MODELING AN AUGUST 1999 OZONE EPISODE IN NORTHEAST TEXAS

Prepared for

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1. INTRODUCTION

The Texas Commission on Environment Quality (TCEQ – formerly the TNRCC) operates three Continuous Air Monitoring Stations (CAMS) in Northeast Texas. In the summer of 1999, these monitors were located near Longview (CAMS 19), Tyler (CAMS 82) and Marshall (CAMS 50). These stations monitor compliance with the National Ambient Air Quality Standard (NAAQS) for ozone. Ozone levels in Northeast Texas have exceeded the level of the ozone NAAQS in recent years.

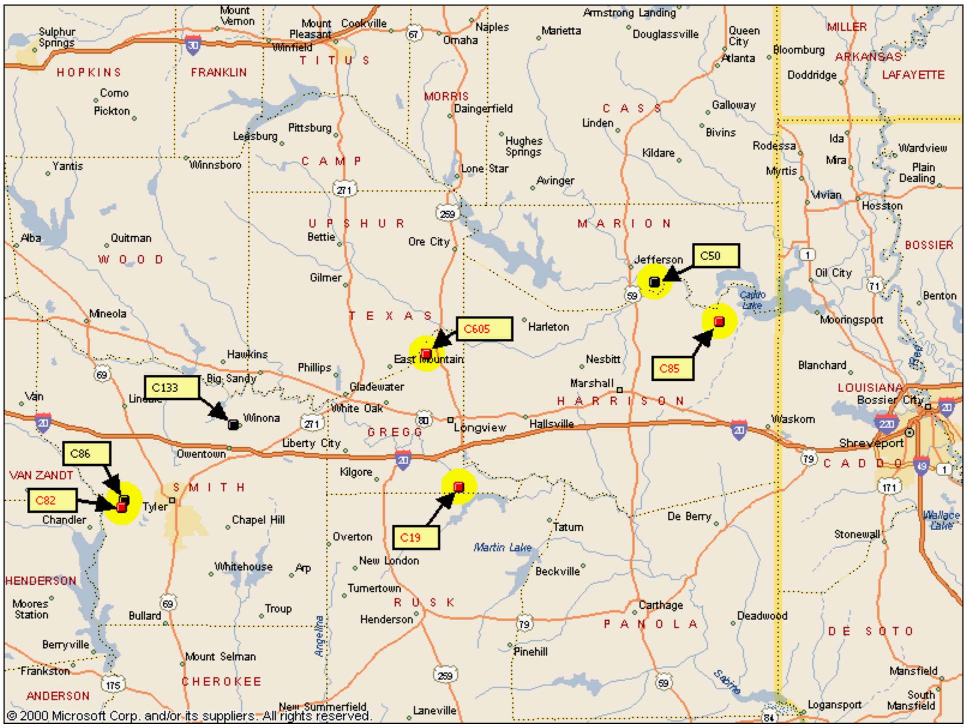


Figure 1-1. Location of Continuous Air Monitoring Stations (CAMS) operated by the TCEQ in Northeast Texas. CAMS 19, 82 and 50 were active in the August 1999.

In 1997 the U.S. Environmental Protection Agency (EPA) promulgated a new 8-hour NAAQS for ozone that is potentially much more stringent than the existing 1-hour standard. The level of the 1-hour ozone NAAQS is 0.12 ppm (equivalent to 124 ppb when rounding is considered) whereas the level of the 8-hour ozone NAAQS is 0.08 ppm (equivalent to 84 ppb). The 8-hour ozone NAAQS was challenged in court and in 2002 the U.S. Supreme Court upheld the new standard but required that the EPA revise its implementation policy. The details of the implementation are still evolving, but it is now clear that designated regions will have to prepare and submit SIPs for 8-hour ozone. In addition to the formally designated ozone nonattainment areas in Texas, there are five "near" nonattainment areas (NNAs) that have been preparing technical studies to support an 8-hour ozone SIP if necessary. The five Texas NNAs are Austin, San Antonio, Victoria, Corpus Christi, and Tyler/Longview/Marshall.

In 1996, the Tyler/Longview/Marshall (TLM) area became a Flexible Attainment Region (FAR) and a mechanism for developing strategies to attain the 1-hour ozone standard was implemented under a Memorandum of Agreement (Flexible Attainment Region Memorandum of Agreement, September 16, 1996). The TLM area has received funding from the Texas legislature to address ozone air quality issues. These resources have funded studies through the East Texas Council of Governments (ETCOG) under the technical and policy direction of the North East Texas Air Care (NETAC) organization. In 1999, ENVIRON completed an ozone modeling study for two 1-hour ozone episodes that included future year modeling for 2007 and the evaluation of future year emission reduction strategies (ENVIRON, 1999). In 2002, the TCEQ submitted a State Implementation Plans (SIP) for Northeast Texas that was based on NETAC studies and included local emissions reductions measures and demonstrated attainment of the 1-hour ozone standard by 2007 (TNRCC, 2002).

The new 8-hour ozone NAAQS will create new ozone nonattainment areas that were not previously designated as non-attainment of the 1-hour ozone NAAQS. An "Early Action Compact" (EAC) protocol was developed by EPA (together with the TCEQ and other stakeholders) to provide incentives for areas that may be designated 8-hour ozone nonattainment to develop and implement control measures on an accelerated schedule. The EAC protocol applies to areas that are attaining the 1-hour ozone NAAQS but may not be attaining the 8-hour NAAQS when EPA formally designates areas. Based on monitoring data through the end of the 2002 ozone season, the TLM area was attaining the 1-hour NAAQS but was not attaining the 8-hour NAAQS at all monitors. In December 2002, the TLM area signed an EAC committing the area to develop 8-hour ozone control strategies and demonstrate that the area will attain the 8-hour ozone standard in 2007. Ozone modeling for a recent period with high 8-hour ozone will be needed for the EAC. This report describes the development of a regional scale ozone model for an ozone episode period from August 1999 that will form the basis of the EAC modeling for Northeast Texas.

The high 8-hour ozone period selected for modeling was August 15th-22nd, 1999. After including 2 additional days to "spin up" the ozone model, this meant modeling the 10 day period August 13th-22nd, 1999. This period was selected based on a conceptual model and episode selection for Northeast Texas, which is summarized in Section 2 of this report. The modeling procedures and modeling domain were developed in an ozone modeling protocol for the August 1999 episode (ENVIRON, 2001). The Comprehensive Air Quality Model with extensions (CAMx) was selected for ozone modeling and the modeling domain is shown in Figure 1-2 and 1-3.

The preparation of ozone model inputs is described in Sections 3 through 5 of this report. Section 3 describes the emission inventory development for the 1999 base year and 2007 future year. Section 4 summarizes the meteorological modeling and extensive details are given in two supporting reports. Section 5 describes the preparation of other CAMx inputs.

Section 6 describes the development of the 1999 base case including model evaluation procedures, diagnostic tests and sensitivity tests. The 1999 base case was refined through a series of improvements to the meteorology, emissions and CAMx inputs. The final 1999 base case was "base case5". The 2007 base case was developed to evaluate future attainment of the ozone NAAQS. The final 2007 base case was "07base2." The summary and conclusions at the end of Section 6 include recommendations for the next steps in EAC ozone modeling for Northeast Texas.

Section 7 describes a detailed evaluation of which emissions sources were primarily responsible for high 8-hour ozone levels in Northeast Texas during the August 1999 episode.

This analysis used the ozone source apportionment technology (OSAT) tools available on CAMx.

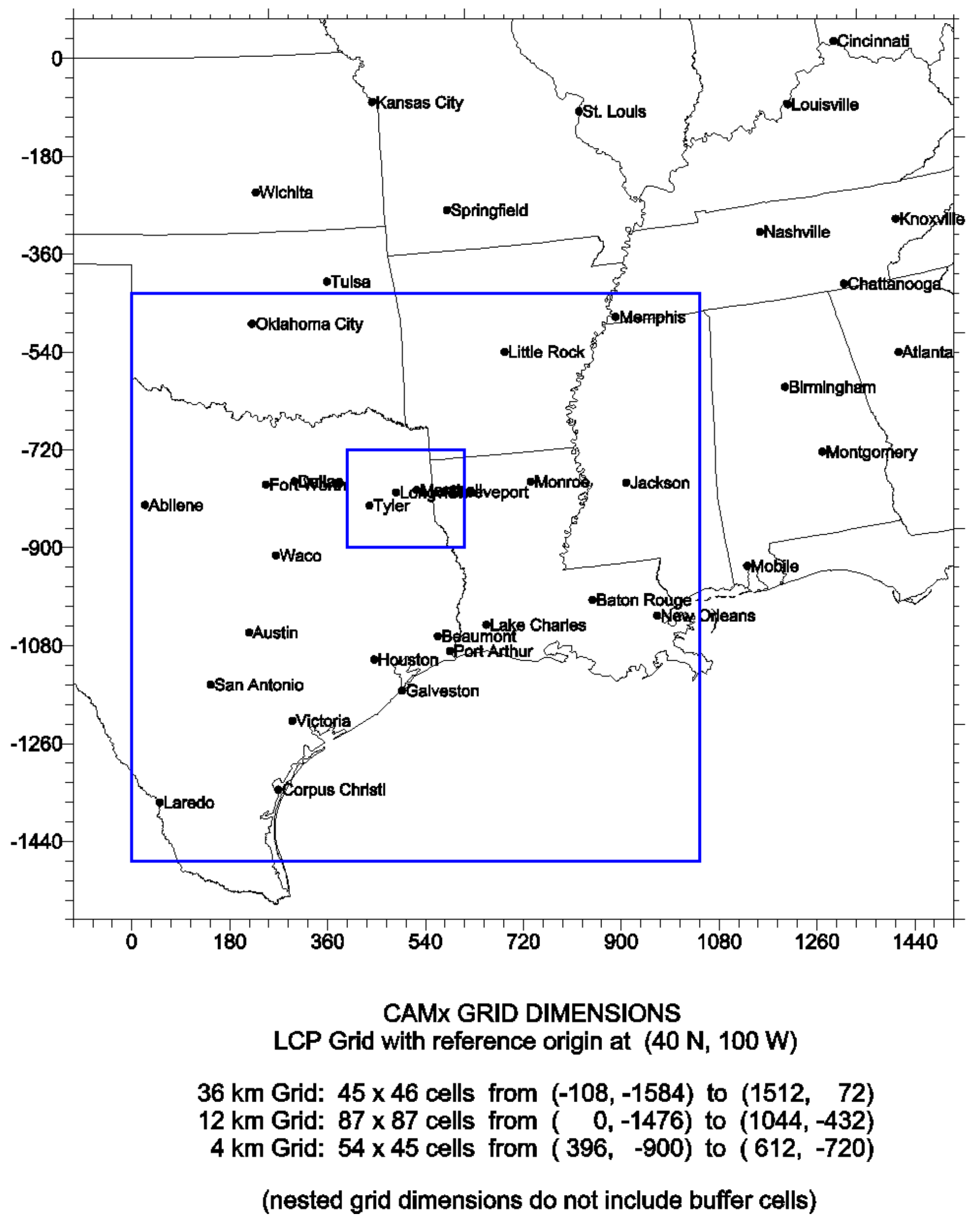


Figure 1-2. CAMx modeling domain for the August 1999 episode showing the 36 km regional grid and the nested 12 km and 4 km fine grids.

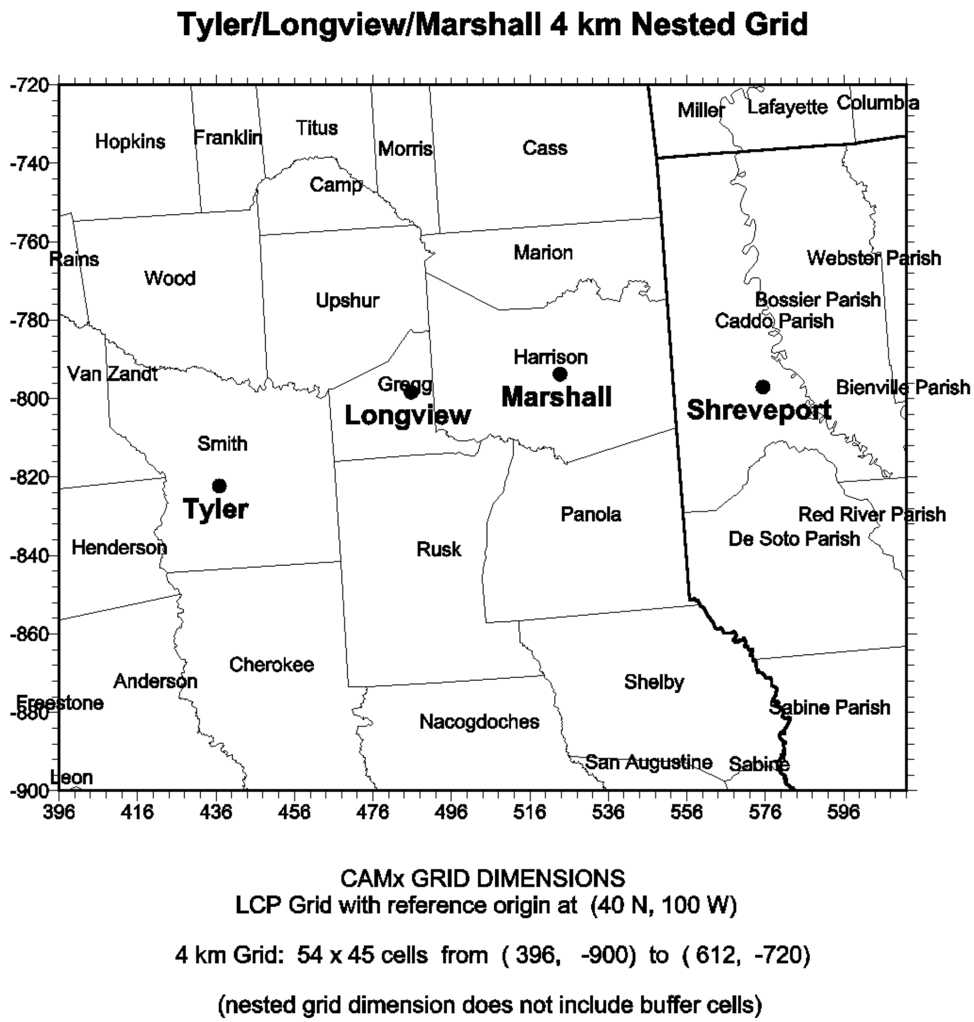


Figure 1-3. CAMx 4 km fine grid covering Northeast Texas for the August 1999 episode.

2. EPISODE SELECTION

An episode selection analysis was performed to identify a period with representative high 8-hour ozone levels that was suitable for developing a new regional ozone model (ENVIRON, 2000). Previous ozone modeling for Northeast Texas (ENVIRON, 1999) developed ozone models for two episodes:

- June 18-23, 1995. A Regional Scale Model (RSM) based on the TCEQ's SIP modeling for Dallas/Fort Worth (TCEQ, 2000; ENVIRON, 1999).

- July 14-18, 1997. An Urban Scale Model (USM) developed specifically for Northeast Texas (ENVIRON, 1999).

These episodes were selected because they had very high 1-hour ozone levels. Both periods were characterized by stagnant meteorology with calm or weak Easterly/Northeasterly winds and high temperatures (ENVIRON, 1998a). The existing ozone models also have high 8-hour ozone levels and could be used in 8-hour ozone analyses. However, a primary objective in selecting a new episode was to ensure that all the different types of meteorological conditions that lead to high 8-hour ozone levels in Northeast Texas are adequately represented. To accomplish this objective, the episode selection identified several periods when there were several consecutive days with 8-hour ozone that did not necessarily exceed the level of the 1-hour ozone standard. The episode selection focused on the three-year period 1997-1999.

EPISODE SELECTION PROCEDURE

A conceptual model of ozone formation in Northeast Texas was prepared and used as the basis for an episode selection analysis (ENVIRON, 2000). The episode selection methodology and conclusions are summarized here. Ozone data for Northeast Texas monitors from 1995 through 1999 were reviewed along with meteorological data such as back-trajectories and daily weather maps. Episodes suitable for developing a new RSM for 8-hour ozone in Northeast Texas were identified by the following criteria:

- Choose periods from the most recent three years at that time, i.e. 1997 to 1999, because the existing modeling includes an older episode from 1995 and there are more extensive air quality data for recent years because of the Marshall CAMS50 monitor and NETAC studies.

- Choose a multi-day period with 3 or more "high ozone" days as defined below.

- Choose a period with high ozone at both Longview and Tyler. Based on the EPA draft modeling guidance (EPA, 1999) and the 1997-1999 design values, high ozone was considered to be an 8-hour value of 85 - 101 ppb at Tyler, and 90 - 110 ppb at Longview.

- Choose a period with representative meteorological conditions for 8-hour ozone, which is stagnation in Northeast Texas associated with a high regional ozone background and transport at the beginning of the stagnation period. This type of event is often referred to as a “regional haze event” because it is associated with hazy air across the whole East Texas region.

- Availability of supporting meteorological data, in particular data from the NCEP EDAS model, is a strong advantage for modeling. EDAS data are available since 1997 with occasional missing days or blackout periods.

- Availability of special air-quality data, such as Baylor Aircraft flights and NETAC monitoring studies, is an advantage.

- An August or September episode may be preferable as this complements the existing June and July episodes, but this factor is secondary to having representative meteorology.

A search through 1997 to 1999 using these selection criteria listed above identified four candidate episodes:

1. August 26 to Sept 4, 1998
2. August 2 to August 7, 1999
3. August 15 to August 22, 1999
4. September 15 to September 20, 1999

The ozone data for these periods are summarized in Table 2-1 along with the maximum temperatures at Longview. The August 2-8, 1999 period was eliminated because ozone data for Longview were missing on August 6 and 7 (see Table 2-1) severely restricting the usefulness of this period for control strategy development.

The August/September 1998 period was given the lowest priority among the remaining three candidates for the following reasons:

- Important supporting meteorological data (the NCEP EDAS analyses) are missing for most of this period.

- The meteorology includes several very stagnant days characterized by transient high ozone readings (i.e., ozone spikes) at Longview (August 27 and 28). These days are very similar to the episodes already modeled for 1-hour ozone.

Table 2-1. Maximum ozone levels and temperatures for four candidate modeling episodes.

Date	Longview Maximum Temperature	Max 8-hour Ozone (ppb)				Max 1-hour Ozone (ppb)			
		Longview CAMS19	Tyler CAMS82	Marshall CAMS50	Big Woods	Longview CAMS19	Tyler CAMS82	Marshall CAMS50	Big Woods
8/26/98	97	85	68	59		108	74	65	
8/27/98	99	104	84	64		118	93	66	
8/28/98	101	114	87	76		129	95	81	
8/29/98	99	96	83	54		123	92	55	
8/30/98	95	73	85	51		79	104	59	
8/31/98	92	82	78	50		88	87	54	
9/1/98	96	73	73	50		78	79	53	
9/2/98	97	86	99	67		89	108	70	
9/3/98	99	107	91	76		125	99	81	
9/4/98	101	96	90	76		107	103	82	
8/2/99	96	95	61	60		108	68	66	
8/3/99	95	84	89	77		94	110	83	
8/4/99	95	91	88	79		132	102	83	
8/5/99	95	114	120	76		124	127	87	
8/6/99	95	missing	97	81		41	118	86	
8/7/99	97	missing	91	98		missing	102	115	
8/15/99	93	66	73	55		73	95	60	
8/16/99	95	105	92	71		124	109	74	
8/17/99	96	110	97	90		134	105	94	
8/18/99	99	88	74	91		91	78	98	
8/19/99	102	91	85	81		101	91	87	
8/20/99	97	80	86	70		90	99	72	
8/21/99	95	87	92	67		95	107	71	
8/22/99	96	91	77	82		107	78	87	
9/15/99	85	75	85	64	70	85	107	71	73
9/16/99	86	79	82	76	72	89	90	82	77
9/17/99	83	75	86	69	69	86	97	79	76
9/18/99	86	86	91	83	78	88	103	99	84
9/19/99	90	97	91	84	96	117	102	92	105
9/20/99	92	110	99	88	89	138	105	91	100

In selecting between the remaining two candidate periods, the August 1999 episode was given the highest priority for modeling because the September 1999 episode appears atypical and may be difficult to model for Northeast Texas. Specifically:

- The meteorology during the September 1999 episode appears to be unusual for high ozone episodes in Northeast Texas.
  - Temperatures were unusually cool for an Northeast Texas ozone episode. Maximum temperatures at Longview were mostly in the mid 80's rather than the high 90's (see Table 2-1).
  - Upper level winds were from the west and unusually strong in the mid-troposphere (about 5 km altitude).
  - Widespread daily rainfall occurred in North Texas and Oklahoma. Archived NEXRAD data show rainfall in the area between Dallas to Shreveport on 4 of the 5 high ozone days.

- An unusual ozone episode (such as September 1999) is not a good choice as the cornerstone of 8-hour ozone control strategy development efforts.

- Some of the unusual meteorological factors mentioned above are also likely to make this a difficult period to model successfully for Northeast Texas. There is a greater risk of the September 1999 episode performing poorly in Northeast Texas than the August 1999 episode.

- The August 1999 episode provides more high ozone days to use for control strategy evaluation than the September 1999 episode (see Table 2-1).

OZONE LEVELS FOR AUGUST 15-22, 1999

The period August 15 – August 22, 1999 was selected for developing a new episode for 8-hour ozone modeling in Northeast Texas. The modeling period was August 13 – August 22, 1999 including 2 spin-up days at the start of the episode to reduce the influence of initial conditions.

The hourly ozone data recorded at the Northeast Texas CAMS during this period are shown in Figure 2-1. High ozone levels were recorded at all three CAMS during this period. On August 18th and 19th the ozone levels were similarly high at all three sites consistent with a high regional background of ozone. These high ozone levels built up between August 15th and 17th. This is consistent with the onset of meteorological stagnation on August 16th continuing through August 18th. Because the ozone-monitoring network in Northeast Texas is relatively sparse, the highest ozone levels on August 16th-18th may not have been recorded by a monitor. Ozone levels at Longview and Marshall declined on August 20th and 21st, but then increased again on August 22nd. The pattern at Tyler is different on these days with higher ozone at Tyler on August 20th and 21st than on August 22nd.

Longview had especially high ozone levels on August 16th and 17th that were significantly higher than at Tyler or Marshall on these days consistent with a localized influence at Longview superimposed on the high regional background. There also are indications that

Tyler experienced localized ozone impacts on August 15th, 20th and 21st because there were short periods when the ozone at Tyler spiked to higher levels than the other monitors. The localized impacts seen on some days at Longview and Tyler are consistent with plumes impacting the monitor locations. These plumes are likely to be associated with emissions sources within the Northeast Texas area and could be from either a major industrial source or an urban area.

The 8-hour average ozone data for the Northeast Texas CAMS on August 15 – August 22, 1999 are shown in Figure 2-2. Comparing Figures 2-2 and 2-1 shows that the 8-hour averaging procedure masks much of the detail that can be seen in 1-hour data. The 1-hour ozone data are more useful for building a conceptual picture of what ozone levels were like at a monitor on a particular day.

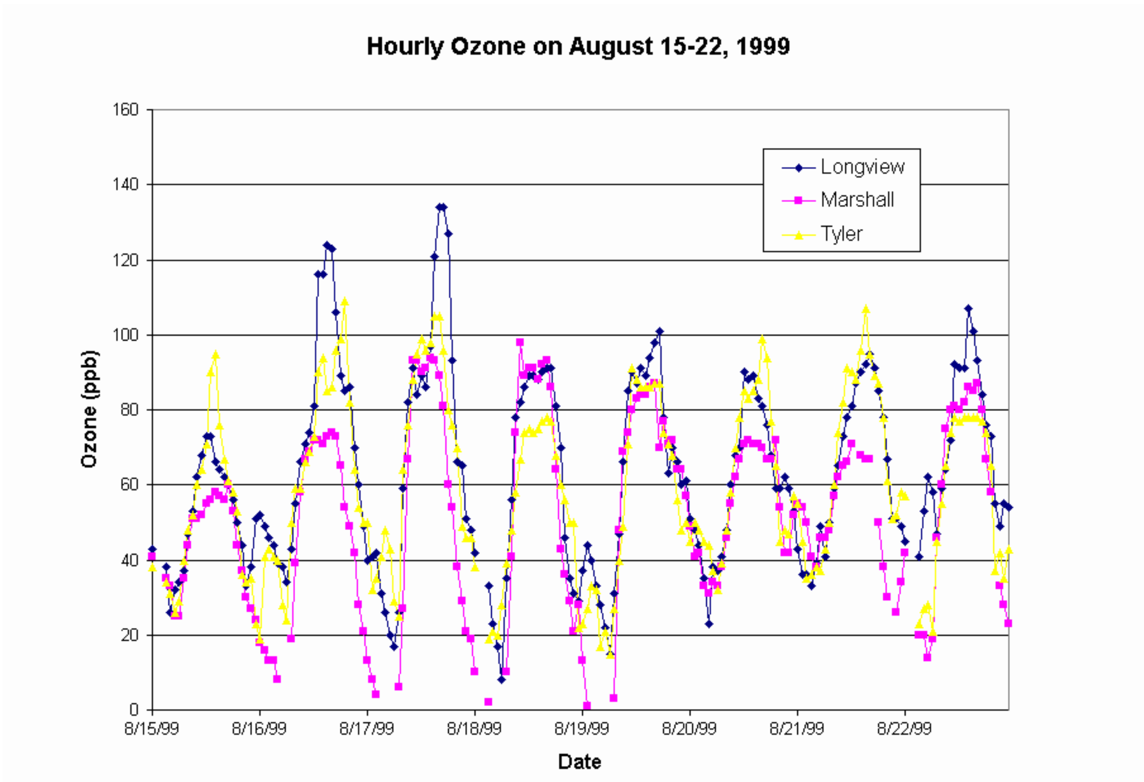


Figure 2-1. 1-hour average ozone levels at Northeast Texas CAMS for August 15-22, 1999.

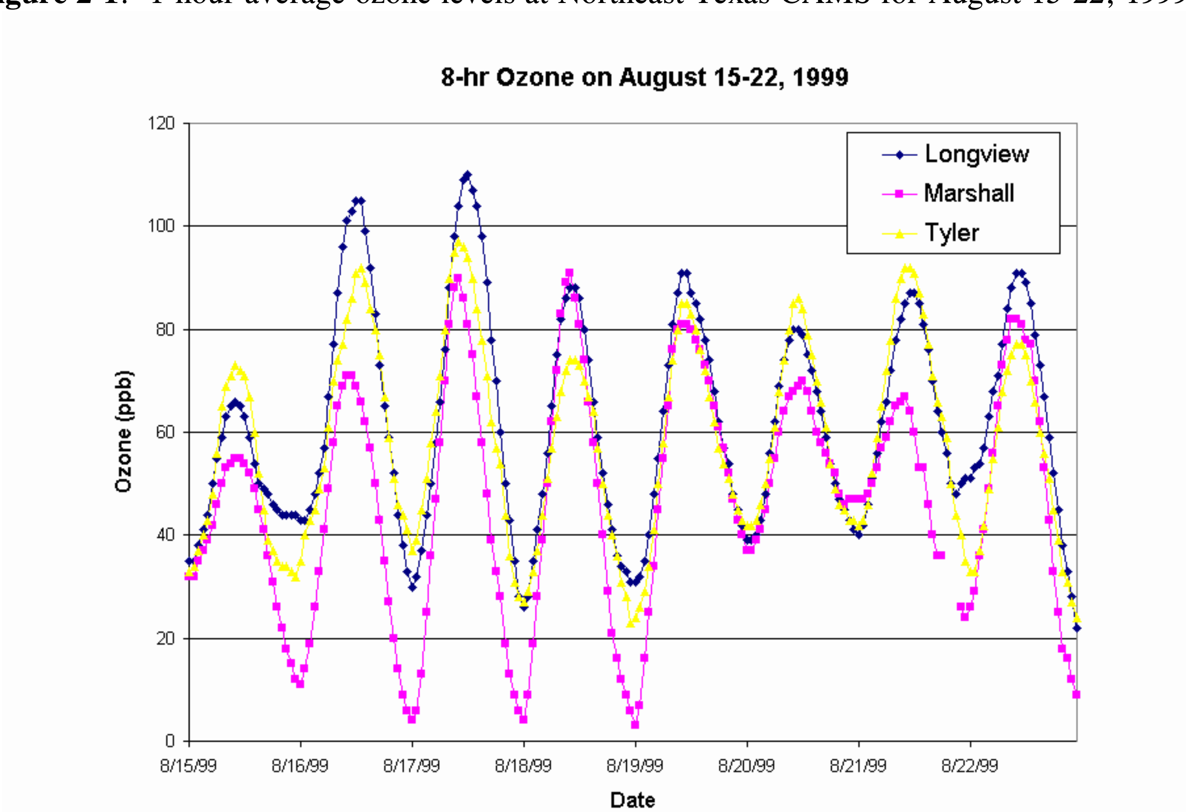


Figure 2-2. 8-hour average ozone levels at Northeast Texas CAMS for August 15-22, 1999.

