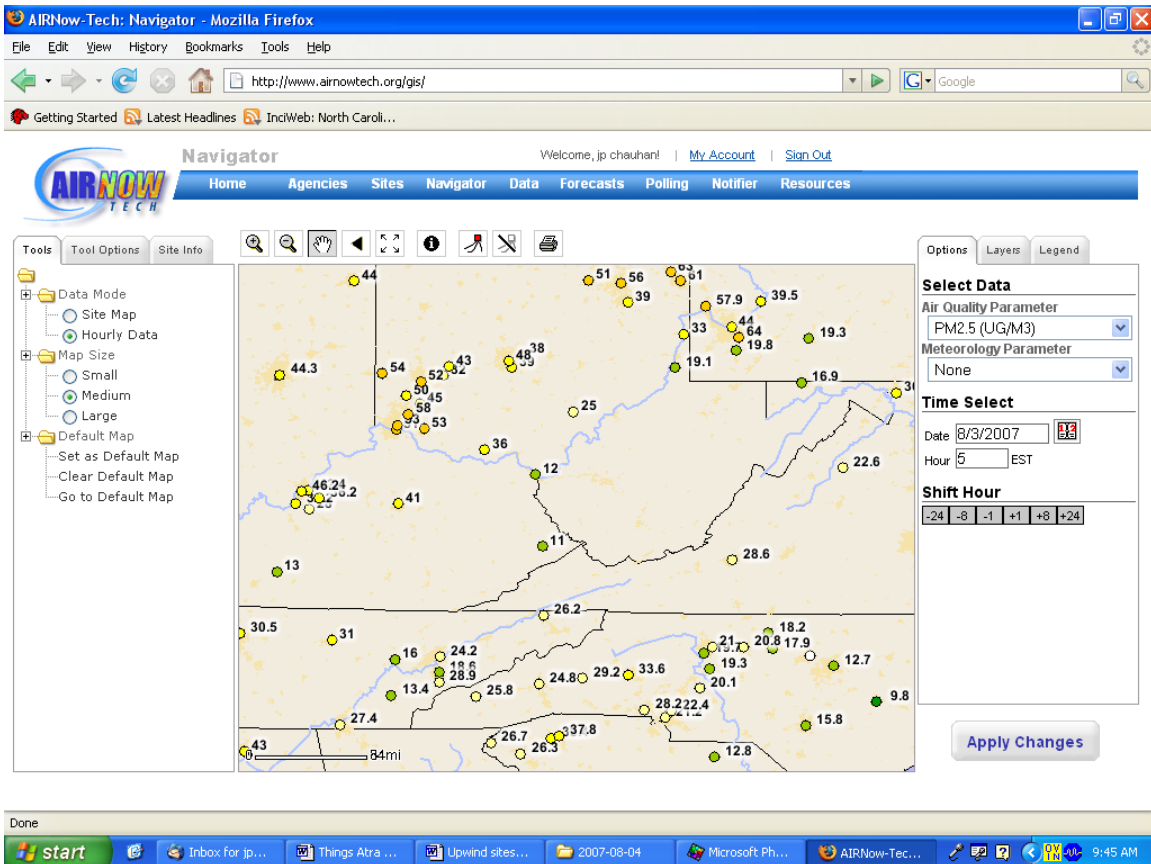
Figure 37 Upwind sites one day before the exceedance at Lexington on 4 August 2007.