BACK TRAJECTORIES FOR AUGUST 15-22, 1999

Local wind data for Northeast Texas are available from the TCEQ CAMS, but while these data are useful for determining the wind direction in the immediate vicinity of a monitor, they are less useful for developing a conceptual picture of regional wind patterns during an ozone episode period. One way to evaluate the regional wind patterns is from back trajectories. The National Oceanic & Atmospheric Administration (NOAA) provides web-based tools to calculate back trajectories at http://www.arl.noaa.gov/ready/hysplit4.html. The NOAA back trajectories are based on archived data from weather forecasting models, so back trajectories are models rather than observations. A single back trajectory shows how a model predicts that air moved to arrive at a fixed end point in space and time.

Back trajectories are useful because they provide a simple picture of air movements to arrive at a given place and time. This picture should not be taken too literally since:

- Back trajectories are computer models with uncertainties.
- The concept of a back trajectory over-simplifies the way air moves in the real atmosphere by neglecting important effects such as vertical mixing and differences in wind speed/direction with height.

For example, if a given back trajectory from Longview traces back to Houston over a 24 hour period, this should not be interpreted as saying that high ozone levels in Northeast Texas must have resulted from transport of pollution from Houston, because: (1) there are uncertainties in the direction of the back trajectory – the winds may not actually have blown from Houston; (2) the back trajectory may pass over many sources between Houston and Northeast Texas; (3) the back trajectory provides no information about whether Houston had high ozone levels at that time, and; (4) the trajectory model does not account for emissions or chemistry. Back trajectories can be indicators of whether transport was a potential contributor to high ozone levels.

Back trajectories for August 16th through 22nd, 1999 are shown in Figure 3-3. These trajectories are based on archived wind data from the NOAA/NCEP Eta Data Analysis (EDAS) system. The back trajectories end at the Longview CAMS-19 monitoring site at 15:00 hours CDT (which is 21:00 hours UTC in the trajectory labeling used in Figure 3-3). Back Trajectories were run for a duration of 32 hours, i.e., back to the morning of the day before, so that they indicate about 1.5 day transport distances. Back trajectories were run for ending altitudes of 500 m and 1000 m to provide an indication of whether wind shear was important. If the 500 m and 1000 m trajectories run in different directions, this indicates that there was significant variation in winds with altitude and that the back trajectory directions are highly uncertain.

The back trajectories show weak easterly winds on August 16th transitioning to stagnation between August 17th and 19th. The stagnation is shown by back trajectories that do not travel far from Northeast Texas and which run in different directions at different altitudes. On August 20th the back trajectories become more organized again with winds from the northeast, but the back trajectories for August 20th and 21st are unusual because the 500 m trajectories travel back further than the 1000 m trajectories. On August 22nd the trajectories return to weak easterly winds and are similar to August 16th.

August 16-19, 1999

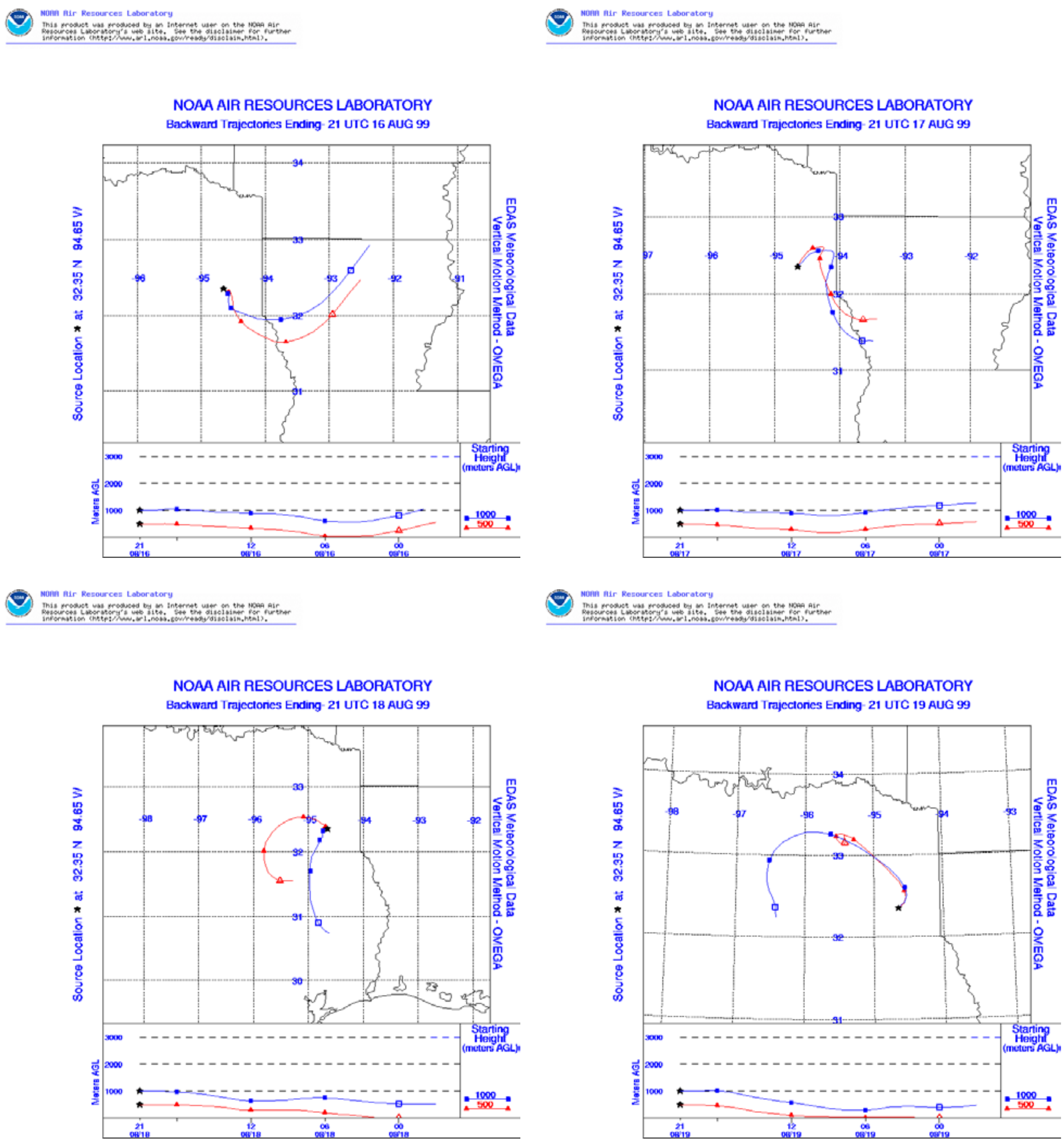


Figure 2-3. Back trajectories from Longview (CAMS19) ending at 15:00 CDT.

August 20-22, 1999

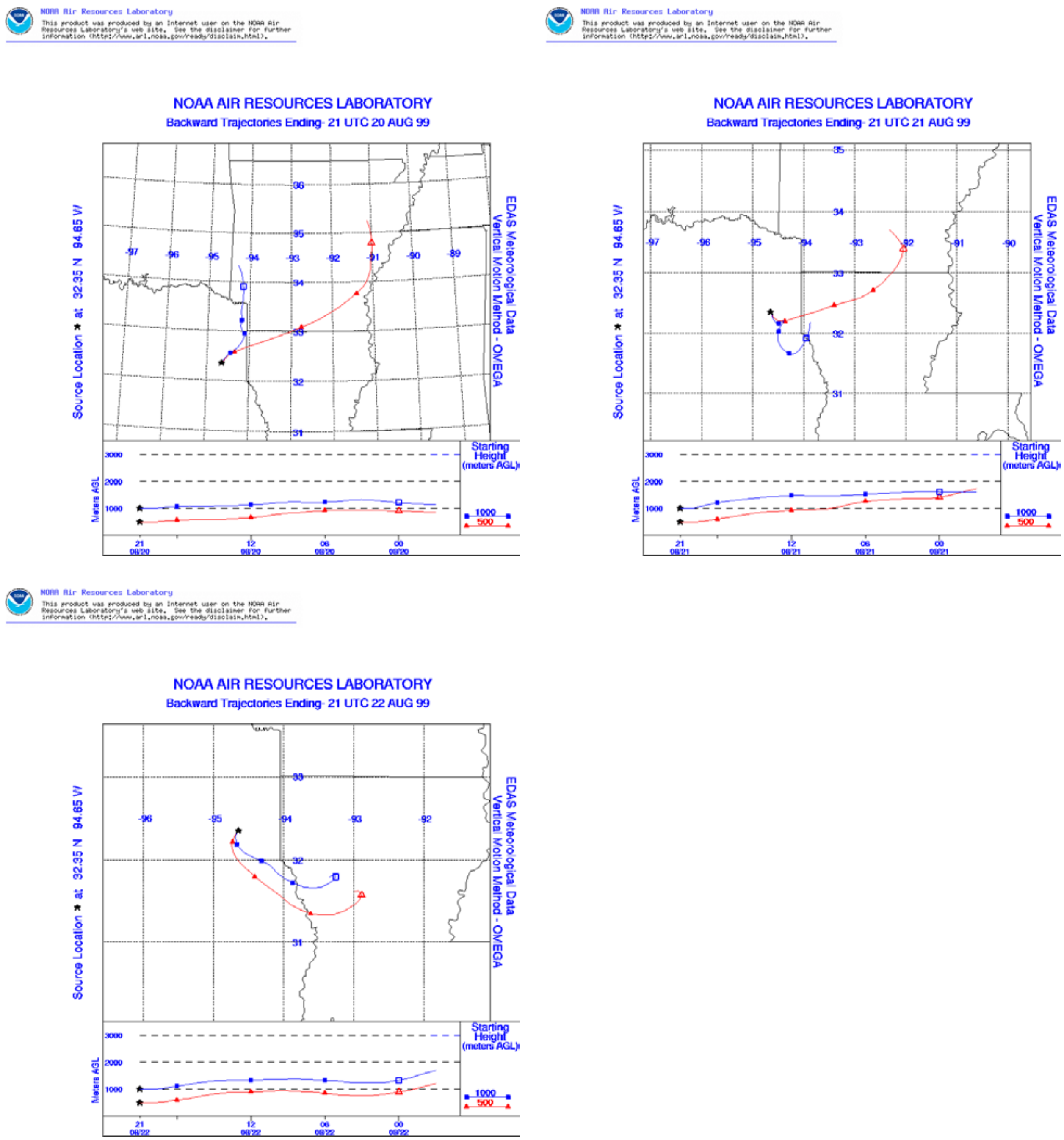


Figure 2-3 (concluded). Back trajectories from Longview(CAMS19) ending at 15:00 CDT.

BACK TRAJECTORIES PLUS OBSERVED OZONE

An analysis was carried out that combined back trajectories with observed ozone levels to investigate the potential for ozone transport. Figures were prepared that combined several types of data for a specific day:

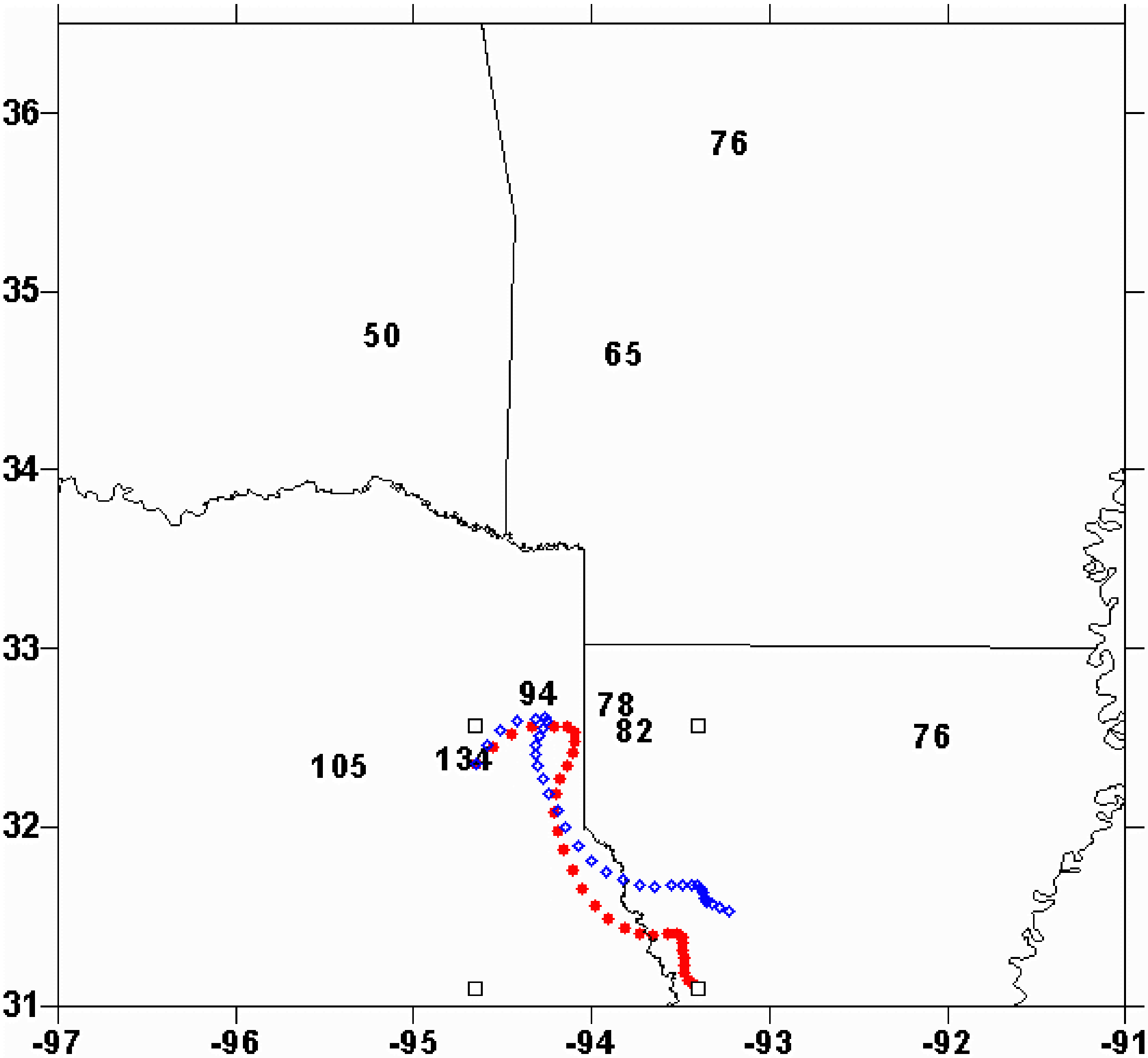
- The daily maximum 1-hour ozone levels at the Longview, Tyler and Marshall CAMS.
- The Longview back-trajectories ending at 15:00 and 500/1000 m.
- The daily maximum 1-hour ozone for the previous day in surrounding areas (Louisiana, Arkansas, Oklahoma). Previous day ozone levels are shown for the surrounding areas because the back trajectories are 1.5 days long from end (Longview) to start.

Figures 2-4 through 2-6 show these analyses for August 17th, 20th and 22nd, respectively. Limitations to keep in mind are that the back-trajectories only provide an indication of the likely transport direction and distance, and that the upwind monitored values may not represent regional ozone levels because many of them are in urban areas.

On August 17th (Figure 2-4), the back trajectories are short and meandering consistent with stagnation. Air in Northeast Texas may have been in Northwest Louisiana on the previous day Peak ozone levels in Northeast Texas on August 17th (94 ppb to 134 ppb) were much higher than in Northwest Louisiana on August 16th (78 ppb to 82 ppb), suggesting a significant contribution from local emissions to the high ozone levels in Northeast Texas on August 17th, 1999.

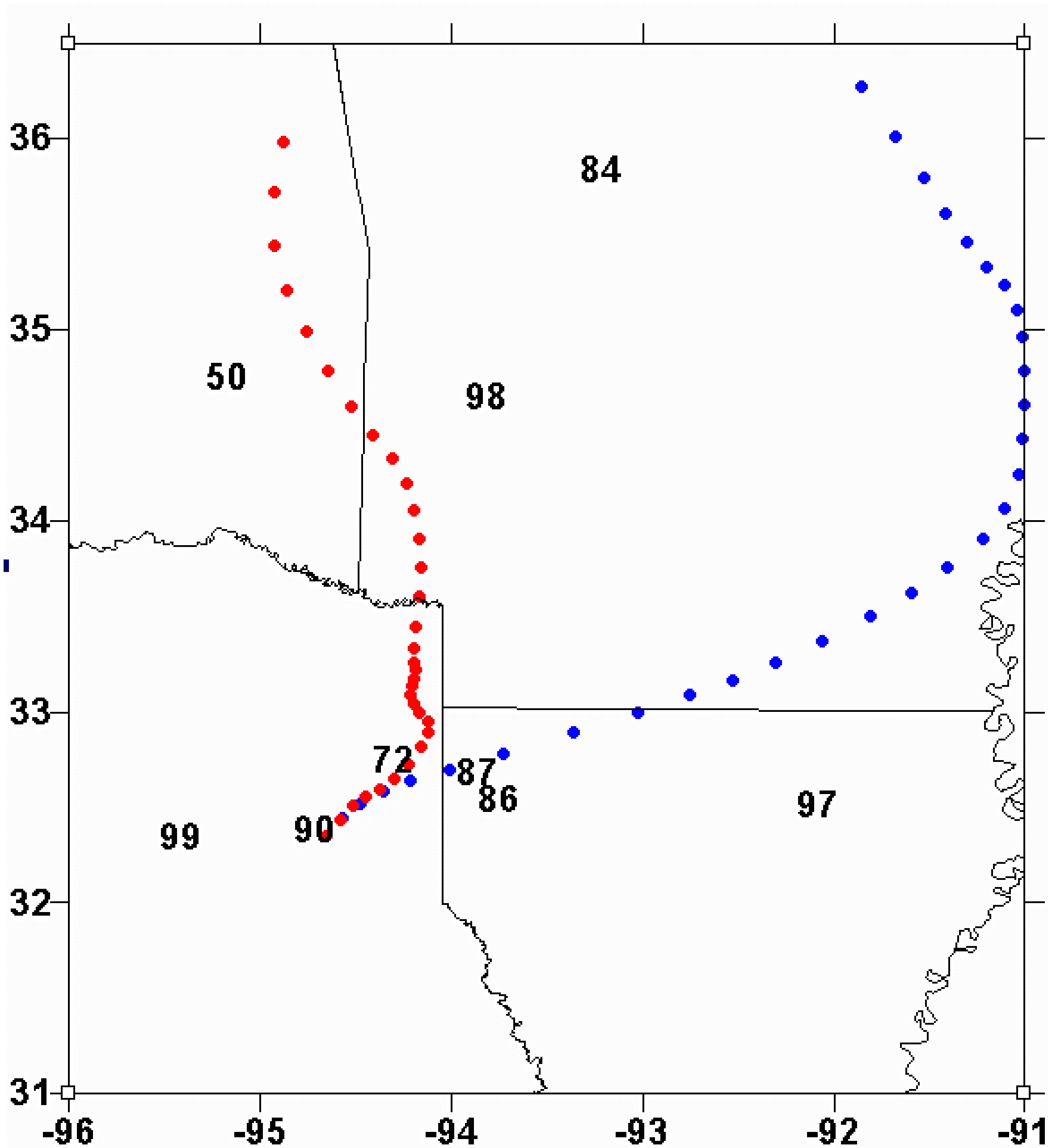
For August 20th (Figure 2-5), the back trajectories suggest that the air in Northeast Texas may have come from an area between Northern Louisiana to Western Arkansas on the previous day. Peak ozone levels in Northeast Texas on August 20th (72 ppb to 99 ppb) were similar to the levels in this upwind area on August 19th (84 ppb to 97 ppb) suggesting that the high ozone in Northeast Texas on August 20th was part of a regional high ozone event that was transported through the region.

For August 22nd (Figure 2-6), the back trajectories suggest that the air in Northeast Texas may have come from Northwest Louisiana on the previous day. Peak ozone levels in Northeast Texas on August 22nd (78 ppb to 107 ppb) were higher than the levels in Northwest Louisiana on August 21st (68 ppb to 73 ppb) suggesting a moderate contribution from local emissions to the high ozone levels in Northeast Texas on August 22nd, 1999.



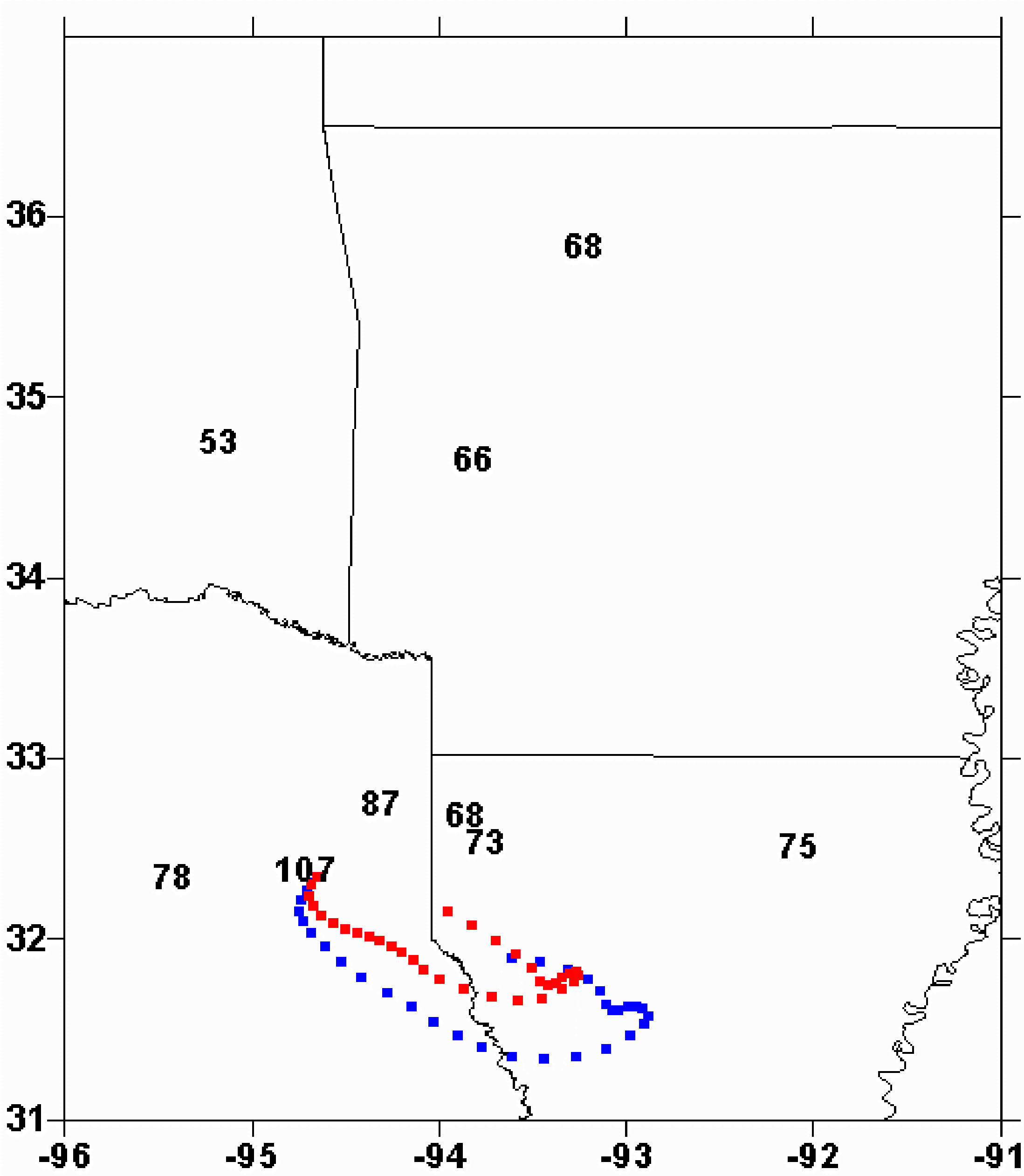
Texas Monitors:	Daily maximum 1-hr ozone on August 17th, 1999
Other Monitors:	Daily maximum 1-hr ozone on August 16th, 1999
Red Symbols:	Back trajectory at 1000 m from 15:00 on August 17th
Blue Symbols:	Back trajectory at 500 m from 15:00 on August 17th

Figure 2-4. Back trajectories for August 17th, 1999 with superimposed daily maximum 1-hour ozone for August 17th and 16th.



Texas Monitors:	Daily maximum 1-hr ozone on August 20th, 1999
Other Monitors:	Daily maximum 1-hr ozone on August 19th, 1999
Red Symbols:	Back trajectory at 1000 m from 15:00 on August 20th
Blue Symbols:	Back trajectory at 500 m from 15:00 on August 20th

Figure 2-5. Back trajectories for August 20th, 1999 with superimposed daily maximum 1-hour ozone for August 20th and 19th.



Texas Monitors:	Daily maximum 1-hr ozone on August 22nd, 1999
Other Monitors:	Daily maximum 1-hr ozone on August 21st, 1999
Red Symbols:	Back trajectory at 1000 m from 15:00 on August 22nd
Blue Symbols:	Back trajectory at 500 m from 15:00 on August 22nd

Figure 2-6. Back trajectories for August 22nd, 1999 with superimposed daily maximum 1-hour ozone for August 22nd and 21st.

3. EMISSIONS MODELING

This section describes the emission inventory preparation for the August 13-22, 1999 modeling episode for the East Texas Near Non-Attainment Area (NNA). Emission inventories are processed using version 2x of the Emissions Processing System (EPS2x) for area, nonroad, onroad mobile and point sources (Environ, 2001). The purpose of the emissions processing is to format the emission inventory for CAMx photochemical modeling. Specifically, the emission inventory is allocated:

- Temporally – to account for seasonal, day of weak and hour of day variability
- Spatially – to reflect the geographic distributions of emissions
- Chemically – to account for the chemical composition of VOC and NOx emissions in terms of the Carbon Bond 4 (CB4) chemical mechanism used in CAMx.

Emissions for different major source groups (e.g., mobile, non-road mobile, area, point and biogenic) are processed separately and merged together prior to CAMx modeling. This simplifies the processing and assists quality assurance (QA) and reporting tasks. The biogenic inventories are generated with GloBEIS version 2.2.

The August 13-22,1999 episode, a Friday through Sunday, is being modeled in CAMx using a Lambert Conformal Projection (LCP) nested grid configuration with grid resolutions of 36, 12 and 4 km (Figure 1-1). In CAMx, emissions are separated between surface (surface and low level point) emissions and elevated point source emissions. For the surface emissions, a separate emission inventory is required for each grid nest, i.e., three inventories. For elevated point sources, a single emission inventory is prepared covering all grid nests.

Two emissions modeling domains are used to generate the required CAMx ready inventories:

1. **Near Non-Attainment Area 4 km Grid**. The NNA emissions grid has 54 x 45 cells at 4 km resolution and covers the same area as the CAMx 4 km nested grid shown in Figures 1-1 and 1-2.

2. **Regional Emissions Grid**. The regional emissions grid has 135 x 138 cells at 12-km resolution and covers the full area shown in Figure 1-1. This emissions grid is used for the 12 km CAMx grid by “windowing out” emissions for the appropriate region. In addition the regional emissions grid is aggregated from three by three 12-km cells to one 36-km cell over the entire area to generate the CAMx 36km grid.

Emission inventories were prepared for the 1999 base year and for a 2007 future year. The emissions data sources and processing are described separately below for point, onroad mobile, area and nonroad, and biogenic sources. Following the data descriptions are summary tables.

DATA SOURCES FOR 1999

Point Sources

Point source data were obtained from several different sources, processed separately and merged prior to modeling. The data include:

- Texas electric generating units (EGUs)
- Texas non-EGU point sources
- Facility specific data
- Texas minor point sources
- Louisiana EGUs
- Louisiana non-EGUs
- Other State point sources

The point source data are processed for a typical peak ozone (PO) season weekday and weekend days. The exception is Texas and Louisiana EGUs, which are hourly episode day specific data, based on continuous emissions monitor (CEM) data that were reported to EPA's "Acid Rain" database.

The 1999 Texas and Louisiana point source data were provided by TCEQ in EPS2 AFS input format.