Statistical Analysis
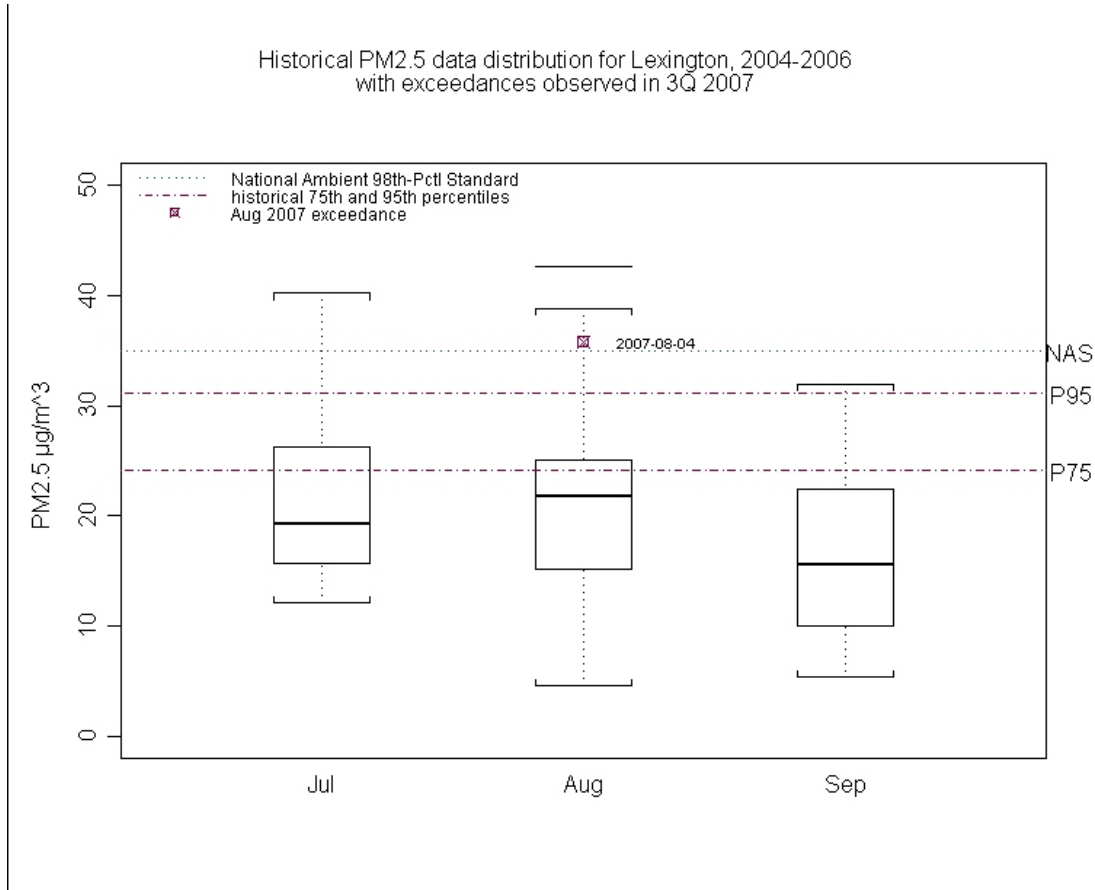
Figure 38: "normal historical fluctuations" of PM2.5 data for the Lexington monitoring station during the third calendar quarter in the form of boxplots for the individual *monthly* distributions with reference lines showing the historical levels of the 75th and 95th percentile levels as well as the level of the National Ambient 98th-percentile Standard (24.0 μg/m^3, 30.3 μg/m^3, and 35.0 μg/m^3, respectively).

EPA has discussed the possible use of the historical 75th and 95th percentiles as objective thresholds for favorable concurrence decisions { [Federal Register: March 10, 2006 (Volume 71, Number 47)] The Treatment of Data Influenced by Exceptional Events: Proposed Rules, p. 12592} The historical 95th percentile level for this event is 31.2 μg/m^3. The 4 Aug 2007 exceedance exceeds the historical 95th percentile level by 15 percent.

PM2.5 data for Lexington from 3Q 2004-2006
robustly fitted lognormal distribution, and
exceedance observed in 2007
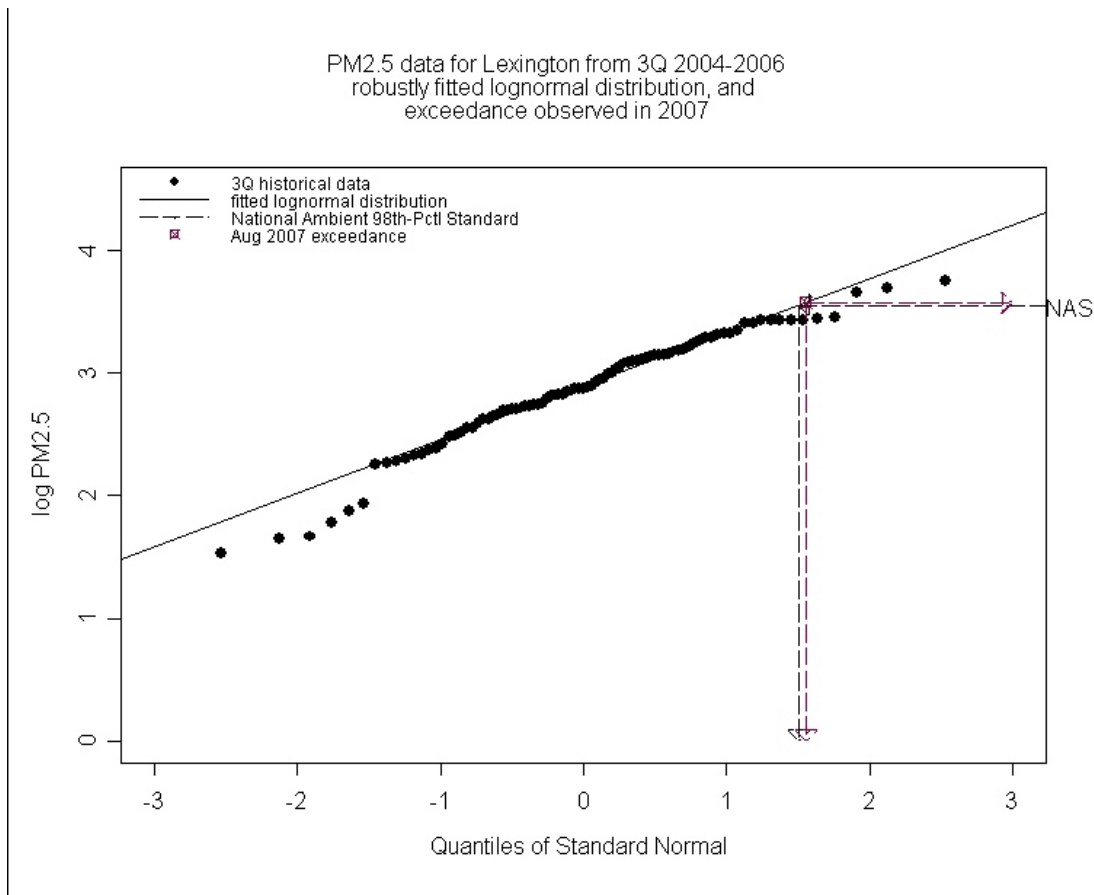
Figure 39: shows "normal historical fluctuations" of PM2.5 data for the Lexington monitoring station during the third calendar quarter in the form of a lognormal distribution quantile plot.

Particulate pollution data are often well approximated by lognormal distributions. This graph shows the natural logarithms of the historical data (in log-µg/m3 units) sorted from smallest concentration to largest concentration, plotted against the corresponding quantiles of a standard normal distribution. An *exact* lognormal distribution closely matching these data is shown as a diagonal straight line in the graph. The level of the National Ambient 98th-percentile Standard (y=3.56) and the 04 Aug 2007 exceedance (y=3.58) are shown as points on the lognormal distribution line, illustrating that expected probability of exceeding the level of the National Ambient 98th-percentile Standard in the absence of exceptional events is about 6.6 percent (1.51 standard deviations greater than the lognormal mean value), and the expected probability of "unexceptional data" exceeding the level observed on 04 Aug 2007 is about 5.9 percent (1.56 standard deviations greater than the lognormal mean value).

 The estimated parameters of the lognormal approximation are:

- median PM2.5 = 18.1
- mean PM2.5 = 19.9
- 98th pctl PM2.5 = 44.4

To demonstrate that the wildfires in Idaho and Canada caused an exceedance of the daily fine particle standard of 35 micrograms per cubic meter at the Lexington monitor on August 4, 2007, we need to find a way to either estimate (1) what the fine particle concentration value would have been on August 4, 2007, if the wildfires had not been present or (2) how many fine particles the wildfires contributed to the fine particle concentration measured at the Lexington monitor on August 5, 2007. Either approach should be sufficient to demonstrate that the wildfires caused this exceedance. There are several possible ways to approach either question. For the impact of these wildfires at Lexington on August 4, 2007, we opted to develop a model using meteorological measurements to estimate what the fine particle concentration value would have been on August 4, 2007 at Lexington if the wildfires had not occurred. A more detailed description of the model is provided below.

The model developed explains about 50% of the observed variation in the fine particle concentrations in the dataset. As a result there is a large amount of uncertainty in the estimation of the fine particle concentration at Lexington on August 4, 2007, using this model. However, we can use the value calculated by the model and the uncertainty calculated by the model for that value to calculate the maximum value that we would expect to see at Lexington on August 4, 2007, with a certain probability. If we calculate the maximum expected value using a 99 percent probability and it is less than 35 micrograms per cubic meter, then there is at most a 1 percent probability that a value above the standard would have occurred at Lexington on August 4, 2007, if smoke from wildfires in Idaho and Canada had not been transported into the area.