The hourly EGU data for both Texas and Louisiana are taken from the EPA's Acid Rain Program Database. The TCEQ Point Source Data Base (PSDB) version bb for 1999 is the basis of the non-EGU Texas data. The emissions for Texas Eastman Chemical Company were updated to version 12b of the 1999 PSDB to correct errors in version bb, as discussed below. Louisiana Department of Environmental Quality (LDEQ) provided TCEQ with a copy of their point source inventory. The files that were downloaded from the TCEQ ftp site ftp://ftp.TCEQ.state.tx.us/pub/AirQuality/AirQualityPlanningAssessment/Modeling/file_transfer/NearNon/ are:

TX EGU	hourly_TXegu_0813-2299.afs_REv6b_latlon_v2
TX Non-EGU	afs.PSDB_0813-2299_REv6b_latlon_negu
TX Minor Points	afs.0813-2299minorpts_nna
LA EGU	hourly_LAegu_0813-2299.afs_v4_latlon
LA Non-EGU	afs.LA_0813-2299v4_latlon_negu

An updated version of the Texas non-EGU data was acquired in order to use the most recent update that Eastman Chemical had submitted to TCEQ. The file *Speciated1999PointEI-data-ascii.zip* was downloaded from http://www.TCEQ.state.tx.us/air/aqp/airquality_photomod.html#ei3 and Eastman Chemical data was extracted for processing.

Day specific data was provided for two stacks at the Eastman Chemical Company facility via email from J. Woolbert (NOXFOROZ-aug99.xls). The episode data specific emissions were incorporated into the inventory and removed from the Texas Non-EGU data.

For all states other than Texas and Louisiana the National Emission Inventory (NEI) 1999 Version 1 for Criteria Pollutants data is used. The file *p99100dbf.zip - 1999 NEI Version 1 Criteria Emissions from Point Sources in DBF Format* was downloaded from EPA's ftp site. This file contains a set of related point source files that were imported into Microsoft Access97. The data is processed to (1) relate separate data tables by common fields, (2) query to extract peak ozone season data for those states within the regional modeling domain other than Texas and Louisiana and (3) export the resultant data table to an ASCII text file for processing through EPS2x.

The criteria for selecting NOx point sources for plume in grid treatment within the 4-km modeling domain is 2 tons NOx on any episode day. For the regional emissions grid, the NOx criteria is 25 tons per day on any episode day.

Mobile Sources

The Texas Transportation Institute (TTI) prepared mobile source emissions for all Texas counties under contract to the TCEQ. (See Technical Note "Near Nonattainment Area Support – Rider 13 / 1999 Analysis by Dennis Perkinson, TTI for Mary McGarry-Barber, TCEQ dated 22 May, 2001). Emission factors are from the EPA's MOBILE5ah model. Vehicle miles traveled (VMT) for 1999 are based on transportation models in all NNA counties that have a complete transportation model and were based on a rural HPMS method elsewhere. The NNA counties for which link based transportation model data are used:

East Texas:	Gregg, Smith
Austin:	Hays, Travis, Williamson
San Antonio:	Bexar
Corpus Christi:	Nueces
Victoria:	Victoria

TTI calculated emissions for each hour for four day-of-week scenarios: Monday-Thursday, Friday, Saturday and Sunday. The temperatures are for average August/September 1999 conditions in each county. The emissions are adjusted from the average temperature scenario to day specific temperatures in each county for modeling. The emissions reported here are for the average temperature scenario used by TTI.

Table 3-1. Texas onroad mobile source emissions (tons per day) from TTI for typical July/August 1999 conditions.

	Weekday			Friday			Saturday			Sunday		
County	**NOx**	**VOC**	**CO**	**NOx**	**VOC**	**CO**	**NOx**	**VOC**	**CO**	**NOx**	**VOC**	**CO**
Bexar	104	78	670	105	92	772	78	66	559	61	51	433
Gregg	11	6	59	11	7	67	9	6	59	7	5	46
Hays	10	5	47	10	6	51	8	5	43	6	4	37
Nueces	27	14	134	28	18	167	23	15	137	18	12	114
Smith	17	10	94	18	12	105	15	10	91	11	8	71
Travis	52	34	265	51	39	307	41	31	243	34	25	199
Victoria	9	4	33	10	5	44	8	4	36	8	5	38
Williamson	15	8	74	15	10	84	12	8	67	10	6	56
All Others	1337	668	6040	1376	758	6778	1062	628	5655	869	540	4935
Total	1582	828	7416	1625	945	8375	1255	772	6889	1023	656	5929

[1] Named counties have link based data. All others have HPMS format activity data.

The emissions estimates prepared by TTI reflect a temperature profile for an average August/September day. To adjust for episodic temperatures, a methodology was developed to calculate a temperature adjustment factor for each county and each hour of the modeling episode. The steps in the process are as follows:

1. Run the MOBILE5ah model using the county-level temperature profile used by TTI and extract the emission factors.

2. For each day in the modeling episode, run the MOBILE5ah model using the hourly county-level episodic temperatures and extract the emission factors.

3. For each hour in the modeling episode, calculate the ratio of episodic emission factor to base emission factor and apply this ratio to the emissions estimate generated by TTI.

The result of this processing was a mobile emissions inventory that accurately reflects the temperature in a given county at any hour during the modeling period. The day specific temperature adjustment was applied for every Texas County in the emissions modeling domain. The temperatures used in the MOBILE5ah input files were extracted from observations obtained from the Western Regional Climate Center (WRCC) FTP site (ftp://ftp.wrcc.dri.edu). The observation field is interpolated to the modeling grid, generating a gridded temperature field for each hour of the modeling episode. The temperature value at the county centroid was taken as representative of a county-wide temperature. The same temperature data were used for the mobile and biogenic emissions.

The link-based emissions are then speciated into CAMx chemical species and written to a CAMx emissions file using EPS2x. The inventory in counties with only county-wide VMT estimates required a gridding step, which was also implemented with EPS2x modules using gridded spatial surrogates (Appendix A).

County specific VMT data for Louisiana was received via email from Ron Rebouche of the Louisiana Department of Environmental Quality (LDEQ)/Environmental Planning Division for all Parishes in Louisiana. The data included annual average day VMT estimates by roadway class for 1999 and 2007. Data and projections are based on data from the annual U.S. Highway Statistics Reports Section V that is based on the Highway Performance Monitoring System (HPMS). This is combined with emissions factors and vehicle mix data, also received from LDEQ, to calculate county-level mobile emissions estimates for six parishes in the Shreveport area. The annual average day emissions estimates were processed through the EPS2x system to generate episode specific model-ready emissions estimates.

The NEI 1999 Version 1 for Criteria Pollutants, released by EPA 20 March 2001, is the basis for the onroad mobile regional emissions inventory for those counties outside Texas and the six Louisiana parishes within the 4-km grid. The data file *m99100txt.zip - 1999 NEI Version 1 Criteria Emissions from Onroad Mobile Sources in ASCII text format* was acquired from EPA's ftp site (ftp.epa.gov). The NEI 1999 onroad emission inventory is processed to (1) extract the typical peak ozone season day data, (2) reformatted to the EPS2x AMS input file format and (3) processed through EPS2x. A rural and urban spatial distribution is used to spatially allocate the urban and rural onroad sources.

Area and Off-Road Sources

Area and off-road emissions estimates for the counties within the East Texas NNA were based on the NETAC 1999 inventory. Refer to "Tyler/Longview/Marshall Flexible Attainment Region Emission Inventory Ozone Prescursors, VOC, NOx and CO 1999 Emissions" May, 2002 for a detailed description of the inventory development. Jerry Demo of Pollution Solutions provided these data via email.

The TCEQ provided emission inventories for Texas area and off-road sources. The data were downloaded from the TCEQ domain at /pub/AirQuality/AirQualityPlanningAssessment/Modeling/file_transfer/TX99AreaNR. The files ams. TX_99.area_base1 and ams.TX_99.NR_base1 are in EPS2x input file format.

For all areas outside Texas, the NEI 1999 Version 1 for Criteria Pollutants, released by EPA 20 March 2001, is the basis for the area and nonroad regional emissions inventory. The data file *a99100txt.zip - 1999 NEI Version 1 Criteria Emissions from Area and Nonroad Sources in ASCII text format* was acquired from EPA's ftp site. The file format documentation is provided at http://www.epa.gov/ttn/chief/eidocs/index.html#pack. The NEI 1999 area and off-road emission inventory is (1) processed to extract the typical peak ozone season day data, (2) reformatted to the EPS2x AMS input file format and (3) processed through EPS2x.

Biogenic Sources

Biogenic emissions were prepared using version 2.2 of the GloBEIS model (Yarwood et al., 1999 a and b). The GloBEIS model was developed by the National Center for Atmospheric Research and ENVIRON under sponsorship from the TCEQ. GloBEIS2 is based on the EPA BEIS2 model with the following improvements:

- Updated emission factor algorithm (called the BEIS99 algorithm).
- Compatible with the EPA's BELD3 landuse/landcover (LULC) database (EPA, 2000).
- Compatible with the TCEQ's Texas specific LULC database (Yarwood et al., 1999b) which includes local survey data for Northeast Texas developed by NETAC (ENVIRON, 1999).
- Ability to use solar radiation data for photosynthetically active radiation (PAR).

GloBEIS2 requires input data for LULC, temperature and solar radiation. The TCEQ provided these data for the August 1999 episode period (Yarwood et al., 2001). Briefly, these data are:

- TCEQ LULC data for Texas and Mexico.
- EPA BELD LULC data for all other U.S. States.
- Hourly temperature data from interpolated NWS observations.
- Hourly solar radiation (PAR) based on GOES satellite data as analyzed by the University of Maryland.

GloBEIS2 was used to calculate day specific, gridded, speciated, hourly emissions of biogenic VOCs and NOx for each modeling grid (36 km, 12 km, 4 km). The BEIS99 emission factor algorithm was used with no correction for seasonal variation in biomass density.

A new version of GloBEIS, version 3, was released in April 2002 (Guenther et al., 2002). GloBEIS3 includes new options such as effects of drought stress and prolonged periods of high temperature. These new options require additional input data and are still being evaluated by the TCEQ modeling group. Therefore, GloBEIS3 was not used for this study. The GloBEIS3 and GloBEIS2 codes calculate the same emissions when using the same input data, so the GloBEIS2 emissions for this study are fully consistent with the newer GloBEIS3 model. The new features of GloBEIS3 will be evaluated in future NETAC studies.

EMISSIONS SUMMARIES FOR 1999

All emission estimates in the following tables reflect gridded, model ready emissions. This means that for partial counties and/or states at the edge of a modeling domain, only the portion of emissions that is within the modeling domain is reported.

Tables 3-2 TO 3-4 are episode day emission summaries by major source type for the NNA counties and two Louisiana parishes.

Table 3-5 indicates episode day NOx emissions for the elevated point sources within the 4km grid which have been flagged for plume in grid treatment in CAMx modeling. Table 3-6 summarizes total NOx, elevated and surface, for Chemical Eastman. Figure 3-1 displays the average episode day NOx for these sources.

Table 3-7 represents total gridded Texas emissions for each episode day.

Tables 3-8 and 3-9 summarize the gridded emissions by major source type for states other than Texas.

Table 3-2. 1999 NOx for East Texas NNA and Shreveport area counties.

1999 NOx tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
Friday, August 13	Area	12.6	7.9	13.1	5.5	8.4	10.1	57.85
	Non-road	5.6	4.2	1.5	8.5	2.7		
	On-road	12.0	14.1	5.1	19.4	3.9	9.3	17.9
	Points	15.7	48.4	77.4	3.7	1.0	3.8	8.7
	Subtotal	45.8	74.6	97.1	37.0	16.0	23.2	84.4
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.2	2.0
	Total	46.0	75.1	97.6	37.7	16.5	24.4	86.4
Saturday, August 14	Area	11.2	7.6	12.8	4.2	8.2	8.4	44.3
	Non-road	4.8	4.2	1.3	7.4	2.6		
	On-road	9.8	11.2	4.2	15.7	3.2	7.0	13.4
	Points	9.7	47.7	80.6	3.0	1.0	3.9	7.3
	Subtotal	35.5	70.7	99.0	30.4	15.1	19.3	64.9
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.3	2.1
	Total	35.7	71.2	99.5	31.1	15.6	20.5	67.0
Sunday, August 15	Area	9.8	7.2	12.5	3.0	8.1	6.7	30.4
	Non-road	3.9	4.0	1.1	6.1	2.5		
	On-road	7.1	8.3	2.8	11.4	2.4	7.0	13.4
	Points	11.4	47.4	80.7	3.0	1.0	3.9	7.4
	Subtotal	32.2	66.8	97.2	23.5	14.0	17.5	51.2
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.2	1.9
	Total	32.4	67.3	97.6	24.2	14.5	18.7	53.1
Monday, August 16	Area	12.6	7.9	13.1	5.5	8.4	10.1	57.85
	Non-road	5.6	4.2	1.5	8.5	2.7		
	On-road	11.0	12.2	4.3	17.8	3.5	9.3	17.9
	Points	14.1	48.7	82.9	3.7	1.0	3.8	10.5
	Subtotal	43.2	73.1	101.8	35.5	15.6	23.2	86.2
	Biogenics	0.2	0.5	0.4	0.6	0.4	1.2	1.9
	Total	43.4	73.5	102.2	36.1	16.0	24.4	88.1
Tuesday, August 17	Area	12.6	7.9	13.1	5.5	8.4		
	Non-road	5.6	4.2	1.5	8.5	2.7		
	On-road	11.5	13.1	4.7	18.5	3.7	9.3	17.9
	Points	15.2	48.5	80.4	3.7	1.0	3.8	10.8
	Subtotal	44.9	73.7	99.7	36.2	15.8	13.1	28.7
	Biogenics	0.2	0.5	0.4	0.6	0.4	1.2	1.9
	Total	45.0	74.2	100.2	36.8	16.3	14.3	30.6
Wednesday, August 18	Area	12.6	7.9	13.1	5.5	8.4		
	Non-road	5.6	4.2	1.5	8.5	2.7		
	On-road	11.8	13.6	4.9	19.0	3.9	9.3	17.9
	Points	14.4	45.9	75.9	3.7	1.0	3.8	10.8
	Subtotal	44.4	71.6	95.4	36.7	16.0	13.1	28.7
	Biogenics	0.2	0.5	0.4	0.6	0.5	1.2	2.0
	Total	44.6	72.1	95.8	37.3	16.4	14.3	30.7
Thursday, August 19	Area	12.6	7.9	13.1	5.5	8.4		
	Non-road	5.6	4.2	1.5	8.5	2.7		
	On-road	12.2	14.2	5.2	19.7	4.0	9.3	17.9
	Points	15.7	49.9	77.8	3.7	1.0	3.8	11.2
	Subtotal	46.1	76.3	97.5	37.4	16.1	13.1	29.1
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.2	2.0
	Total	46.3	76.8	98.0	38.1	16.6	14.3	31.1
Friday, August 20	Area	12.6	7.9	13.1	5.5	8.4		
	Non-road	5.6	4.2	1.5	8.5	2.7		

1999 NOx tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
	On-road	12.1	14.1	5.3	19.6	4.0	9.3	17.9
	Points	17.3	44.3	81.9	3.7	1.0	3.8	11.8
	Subtotal	47.6	70.5	101.7	37.3	16.1	13.1	29.7
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.3	2.1
	Total	47.8	71.0	102.2	38.0	16.6	14.4	31.8
Saturday, August 21	Area	11.2	7.6	12.8	4.2	8.2	8.4	44.3
	Non-road	4.8	4.2	1.3	7.4	2.6		
	On-road	9.6	10.7	4.0	15.4	3.0	7.0	13.4
	Points	16.1	22.1	80.6	3.0	1.0	3.9	12.0
	Subtotal	41.7	44.5	98.7	30.0	14.9	19.3	69.7
	Biogenics	0.2	0.5	0.4	0.6	0.5	1.2	1.9
	Total	41.8	45.0	99.1	30.7	15.4	20.5	71.6
Sunday, August 22	Area	9.8	7.2	12.5	3.0	8.1	6.7	30.4
	Non-road	3.9	4.0	1.1	6.1	2.5		
	On-road	7.2	8.8	3.0	11.5	2.5	7.0	13.4
	Points	12.2	38.8	80.8	3.0	1.0	3.9	9.5
	Subtotal	33.2	58.8	97.4	23.7	14.1	17.5	53.3
	Biogenics	0.2	0.5	0.4	0.6	0.5	1.2	1.9
	Total	33.4	59.2	97.8	24.3	14.6	18.7	55.2
Average Episode Day	Area	11.8	7.7	12.9	4.7	8.3	5.0	26.5
	Non-road	5.1	4.2	1.4	7.8	2.7		
	On-road	10.4	12.0	4.3	16.8	3.4	8.3	16.1
	Points	14.2	44.2	79.9	3.4	1.0	3.8	10.0
	Subtotal	41.5	68.1	98.5	32.8	15.4	17.2	52.6
	Biogenics	0.2	0.5	0.5	0.6	0.5	1.2	2.0
	Total	41.7	68.5	99.0	33.4	15.8	18.4	54.5

Table 3-3. 1999 VOC for East Texas NNA and Shreveport area counties.

1999 VOC tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
Friday, August 13	Area	14.8	13.4	11.9	14.6	13.5	8.9	33.4
	Non-road	2.8	5.4	4.1	9.2	3.3		
	On-road	7.4	6.9	3.4	11.9	2.2	4.7	9.7
	Points	3.3	15.1	2.0	10.2	0.8	1.6	5.9
	Subtotal	28.3	40.8	21.4	45.9	19.7	15.1	49.0
	Biogenics	62.9	312.7	274.9	265.7	172.5	247.4	242.0
	Total	91.2	353.5	296.2	311.6	192.1	262.6	291.0
Saturday, August 14	Area	11.5	11.3	10.1	10.1	12.5	6.5	24.5
	Non-road	4.0	24.8	12.5	33.7	14.7		
	On-road	6.3	6.0	2.9	10.2	1.9	3.5	7.3
	Points	3.0	14.3	2.0	6.2	0.8	1.6	5.8
	Subtotal	24.9	56.4	27.4	60.2	29.8	11.6	37.6
	Biogenics	67.0	339.1	294.1	280.1	183.1	273.0	266.4
	Total	91.9	395.5	321.6	340.4	212.9	284.6	304.0
Sunday, August 15	Area	10.0	10.4	9.3	7.7	11.9	5.4	21.1
	Non-road	3.8	24.8	12.4	33.5	14.6		
	On-road	4.7	4.6	2.0	7.5	1.5	3.5	7.3
	Points	3.0	14.3	2.0	6.2	0.8	1.6	5.8
	Subtotal	21.5	54.1	25.7	54.9	28.8	10.5	34.1
	Biogenics	62.3	308.6	276.9	266.9	169.2	232.1	234.9
	Total	83.8	362.7	302.6	321.8	198.0	242.6	269.0
Monday, August 16	Area	14.8	13.4	11.9	14.6	13.5	8.9	33.4
	Non-road	2.8	5.4	4.1	9.2	3.3		
	On-road	6.0	5.0	2.6	9.9	1.7	4.7	9.7
	Points	3.3	15.1	2.0	10.2	0.8	1.6	5.9
	Subtotal	27.0	39.0	20.6	43.9	19.2	15.1	49.0
	Biogenics	56.7	290.0	253.3	238.7	153.6	235.3	230.8
	Total	83.6	329.0	273.8	282.6	172.8	250.4	279.8
Tuesday, August 17	Area	14.8	13.4	11.9	14.6	13.5	8.9	33.4
	Non-road	2.8	5.4	4.1	9.2	3.3		
	On-road	6.4	5.6	2.9	10.4	1.8	4.7	9.7
	Points	3.3	15.1	2.0	10.2	0.8	1.6	5.9
	Subtotal	27.3	39.6	20.9	44.3	19.3	15.1	49.0
	Biogenics	56.9	290.5	244.7	235.0	158.4	233.1	229.0
	Total	84.2	330.1	265.6	279.3	177.7	248.2	278.0
Wednesday, August 18	Area	14.8	13.4	11.9	14.6	13.5	8.9	33.4
	Non-road	2.8	5.4	4.1	9.2	3.3		
	On-road	6.6	6.0	3.0	10.7	1.9	4.7	9.7
	Points	3.3	15.1	2.0	10.2	0.8	1.6	5.9
	Subtotal	27.5	39.9	21.0	44.6	19.4	15.1	49.0
	Biogenics	59.3	306.9	259.2	243.2	163.2	255.9	245.3
	Total	86.8	346.8	280.2	287.9	182.6	271.0	294.3
Thursday, August 19	Area	14.8	13.4	11.9	14.6	13.5	8.9	33.4
	Non-road	2.8	5.4	4.1	9.2	3.3		
	On-road	6.9	6.4	3.2	11.2	2.0	4.7	9.7
	Points	3.3	15.1	2.0	10.2	0.8	1.6	5.9
	Subtotal	27.8	40.3	21.3	45.2	19.6	15.1	49.0
	Biogenics	65.6	325.3	277.3	275.0	183.5	268.4	255.1
	Total	93.4	365.6	298.6	320.2	203.0	283.5	304.1
Friday, August 20	Area	14.8	13.4	11.9	14.6	13.5	8.9	33.4
	Non-road	2.8	5.4	4.1	9.2	3.3		

1999 VOC tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
	On-road	7.4	6.9	3.5	12.1	2.2	4.7	9.7
	Points	3.3	15.1	2.0	10.2	0.8	1.6	5.9
	Subtotal	28.4	40.8	21.5	46.1	19.7	15.1	49.0
	Biogenics	68.6	350.8	301.9	286.9	187.9	282.7	277.2
	Total	97.0	391.6	323.4	332.9	207.6	297.8	326.2
Saturday, August 21	Area	11.5	11.3	10.1	10.1	12.5	6.5	24.5
	Non-road	4.0	24.8	12.5	33.7	14.7		
	On-road	6.2	5.7	2.7	9.9	1.8	3.5	7.3
	Points	3.0	14.3	2.0	6.2	0.8	1.6	5.8
	Subtotal	24.7	56.1	27.3	60.0	29.7	11.6	37.6
	Biogenics	60.0	301.5	258.7	254.0	166.3	232.2	232.9
	Total	84.7	357.6	286.0	314.0	196.0	243.8	270.5
Sunday, August 22	Area	10.0	10.4	9.3	7.7	11.9	5.4	21.1
	Non-road	3.8	24.8	12.4	33.5	14.6		
	On-road	4.8	5.0	2.1	7.7	1.6	3.5	7.3
	Points	3.0	14.3	2.0	6.2	0.8	1.6	5.8
	Subtotal	21.6	54.5	25.8	55.1	28.9	10.5	34.1
	Biogenics	55.6	291.7	232.6	221.2	156.6	241.8	233.7
	Total	77.2	346.2	258.4	276.3	185.5	252.3	267.8
Average Episode Day	Area	13.2	12.4	11.0	12.3	13.0	7.7	29.2
	Non-road	3.3	13.2	7.5	19.0	7.8		
	On-road	6.3	5.8	2.8	10.2	1.9	4.2	8.7
	Points	3.2	14.8	2.0	8.6	0.8	1.6	5.9
	Subtotal	25.9	46.1	23.3	50.0	23.4	13.5	43.7
	Biogenics	61.5	311.7	267.4	256.7	169.4	250.2	244.7
	Total	87.4	357.9	290.6	306.7	192.8	263.7	288.5

Table 3-4. 1999 CO for East Texas NNA and Shreveport area counties.

1999 CO tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
Friday, August 13	Area	3.6	7.0	8.2	8.4	5.5	35.7	94.5
	Non-road	40.1	8.9	11.3	46.2	5.2		
	On-road	73.3	79.2	29.5	114.8	18.7	37.1	76.3
	Points	5.7	12.6	6.1	2.3	0.7	1.5	2.7
	Subtotal	122.7	107.8	55.2	171.6	30.2	74.3	173.4
	Biogenics	6.1	32.0	29.9	26.9	18.6	24.7	23.1
	Total	128.9	139.8	85.1	198.5	48.8	99.0	196.5
Saturday, August 14	Area	3.1	6.4	7.6	6.7	4.9	38.8	119.2
	Non-road	59.2	17.8	16.0	70.0	9.3		
	On-road	63.2	69.4	25.4	98.5	16.4	27.8	57.2
	Points	5.4	12.6	6.1	1.3	0.7	1.5	2.7
	Subtotal	131.0	106.2	55.1	176.5	31.3	68.1	179.1
	Biogenics	6.3	33.9	32.1	27.7	18.5	26.4	24.9
	Total	137.3	140.1	87.1	204.2	49.9	94.5	204.0
Sunday, August 15	Area	2.7	5.8	7.1	5.1	4.4	34.8	111.6
	Non-road	57.9	17.5	15.7	68.2	9.1		
	On-road	46.9	53.8	17.2	74.3	12.8	27.8	57.2
	Points	5.4	12.6	6.1	1.3	0.7	1.5	2.7
	Subtotal	112.9	89.7	46.1	148.9	27.0	64.1	171.4
	Biogenics	6.0	31.6	30.3	26.4	17.5	23.4	22.8
	Total	118.9	121.3	76.4	175.3	44.5	87.5	194.2
Monday, August 16	Area	3.6	7.0	8.2	8.4	5.5	35.7	94.5
	Non-road	40.1	8.9	11.3	46.2	5.2		
	On-road	60.2	58.7	22.8	97.4	14.9	37.1	76.3
	Points	5.7	12.6	6.1	2.3	0.7	1.5	2.7
	Subtotal	109.6	87.2	48.4	154.2	26.3	74.3	173.5
	Biogenics	5.3	28.8	27.4	23.2	15.4	22.8	21.5
	Total	114.9	116.0	75.8	177.5	41.7	97.0	195.0
Tuesday, August 17	Area	3.6	7.0	8.2	8.4	5.5	35.7	94.5
	Non-road	40.1	8.9	11.3	46.2	5.2		
	On-road	64.1	65.8	25.6	102.4	16.3	37.1	76.3
	Points	5.7	12.6	6.1	2.3	0.7	1.5	2.7
	Subtotal	113.5	94.3	51.2	159.2	27.7	74.3	173.5
	Biogenics	5.4	29.5	27.3	23.1	15.9	23.2	22.0
	Total	118.9	123.8	78.5	182.3	43.6	97.5	195.5
Wednesday, August 18	Area	3.6	7.0	8.2	8.4	5.5	35.7	94.5
	Non-road	40.1	8.9	11.3	46.2	5.2		
	On-road	66.3	69.6	26.8	105.6	17.1	37.1	76.3
	Points	5.7	12.6	6.1	2.3	0.7	1.5	2.7
	Subtotal	115.8	98.1	52.4	162.4	28.6	74.3	173.5
	Biogenics	5.7	31.3	28.6	24.6	17.2	25.0	23.3
	Total	121.5	129.4	81.1	187.0	45.8	99.3	196.8
Thursday, August 19	Area	3.6	7.0	8.2	8.4	5.5	35.7	94.5
	Non-road	40.1	8.9	11.3	46.2	5.2		
	On-road	69.2	74.4	28.8	110.6	18.2	37.1	76.3
	Points	5.7	12.6	6.1	2.3	0.7	1.5	2.7
	Subtotal	118.6	103.0	54.4	167.5	29.6	74.3	173.5
	Biogenics	6.2	32.5	29.7	27.2	19.1	25.9	23.8
	Total	124.8	135.5	84.2	194.6	48.7	100.2	197.2
Friday, August 20	Area	3.6	7.0	8.2	8.4	5.5	35.7	94.5
	Non-road	40.1	8.9	11.3	46.2	5.2		

1999 CO tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
	On-road	74.0	79.2	30.5	116.7	19.1	37.1	76.3
	Points	5.7	12.4	6.1	2.3	0.7	1.5	2.7
	Subtotal	123.5	107.6	56.1	173.5	30.5	74.3	173.5
	Biogenics	6.3	34.6	32.2	27.8	19.0	27.3	25.7
	Total	129.8	142.2	88.4	201.2	49.5	101.6	199.1
Saturday, August 21	Area	3.1	6.4	7.6	6.7	4.9	38.8	119.2
	Non-road	59.2	17.8	16.0	70.0	9.3		
	On-road	61.6	65.3	23.8	95.8	15.4	27.8	57.2
	Points	5.5	12.6	6.1	1.3	0.7	1.5	2.7
	Subtotal	129.4	102.1	53.5	173.8	30.3	68.1	179.1
	Biogenics	5.6	30.3	28.0	24.6	16.8	23.3	22.2
	Total	135.1	132.4	81.5	198.3	47.1	91.4	201.4
Sunday, August 22	Area	2.7	5.8	7.1	5.1	4.4	34.8	111.6
	Non-road	57.9	17.5	15.7	68.2	9.1		
	On-road	48.2	58.3	18.4	75.9	13.7	27.8	57.2
	Points	5.4	12.6	5.9	1.3	0.7	1.5	2.7
	Subtotal	114.1	94.3	47.1	150.5	28.0	64.1	171.4
	Biogenics	5.4	29.9	26.7	22.9	16.2	23.7	22.3
	Total	119.5	124.1	73.7	173.3	44.2	87.8	193.7
Average Episode Day	Area	3.3	6.7	7.9	7.4	5.1	36.2	102.8
	Non-road	47.5	12.4	13.1	55.3	6.8		
	On-road	62.7	67.4	24.9	99.2	16.3	33.4	68.6
	Points	5.6	12.6	6.1	1.9	0.7	1.5	2.7
	Subtotal	119.1	99.0	51.9	163.8	29.0	71.0	174.2
	Biogenics	5.8	31.5	29.2	25.4	17.4	24.6	23.2
	Total	125.0	130.5	81.2	189.2	46.4	95.6	197.3

Table 3-5. Tons/day NOx for facilities treated with plume in grid within the 4km domain. These represent only the elevated point emissions at each facility.

Facility Name	Stack	Aug 13	Aug 14	Aug 15	Aug 16	Aug 17	Aug 18	Aug 19	Aug 20	Aug 21	Aug 22	Episode Average
Arsenal	1	0	0	0	0	0	0	0	2.4	2.2	0	0.5
Arsenal Total		0	0	0	0	0	0	0	2.4	2.2	0	0.5
Dolet_Hills_Power	1	36.9	38.6	36.7	39	40.5	39.6	37.9	36.9	36.9	37.1	38.0
Dolet_Hills_Power Total		36.9	38.6	36.7	39	40.5	39.6	37.9	36.9	36.9	37.1	38.0
Eastman_Chemical_Co	148	0	0	0	0	0	0.8	2.4	2.3	2.3	2.1	1.0
	149	2.4	2.3	2.3	2.4	2.4	2	2	1.9	2.2	1.9	2.2
Eastman_Chemical_Co Total		2.4	2.3	2.3	2.4	2.4	2.8	4.4	4.2	4.5	4	3.2
Knox_Lee	3	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.5	0.3	0.3	0.3
	4	1.4	0.3	0.8	1.2	1.2	0.4	0.9	0.7	1.5	0.8	0.9
	5	3.3	1	1.9	2.1	3.2	3.3	3.7	5	3.6	2.3	2.9
	6	5.1	2.8	3	4.9	4.9	4.8	5.2	5.6	5.2	3.5	4.5
Knox_Lee Total		10.1	4.3	6	8.5	9.6	8.8	10.2	11.8	10.6	6.9	8.7
Lieberman	3	0	0	0	2.3	2.4	2.4	2.6	2.6	3.2	0	1.6
Lieberman Total		0	0	0	2.3	2.4	2.4	2.6	2.6	3.2	0	1.6
Martin_Lake	5	27.1	27.2	28.1	29.5	27.1	26.6	27.3	28.5	28.5	29.2	27.9
	6	24.7	24.7	23.2	23.8	23.1	23.2	24.3	25.5	25	25.2	24.3
	7	24.2	27.3	28	28.2	28.8	24.7	24.8	26.5	25.7	25	26.3
Martin_Lake Total		76	79.2	79.3	81.5	79	74.5	76.4	80.5	79.2	79.4	78.5
Monticello	7	20.6	20.7	20.4	21.6	20.7	22.2	21.5	22.8	22	20.8	21.3
	9	20.4	20	20.3	19.9	19.2	20.2	20.3	20	20	19.2	20.0
	10	20.8	21.1	21	21.5	21.7	22.3	22.9	21.7	21.4	21.1	21.6
Monticello Total		61.8	61.8	61.7	63	61.6	64.7	64.7	64.5	63.4	61.1	62.8
Pirkey	1	28.4	27.8	27.5	28.7	28.4	25.4	28	22.5	0	17.1	23.4
Pirkey Total		28.4	27.8	27.5	28.7	28.4	25.4	28	22.5	0	17.1	23.4
Stryker_Creek	1	3.7	4.1	3.8	4.3	4.1	3.9	4.4	3.4	3.6	2.4	3.8
	2	3.7	4.1	3.8	4.3	4.1	3.9	4.4	3.4	3.6	2.4	3.8
	3	3	3	3	3.2	3.2	3.4	3.5	2.9	2.8	2.8	3.1
	4	3	3	3	3.2	3.2	3.4	3.5	2.9	2.8	2.8	3.1
Stryker_Creek Total		13.4	14.2	13.6	15	14.6	14.6	15.8	12.6	12.8	10.4	13.7
Welsh	11	35.5	33.3	35	34.5	36.1	35	34.9	32.8	32.8	29.7	34.0
	12	27.9	25.8	26	27.2	26.3	25.9	27.2	26.2	27.4	23.3	26.3
	13	26.9	24.7	18.7	0	0	0	0	0	0.3	18.7	8.9
Welsh Total		90.3	83.8	79.7	61.7	62.4	60.9	62.1	59	60.5	71.7	69.2
Wilkes	1	6.1	4.3	4	7.1	5.6	7.5	7.2	8	8.1	5.6	6.4
	2	5.4	3.9	4.6	5.1	5.4	7.4	7.1	6.6	8.7	5	5.9
	3	1.8	1.1	1.1	1.9	2	2.1	2.2	2.3	2.5	1.7	1.9
Wilkes Total		13.3	9.3	9.7	14.1	13	17	16.5	16.9	19.3	12.3	14.1

Note: Plume in grid was selected for sources with NOx > 2 tons/day on any episode day Aug 13 – 22, 1999.

Table 3-6. Chemical Eastman average August 1999 episode day (tons per day). The 'other' represents almost four hundred generating stacks.

	Stack 148	Stack 149	Other Elevated	Other Surface	Total
NOx	1.0	2.2	9.3	1.9	14.4
VOC	.016	.016	1.0	9.7	10.7

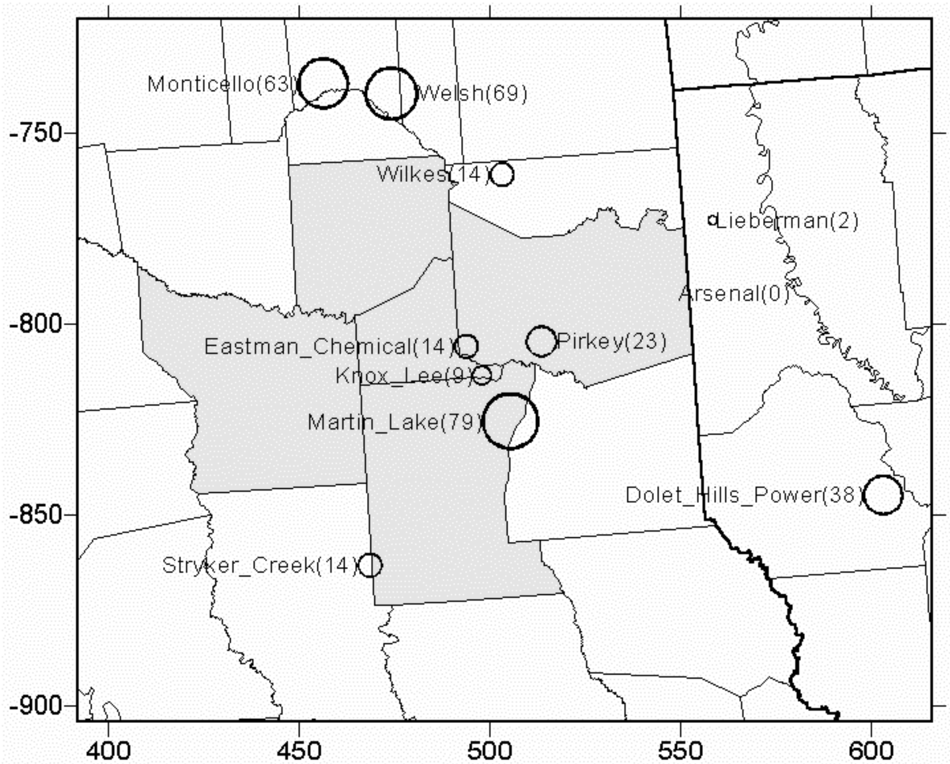


Figure 3-1. 1999 average episode day NOx for the facilities in Table 3-5. These represent elevated sources for all facilities with the exception of Eastman_Chemical which represents the total NOx from Table 3-6.

Table 3-7. Texas gridded 1999 episode day emissions by major source type.

Episode day	Area	Non-road	On-road	EGUs	Other Points	Off shore	Shipping	Total Anthropogenic	Biogenic	Total
Tons NOx										
Friday, August 13	636	1044	2121	1418	1011	549	35	6814	1150	7964
Saturday, August 14	619	972	1715	1349	1008	549	35	6247	1137	7384
Sunday, August 15	602	889	1362	1281	1008	549	35	5726	1161	6887
Monday, August 16	636	1044	1930	1350	1011	549	35	6555	1148	7702
Tuesday, August 17	636	1044	1907	1328	1011	549	35	6510	1083	7593
Wednesday, August 18	636	1044	1966	1386	1011	549	35	6627	1098	7726
Thursday, August 19	636	1044	2085	1414	1011	549	35	6775	1132	7907
Friday, August 20	636	1044	2147	1354	1011	549	35	6776	1122	7898
Saturday, August 21	619	972	1590	1262	1008	549	35	6035	1100	7135
Sunday, August 22	602	889	1258	1200	1008	549	35	5541	1053	6594
Tons VOC										
Friday, August 13	1736	467	1213	19	558	189	1	4184	22157	26341
Saturday, August 14	1395	843	1019	19	531	189	1	3997	22265	26263
Sunday, August 15	1197	827	830	19	531	189	1	3594	20962	24556
Monday, August 16	1736	467	999	19	558	189	1	3970	20416	24386
Tuesday, August 17	1736	467	981	19	558	189	1	3952	20157	24109
Wednesday, August 18	1736	467	1018	18	558	189	1	3989	21452	25441
Thursday, August 19	1736	467	1094	18	558	189	1	4066	23320	27386
Friday, August 20	1736	467	1232	18	558	189	1	4203	22379	26582
Saturday, August 21	1395	843	938	18	531	189	1	3916	20641	24558
Sunday, August 22	1197	827	757	18	531	189	1	3521	18867	22388
Tons CO										
Friday, August 13	958	4782	11111	223	812	126	5	18018	2610	20628
Saturday, August 14	823	6151	9447	220	803	126	5	17576	2560	20136
Sunday, August 15	690	6024	7803	222	803	126	5	15673	2456	18129
Monday, August 16	958	4782	9280	222	812	126	5	16185	2333	18518
Tuesday, August 17	958	4782	9114	220	812	126	5	16018	2269	18286
Wednesday, August 18	958	4782	9444	211	812	126	5	16338	2428	18766
Thursday, August 19	958	4782	10151	210	812	126	5	17045	2642	19688
Friday, August 20	958	4782	11282	218	812	126	5	18184	2571	20755
Saturday, August 21	823	6151	8715	216	803	126	5	16840	2376	19216
Sunday, August 22	690	6024	7112	214	803	126	5	14974	2246	17220

Table 3-8. Summary of gridded emissions by major source type for states other than Texas.

	Area			On-road			Points			Anthropogenic		
State	Weekday	Sat	Sun	Weekday	Sat	Sun	Weekday	Sat	Sun	Total Weekday	Total Sat	Total Sun
NOx												
Alabama	562	497	425	546	409	409	821	804	804	1930	1710	1639
Arkansas	393	346	295	297	223	223	314	313	313	1004	882	831
Florida	97	92	81	120	90	90	136	135	135	353	317	306
Georgia	479	409	335	627	470	470	538	534	534	1644	1413	1339
Illinois	304	294	283	236	177	177	657	644	644	1197	1115	1103
Indiana	242	217	192	235	176	176	855	851	851	1332	1245	1219
Kansas	785	704	621	270	202	202	513	473	473	1568	1380	1297
Kentucky	613	519	423	465	349	349	967	960	960	2046	1829	1732
Louisiana	1074	982	863	436	327	327	1166	1163	1163	2675	2472	2353
Mississippi	453	400	343	361	270	270	501	501	501	1314	1171	1114
Missouri	482	444	402	551	413	413	614	607	607	1646	1464	1422
Nebraska	92	90	88	21	16	16	32	32	32	145	138	136
North Carolina	8	6	5	18	13	13	12	12	12	38	32	31
Ohio	107	90	73	125	93	93	664	663	663	896	847	829
Oklahoma	375	337	295	415	311	311	648	644	644	1439	1292	1250
South Carolina	1	1	1	3	2	2	0	0	0	5	4	3
Tennessee	663	611	554	578	434	434	769	790	790	2010	1834	1777
Virginia	4	4	3	10	8	8	0	0	0	15	12	11
West Virginia	18	17	15	17	13	13	130	129	129	165	159	157
Grand Total	6751	6061	5298	5329	3997	3997	9339	9256	9256	21420	19314	18550
VOC												
Alabama	798	656	558	390	292	292	293	243	243	1481	1192	1094
Arkansas	560	428	353	196	147	147	98	83	83	854	658	583
Florida	239	278	259	86	64	64	16	15	15	341	357	338
Georgia	703	507	421	398	299	299	68	48	48	1169	854	768
Illinois	278	202	170	142	106	106	181	130	130	601	439	406
Indiana	353	228	166	157	118	118	56	34	34	567	380	317
Kansas	525	390	328	185	139	139	78	41	41	787	570	508
Kentucky	568	406	324	299	224	224	208	139	139	1074	769	687
Louisiana	640	905	854	274	205	205	258	272	272	1172	1382	1331
Mississippi	671	529	456	237	178	178	128	111	111	1036	817	744
Missouri	677	493	391	316	237	237	191	141	141	1183	870	769
Nebraska	66	57	53	13	10	10	4	4	4	83	70	66
North Carolina	27	20	16	8	6	6	7	2	2	42	28	24
Ohio	214	143	107	81	61	61	38	22	22	333	226	190
Oklahoma	464	377	322	304	228	228	166	143	143	934	748	693
South Carolina	4	4	3	2	2	2	0	0	0	6	5	5
Tennessee	951	665	511	385	289	289	311	160	160	1648	1114	960
Virginia	11	7	6	5	4	4	1	0	0	16	11	10
West Virginia	25	18	14	12	9	9	27	24	24	63	51	47
Grand Total	7775	6312	5311	3489	2617	2617	2127	1612	1612	13391	10541	9540
CO												
Alabama	5133	5521	5371	3365	2523	2523	586	545	545	9084	8589	8440
Arkansas	2049	2300	2217	1565	1174	1174	308	305	305	3922	3778	3695
Florida	947	1177	1136	720	540	540	40	39	39	1707	1756	1715
Georgia	4605	5018	4713	3685	2764	2764	187	175	175	8478	7957	7652
Illinois	651	812	783	1124	843	843	66	63	63	1842	1718	1689
Indiana	831	948	882	1237	928	928	263	156	156	2331	2031	1965

State	Area			On-road			Points			Anthropogenic		
	Weekday	Sat	Sun	Weekday	Sat	Sun	Weekday	Sat	Sun	Total Weekday	Total Sat	Total Sun
Kansas	1385	1654	1590	1550	1162	1162	211	194	194	3145	3011	2947
Kentucky	1530	1776	1659	2426	1820	1820	213	203	203	4170	3800	3682
Louisiana	2172	3312	3195	2411	1808	1808	855	872	872	5439	5992	5876
Mississippi	3197	3453	3357	1954	1465	1465	254	254	254	5405	5172	5077
Missouri	2347	2875	2744	2496	1872	1872	303	296	296	5146	5043	4912
Nebraska	171	200	198	105	79	79	4	4	4	281	283	280
North Carolina	98	102	94	64	48	48	9	9	9	171	159	150
Ohio	808	924	874	672	504	504	106	103	103	1586	1530	1481
Oklahoma	1310	1668	1609	2473	1855	1855	638	632	632	4421	4155	4095
South Carolina	26	25	24	16	12	12	0	0	0	42	38	36
Tennessee	2496	2857	2674	3267	2450	2450	263	270	270	6026	5578	5394
Virginia	29	31	29	38	29	29	0	0	0	67	60	58
West Virginia	68	78	71	94	71	71	24	24	24	187	173	166
Grand Total	29854	34731	33218	29262	21946	21946	4333	4146	4146	63449	60823	59310

Table 3-9. Gridded biogenic emissions for states other than Texas.

	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
NOx										
Alabama	85	74	65	74	79	82	80	73	69	73
Arkansas	137	101	95	110	125	133	134	106	104	115
Florida	11	10	9	10	10	10	10	10	10	10
Georgia	52	54	47	51	54	56	54	46	47	48
Illinois	336	275	279	344	378	330	311	292	295	329
Indiana	161	115	123	142	163	146	140	126	131	142
Kansas	433	477	641	713	671	581	494	468	549	548
Kentucky	173	111	115	139	164	155	151	122	124	133
Louisiana	118	110	91	98	106	115	121	110	103	105
Mississippi	141	111	98	111	124	128	137	119	112	119
Missouri	242	216	240	294	290	282	245	232	246	263
Nebraska	146	171	229	232	214	191	167	173	195	189
North Carolina	2	2	2	2	2	2	2	1	1	1
Ohio	25	17	18	21	26	22	19	18	19	20
Oklahoma	197	190	230	246	238	229	204	187	208	237
South Carolina	0	0	0	0	0	0	0	0	0	0
Tennessee	135	89	88	107	120	123	122	93	95	102
Virginia	1	1	0	1	1	1	1	0	0	0
West Virginia	0	0	0	0	1	0	0	0	0	0
Total	2396	2124	2373	2693	2767	2585	2392	2178	2308	2435
VOC										
Alabama	15629	12994	9764	12476	14017	14973	14720	12458	10971	11808
Arkansas	12062	8025	7596	9437	11983	12996	12615	8389	8181	10093
Florida	2685	2332	1958	2286	2523	2267	2327	2116	2232	2227
Georgia	6775	7393	5654	6513	7363	8137	7583	5301	5280	5530
Illinois	1551	931	1101	1715	1933	1201	1167	1146	1290	1578
Indiana	1499	548	857	1190	1573	1120	933	819	980	1143
Kansas	814	979	1687	2103	1886	1650	1143	944	1326	1088
Kentucky	5696	1729	2672	4286	5791	4751	4081	2324	3214	3686
Louisiana	9805	9146	6853	7888	8938	9978	10747	8994	8080	8639
Mississippi	14659	11134	8864	11526	13261	13903	14794	12234	11243	12388
Missouri	6962	5435	6819	10159	10468	9264	7077	6149	7273	8395
Nebraska	124	200	339	353	298	241	192	199	255	190
North Carolina	806	774	576	732	881	921	809	519	504	544
Ohio	640	167	329	531	793	526	334	318	412	452
Oklahoma	6990	5479	6171	6457	7271	7616	6820	5198	5184	6564
South Carolina	142	157	106	131	152	169	154	93	92	101
Tennessee	9104	4025	4682	7004	8586	8444	8236	4275	5189	6099
Virginia	180	108	87	157	192	164	152	82	91	106
West Virginia	155	52	80	144	211	149	118	67	102	109
Total	96278	71608	66196	85087	98120	98470	94004	71626	71898	80740
CO										
Alabama	1593	1342	1044	1270	1427	1520	1498	1319	1165	1268
Arkansas	1238	861	774	904	1125	1250	1255	885	843	990
Florida	372	340	290	335	355	332	327	310	316	323
Georgia	705	731	594	674	743	811	768	569	555	592
Illinois	167	112	115	160	186	157	142	125	127	152
Indiana	176	98	114	145	182	151	138	116	126	144
Kansas	132	145	228	287	260	226	163	147	187	184
Kentucky	652	327	358	499	647	558	498	361	392	431

	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
Louisiana	1153	1063	801	882	1009	1139	1249	1057	954	990
Mississippi	1474	1139	916	1098	1272	1338	1438	1247	1137	1203
Missouri	602	487	550	755	800	781	602	532	582	659
Nebraska	21	26	41	44	39	32	26	27	33	30
North Carolina	74	68	58	69	78	79	76	53	50	53
Ohio	92	50	57	73	105	77	61	57	61	65
Oklahoma	658	529	585	606	650	685	609	486	518	650
South Carolina	14	15	12	14	15	16	16	10	10	11
Tennessee	881	491	492	663	783	785	780	517	517	572
Virginia	20	14	12	17	20	18	17	12	12	13
West Virginia	18	11	12	17	23	18	14	12	13	13
Total	10041	7848	7050	8511	9718	9973	9679	7843	7598	8342

DATA SOURCES FOR 2007

Point Sources

Point source data were obtained from several different sources, processed separately and merged prior to modeling. The data include:

- Texas electric generating units (EGUs)
- Texas non-EGU point sources
- Facility specific data
- Texas minor point sources
- Other State point sources

The point source data are processed for a typical peak ozone (PO) season weekday and weekend days.

The 2007 Texas point source data were provided by TCEQ in EPS2x AFS input format. The hourly EGU data are developed from the EPA's Acid Rain Program Database and are based on 30-day peaks at each facility in the summer quarter of 1997, 1998 and 1999. These data include 'new' sources within 100 miles of the non-attainment areas. Controls are applied to the EGU data to represent TCEQ's NOx rules. The TCEQ Point Source Data Base (PSDB) is the basis of the non-EGU Texas data. These data were provided as 2007 estimates and incorporated growth and controls. The files which were downloaded from the TCEQ ftp site ftp://ftp.TCEQ.state.tx.us/pub/AirQuality/AirQualityPlanningAssessment/Modeling/file_transfer/HGPoints/forDec2000SIP/ are:

TX EGU	hourly_NAA30dayTXegu.afs_newEGU100miDFWandHGA_11
TX Non-EGU	afs.tx_negu.930905-930911_12.tier2_07.NewNEGU.new

Many facilities in the Northeast Texas region provided future year emission estimates in developing the Northeast Texas Region Ozone SIP Revision (March, 2002) which are used in this modeling inventory. These sources were removed from the Texas files listed and replaced with the SIP data above. In addition, permits for new EGU units in the Northeast Texas region were researched and emission estimates were provided via email from TCEQ's Ron Thomas.

For all states other than Texas the U.S. EPA 2007 national inventories developed to assist future modeling of the Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel, henceforth referred to as 2007 HDD inventory, were downloaded from EPA's ftp site.

ftp://ftp.epa.gov/EmisInventory/HDD_Rule/2007BaseCase/

Regional EGU	Egu/eg07ms2h.zip
Regional Non-EGU	NonEGUPoint/pt07ms2h.zip

The compressed files (*.zip*) contain a Dbase/FoxPro formatted file (*.dbf*) which were converted to Ascii text (*.dat*) for processing. The data is processed to (1) extract peak ozone season data for those states within the regional modeling domain other than Texas, (2) reformatted to EPS2x AFS input file format and (3) processed through EPS2x. The 2007

HDD inventories are described in detail in *Procedures for Developing Base Year and Future Year Mass and Modeling Inventories for the Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel (HDD) Rulemaking* (ftp://ftp.epa.gov/EmisInventory/HDD_Rule/ProceduresDocument/ProcRptFinal.wpd).

The NOx criterion for selecting plume in grid treatment within the 4km modeling domain is 2 tons NOx on any day. For the regional emissions grid the NOx criterion is 25 tons per day.

Mobile Sources

The Texas Transportation Institute (TTI) prepared mobile source emissions for all Texas counties under contract to the TCEQ. (See Technical Note "Near Nonattainment Area Support – Rider 13 / 1999 Analysis by Dennis Perkinson, TTI for Mary McGarry-Barber, TCEQ dated 22 May, 2001). Emission factors are from the EPA's MOBILE5ah model. Vehicle miles traveled (VMT) for 2007 are based on transportation models in all NNA counties that have a complete transportation model and were based on a rural HPMS method elsewhere. The NNA counties for which link based transportation model data are used:

East Texas:	Gregg, Smith
Austin:	Hays, Travis, Williamson
San Antonio:	Bexar
Corpus Christi:	Nueces
Victoria:	Victoria

The 2007 TTI data were processed for using the same methods described for 1999, above. This resulted in hourly specific mobile source emissions for all Texas Counties.

County specific VMT data was received via email from Ron Rebouche of the Louisiana Department of Environmental Quality(LDEQ)/Environmental Planning Division for all Parishes in Louisiana. The data included annual average day VMT estimates by roadway class for 1999 and 2007. Data and projections are based on data from the annual U.S. Highway Statistics Reports Section V that is based on the Highway Performance Monitoring System (HPMS). This is combined with emissions factors and vehicle mix data, also received from LDEQ, to calculate county-level mobile emissions estimates for six parishes in the Shreveport area. The annual average day emissions estimates were processed through the EPS2x system to generate episode specific model-ready emissions estimates.

The EPA HDD inventory is the basis for the onroad mobile regional emissions inventory for those counties outside Texas and the six Louisiana parishes within the 4km grid. The data were downloaded from

ftp://ftp.epa.gov/EmisInventory/HDD_Rule/2007ControlCase/Mobile

Regional On-road	m07ms3hc.zip

The 2007 HDD onroad emission inventory is processed to (1) extract the typical peak ozone season day data, (2) reformatted to the EPS2x AMS input file format and (3) processed through EPS2x. A rural and urban spatial distribution is used to spatially allocate the urban and rural onroad sources.

Area and Off-Road Sources

Area and off-road 1999 emissions estimates for the counties within the East Texas NNA were provided by Pollution Solutions. Refer to "Tyler/Longview/Marshall Flexible Attainment Region Emission Inventory Ozone Precursors, VOC, NOx and CO 1999 Emissions" May, 2002 for a detailed description of the inventory development. These data were provided via email by Jerry Demo of Pollution Solutions. The area source data were grown to 2007 estimates with factors by source classification code generated using EGAS 4.0. In addition, control factors were applied by county based on the documented SIP rules in Coulter-Burke, et al., (2002). The 1999 off-road sources were adjusted to 2007 estimates with factors developed by county and source classification code based on the TCEQ 1990-2010 Emission Inventory Trends and Projections**.** The 1999 TCEQ area source data outside the East Texas NNA were grown and controlled similarly to the NNA area sources. Growth factors were generated using EGAS 4.0 and control factors were developed based on the documented SIP rules.

Off-road 2007 data for Texas counties outside the East Texas NNA were taken from the TCEQ 1990-2010 Emission Inventory Trends and Projections. These data were factored to apply controls which were not implemented or on the books when the Trends analysis was completed.

For all remaining areas, EPA's 2007 HDD inventories are the basis for the area and off-road regional emissions inventory. The HDD 2007 area and off-road emission inventories are (1) processed to extract the typical peak ozone season day data, (2) reformatted to the EPS2x AMS input file format and (3) processed through EPS2x.

ftp://ftp.epa.gov/EmisInventory/HDD_Rule/2007BaseCase/Area_Nonroad

Regional Area	ar07ms2h.zip

ftp://ftp.epa.gov/EmisInventory/HDD_Rule/2007ControlCase/Area_Nonroad

Regional Non-road	n7ms1hc.zip

Biogenic Sources

Biogenic emissions were prepared using version 2.2 of the GloBEIS model (Yarwood et al., 1999 a and b). These data were developed for the 1999 base case modeling and are identical for the 2007 modeling inventory.

EMISSIONS SUMMARIES FOR 2007

All emission estimates in the following tables reflect gridded, model ready emissions. This means that for partial counties and/or states at the edge of a modeling domain, only the portion of emissions that is within the modeling domain is reported.

Tables 3-10 to 3-12 are episode day emission summaries by major source type for the NNA counties and two Louisiana parishes.

Table 3-13 indicates episode day NOx emissions for the elevated point sources within the 4km grid which have been selected for plume in grid treatment in CAMx modeling. Table 3-14 summarizes total NOx, elevated and surface, for Texas Eastman. Figure 3-2 displays the average episode day NOx for these sources. Table 3-15 lists new facilities in Northeast Texas; sources not present in the 1999 base year modeling.

Table 3-16 represents total gridded Texas emissions for each episode day.

Tables 3-17 and 3-18 summarize the gridded emissions by major source type for states other than Texas.

Table 3-10. 2007 NOx for East Texas NNA and Shreveport area counties.