Using the developed model and calculating the maximum expected value using a 99 percent probability indicates that there is a 1 percent probability that a value exceeding 40.5 micrograms per cubic meter would have occurred at Lexington on 8/4/2007. Thus, without the wildfires, the developed model indicates there is more than a 1 percent probability that the National Ambient Air Quality Standard would have been exceeded on that day. The actual observed value at Lexington on 8/4/2007, 35.8 micrograms per meter cubed, is only 4.7 $\mu g/m^3$ below the 99% probability limit, and the EPA uses a weight of evidence procedure in providing concurrence decisions. This report has furnished additional evidence (satellite photos, chemical filter analysis, and transport analysis) supporting the conclusion that the Lexington exceedance on 8/4/07 was caused by smoke from wildfires in Idaho and Montana

As a result, we believe that the value of 35.8 micrograms per cubic meter, which exceeded the daily fine particle standard, would not have occurred at Lexington if smoke from wildfires in Idaho and Canada had not been transported to North Carolina beginning on August 4, 2007, and lasting at least through August 8, 2007, in the Lexington area.

Linear Models

AT daily mean ambient temperature at the PM2.5 monitoring station
RH daily mean relative humidity at the PM2.5 monitoring station
WS24 daily arith mean wind speed at KEXX, the NOAA automated met station at
Lexington, NC.
VWD24 daily vector average wind direction at KEXX
WG24 daily mean wind gust speeds at KEXX
RN24 daily total precipitation at KEXX
RN24.lag1 previous-day daily total precipitation at KEXX

WG24, RN24, and RN24.lag1 were omitted from model because they had missing values
on the exceedance day, which prevents any model that uses these variables from making
a prediction.

Method of analysis

Define a covariate for each exceptional event, setting its value at +1 on the the days of the
event and 0 on all other dates. PM.e2 is the covariate for 08/04/2007 (actual
concentration 35.8).

Define the response variable PM2.5 as follows:
Response Variable "PM2.5" = actual PM2.5 concentration, if there is not an exceptional
event
= 0.0 on the day of this exceptional event

Fit linear model as defined below. The coefficient associated with PM.e2 provides an
estimate of the expected concentrations that would have occurred if there had not been an
exceptional event. (The coefficient value is to be subtracted from the surrogate 0.0 value,
so it is actually the *negative* of the estimated concentration.)

Results
Call: aov(formula = PM2.5 ~ AT + RH + WS24 + VWD24 + PM.e2, data =
LXtest006.df, na.action = na.exclude)

Residuals:				
Min	1Q	Median	3Q	Max
-17	-4.021	-0.4578	3.519	19.38

Coefficients:				
	Value	Std. Error	t value	Pr(>|t|)
(Intercept)	-391.4357	103.4623	-3.7834	0.0003
AT	1.7806	0.2184	8.1538	0.0000

RH	0.4921	0.1360	3.6180	0.0005
WS24	-0.7711	0.4879	-1.5804	0.1173
VWD24	-0.0050	0.0062	-0.8123	0.4187
PM.e2	-25.9701	6.3713	-4.0761	0.0001

Residual standard error: 6.155 on 95 degrees of freedom
Multiple R-Squared: 0.456
F-statistic: 15.92 on 5 and 95 degrees of freedom, the p-value is 2.263e-011
18 observations deleted due to missing values

Discussion

The linear model explains about one-half of the observed variation in PM2.5 concentrations in the dataset, and there is accordingly a large amount of uncertainty in the estimation of the two concentrations that were affected by exceptional events.

The estimates are reported using the assumptions that commonly justify regression analysis and analysis of variance. The expected values are as shown in the Coefficients tables, 2.366* Std. Error defines a 99-percent upper bound under the observed uncertainty.

This means that "but for the exceptional event" we have concentrations as shown in Table 2. The column labeled "expectation" is the model's estimate of what concentration would have most likely been observed were the exceptional event not present. The column labeled "99% probability upper limit" takes the standard error into account and shows a threshold that there is less than 1 percent probability of exceeding. With this exceptional event, the expected concentration was 26.0 μg/m^3 on 04 Aug 2007 and the 99-percent upper probability limit was approximately 40.5 μg/m^3 -- which is 4.7 μg/m^3 greater than the observed concentration.

The expected value result suggests that there would not have been an exceedance on 4 Aug 2007 in the absence of the exceptional event. The probability limits, however, undermine this conclusion, because they suggest a significant probability (greater than 1 percent) remains for an exceedance of the threshold of the annual standard to occur under observed conditions that are independent of the event.

Table 2: Lexington Exceptional Event Concentration Statistics

Date	actual	expectation	99%-probability upper limit
04 Aug 2007	35.8	25.97	40.53