2007 NOx tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
Friday, August 13	Area	13.1	8.1	13.1	5.9	8.4	4.0	46.3
	Non-road	4.4	3.0	1.1	6.6	1.9	5.2	12.2
	On-road	8.6	10.9	3.8	15.9	3.0	8.9	16.0
	Points	14.7	36.8	63.1	4.4	5.2	4.4	7.8
	Subtotal	40.8	58.9	81.1	32.8	18.6	22.6	82.3
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.2	2.0
	Total	40.9	59.3	81.6	33.5	19.1	23.8	84.3
Saturday, August 14	Area	11.6	7.7	12.9	4.5	8.3	3.7	42.5
	Non-road	3.8	3.0	1.0	5.8	1.9	4.9	11.5
	On-road	7.1	8.8	3.1	13.1	2.5	6.7	12.0
	Points	14.4	36.8	63.1	3.9	5.2	4.4	7.6
	Subtotal	36.8	56.3	80.0	27.4	17.8	19.8	73.6
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.3	2.1
	Total	37.0	56.8	80.5	28.0	18.3	21.0	75.7
Sunday, August 15	Area	10.0	7.2	12.6	3.2	8.1	3.6	40.7
	Non-road	3.1	2.9	0.8	4.8	1.8	4.9	11.5
	On-road	5.2	6.6	2.1	9.5	1.9	6.7	12.0
	Points	14.4	36.8	63.1	3.9	5.2	4.4	7.5
	Subtotal	32.7	53.5	78.5	21.4	17.0	19.6	71.6
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.2	1.9
	Total	32.9	53.9	79.0	22.1	17.5	20.8	73.6
Monday, August 16	Area	13.1	8.1	13.1	5.9	8.4	4.0	46.3
	Non-road	4.4	3.0	1.1	6.6	1.9	5.2	12.2
	On-road	7.8	9.3	3.1	14.5	2.6	8.9	16.0
	Points	14.7	36.8	63.1	4.4	5.2	4.4	7.8
	Subtotal	40.0	57.2	80.5	31.4	18.2	22.6	82.3
	Biogenics	0.2	0.5	0.4	0.6	0.4	1.2	1.9
	Total	40.1	57.6	80.9	32.0	18.7	23.8	84.2
Tuesday, August 17	Area	13.1	8.1	13.1	5.9	8.4	4.0	46.3
	Non-road	4.4	3.0	1.1	6.6	1.9	5.2	12.2
	On-road	8.2	10.0	3.5	15.1	2.8	8.9	16.0
	Points	14.7	36.8	63.1	4.4	5.2	4.4	7.8
	Subtotal	40.3	57.9	80.8	32.0	18.4	22.6	82.3
	Biogenics	0.2	0.5	0.4	0.6	0.4	1.2	1.9
	Total	40.5	58.4	81.2	32.6	18.8	23.8	84.2
Wednesday, August 18	Area	13.1	8.1	13.1	5.9	8.4	4.0	46.3
	Non-road	4.4	3.0	1.1	6.6	1.9	5.2	12.2
	On-road	8.4	10.4	3.6	15.5	2.9	8.9	16.0
	Points	14.7	36.8	63.1	4.4	5.2	4.4	7.8
	Subtotal	40.6	58.3	80.9	32.4	18.5	22.6	82.3
	Biogenics	0.2	0.5	0.4	0.6	0.5	1.2	2.0
	Total	40.7	58.8	81.4	33.0	19.0	23.8	84.3
Thursday, August 19	Area	13.1	8.1	13.1	5.9	8.4	4.0	46.3
	Non-road	4.4	3.0	1.1	6.6	1.9	5.2	12.2
	On-road	8.7	10.9	3.8	16.1	3.1	8.9	16.0
	Points	14.7	36.8	63.1	4.4	5.2	4.4	7.8
	Subtotal	40.8	58.8	81.1	33.0	18.6	22.6	82.3
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.2	2.0
	Total	41.0	59.3	81.6	33.7	19.1	23.8	84.3
Friday, August 20	Area	13.1	8.1	13.1	5.9	8.4	4.0	46.3
	Non-road	4.4	3.0	1.1	6.6	1.9	5.2	12.2

2007 NOx tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
	On-road	12.1	14.1	5.3	19.6	4.0	8.9	16.0
	Points	14.7	36.8	63.1	4.4	5.2	4.4	7.8
	Subtotal	44.3	62.0	82.6	36.5	19.6	22.6	82.3
	Biogenics	0.2	0.5	0.5	0.7	0.5	1.3	2.1
	Total	44.5	62.5	83.1	37.2	20.1	23.9	84.4
Saturday, August 21	Area	11.6	7.7	12.9	4.5	8.3	3.7	42.5
	Non-road	3.8	3.0	1.0	5.8	1.9	4.9	11.5
	On-road	6.9	8.4	3.0	12.8	2.3	6.7	12.0
	Points	14.4	36.8	63.1	3.9	5.2	4.4	7.6
	Subtotal	36.7	55.8	79.9	27.0	17.7	19.8	73.6
	Biogenics	0.2	0.5	0.4	0.6	0.5	1.2	1.9
	Total	36.9	56.3	80.3	27.7	18.2	21.0	75.5
Sunday, August 22	Area	10.0	7.2	12.6	3.2	8.1	3.6	40.7
	Non-road	3.1	2.9	0.8	4.8	1.8	4.9	11.5
	On-road	5.3	7.0	2.2	9.7	2.0	6.7	12.0
	Points	14.4	36.8	63.1	3.9	5.2	4.4	7.5
	Subtotal	32.8	53.9	78.7	21.6	17.1	19.6	71.6
	Biogenics	0.2	0.5	0.4	0.6	0.5	1.2	1.9
	Total	33.0	54.4	79.1	22.2	17.5	20.8	73.6
Average Episode Day	Area	12.2	7.8	13.0	5.1	8.3	3.9	44.4
	Non-road	4.0	3.0	1.0	6.1	1.9	5.1	11.9
	On-road	7.8	9.6	3.4	14.2	2.7	8.0	14.4
	Points	14.6	36.8	63.1	4.2	5.2	4.4	7.7
	Subtotal	38.6	57.3	80.4	29.6	18.2	21.4	78.4
	Biogenics	0.2	0.5	0.5	0.6	0.5	1.2	2.0
	Total	38.8	57.7	80.9	30.2	18.6	22.7	80.4

Table 3-11. 2007 VOC for East Texas NNA and Shreveport area counties.

2007 VOC tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
Friday, August 13	Area	15.6	14.2	12.7	15.8	13.9	5.3	22.5
	Non-road	1.9	4.2	2.7	7.2	2.5	2.0	4.8
	On-road	6.2	6.2	2.9	11.7	2.0	4.2	7.8
	Points	7.3	18.1	2.4	11.1	1.3	1.2	3.9
	Subtotal	31.0	42.7	20.7	45.8	19.7	12.7	39.0
	Biogenics	62.9	312.7	274.9	265.7	172.5	247.4	242.0
	Total	93.9	355.4	295.6	311.5	192.2	260.1	281.0
Saturday, August 14	Area	12.1	11.7	10.4	11.0	12.8	5.3	22.5
	Non-road	2.9	19.4	9.2	27.4	11.4	1.7	4.0
	On-road	5.3	5.4	2.5	9.9	1.7	3.2	5.8
	Points	6.1	17.5	2.4	8.5	1.3	1.2	3.9
	Subtotal	26.4	54.0	24.6	56.9	27.3	11.4	36.2
	Biogenics	67.0	339.1	294.1	280.1	183.1	273.0	266.4
	Total	93.4	393.1	318.8	337.0	210.4	284.4	302.6
Sunday, August 15	Area	10.1	10.5	9.4	7.9	12.0	5.3	22.5
	Non-road	2.8	19.4	9.2	27.3	11.4	1.7	4.0
	On-road	3.9	4.2	1.7	7.3	1.4	3.2	5.8
	Points	6.1	17.5	2.4	8.5	1.3	1.2	2.8
	Subtotal	22.9	51.5	22.8	51.0	26.1	11.4	35.1
	Biogenics	62.3	308.6	276.9	266.9	169.2	232.1	234.9
	Total	85.2	360.2	299.7	317.9	195.3	243.5	270.0
Monday, August 16	Area	15.6	14.2	12.7	15.8	13.9	5.3	22.5
	Non-road	1.9	4.2	2.7	7.2	2.5	2.0	4.8
	On-road	5.1	4.5	2.2	9.6	1.5	4.2	7.8
	Points	7.3	18.1	2.4	11.1	1.3	1.2	3.9
	Subtotal	29.9	41.0	20.0	43.7	19.3	12.7	39.0
	Biogenics	56.7	290.0	253.3	238.7	153.6	235.3	230.8
	Total	86.6	331.1	273.3	282.4	172.9	248.0	269.8
Tuesday, August 17	Area	15.6	14.2	12.7	15.8	13.9	5.3	22.5
	Non-road	1.9	4.2	2.7	7.2	2.5	2.0	4.8
	On-road	5.4	5.1	2.5	10.0	1.7	4.2	7.8
	Points	7.3	18.1	2.4	11.1	1.3	1.2	3.9
	Subtotal	30.2	41.6	20.3	44.1	19.4	12.7	39.0
	Biogenics	56.9	290.5	244.7	235.0	158.4	233.1	229.0
	Total	87.1	332.1	265.0	279.1	177.8	245.8	267.9
Wednesday, August 18	Area	15.6	14.2	12.7	15.8	13.9	5.3	22.5
	Non-road	1.9	4.2	2.7	7.2	2.5	2.0	4.8
	On-road	5.5	5.4	2.6	10.3	1.7	4.2	7.8
	Points	7.3	18.1	2.4	11.1	1.3	1.2	3.9
	Subtotal	30.4	41.9	20.4	44.4	19.5	12.7	39.0
	Biogenics	59.3	306.9	259.2	243.2	163.2	255.9	245.3
	Total	89.6	348.8	279.6	287.6	182.7	268.6	284.2
Thursday, August 19	Area	15.6	14.2	12.7	15.8	13.9	5.3	22.5
	Non-road	1.9	4.2	2.7	7.2	2.5	2.0	4.8
	On-road	5.7	5.7	2.8	10.8	1.9	4.2	7.8
	Points	7.3	18.1	2.4	11.1	1.3	1.2	3.9
	Subtotal	30.6	42.2	20.6	44.9	19.6	12.7	39.0
	Biogenics	65.6	325.3	277.3	275.0	183.5	268.4	255.1
	Total	96.2	367.5	298.0	319.9	203.1	281.1	294.1
Friday, August 20	Area	15.6	14.2	12.7	15.8	13.9	5.3	22.5
	Non-road	1.9	4.2	2.7	7.2	2.5	2.0	4.8

2007 VOC tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
	On-road	6.2	6.2	3.0	11.9	2.0	4.2	7.8
	Points	7.3	18.1	2.4	11.1	1.3	1.2	3.9
	Subtotal	31.1	42.7	20.8	46.0	19.7	12.7	39.0
	Biogenics	68.6	350.8	301.9	286.9	187.9	282.7	277.2
	Total	99.7	393.5	322.7	332.8	207.7	295.4	316.1
Saturday, August 21	Area	12.1	11.7	10.4	11.0	12.8	5.3	22.5
	Non-road	2.9	19.4	9.2	27.4	11.4	1.7	4.0
	On-road	5.2	5.1	2.4	9.7	1.6	3.2	5.8
	Points	6.1	17.5	2.4	8.5	1.3	1.2	3.9
	Subtotal	26.3	53.7	24.5	56.6	27.2	11.4	36.2
	Biogenics	60.0	301.5	258.7	254.0	166.3	232.2	232.9
	Total	86.3	355.2	283.2	310.7	193.5	243.6	269.1
Sunday, August 22	Area	10.1	10.5	9.4	7.9	12.0	5.3	22.5
	Non-road	2.8	19.4	9.2	27.3	11.4	1.7	4.0
	On-road	4.0	4.5	1.8	7.4	1.5	3.2	5.8
	Points	6.1	17.5	2.4	8.5	1.3	1.2	2.8
	Subtotal	23.0	51.9	22.9	51.1	26.2	11.4	35.1
	Biogenics	55.6	291.7	232.6	221.2	156.6	241.8	233.7
	Total	78.6	343.6	255.6	272.3	182.8	253.1	268.8
Average Episode Day	Area	13.8	13.0	11.6	13.3	13.3	5.3	22.5
	Non-road	2.3	10.3	5.3	15.2	6.1	1.9	4.5
	On-road	5.3	5.2	2.5	9.9	1.7	3.8	7.0
	Points	6.8	17.9	2.4	10.0	1.3	1.2	3.6
	Subtotal	28.2	46.3	21.8	48.4	22.4	12.1	37.6
	Biogenics	61.5	311.7	267.4	256.7	169.4	250.2	244.7
	Total	89.6	358.0	289.1	305.1	191.8	262.3	282.4

Table 3-12. 2007 CO for East Texas NNA and Shreveport area counties.

2007 CO tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
Friday, August 13	Area	3.8	7.3	8.5	9.0	5.8	4.3	12.0
	Non-road	46.2	10.0	11.6	52.1	5.8	27.6	85.9
	On-road	55.6	59.1	23.5	105.8	15.1	30.4	56.3
	Points	5.4	12.3	5.1	5.3	3.8	1.7	1.6
	Subtotal	111.1	88.7	48.8	172.2	30.4	64.0	155.8
	Biogenics	6.1	32.0	29.9	26.9	18.6	24.7	23.1
	Total	117.2	120.7	78.7	199.1	49.0	88.8	178.9
Saturday, August 14	Area	3.3	6.7	7.9	7.2	5.2	4.2	11.5
	Non-road	69.4	20.0	17.0	80.0	10.3	21.0	62.2
	On-road	48.0	52.1	20.4	89.8	13.4	22.8	42.2
	Points	5.0	12.2	5.1	1.4	3.8	1.7	1.6
	Subtotal	125.7	91.0	50.4	178.4	32.6	49.8	117.5
	Biogenics	6.3	33.9	32.1	27.7	18.5	26.4	24.9
	Total	132.0	124.9	82.5	206.1	51.2	76.2	142.4
Sunday, August 15	Area	2.8	6.0	7.3	5.4	4.6	4.2	11.2
	Non-road	68.0	19.7	16.7	78.2	10.1	21.0	62.2
	On-road	35.6	40.3	13.9	65.3	10.5	22.8	42.2
	Points	5.0	12.2	5.1	1.4	3.8	1.7	1.6
	Subtotal	111.3	78.2	43.0	150.3	29.0	49.8	117.2
	Biogenics	6.0	31.6	30.3	26.4	17.5	23.4	22.8
	Total	117.2	109.8	73.3	176.7	46.5	73.2	140.0
Monday, August 16	Area	3.8	7.3	8.5	9.0	5.8	4.3	12.0
	Non-road	46.2	10.0	11.6	52.1	5.8	27.6	85.9
	On-road	45.3	42.8	17.6	85.5	11.4	30.4	56.3
	Points	5.4	12.3	5.1	5.3	3.8	1.7	1.6
	Subtotal	100.7	72.3	42.8	151.9	26.7	64.0	155.8
	Biogenics	5.3	28.8	27.4	23.2	15.4	22.8	21.5
	Total	106.0	101.1	70.2	175.1	42.1	86.8	177.4
Tuesday, August 17	Area	3.8	7.3	8.5	9.0	5.8	4.3	12.0
	Non-road	46.2	10.0	11.6	52.1	5.8	27.6	85.9
	On-road	48.0	48.2	19.9	89.6	12.6	30.4	56.3
	Points	5.4	12.3	5.1	5.3	3.8	1.7	1.6
	Subtotal	103.4	77.7	45.1	156.0	27.9	64.0	155.8
	Biogenics	5.4	29.5	27.3	23.1	15.9	23.2	22.0
	Total	108.8	107.3	72.4	179.1	43.8	87.3	177.8
Wednesday, August 18	Area	3.8	7.3	8.5	9.0	5.8	4.3	12.0
	Non-road	46.2	10.0	11.6	52.1	5.8	27.6	85.9
	On-road	49.5	51.0	20.9	92.3	13.3	30.4	56.3
	Points	5.4	12.3	5.1	5.3	3.8	1.7	1.6
	Subtotal	105.0	80.6	46.1	158.7	28.6	64.0	155.8
	Biogenics	5.7	31.3	28.6	24.6	17.2	25.0	23.3
	Total	110.7	111.9	74.8	183.3	45.8	89.1	179.1
Thursday, August 19	Area	3.8	7.3	8.5	9.0	5.8	4.3	12.0
	Non-road	46.2	10.0	11.6	52.1	5.8	27.6	85.9
	On-road	51.5	54.7	22.5	96.7	14.2	30.4	56.3
	Points	5.4	12.3	5.1	5.3	3.8	1.7	1.6
	Subtotal	106.9	84.3	47.7	163.0	29.5	64.0	155.8
	Biogenics	6.2	32.5	29.7	27.2	19.1	25.9	23.8
	Total	113.1	116.8	77.5	190.2	48.6	90.0	179.6
Friday, August 20	Area	3.8	7.3	8.5	9.0	5.8	4.3	12.0
	Non-road	46.2	10.0	11.6	52.1	5.8	27.6	85.9

2007 CO tons Episode Day	Source	Gregg 48183	Harrison 48203	Rusk 48401	Smith 48423	Upshur 48459	Bossier 22015	Caddo 22017
	On-road	56.1	59.1	24.3	107.5	15.3	30.4	56.3
	Points	5.4	12.3	5.1	5.3	3.8	1.7	1.6
	Subtotal	111.6	88.7	49.6	173.9	30.7	64.0	155.8
	Biogenics	6.3	34.6	32.2	27.8	19.0	27.3	25.7
	Total	117.9	123.3	81.8	201.7	49.6	91.3	181.5
Saturday, August 21	Area	3.3	6.7	7.9	7.2	5.2	4.2	11.5
	Non-road	69.4	20.0	17.0	80.0	10.3	21.0	62.2
	On-road	46.9	49.0	19.1	87.3	12.5	22.8	42.2
	Points	5.0	12.2	5.1	1.4	3.8	1.7	1.6
	Subtotal	124.5	87.9	49.1	175.9	31.8	49.8	117.5
	Biogenics	5.6	30.3	28.0	24.6	16.8	23.3	22.2
	Total	130.2	118.2	77.1	200.5	48.5	73.1	139.7
Sunday, August 22	Area	2.8	6.0	7.3	5.4	4.6	4.2	11.2
	Non-road	68.0	19.7	16.7	78.2	10.1	21.0	62.2
	On-road	36.4	43.7	14.8	66.7	11.3	22.8	42.2
	Points	5.0	12.2	5.1	1.4	3.8	1.7	1.6
	Subtotal	112.1	81.7	44.0	151.7	29.8	49.8	117.2
	Biogenics	5.4	29.9	26.7	22.9	16.2	23.7	22.3
	Total	117.5	111.5	70.6	174.6	46.0	73.5	139.5
Average Episode Day	Area	3.5	6.9	8.2	7.9	5.4	4.3	11.8
	Non-road	55.2	13.9	13.7	62.9	7.5	25.0	76.4
	On-road	47.3	50.0	19.7	88.7	13.0	27.3	50.7
	Points	5.2	12.3	5.1	3.8	3.8	1.7	1.6
	Subtotal	111.2	83.1	46.7	163.2	29.7	58.3	140.4
	Biogenics	5.8	31.5	29.2	25.4	17.4	24.6	23.2
	Total	117.1	114.6	75.9	188.6	47.1	82.9	163.6

Table 3-13. Tons/day NOx for facilities treated with plume in grid within the 4km domain for 2007 August episode. These represent only the elevated point emissions at each facility.

Facility Name	Data Source	Stack	Weekday	Saturday	Sunday	Episode Average
Dolet_Hills_Power		1	32.5	29.9	28.5	30.3
Dolet_Hills_Power Total	EPA HDD Rulemaking		32.5	29.9	28.5	30.3
Gateway_Pwr		1000	1.4	1.4	1.4	1.4
		2000	1.4	1.4	1.4	1.4
		3000	1.4	1.4	1.4	1.4
Gateway_Pwr	TCEQ		4.2	4.2	4.2	4.2
Knox_Lee		2	0.3	0.3	0.3	0.3
		3	0.3	0.3	0.3	0.3
		4	2.1	2.1	2.1	2.1
		5	3.2	3.2	3.2	3.2
Knox_Lee Total	NETx SIP		5.9	5.9	5.9	5.9
LG&E		100	0.9	0.9	0.9	0.9
		200	0.9	0.9	0.9	0.9
		300	0.9	0.9	0.9	0.9
		400	0.9	0.9	0.9	0.9
		500	0.9	0.9	0.9	0.9
		600	0.9	0.9	0.9	0.9
LG&E	TCEQ		5.1	5.1	5.1	5.1
Libbey_Glass		0	2.5	2.5	2.5	2.5
Libbey_Glass Total	EPA HDD Rulemaking		2.5	2.5	2.5	2.5
Logansport		0	2.6	2.6	2.6	2.6
Logansport Total	EPA HDD Rulemaking		2.6	2.6	2.6	2.6
Martin_Lake		1	18.5	18.5	18.5	18.5
		2	19.8	19.8	19.8	19.8
		3	19.2	19.2	19.2	19.2
Martin_Lake Total	NETx SIP		57.5	57.5	57.5	57.5
Monticello		1	15	15	15	15
		2	14.7	14.7	14.7	14.7
		3	18.7	18.7	18.7	18.7
Monticello Total	NETx SIP		48.4	48.4	48.4	48.4
Pirkey		1	18	18	18	18
Pirkey Total	NETx SIP		18	18	18	18
Stryker_Creek		1	9.4	9.4	9.4	9.4
		2	4.7	4.7	4.7	4.7
Stryker_Creek Total	NETx SIP		14.1	14.1	14.1	14.1
Tenaska		1	1.3	1.3	1.3	1.3
		2	1.3	1.3	1.3	1.3
		3	1.3	1.3	1.3	1.3
Tenaska	TCEQ		3.9	3.9	3.9	3.9
Welsh		11	10.1	10.1	10.1	10.1
		12	9.7	9.7	9.7	9.7
		13	9.4	9.4	9.4	9.4
Welsh Total	TCEQ		29.2	29.2	29.2	29.2
Wilkes		1	1.5	1.5	1.5	1.5
		2	2.9	2.9	2.9	2.9
		3	2.6	2.6	2.6	2.6
Wilkes Total	NETx SIP		7	7	7	7

Note: Plume in grid was selected for sources with NOx > 2 tons/day on any episode day Aug 13-22.

Table 3-14. Texas Eastman total elevated and surface NOx tpd for average August 2007 episode day. The 'other' represents over a hundred individual stacks.

	Cogen Unit Stack 1	Cogen Unit Stack 2	Other Elevated	Other Surface	Total
NOx	1.05	1.05	7.2	1.2	10.5
VOC	0.0	0.0	0.8	9.5	10.3

Note: The cogen unit emissions are not actually Texas Eastman emissions, but are included in this table because Texas Eastman agreed to offset the cogen emissions as part of their overall NOx reduction commitment.

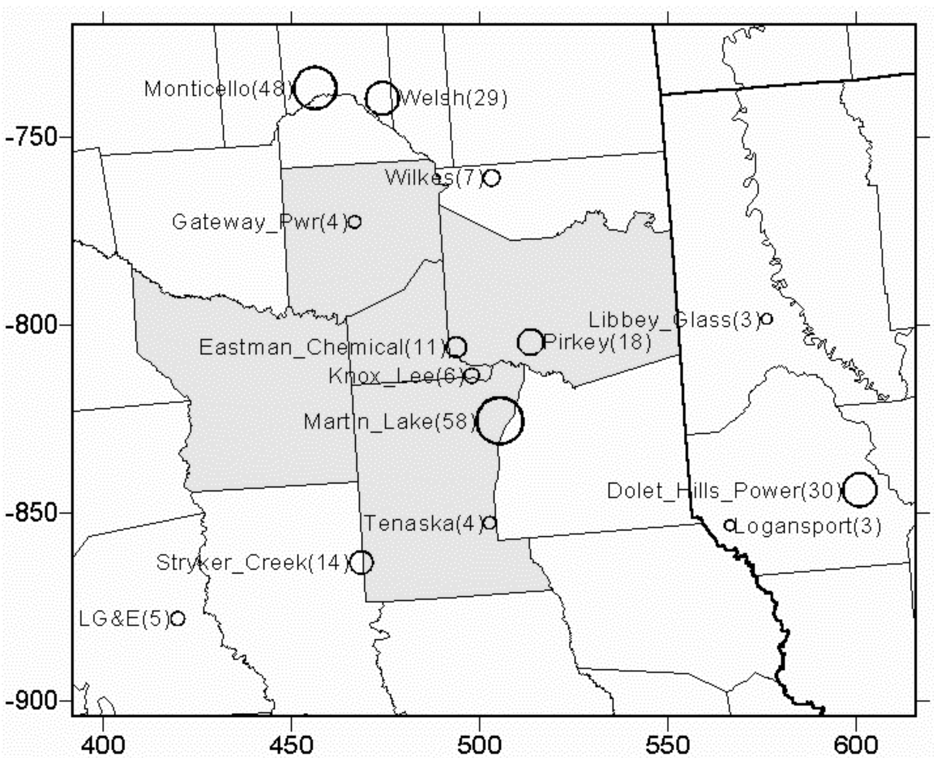


Figure 3-2. 2007 average episode day NOx for the facilities in Table 3-13. These represent elevated sources for all facilities with the exception of Texas Eastman Chemical Co. which represents the total NOx from Table 3-14.

Table 3-15. 'New' point sources in Northeast Texas. Sources in the 2007 modeling which were not present in the 1999 base year modeling.

Facility Name	County	NOx
Entergy Power Ventures	Harrison	0.9
Gateway Power Project	Upshur	4.1
LG&E Power	Anderson	5.1
Tenaska Gateway	Rusk	3.8

Table 3-16. Texas gridded 2007 episode day emissions by major source type.

Episode day	Area	Non-road	On-road	EGUs	Other Points	Off shore	Shipping	Total Anthropogenic	Biogenic	Total
Tons NOx										
Friday, August 13	640	759	1004	752	1316	549	42	5063	1150	6213
Saturday, August 14	622	802	780	752	1309	549	42	4857	1137	5994
Sunday, August 15	604	748	612	752	1309	549	42	4616	1161	5778
Monday, August 16	640	759	977	752	1316	549	42	5036	1148	6184
Tuesday, August 17	640	759	966	752	1316	549	42	5025	1083	6108
Wednesday, August 18	640	759	985	752	1316	549	42	5044	1098	6142
Thursday, August 19	640	759	1027	752	1316	549	42	5085	1132	6218
Friday, August 20	640	759	1015	752	1316	549	42	5074	1122	6197
Saturday, August 21	622	802	737	752	1309	549	42	4814	1100	5914
Sunday, August 22	604	748	567	752	1309	549	42	4571	1053	5624
Tons VOC										
Friday, August 13	1878	479	613	23	674	189	1	3859	22157	26017
Saturday, August 14	1466	1313	500	23	640	189	1	4135	22265	26401
Sunday, August 15	1235	1303	403	23	640	189	1	3797	20962	24759
Monday, August 16	1878	479	521	23	674	189	1	3767	20416	24184
Tuesday, August 17	1878	479	511	23	674	189	1	3758	20157	23915
Wednesday, August 18	1878	479	524	23	674	189	1	3771	21452	25223
Thursday, August 19	1878	479	554	23	674	189	1	3800	23320	27120
Friday, August 20	1878	479	620	23	674	189	1	3867	22379	26246
Saturday, August 21	1466	1313	468	23	640	189	1	4104	20641	24745
Sunday, August 22	1235	1303	369	23	640	189	1	3764	18867	22630
Tons CO										
Friday, August 13	992	6417	5106	211	1074	126	6	13932	2610	16541
Saturday, August 14	846	8259	4216	211	1060	126	6	14723	2560	17283
Sunday, August 15	704	8004	3439	211	1060	126	6	13550	2456	16006
Monday, August 16	992	6417	4293	211	1074	126	6	13118	2333	15451
Tuesday, August 17	992	6417	4214	211	1074	126	6	13040	2269	15308
Wednesday, August 18	992	6417	4326	211	1074	126	6	13151	2428	15579
Thursday, August 19	992	6417	4581	211	1074	126	6	13406	2642	16048
Friday, August 20	992	6417	5171	211	1074	126	6	13996	2571	16567
Saturday, August 21	846	8259	3951	211	1060	126	6	14459	2376	16835
Sunday, August 22	704	8004	3150	211	1060	126	6	13261	2246	15507

Table 3-17. Summary of August 2007 gridded emissions by major source type for states other than Texas.

	Area			On-road			Points			Anthropogenic		
State	Wkday	Sat	Sun	Wkday	Sat	Sun	Wkday	Sat	Sun	Total Weekday	Total Sat	Total Sun
NOx												
Alabama	439	406	400	371	305	270	457	437	426	1266	1148	1097
Arkansas	369	316	312	218	181	164	237	223	216	825	721	692
Florida	78	74	74	95	78	68	128	122	119	302	275	262
Georgia	377	353	352	472	385	333	255	240	233	1104	978	917
Illinois	258	200	200	145	121	111	274	263	257	678	584	567
Indiana	199	172	171	165	137	124	260	242	232	624	551	527
Kansas	675	562	552	192	158	141	553	527	514	1420	1247	1207
Kentucky	571	522	512	307	254	227	357	335	315	1235	1111	1054
Louisiana	1035	981	967	302	249	222	1007	988	979	2344	2218	2168
Mississippi	381	341	335	232	193	176	429	412	403	1042	946	913
Missouri	417	342	341	384	315	277	240	226	218	1041	883	836
Nebraska	73	51	51	19	16	15	45	43	41	137	110	108
North Carolina	7	6	6	11	9	9	7	7	7	25	23	23
Ohio	95	85	84	102	83	72	188	175	169	384	343	324
Oklahoma	331	277	273	287	236	208	647	619	605	1265	1132	1085
South Carolina	1	1	1	3	2	2	0	0	0	4	3	3
Tennessee	608	575	573	410	337	296	320	307	299	1338	1219	1168
Virginia	4	3	3	10	8	8	0	0	0	14	12	11
West Virginia	44	43	43	13	11	10	52	48	47	109	103	100
Grand Total	5962	5313	5250	3739	3080	2732	5457	5214	5080	15158	13606	13062
VOC												
Alabama	548	520	520	245	200	172	167	167	165	960	886	856
Arkansas	460	443	443	127	105	93	35	35	29	623	583	565
Florida	191	186	186	63	51	43	13	13	12	267	250	242
Georgia	640	614	614	227	184	157	78	78	73	945	877	845
Illinois	225	215	215	65	54	48	117	117	112	407	386	376
Indiana	280	271	271	89	74	65	39	39	36	409	383	372
Kansas	437	419	419	123	100	87	40	40	39	600	560	545
Kentucky	465	447	447	160	131	115	180	180	164	806	759	727
Louisiana	507	492	492	186	152	132	232	232	231	925	876	855
Mississippi	480	462	462	141	117	103	151	151	148	773	730	714
Missouri	537	510	510	183	149	129	158	157	140	877	816	779
Nebraska	53	51	51	9	7	7	3	3	3	65	61	61
North Carolina	22	21	21	5	4	4	3	3	3	29	28	28
Ohio	165	155	155	47	38	32	29	29	28	241	222	215
Oklahoma	365	352	352	194	158	135	97	96	96	656	606	582
South Carolina	3	2	2	1	1	1	0	0	0	4	4	3
Tennessee	796	771	771	238	193	166	193	193	174	1227	1157	1110
Virginia	9	9	9	4	4	3	1	1	1	14	13	13
West Virginia	19	19	19	8	6	5	7	7	7	34	32	31
Grand Total	6201	5959	5958	2116	1727	1498	1543	1540	1461	9860	9227	8918
CO												
Alabama	2495	2050	2049	2865	2322	1976	613	611	610	5973	4983	4635
Arkansas	1959	1715	1714	1354	1111	976	330	329	328	3643	3155	3019
Florida	567	458	458	805	648	540	40	40	39	1412	1145	1037
Georgia	3125	2443	2442	2707	2188	1848	230	228	227	6061	4858	4518
Illinois	652	480	480	772	637	568	62	61	60	1486	1179	1109

	Area			On-road			Points			Anthropogenic		
State	Wkday	Sat	Sun	Wkday	Sat	Sun	Wkday	Sat	Sun	Total Weekday	Total Sat	Total Sun
Indiana	753	569	568	1076	882	771	265	263	262	2094	1713	1601
Kansas	1234	929	928	1331	1081	925	241	238	236	2806	2248	2089
Kentucky	1444	1127	1125	1915	1565	1359	235	232	231	3594	2924	2716
Louisiana	1855	1535	1533	2143	1745	1502	2418	2414	2411	6416	5693	5445
Mississippi	1599	1371	1370	1542	1265	1110	363	360	359	3504	2996	2839
Missouri	2143	1575	1574	2128	1729	1482	317	315	314	4587	3619	3370
Nebraska	113	85	85	89	75	70	7	7	7	210	167	162
North Carolina	70	57	57	50	43	40	10	10	10	131	110	107
Ohio	811	577	577	521	422	358	100	99	98	1433	1098	1033
Oklahoma	1255	962	961	2163	1749	1482	679	674	672	4096	3386	3116
South Carolina	12	10	10	14	12	11	0	0	0	26	22	21
Tennessee	2264	1777	1776	2944	2380	2014	299	298	297	5507	4455	4087
Virginia	20	16	16	46	39	36	0	0	0	66	55	52
West Virginia	58	46	46	94	76	65	13	13	12	165	135	123
Grand Total	22429	17781	17770	24559	19967	17136	6222	6191	6173	53210	43938	41079

Table 3-18. Gridded biogenic emissions for states other than Texas.

	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
NOx										
Alabama	85	74	65	74	79	82	80	73	69	73
Arkansas	137	101	95	110	125	133	134	106	104	115
Florida	11	10	9	10	10	10	10	10	10	10
Georgia	52	54	47	51	54	56	54	46	47	48
Illinois	336	275	279	344	378	330	311	292	295	329
Indiana	161	115	123	142	163	146	140	126	131	142
Kansas	433	477	641	713	671	581	494	468	549	548
Kentucky	173	111	115	139	164	155	151	122	124	133
Louisiana	118	110	91	98	106	115	121	110	103	105
Mississippi	141	111	98	111	124	128	137	119	112	119
Missouri	242	216	240	294	290	282	245	232	246	263
Nebraska	146	171	229	232	214	191	167	173	195	189
North Carolina	2	2	2	2	2	2	2	1	1	1
Ohio	25	17	18	21	26	22	19	18	19	20
Oklahoma	197	190	230	246	238	229	204	187	208	237
South Carolina	0	0	0	0	0	0	0	0	0	0
Tennessee	135	89	88	107	120	123	122	93	95	102
Virginia	1	1	0	1	1	1	1	0	0	0
West Virginia	0	0	0	0	1	0	0	0	0	0
Total	2396	2124	2373	2693	2767	2585	2392	2178	2308	2435
VOC										
Alabama	15629	12994	9764	12476	14017	14973	14720	12458	10971	11808
Arkansas	12062	8025	7596	9437	11983	12996	12615	8389	8181	10093
Florida	2685	2332	1958	2286	2523	2267	2327	2116	2232	2227
Georgia	6775	7393	5654	6513	7363	8137	7583	5301	5280	5530
Illinois	1551	931	1101	1715	1933	1201	1167	1146	1290	1578
Indiana	1499	548	857	1190	1573	1120	933	819	980	1143
Kansas	814	979	1687	2103	1886	1650	1143	944	1326	1088
Kentucky	5696	1729	2672	4286	5791	4751	4081	2324	3214	3686
Louisiana	9805	9146	6853	7888	8938	9978	10747	8994	8080	8639
Mississippi	14659	11134	8864	11526	13261	13903	14794	12234	11243	12388
Missouri	6962	5435	6819	10159	10468	9264	7077	6149	7273	8395
Nebraska	124	200	339	353	298	241	192	199	255	190
North Carolina	806	774	576	732	881	921	809	519	504	544
Ohio	640	167	329	531	793	526	334	318	412	452
Oklahoma	6990	5479	6171	6457	7271	7616	6820	5198	5184	6564
South Carolina	142	157	106	131	152	169	154	93	92	101
Tennessee	9104	4025	4682	7004	8586	8444	8236	4275	5189	6099
Virginia	180	108	87	157	192	164	152	82	91	106
West Virginia	155	52	80	144	211	149	118	67	102	109
Total	96278	71608	66196	85087	98120	98470	94004	71626	71898	80740
CO										
Alabama	1593	1342	1044	1270	1427	1520	1498	1319	1165	1268
Arkansas	1238	861	774	904	1125	1250	1255	885	843	990
Florida	372	340	290	335	355	332	327	310	316	323
Georgia	705	731	594	674	743	811	768	569	555	592
Illinois	167	112	115	160	186	157	142	125	127	152
Indiana	176	98	114	145	182	151	138	116	126	144
Kansas	132	145	228	287	260	226	163	147	187	184
Kentucky	652	327	358	499	647	558	498	361	392	431

	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
Louisiana	1153	1063	801	882	1009	1139	1249	1057	954	990
Mississippi	1474	1139	916	1098	1272	1338	1438	1247	1137	1203
Missouri	602	487	550	755	800	781	602	532	582	659
Nebraska	21	26	41	44	39	32	26	27	33	30
North Carolina	74	68	58	69	78	79	76	53	50	53
Ohio	92	50	57	73	105	77	61	57	61	65
Oklahoma	658	529	585	606	650	685	609	486	518	650
South Carolina	14	15	12	14	15	16	16	10	10	11
Tennessee	881	491	492	663	783	785	780	517	517	572
Virginia	20	14	12	17	20	18	17	12	12	13
West Virginia	18	11	12	17	23	18	14	12	13	13
Total	10041	7848	7050	8511	9718	9973	9679	7843	7598	8342

TEXAS EASTMAN VOC SPECIATION PROFILES

VOC profiles were developed for Texas Eastman based on detailed emissions data reported to TCEQ for 1999. The Texas Eastman speciated VOC data were extracted from version 12b of the TCEQ point source data base. These data were used to develop 200 point specific speciation profiles. Over 94% of the total Texas Eastman VOCs were speciated according to the reported VOC components. The remaining 6% could not be speciated with the PSDB data because the reported data contained insufficient detail, and so these emissions were speciated using default TCEQ/EPA profiles. Table 3-18 summarizes the tons/day of each VOC component used in the point specific profiles while the corresponding TCEQ identifying FIN and EPN codes are presented in Table 3-19.

Table 3-19. Texas Eastman 1999 VOC emissions (tons/day) by compound for sources with point specific profiles.

VOC Name	Emissions
ethylene	4.53904
propene	0.99026
propane	0.55630
ethyl alcohol	0.41464
ethyl acetate	0.39446
isobutylacetate	0.26186
methylchloride	0.21202
ethane	0.20591
isobutyraldehyde	0.18119
methane	0.15586
ethyl ether	0.15553
n-butyl alcohol	0.12768
formaldehyde	0.12652
n-propyl alcohol	0.09366
mineral spirits	0.09229
butyraldehyde	0.09201
benzene	0.08691
toluene	0.07996
ethers-unspec	0.07981
isobutyl alcohol	0.06949
2-ethylhexanol	0.06916
ethylene glycol	0.06869
n-butane	0.06631
acetaldehyde	0.06524
propionaldehyde	0.06416
maleic anhydride	0.05537
esters,unspec	0.04365
aromatics-unspec	0.04029
chloroform	0.03731
hexane	0.03717
isopropyl alcohol	0.03398
alcohols,unspec	0.03308
acetone	0.03293
glycols-unspec	0.03249
ethyl chloride	0.02958
isomers of pentane	0.02860
1,3-butadiene	0.02800
styrene	0.02767
aniline	0.02737
methyl alcohol	0.02567
ethylbenzene	0.02502
isomers of xylene	0.02385
1-hexene	0.02003
aldehydes-unspec	0.01821
acetic acid	0.01688
isobutylisobutyrate	0.01475
ethylhexaldehyde	0.01381
isomers of butene	0.01085
cyclohexane	0.01058

VOC Name	Emissions
glycol ether	0.00944
propionic acid	0.00933
butene	0.00900
acetylene	0.00883
olefins-unspec	0.00797
isobutane	0.00744
heptane	0.00678
methylacrylate	0.00672
acrylonitrile	0.00628
isopentane	0.00609
napthalene	0.00524
methylethyl ketone	0.00426
tetrahydrofuran	0.00355
ethylene oxide	0.00324
isomers of hexane	0.00280
methylisobutyl keto	0.00262
4-methylaniline	0.00213
t-butyl alcohol	0.00210
butylacrylate	0.00190
o-xylene	0.00144
sec-butyl alcohol	0.00131
vinyl acetate	0.00129
crotonaldehyde	0.00074
n-butylacetate	0.00065
carbon tetrachlorid	0.00052
n-propylacetate	0.00040
chlorobenzene	0.00038
3-methylpentane	0.00031
hexadiene	0.00028
octane	0.00024
methylcyclopentane	0.00022
formic acid	0.00015
acrylic acid	0.00015
naphtha	0.00015
chlorinated hydrocar	0.00007
cyclopentane	0.00005
methylformate	0.00004
trans-2-butene	0.00003
ethylene dichloride	0.00003
ethylene dibromide	0.00003
methyl acrylic acid	0.00003
n-hexanol	0.00003
ketones-unspec	0.00003
nonane	0.00002
n-pentane	0.00001
ethyl acrylate	0.00001
acetonitrile	0.00001

Table 3-20. Texas Eastman point sources (EPN/FIN) for which facility specific speciation profiles were developed, and total VOC emissions by point.

FIN	EPN	Total VOC (tons/day)
EB025T51	025T62	0.00742
EB025T58	025T62	0.01445
EB025WW1	F025WW1	0.01006
EB093FG1	F093FG1	0.00848
EB093T703	093T704	0.04689
EB106FG1	F106FG1	0.00564
EB108FG2	F108FG2	0.06323
EB108KT7	108KT7	0.01713
EB108T521	042FL1	0.02199
EP008FG1	F008FG1	0.56191
EP008FG2	F008FG2	0.12979
EP008T71	008T71	0.00838
EP009T14	116FL2H	0.02048
EP034D203	034D203	0.17016
EP035D203	035D203	0.11751
EP036FG1	F036FG1	0.02194
EP036U1	036U1	0.01343
EP037FG1	F037FG1	0.01840
EP037GA1	037GA1	0.00572
EP037U501	037U501	0.05498
EP038FG1	F038FG1	0.00695
EP038FG2	F038FG2	0.00581
OL007FG1	F007FG1	0.20317
OL007VS1	116FL2H	0.04764
OL014FG2	F014FG2	0.01033
OL014FG3	F014FG3	0.00602
OL032FG1	F032FG1	0.42642
OL032GA1	032GA1	0.01572
OL032VS1	233FL1	0.07251
OL033FG1	F033FG1	0.65063
OL033GA1	033GA1	0.01280
OL033VS1	170FL1	0.07484
OL041FG1	F041FG1	0.04594
OL041FG2	F041FG2	0.00776
OL042FL2	042FL2	0.00630
OL043FG1	F043FG1	0.56196
OL043VS1	042FL1	0.06909
OL170FL2	170FL2	0.00772
OL225B1A	225B1A	0.00878
OL225B1B	225B1B	0.00878
OL226FG1	F226FG1	0.91296
OL226VS1	225FL1	0.00570
OL229CT7	F136CT7	0.02262
OL229H1	229H1	0.00515
OL229H2	229H2	0.00515
OL229H3	229H3	0.00515
OL229H4	229H4	0.00515
OL229WW1	229WW1	0.01420
OLF041FG3	F041FG3	0.00665
OX010FG3	F010FG3	0.01034
OX010T220	030B11	0.00563
OX011FG3	F011FG3	0.02355
OX015FG1	F015FG1	0.13892
OX015FG2	F015FG2	0.28606
OX015R502	015E508	0.08448
OX015R504	015E550	0.13305
OX015R507	015E569	0.08448
OX015T507	015T507	0.02220
OX015T508	015VS1	0.01798
OX015T524	015VS1	0.01562
OX015T535	015E505	0.01018
OX015T94	015T96	0.00527
OX016FG1	F016FG1	0.02131
OX016FG2	F016FG2	0.02131
OX016FG3	F016FG3	0.01126
OX016T560	016E573	0.01018
OX016VS4	016CU1	0.00616
OX050T422	050T422	0.00577
OX053FG1	F053FG1	0.23133
OX053FG2	F053FG2	0.09875
OX061FG1	F061FG1	0.03071
OX061H1	061CD6	0.00566
OX061H1	061CD7	0.00566
OX061H5	061CD12	0.00575
OX061H5	061CD17	0.01579
OX061H7	061CD14	0.01632
OX061H7	061CD61	0.01632
OX062C16	062C16	0.01287
OX062C17	062C17	0.01284
OX062C19	062C19	0.01297
OX062C20	062C20	0.01273
OX062C22	062C22	0.01642
OX062C7	062C7	0.01204
OX062C9	062C9	0.01073
OX062FG1	F062FG1	0.03317
OX062H11A	062CD18A	0.00839
OX062H11A	062CD18B	0.00839
OX062H11A	062CD18C	0.00839
OX062H11B	062CD18A	0.00839
OX062H11B	062CD18B	0.00839
OX062H11B	062CD18C	0.00839
OX062H13A	062CD26	0.01529
OX062H13A	062CD28	0.01529
OX062H13B	062CD26	0.01529
OX062H13B	062CD28	0.01529
OX062H17	062CD32	0.02950
OXF010FG2	F010FG2	0.08329
OXO10FG1	F010FG1	0.07762
PE012C1C	012C1CE	0.00509
PE012DM4B5	012DM4B5	0.00827
PE012FG1	F012FG1	0.17988
PE012FG4	F012FG4	0.39147

FIN	EPN	Total VOC (tons/day)
PE012FG5	F012FG5	0.47169
PE012FG6	F012FG6	0.01997
PE012FG8	063CU1	0.00877
PE012FG8	F012FG8	0.19044
PE012P12BD	012P12BD	0.00821
PE012S34G	012S34G	0.01643
PE012S34P	012S34P	0.00821
PE012S34R	012S34R	0.00822
PE012S34Y	012S34Y	0.00821
PE012S78	012S78	0.03603
PE012S79	012S79	0.03603
PE012S80	116FL2H	0.01576
PE012STD	012STD	0.01216
PE012STE	012STE	0.00520
PE013C1F	013C1FE	0.00737
PE013C1G	013C1GE	0.01002
PE013C7A	013C7AE	0.01248
PE013C7B	013C7BE	0.01248
PE013D310	013D310	0.01140
PE013D311	013D311	0.01140
PE013D312	013D312	0.01140
PE013D313	013D313	0.01140
PE013D340	013D340	0.01842
PE013D341	013D341	0.01842
PE013D342	013D342	0.01842
PE013D343	013D343	0.01842
PE013D344	013D344	0.01842
PE013D345	013D345	0.01842
PE013DM4B6	013DM4B6	0.00827
PE013DM4B7	013DM4B7	0.03033
PE013DMR1	013DMR1	0.01745
PE013FG1	F013FG1	0.43451
PE013S34H	013S34H	0.00821
PE063C5A	063C5AE	0.00908
PE063C5B	063C5BE	0.00908
PE065D614	065D614	0.00777
PE065D615	065D615	0.00777
PE065D616	065D616	0.00777
PE065D617	065D617	0.00777
PE065D618	065D618	0.00777
PE066FG1	F066FG1	0.08703
PE066FG2	F066FG2	0.02397
PE066FG3	F066FG3	0.01744
PE137VS1	137VS1	0.08770
PE143FG1	F143FG1	0.17180
PE146FG1	F146FG1	0.00776
PE224T01	224T01	0.00733
PE224VS1	145FL1	0.01083
PE252EX1	F045CT5	0.00797
PE252F710	252BH710	0.00571

FIN	EPN	Total VOC (tons/day)
PE252FG1	F252FG1	0.07270
PE252VS1	085FL1	0.02619
PE256FG1	F256FG1	0.01005
PP028FG1	F028FG1	0.16774
PP028T331	054FL2	0.00897
PP028VS1	054FL2	0.00749
PP054FL2	054FL2	0.01716
RD005AV2	F005AV2	0.00659
RD005FG6	F005FG6	0.12189
RD005FG7	F005FG7	0.02959
RD005S3425	128FL1	0.00773
RD059FG1	F059FG1	0.01389
RDF066FG4	F066FG4	0.00938
SD008LR1	008LR1	0.02006
SD015LR1	015LR1	0.01895
SD015LT76	015LT76	0.00588
SD020FG1	F020FG1	0.04346
SD020T100	020T100	0.00500
SD020T112	020T112	0.00770
SD020T115	020T115	0.00554
SD021T131	021T131	0.00554
SD027FG1	F027FG1	0.01298
SD049FG1	F049FG1	0.02169
SD049T200	049T200	0.00614
SD049T201	049T201	0.00614
SD049T202	049T202	0.04835
SD051FG1	F051FG1	0.06692
SD093T9	093T9	0.00665
SD098FG1	F098FG1	0.02888
SD103LR1	170FL1	0.01224
SD205LR1	225FL1	0.00801
SD269FG1	F269FG1	0.04268
SD269GA1	269GA1	0.00960
UD009CT1	F009CT1	0.00705
UD010CT6	F010CT6	0.00535
UD030B11	030B11	0.00763
UD030B12	030B12	0.00794
UD030FG1	F030FG1	0.00580
UD040CT2	F040CT2	0.04997
UD042CT4	F042CT4	0.02006
UD045CT5	F045CT5	0.02266
UD047B13	047B13	0.01570
UD047B14	047B14	0.01570
UD063CT3	F063CT3	0.02178
UD136CT7	F136CT7	0.01011
UD187FG1	F187FG1	0.01040
UD239T4	239T4	0.01499
UD633SB1	F633SB1	0.00608

4. METEOROLOGY

CAMx requires meteorological input data for the parameters described in Table 4-1.

Table 4-1. CAMx meteorological input data requirements.

CAMx Input Parameter	Description
Layer interface height (m)	3-D gridded time-varying layer heights for the start and end of each hour
Winds (m/s)	3-D gridded wind vectors (u,v) for the start and end of each hour
Temperature (K)	3-D gridded temperature and 2-D gridded surface temperature for the start and end of each hour
Pressure (mb)	3-D gridded pressure for the start and end of each hour
Vertical Diffusivity (m^2/s)	3-D gridded vertical exchange coefficients for each hour
Water Vapor (ppm)	3-D gridded water vapor mixing ratio for each hour
Cloud Cover	3-D gridded cloud cover for each hour
Rainfall Rate (in/hr)	2-D gridded rainfall rate for each hour

MM5 MODELING

All of the CAMx meteorological input data were derived from the Fifth Generation Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Model (MM5; Duhdia, 1993). The meteorological modeling reports for this study (Emery and Tai, 2002; Emery, Tai and Jia, 2003) describe the MM5 model, the meteorological domain, and input data sources and preparation methodology. The MM5 modeling used nested 108 km, 36 km, 12 km and 4 km grids and the grid configuration for the final MM5 run (Run 6) is shown in Figure 4-1. The MM5 modeling used 28 layers as described below.

The meteorological modeling reports (Emery and Tai, 2002; Emery, Tai and Jia, 2003) present the performance evaluation methodology and results for several different runs, both graphically and statistically, and recommend a final set of meteorological fields for use in CAMx. These results are summarized briefly below.

MM5 Runs

The CAMx modeling described in Section 6 utilized the output from several different MM5 runs, namely:

- “Run 3b”, the final of four original MM5 runs described by Emery and Tai (2002). Important model configuration options included the Gayno-Seaman boundary layer scheme, Dudhia Cloud radiation parameterization, Kain-Fritsch cumulus parameterization, “simple ice” cloud microphysics, 5-layer soil model, analysis nudging to EDAS initialization fields, and observation nudging to surface data and soundings/profilers.

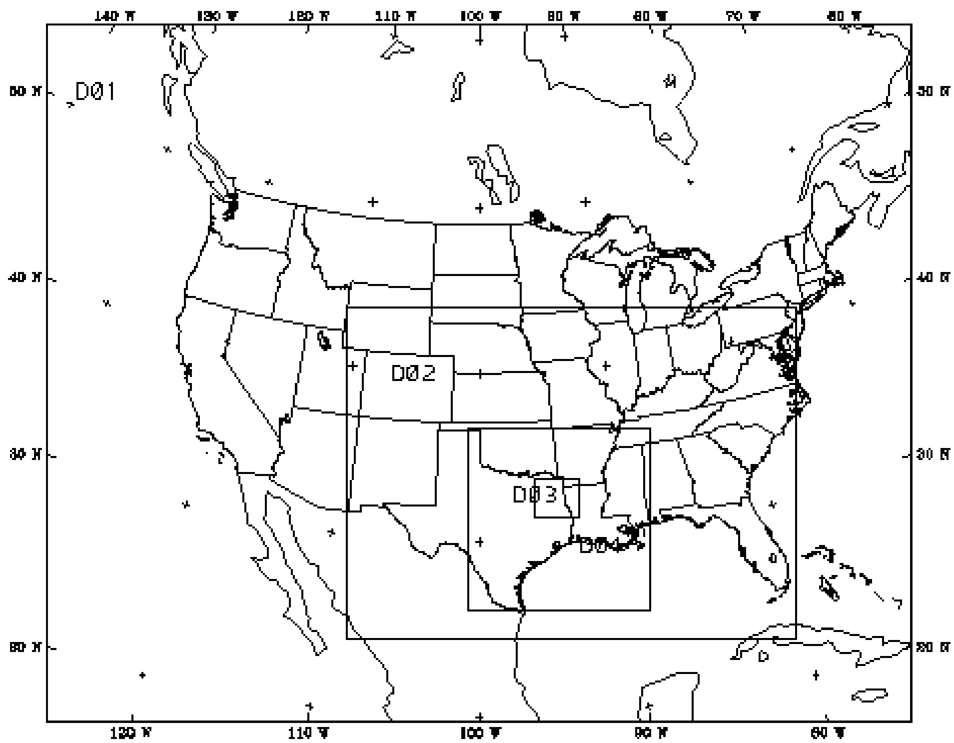


Figure 4-1. The MM5 grid system (108/36/12/4 km) for Run 6.

- "Run 5", the first of three sensitivity runs described by Emery, Tai and Jia (2003), in which the Gayno-Seaman boundary layer scheme was replaced by the Blackadar scheme.

- "Run 5b", the second of three sensitivity runs that continued to use the Blackadar boundary layer scheme but changed the radiation parameterization from Dudhia Cloud to RRTM.

- "Run 6", a final revised MM5 application that included the Pleim-Xiu coupled land surface and boundary layer model, the RRTM radiation parameterization, a revised domain definition with a slightly larger 36-km grid, revised data assimilation (FDDA) methodology, and analysis nudging to EDAS "analysis" rather than "initialization" fields.

As described in the latter of the two meteorological modeling reports, "Run 6" was considered the best overall performing meteorological simulation.

Stagnation During the August 1999 Episode

An important difference among the MM5 simulations was the strength of meteorological stagnation predicted over Northeast Texas during the August 17-20 period. Lower wind speeds were observed during this period than immediately before or afterwards, leading to a period of high ozone levels. However, the meteorological fields predicted by MM5 in Runs 3b, 5 and 5b were too stagnant during this time leading to excessively high peak ozone levels in Northeast Texas. This problem was traced primarily to the meteorological data being used for analysis nudging in the MM5 4-dimensional data assimilation (4DDA). MM5 Runs 3b, 5, and 5b assimilated data from EDAS "initialization" data. The initialization data are developed during the spin-up period for the operational Eta forecast model, during which time the model is being guided by its own assimilation of analyzed meteorological data (the EDAS "analysis" data). MM5 run 6 assimilated the EDAS analysis data directly.

The difference in the amount of stagnation predicted by MM5 in Runs 5b and 6 was not obvious from statistical evaluations of predicted wind speeds and directions. However, the difference is clear in the predicted wind and pressure patterns. Figures 4-2 through 4-5 present a series of surface wind and sea level pressure plots for August 17th, 1999 at 6 PM CST for the area of the MM5 12 km grid. Figures 4-2 and 4-3 show the MM5 predicted surface winds and pressure for Runs 5b and 6, respectively. Over Northeast Texas, MM5 Run 5b predicted a local high (1018 mbar) with winds organized around the high. In contrast, MM5 Run 6 predicted weak and disorganized winds over Northeast Texas with no local pressure high. The primary reason for this difference is the data used for the 4DDA analysis nudging. Figures 4-4 and 4-5 show the EDAS initialization and analysis fields, respectively, for this same time. The initialization fields (used with MM5

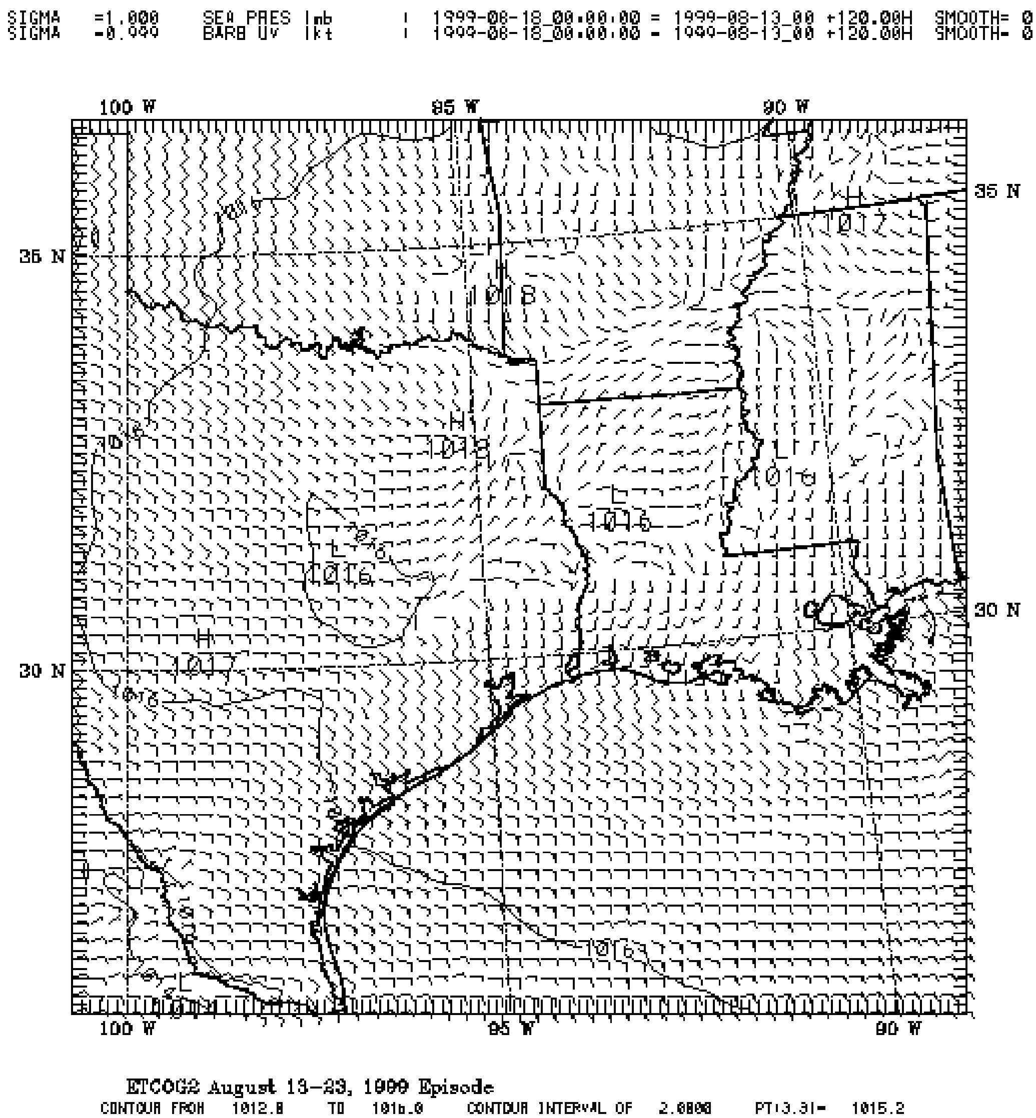


Figure 4-2. MM5 Run 5b surface winds and sea level pressure on August 17, 1999, 6 PM CST.

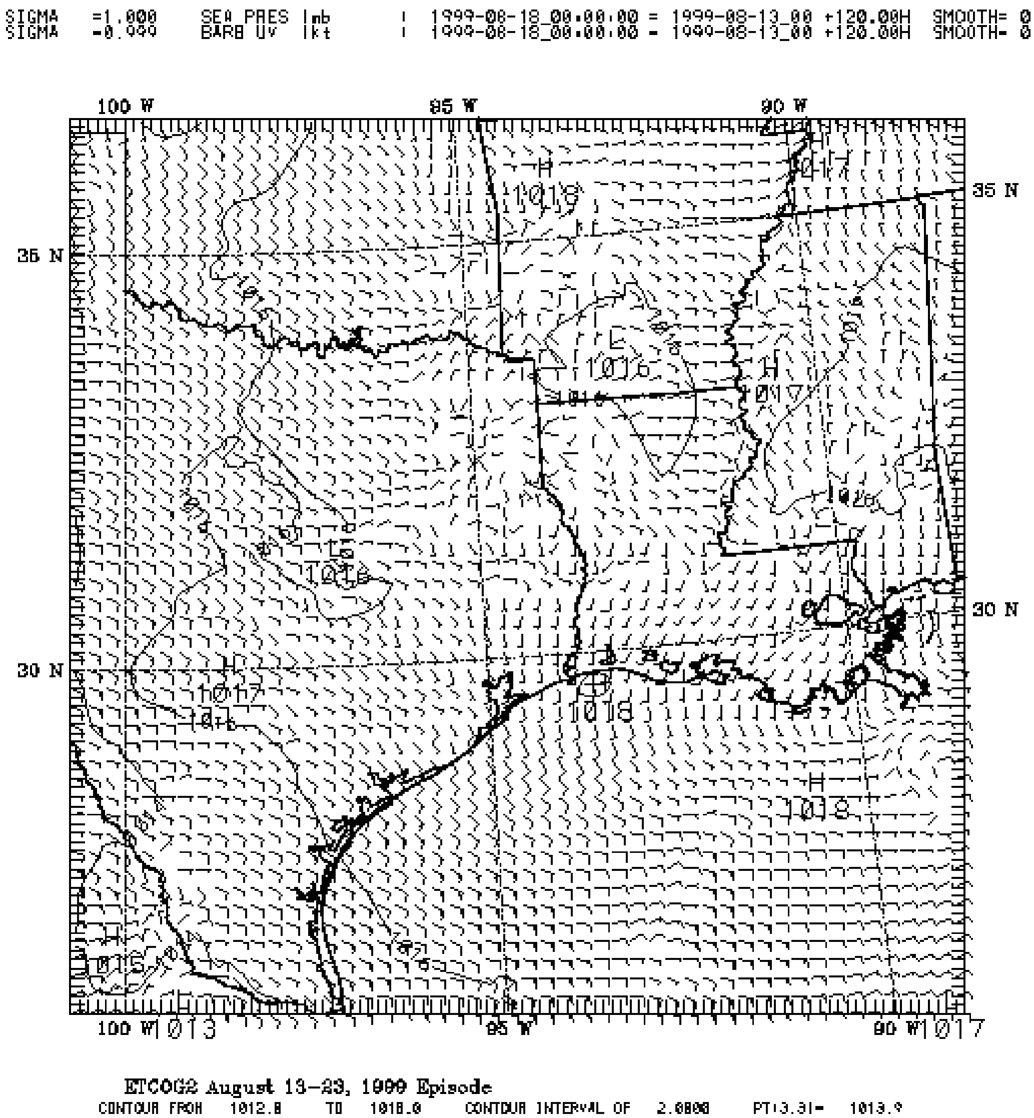


Figure 4-3. MM5 Run 6 surface winds and sea level pressure on August 17, 1999, 6 PM CST.

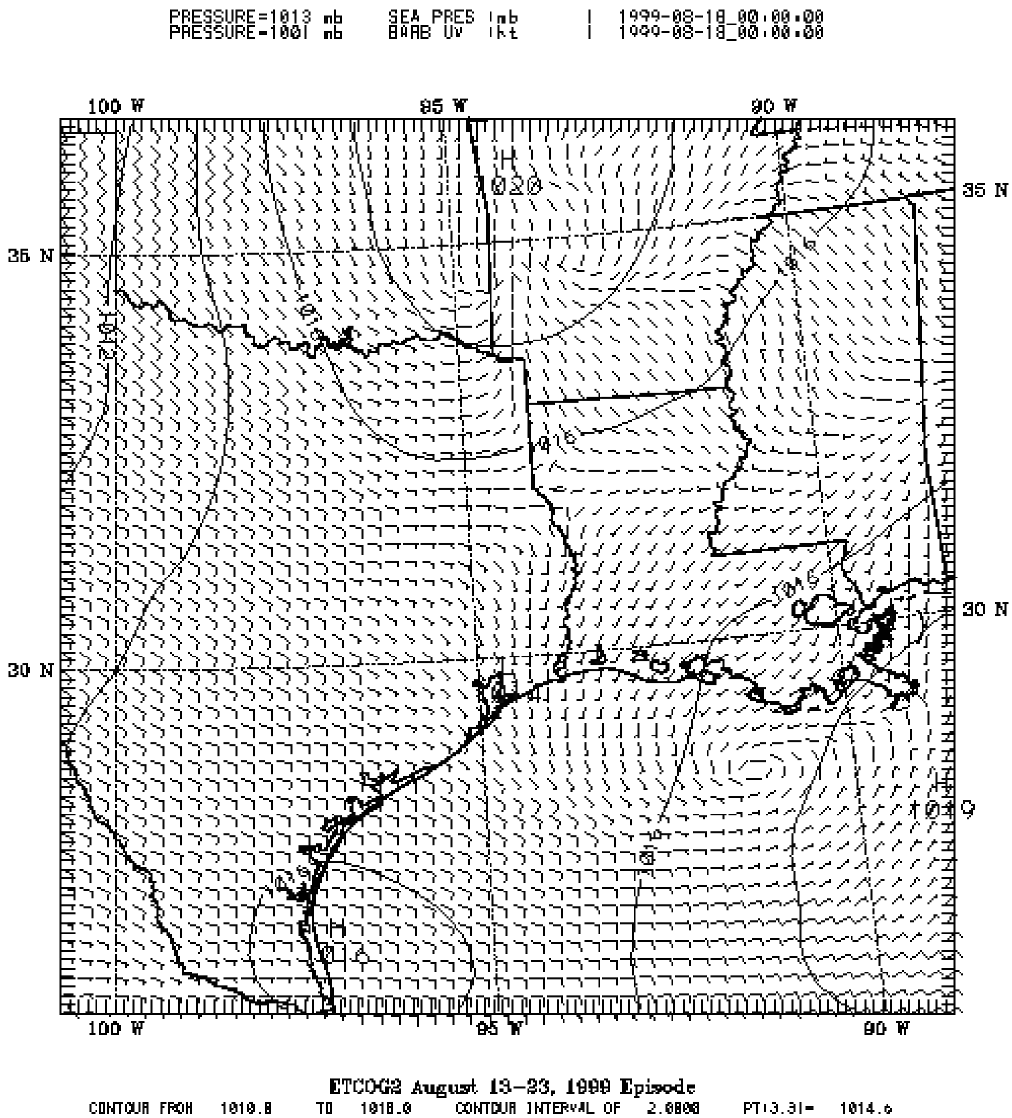


Figure 4-4. EDAS "initialization" surface winds and sea level pressure used to nudge MM5 Run 5B on August 17, 1999, 6 PM CST.

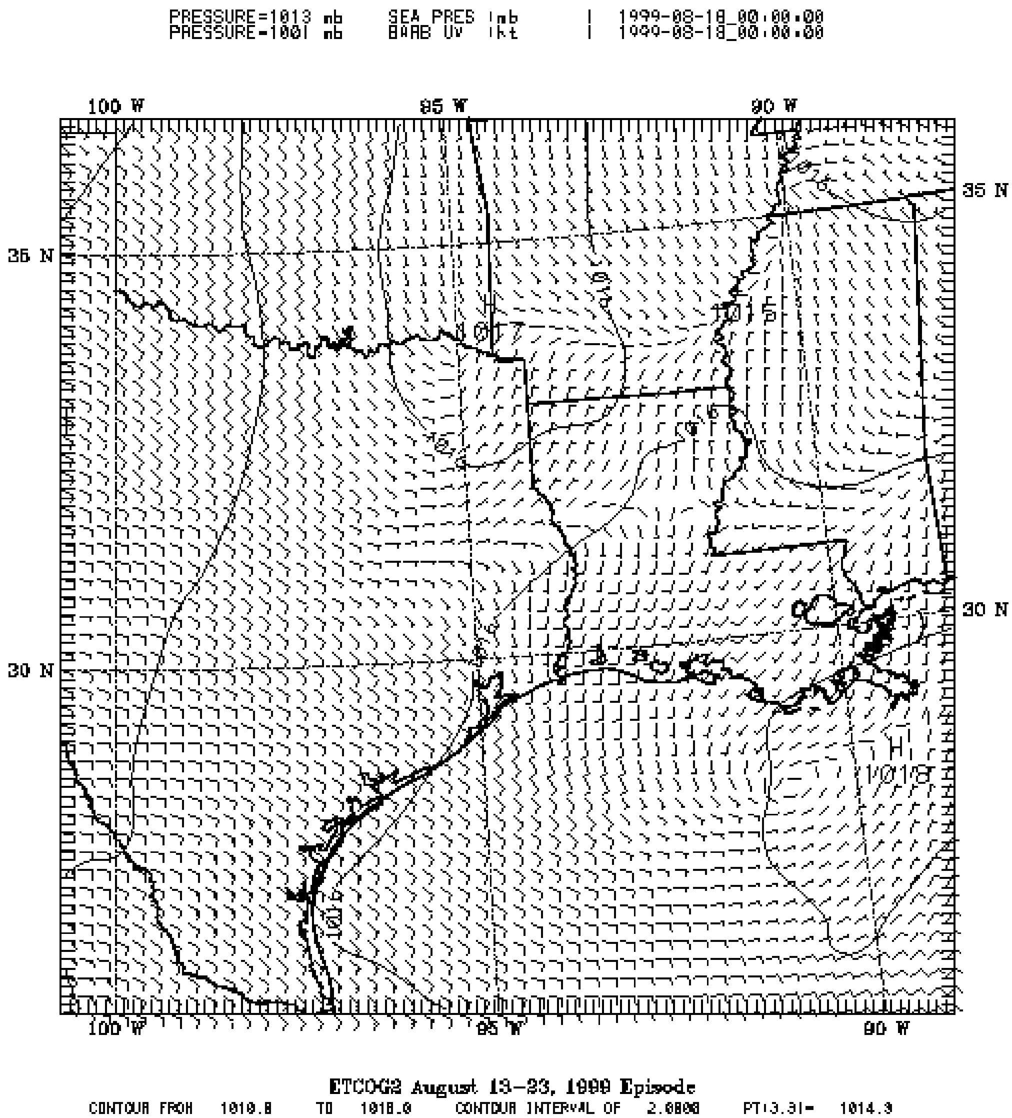


Figure 4-5. EDAS "analysis" surface winds and sea level pressure used to nudge MM5 Run 6 on August 17, 1999, 6 PM CST.

Run 5b) have higher pressure over Northeast Texas than the analysis fields (used with MM5 Run 6). Comparison of the EDAS fields to archived daily weather maps showed that high pressure in Northeast Texas was over-stated by the EDAS initialization fields.

The modeled and observed winds and temperatures at Longview (CAMS 19) are compared in Figures 4-6 and 4-7, respectively. Overall, both runs replicate the observed winds quite well and it is difficult to say that one or other is better. Both follow the observed speed trends well, but both generally over predicted by about 1 m/s on average. The same general conclusions are reached for wind direction, although Run 5b perhaps indicates a slightly more noisy performance. The temperature predictions show that Run 6 was generally too warm during the day during the mid to late portions of the episode. Run 5b generally under predicted temperatures during much of the period. Overall, Run 6 provides a better balance for temperature performance.

Boundary Layer Depths

Vertical profiles of observed wind, temperature and humidity from Shreveport and Palestine were compared to the soundings simulated by MM5 in Runs 3b, 5b, and 6. In Shreveport, Runs 5b and 6 typically performed better for winds than Run 3b (with Run 6 the best overall), which we believe is related to the issues identified with the Gayno-Seaman boundary layer scheme used in Run 3b. While Run 6 consistently over predicted the temperature profile in the boundary layer, it agreed most closely with the observed profile. Runs 3b and 5b were cooler than observed through the boundary layer, and generally indicated more static stability and slightly lower mixing depths than observed. Run 6 also typically performed better for boundary layer humidity than the other runs (least error), but humidity was often slightly under predicted. Usually, Runs 3b and 5b over estimated surface and boundary layer humidity. While Runs 3b and 5b seemed to place the top of the boundary layer near or below the observed level, the mixing depth in Run 6 was higher than observed. Very similar results were seen for the three MM5 simulations at the Palestine site.

The spatial patterns of boundary layer heights over the south-central U.S. were further assessed for Runs 5b and 6. Run 6, which used the Plein-Xiu coupled surface-boundary layer model, consistently developed deeper mixing depths throughout the south-central U.S. than Run 5b, which used the Blackadar boundary layer model. Typically, the Run 5b depths over East Texas ranged from 1000 – 2000 m, whereas the Run 6 depths were usually 2000-2500 m. Run 3b generated mixing depths similar to Run 5b but the mixing depths showed large spatial variability that was unreasonable and appeared to be an artifact of the Gayno-Seaman boundary layer scheme. This characteristic may have the largest impacts on air quality simulations, far more than any wind or temperature differences.

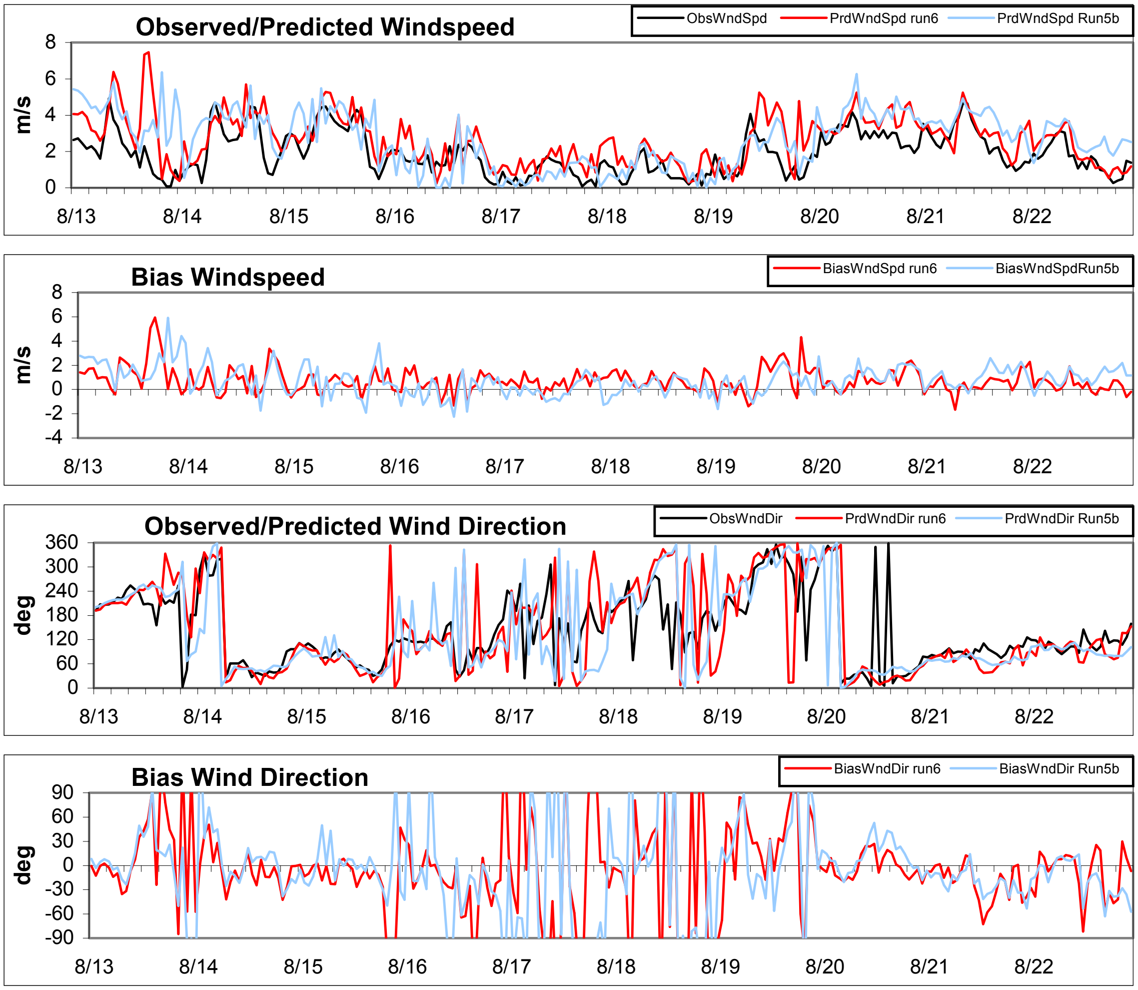


Figure 4-6. Hourly predicted (Runs 5b and 6) and observed wind speed and direction at Longview (CAMS 19).

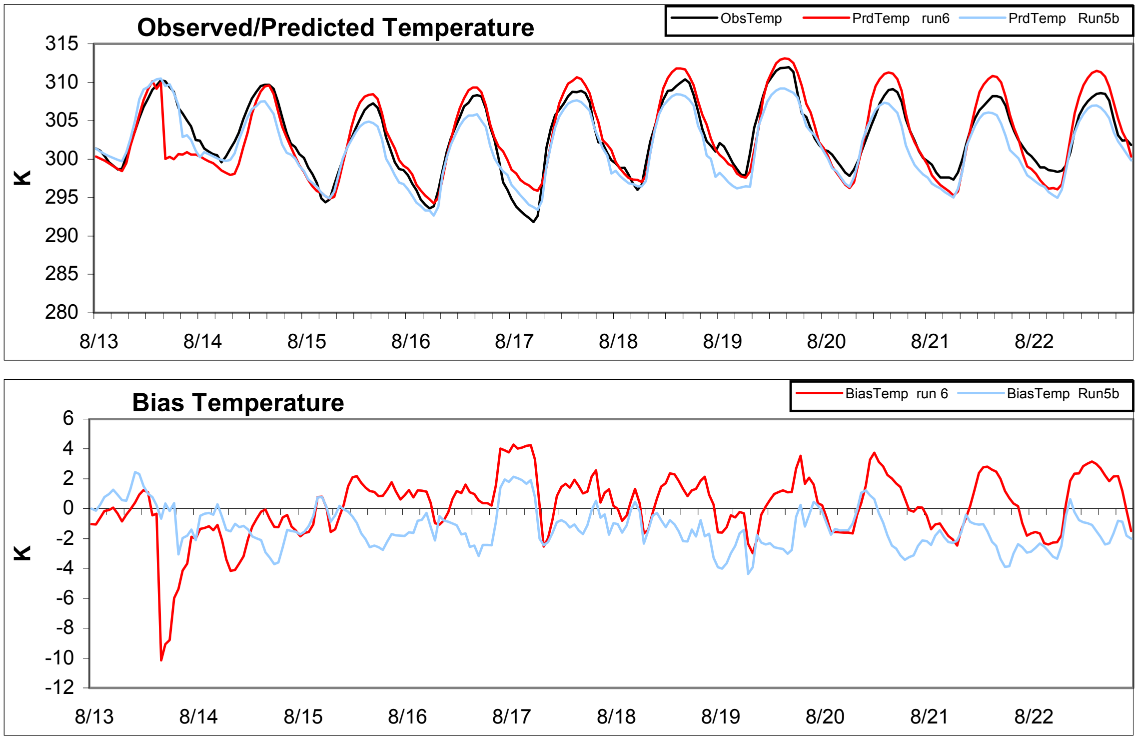


Figure 4-7. Hourly predicted (Runs 5b and 6) and observed temperature at Longview (CAMS 19).

CAMx INPUT DATA PREPARATION

MM5 output fields were translated to CAMx-ready inputs using ENVIRON's MM5CAMx translation software. This program performs several functions:

1. Extracts wind, temperature, pressure, humidity, cloud, and rain fields from each MM5 grid that matches the corresponding CAMx grid.
2. Performs mass-weighted vertical aggregation of data for CAMx layers that span multiple MM5 layers.
3. Diagnoses fields of vertical diffusion coefficient (Kv), which are not directly output by MM5.
4. Outputs the meteorological data into CAMx-ready input files.

The MM5CAMx program has been written to carefully preserve the consistency of the predicted wind, temperature and pressure fields output by MM5. This is the key to preparing mass-consistent inputs, and therefore for obtaining the best possible performance from CAMx.

The data prepared by MM5CAMx were directly input to CAMx. Meteorological inputs were developed for both 13-layer and 15-layer CAMx applications (Figure 4-8). In the former case, a single 40 m deep CAMx surface layer was extracted from the aggregation of the lowest two 20 m MM5 layers. In the latter case, these two lowest MM5 layers were not aggregated, but directly mapped to two identical layers in CAMx to test the air quality model response to higher resolution very near the surface. Additional layers were also added aloft.

Vertical diffusivities are an important input to the CAMx simulation since they determine the rate and depth of mixing in the planetary boundary layer (PBL) and above. In general, diffusivities directly output from meteorological models, or diffusivities diagnosed from other output variables, require careful examination before they are used in air quality modeling. This may be because the air quality model results are much more sensitive to diffusivities than the meteorological model results. In CAMx simulations using meteorology from MM5 "Run 3b" the vertical diffusivities were calculated from output fields of turbulent kinetic energy predicted by the Gayno-Seaman boundary layer model. This approach is preferred as it provides a direct means to translate turbulence intensity in MM5 to diffusion rates in CAMx. For MM5 simulations "Run 5," "Run 5b"and "Run 6" the MM5 boundary layer (mixing) depths were used to define a profile of vertical diffusivity values in each grid column, depending on surface layer stability and the underlying surface characteristics. The methodology follows from O'Brien (1970). This method was necessary because the Blackadar and Pleim-Xiu PBL schemes do not generate fields of turbulent kinetic energy.

Layer	sigma	pressure	height	thickness	CAMx Layers
28	0.0000	50.00	18874.41	1706.76	
27	0.0250	73.75	17167.65	1362.47	
26	0.0500	97.50	15805.17	2133.42	
25	0.1000	145.00	13671.75	1664.35	
24	0.1500	192.50	12007.40	1376.75	
23	0.2000	240.00	10630.65	1180.35	
22	0.2500	287.50	9450.30	1036.79	
21	0.3000	335.00	8413.52	926.80	
20	0.3500	382.50	7486.72	839.57	
19	0.4000	430.00	6647.15	768.53	
18	0.4500	477.50	5878.62	709.45	
17	0.5000	525.00	5169.17	659.47	
16	0.5500	572.50	4509.70	616.58	
15	0.6000	620.00	**3893.12**	579.34	--15---
14	0.6500	667.50	**3313.78**	546.67	--14---
13	0.7000	715.00	**2767.11**	517.77	--13---
12	0.7500	762.50	**2249.35**	491.99	--12---
11	0.8000	810.00	**1757.36**	376.81	--11---
10	0.8400	848.00	**1380.55**	273.60	--10---
9	0.8700	876.50	**1106.95**	266.37	---9---
8	0.9000	905.00	**840.58**	259.54	---8---
7	0.9300	933.50	**581.04**	169.41	---7---
6	0.9500	952.50	**411.63**	166.65	---6---
5	0.9700	971.50	**244.98**	82.31	---5---
4	0.9800	981.00	**162.67**	65.38	---4---
3	0.9880	988.60	**97.29**	56.87	---3---
2	0.9950	995.25	**40.43**	20.23	---2---
1	0.9975	997.62	**20.19**	20.19	---1---
0	1.0000	1000.00	**0.00**		=============Surface======

Figure 4-8. MM5 and CAMx vertical grid structures based on 28 sigma-p levels. Heights (m) are above sea level according to a standard atmosphere; pressure is in millibars.

5. OTHER CAMx INPUT DATA

The emissions and meteorological input data for the CAMx ozone modeling were described in Sections 3 and 4, respectively. The other input data and model options are described in the section of the report.

CHEMISTRY DATA

The CAMx "chemistry parameters" file determines which photochemical mechanism is used to model ozone formation. CAMx was run with an updated version of the Carbon Bond 4 mechanism (CB4), referred to as mechanism 3 in CAMx, which is described in the CAMx User's Guide (ENVIRON, 2002). Mechanism 3 is the CB4 mechanism with updated radical-radical termination reactions and updated isoprene mechanism as used for the OTAG modeling and other TCEQ modeling studies.

The chemistry parameters file specifies the rates for all of the "thermochemical" reactions in the CB4 mechanism. The CB4 mechanism also includes several "photolysis" reactions that depend upon the presence of sunlight. The photolysis rates input file determines the rates for chemical reactions in the mechanism that are driven by sunlight. Photolysis rates were calculated using the Tropospheric visible Ultra-Violet (TUV) model developed by the National Center for Atmospheric Research (Madronich, 1993 and 2002). TUV is a state-of-the-science solar radiation model that is designed for photolysis rate calculations. TUV accounts for environmental parameters that influence photolysis rates including solar zenith angle, altitude above the ground, surface UV albedo, aerosols (haze), and stratospheric ozone column.

The albedo/haze/ozone input file is used in conjunction with the photolysis rates input file to specify several of the environmental factors that influence photoloysis rates. The photolysis rates and albedo/haze/ozone files must be coordinated to function together correctly. The surface UV albedo was calculated based on the gridded land use data using the landuse specific UV albedo values given in Table 5-1. The albedo is varies spatially according to the land cover distribution, but does not vary with time. The total ozone column was based on satellite data from the Total Ozone Mapping Spectrometer (TOMS), which are available from a web site maintained by the NASA Goddard Space Flight Center (http://jwocky.gsfc.nasa.gov). Daily ozone column are available at 1.25°longitude by 1° latitude resolution and were mapped to the CAMx grid. The haze optical depth was assumed to be 0.1.

INITIAL AND BOUNDARY CONDITIONS

The initial conditions (ICs) are the pollutant concentrations specified throughout the modeling domain at the start of the simulation. Boundary conditions (BCs) are the pollutant concentrations specified at the perimeter of the modeling domain. The boundary conditions should little or no impact on the model results for Northeast Texas in this study because regional modeling is being performed. One of the reasons for performing regional scale modeling rather than urban scale modeling is to minimize the importance of ICs and BCs. Using a large regional domain moves the boundaries far away (in distance and transport time) from the study area. Including several "spin-up" days prior to the episode period allows time for the influence of initial conditions to be removed.

Table 5-1. CAMx land use categories and the default surface roughness values (m) and UV albedo assigned to each category within CAMx.

Category Number	Land Cover Category	Surface Roughness (meters)	UV Albedo
1	Urban	3.00	0.08
2	Agricultural	0.25	0.05
3	Rangeland	0.05	0.05
4	Deciduous forest	1.00	0.05
5	Coniferous forest including wetland	1.00	0.05
6	Mixed forest	1.00	0.05
7	Water	0.0001	0.04
8	Barren land	0.002	0.08
9	Non-forested wetlands	0.15	0.05
10	Mixed agricultural and range	0.10	0.05
11	Rocky (with low shrubs)	0.10	0.05

Clean background values were used for the ICs and BCs similar to the clean values used by the Ozone Transport Assessment Group (OTAG) for regional scale modeling of the Eastern US (OTAG, 1996). Changes from the OTAG values are the use of constant values of 40 ppb for ozone and 100 ppb for CO. The initial and boundary concentrations are shown in Table 5-2.

Table 5-2. Clean values to be used for the initial and boundary concentrations.

Species	Concentration (ppb)
O3	40.0
NO	0.000049
NO2	0.08555
CO	100.0
PAR	3.078
HCHO	1.068
ETH	0.005315
ALD2	0.1051
TOL	0.006043
PAN	0.03834
HNO2	0.000728
HNO3	1.525
H2O2	2.263

SURFACE CHARACTERISTICS (LANDUSE)

CAMx requires gridded landuse data to characterize surface boundary conditions, such as surface roughness, deposition parameters, vegetative distribution, and water/land boundaries. CAMx land use files provide the fractional contribution (0 to 1) of eleven land use categories (Table 5-2) to the surface area of grid cell.

Gridded land cover data were developed from the same landuse databases that were used in the generation of spatial emission surrogates (Appendix A). A program was written to re-cast the raw spatial surrogate data into the eleven CAMx land use categories, to grid the data to the 36, 12, and 4 km CAMx grids, and to write the results to a model-ready format. Figures 5-1 and 5-2 show the dominant land use category in each grid cell for the 36 km and 12 km grids, respectively. The dominant land use comprises the majority of surface cover in each cell and the "Forest" category is the sum of the three CAMx categories 4 to 6.

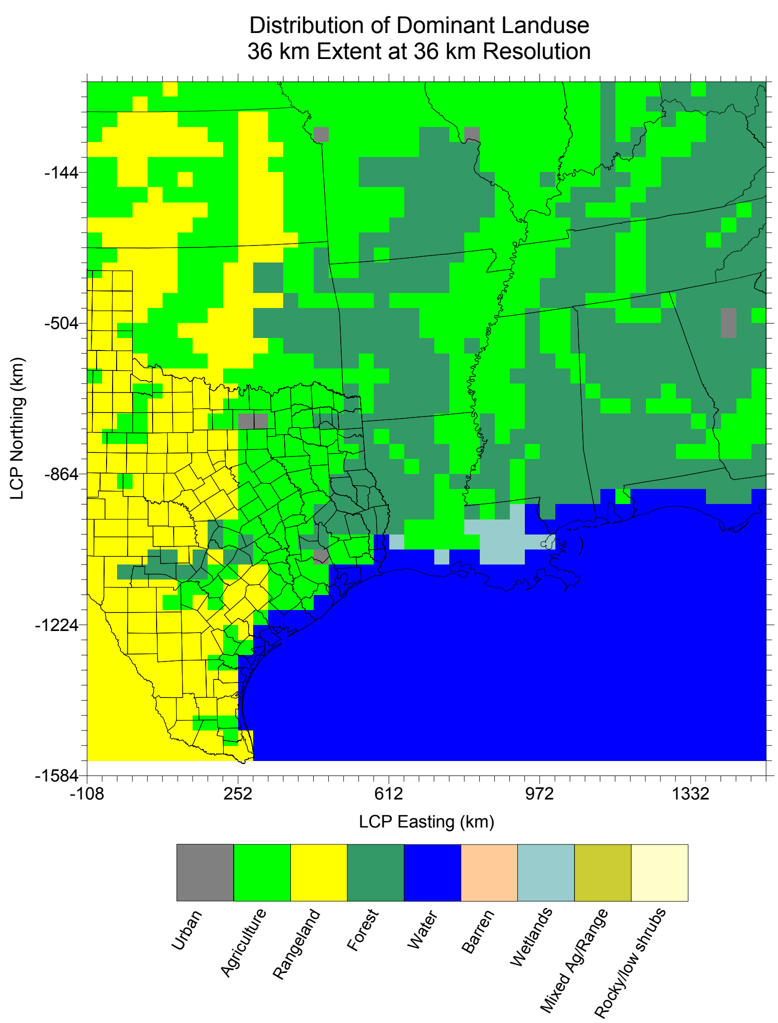


Figure 5-1. Distribution of the dominant land cover type in each grid cell of the 36-km CAMx grid.

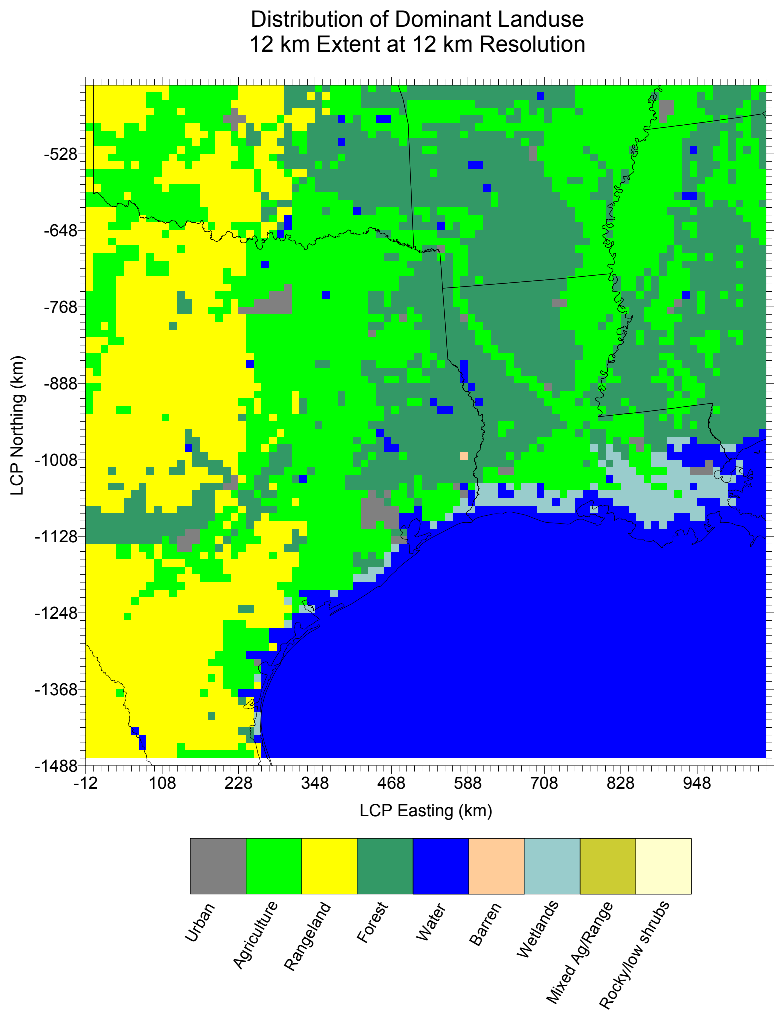


Figure 5-2. Distribution of the dominant land cover type in each grid cell of the 12-km CAMx grid

CAMx MODEL OPTIONS

CAMx has several user-selectable options that are specified for each simulation through the CAMx control file. Most of these options follow naturally from other choices about model inputs. An example CAMx control script is shown in Figure 5-3. There are four model options that must be decided for each project: the choice of advection scheme, the plume-in-grid scheme, the chemical mechanism and the chemistry solver. The selection for each option is decided at the stage of the base case model performance evaluation and then held fixed for the evaluation of any future year emission scenarios. The recommended choices for these options are discussed below. See the CAMx User's Guide (ENVIRON, 2000) for more details on these options.

Advection Scheme

CAMx version 3.1 has three optional methods for calculating horizontal advection (the movement of pollutants due to resolved horizontal winds) called Smolarkiewicz, Bott and Piecewise Parabolic Method (PPM). The Smolarkiewicz scheme has been used for many years, and was used in the previous modeling for Northeast Texas (ENVIRON, 1999). The Smolarkiewicz scheme has been criticized for causing too much artificial diffusion of pollutants, tending to "smear out" features and artificially overstate transport. The Bott and PPM schemes are newer and have less artificial diffusion than the Smolarkiewicz scheme. The PPM scheme was used for this study as it has been determined to be the least numerically diffusive, runs at speeds similar to Smolarkiewicz, and does not exhibit certain "noisy" features near sharp gradients that are apparent with the Bott approach.

Plume-in-Grid

CAMx includes an optional sub-grid scale plume model that can be used to represent the dispersion and chemistry of major NOx point source plumes close to the source. We used the Plume-in-Grid (PiG) sub-model for major NOx sources (i.e., point sources with episode average NOx emissions greater than 2 tons per day in the 4-km grid). Selection of PiG sources was discussed in Section 3.

Chemical Mechanism

CAMx provides several two main alternatives for the chemical mechanisms used to describe the gas-phase chemistry of ozone formation, namely the Carbon Bond 4 (CB4) and SAPRC99 mechanisms. The most widely used mechanism for regional applications is CB4 with the updated isoprene and radical termination reactions, and CB4 was used for this study.

Chemistry Solver

CAMx has two options for the numerical scheme used to solve the chemical mechanism. The first option is the CMC fast solver that has been used in every prior version of CAMx. The second option is an IEH solver. The CMC solver is faster and more accurate than most chemistry solvers used for ozone modeling. The IEH solver is even more accurate than the CMC solver, but slower. The CMC solver was used in initial runs for this study and then the IEH solver was used in the final base case and future year runs for this study because it is the most accurate and the computer runtime requirements were acceptable for this study. The IEH solver uses exactly the same chemical mechanism as the CMC solver. The CMC solver did not exhibit any problems in this study.

```
CAMx Version        |VERSION3.1
Run Message         |CAMx v3.10 base5 Aug 13-22 1999
Root output name    |/disk37/etcog2/camx/output/base5/camx.990816.base5
Start yr/mo/dy/hr   |1999 08 16    0.
End   yr/mo/dy/hr   |1999 08 16 2400.
dtmx,dtin,dtem,dtou|30. 60. 60. 60.
nx,ny,nz            |45  46  15
Coordinate ID       |LAMBERT
xorg,yorg,dx,dy     |-108. -1584. 36. 36. -100. 40. 60. 30.
time zone           |6
PiG parameters      |2000. 12.
Avg output species |16
                    |NO        NO2       O3        PAR       TOL       ETH
                    |OLE       PAN       ISOP      XYL       FORM      ALD2
                    |HNO3      NXOY      NTR       CO
# nested grids      |2
nest grid params    | 4 32  4 32 15 3
nest grid params    |15 20 20 24 15 9
SMOLAR,BOTT, PPM?   |PPM
Chemistry solver    |IEH
Restart             |true
Chemistry           |true
Dry dep             |true
Wet dep             |false
PiG submodel        |true
Staggered winds     |true
Treat area emiss    |true
Treat point emiss   |true
1-day emiss inputs |true
3-D average file    |false
Source Apportion    |false
Chemparam           |../../input/other/CAMx31.chemparam.3
Photolysis rates    |../../input/other/camx.etcog.rates.do
Landuse             |../../input/other/CAMx.landuse.36km.lcp
Height/pressure     |../../input/met/met-36km/camx.zp.etcog.36km.990816.run6.4km15.bin
Wind                |../../input/met/met-36km/camx.uv.etcog.36km.990816.run6.4km15.bin
Temperature         |../../input/met/met-36km/camx.tp.etcog.36km.990816.run6.4km15.bin
Water vapor         |../../input/met/met-36km/camx.qa.etcog.36km.990816.run6.4km15.bin
Cloud cover         |../../input/met/met-36km/camx.cl.etcog.36km.990816.run6.4km15.bin
Rainfall            |
Vertical diffsvty   |../../input/met/met-36km/camx.kv.etcog.36km.990816.run6.4km15.ob70.bin
Initial conditions |
Boundary conditions|../../input/ic-bc-tc/bc.36km.4km15.const.bin
Top concentration   |../../input/ic-bc-tc/tc.36km.const
Albedo/haze/ozone   |../../input/other/ahomap.etcog.aug99.dat
Point emiss         |/disk34/etcog2/eps2x/12km/emiss/ptsrce.reg_et.pig.990816.a2
Area emiss          |/disk34/etcog2/eps2x/12km/emiss/emiss.surface.ET_reg_36km.990816.a0
Landuse          #1 |../../input/other/CAMx.landuse.12km.lcp
Landuse          #2 |../../input/other/CAMx.landuse.4km.buffered.lcp
Height/pressure #1 |../../input/met/met-12km/camx.zp.etcog.12km.990816.run6.4km15.bin
Height/pressure #2 |../../input/met/met-04km/camx.zp.etcog.04km.990816.run6.4km15.bin
Wind             #1 |../../input/met/met-12km/camx.uv.etcog.12km.990816.run6.4km15.bin
Wind             #2 |../../input/met/met-04km/camx.uv.etcog.04km.990816.run6.4km15.bin
Temperature      #1 |../../input/met/met-12km/camx.tp.etcog.12km.990816.run6.4km15.bin
Temperature      #2 |../../input/met/met-04km/camx.tp.etcog.04km.990816.run6.4km15.bin
Vertical diff    #1 |../../input/met/met-12km/camx.kv.etcog.12km.990816.run6.4km15.ob70.bin
Vertical diff    #2 |../../input/met/met-04km/camx.kv.etcog.04km.990816.run6.4km15.ob70.bin
Area emiss       #1 |/disk34/etcog2/eps2x/12km/emiss/emiss.surface.ET_reg_12km.wbuf.990816.a0
Area emiss       #2 |/disk34/etcog2/eps2x/4km/emiss/emiss.surface.et4km_wbuf.990816.a2
coarse restart      |/disk37/etcog2/camx/output/base5/camx.990815.base5.inst.2
fine   restart      |/disk37/etcog2/camx/output/base5/camx.990815.base5.finst.2
PiG    restart      |/disk37/etcog2/camx/output/base5/camx.990815.base5.pig
```

Figure 5-3. Example CAMx control script for August 16th, 1999 of Base Case 5.

6. OZONE MODELING

This section describes the ozone modeling results for the August 1999 regional scale model (RSM) developed for Northeast Texas. The August 13-22, 1999 period was selected because it was a period when Northeast Texas experienced an extended period of high 8-hour and 1-hour ozone values. The episode selection and conceptual model were presented in Section 2 and the maximum observed ozone levels are summarized in (Table 6-1). The main episode days were August 15th through August 22nd. Two additional days (August 13th and 14th) were modeled as "spin-up" days.

Table 6-1. Maximum ozone levels and temperatures for the August 1999 episode days.

Date	Longview Maximum Temperature	Max 8-hour Ozone (ppb) Longview CAMS 19	Max 8-hour Ozone (ppb) Tyler CAMS 82	Max 8-hour Ozone (ppb) Marshall CAMS 50	Max 1-hour Ozone (ppb) Longview CAMS 19	Max 1-hour Ozone (ppb) Tyler CAMS 82	Max 1-hour Ozone (ppb) Marshall CAMS 50
8/15/99	93	66	73	55	73	95	60
8/16/99	95	105	92	71	124	109	74
8/17/99	96	110	97	90	134	105	94
8/18/99	99	88	74	91	91	78	98
8/19/99	102	91	85	81	101	91	87
8/20/99	97	80	86	70	90	99	72
8/21/99	95	87	92	67	95	107	71
8/22/99	96	91	77	82	107	78	87

The preparation of the CAMx model inputs were described in Sections 3 (Emissions), 4 (Meteorology) and 5 (Other CAMx Inputs) of this report. The ozone modeling used version 3.1 of the CAMx model (ENVIRON, 2002). The CAMx modeling domain used a 2-way nested 36/12/4 km grid structure as shown in Figure 1-1. The CAMx 4 km grid covering Northeast Texas is shown in Figure 6-1 with the locations of TCEQ ozone monitors operating in August 1999 at Longview (CAMS 19), Tyler (CAMS 82) and Marshall (CAMS 50) and AIRS ozone monitors in Shreveport (220170001 in Caddo Parish and 220150008 in Bossier Parish). The five NETAC counties are shaded and four point sources close to CAMS 19 are marked.

Ozone modeling was conducted for the 1999 base year and a 2007 future year. Several base cases were completed for 1999 as model performance was refined through improvements to CAMx inputs and configuration. The base case development process is summarized below culminating with base case 5 (base5). The final 2007 base case was base case 2 (07base2).

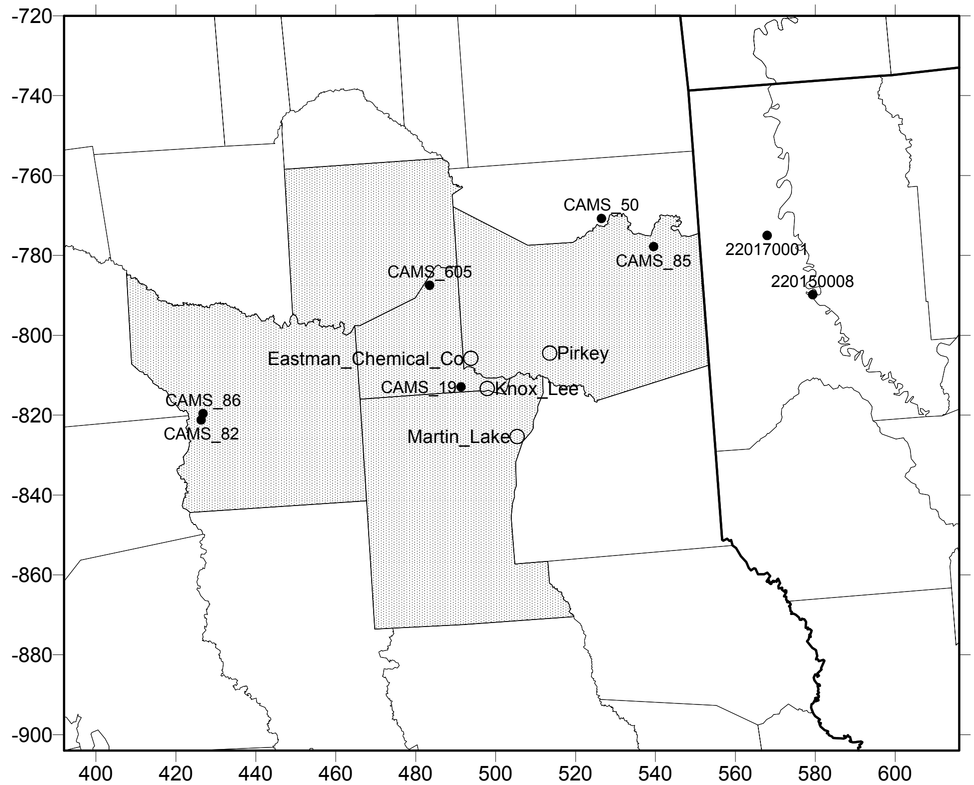


Figure 6-1. Map of the CAMx 4 km grid with locations of TCEQ ozone monitors operating in August 1999 at Longview (CAMS 19), Tyler (CAMS 82) and Marshall (CAMS 50) and AIRS ozone monitors in Shreveport (220170001 in Caddo Parish and 220150008 in Bossier Parish). The five NETAC counties are shaded and four point source close to CAMS 19 are shown.

1999 BASE CASES

Model Performance Evaluation Approach

Model performance was evaluated by comparing predicted and observed hourly ozone values for all monitoring sites in the 12 km and the Northeast Texas monitors in the 4 km grids. The 1-hour ozone values were compared rather than 8-hour values because this provides a more stringent test of whether the model is describing the temporal variation in ozone at each monitor. Within an 8-hour period a model may both over- and under-estimate the observed ozone levels, so evaluating performance using 8-hour average data tends to obscure underlying performance features.

EPA established performance goals for 1-hour ozone modeling for three statistical measures (EPA, 1996):

- Accuracy of the predicted peak 1-hour ozone. The ratio of the highest predicted 1-hour ozone to the highest observed 1-hour ozone. We limit the predicted peak to within a 50-km radius of the observed peak to avoid comparing a predicted peak in Dallas with an observed peak in Houston, for example. The EPA goal is within +/- 20% error.

- Normalized bias for observed values above 60 ppb – a measure of whether the model tends to over or under-predict high 1-hour ozone values. The EPA goal is within +/- 15% normalized bias.

$$Normalized\ Bias = 100\left(\frac{1}{N}\right)\sum (O_{tl} - E_{tl}) / O_{tl}$$

Where O_{tl} and E_{tl} are, respectively, the observed and estimated hourly ozone concentration at site l and time t (i.e., matched by time and location).

- Gross error for observed values above 60 ppb – a measure of overall agreement for high ozone values. The EPA goal is less than 35% normalized gross error.

$$Normalized\ Gross\ Error = 100\left(\frac{1}{N}\right)\sum |O_{tl} - E_{tl}| / O_{tl}$$

There are no similar statistical performance goals for 8-hour ozone performance. EPA's draft modeling guidance for 8-hour ozone (EPA, 1999) emphasizes consideration of whether model results are consistent with a conceptual understanding of what happened during the episode period.

Model performance was also evaluate using isopleth plots that compare the spatial patterns of ozone to the observed monitored values on a map, and timeseries plots that compare the observed and predicted ozone levels at a specific monitor overtime.

The only ozone precursor data available in the 4 km grid were NOx data from the Longview monitor (CAMS 19).

BASE CASE 1

CAMx base case 1 used meteorology from MM5 run 3b, as discussed in Section 4. Close examination of the vertical mixing predictions from run 3b showed unrealistic geographic variations in mixing that appeared to be artifacts of the Gayno-Seaman PBL scheme used in run 3b. These problems were not obvious from the meteorological performance evaluation (Emery and Tai, 2002). However, similar problems have been found in other studies and were discussed at a July 2002 EPA workshop on meteorological modeling for air quality applications. Following this workshop, a new MM5 simulation (run 5) was completed that used the same MM5 configuration as run 3b, but replaced the Gayno-Seaman PBL scheme with the Blackadar PBL scheme. Run 5 showed improved performance over run 3b and was used in CAMx Base Case 2. No ozone modeling results are shown from CAMx base case 1.

BASE CASE 2

CAMx base case 2 used meteorology from MM5 run 5, as discussed in Section 4. Table 6-2 shows the normalized bias over all monitors in the 4 km and 12 km grids in base case 2. There was a tendency to underpredict ozone at monitor locations in both grids on all days. The 12 km grid results are dominated by the Houston and Dallas areas because they have a large number of monitors. The 4 km grid results are for the three Northeast Texas monitors shown in Figure 6-1 (Longview, Tyler, Marshall) and exclude the two Shreveport monitors. The Shreveport monitors were excluded because the focus of this study is on Northeast Texas.

Table 6-2. Normalized bias for base case 2 12 km and 4 km grid results.

Grid	Aug 15	Aug 16	Aug 17	Aug 18	Aug 19	Aug 20	Aug 21	Aug 22
12 km	-11.9	-7.8	-12.9	-4.1	-5.5	-10.6	-20.9	-12.9
4 km NE Texas	-11.1	-19.5	-15.8	1.5	-7.5	-22.2	-31.2	-13.4

Note: Cells shaded gray fail the EPA performance goal of +/-15%

The bias for the 12 km grid met the EPA goal for all days except August 21st. The bias for the 4 km grid was outside the EPA goal on 4 of 7 days, namely the 16th, 17th, 20th and 21st. The tendency to under-predict daytime ozone at monitors within the 4 km grid is shown in more detail in the timeseries plots in Figure 6-2. The negative bias existed for monitors near urban areas (Longview, Tyler, Bossier Parish) and more rural monitors (Marshall and Caddo Parish) suggesting that the modeled ozone levels entering Northeast Texas were too low. This issue was explored as part of a series of diagnostic tests, described below.

Despite the negative ozone bias, high ozone levels were predicted in the 4 km grid with base case 2. Figure 6-3 shows the daily maximum modeled and observed 1-hour ozone for August 17th, 1999. The highest modeled ozone levels in the 4 km grid were to the north of the NETAC area where there are no monitors to determine whether the model is correct. However, the modeled peak 1-hour ozone was very high and is suspect.

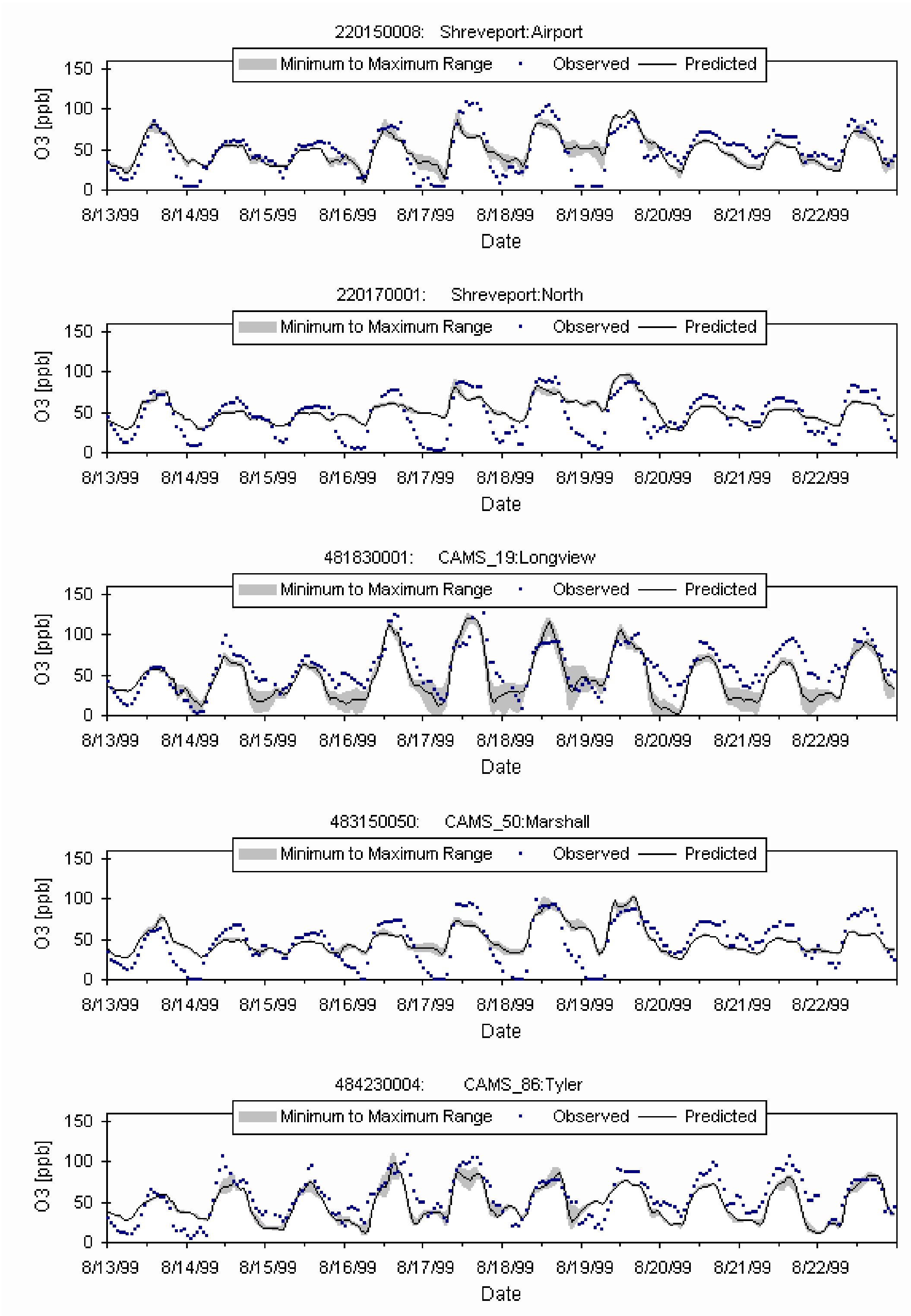


Figure 6-2. Time series of 1-hour ozone for the 4 km grid for 1999 base case 2.

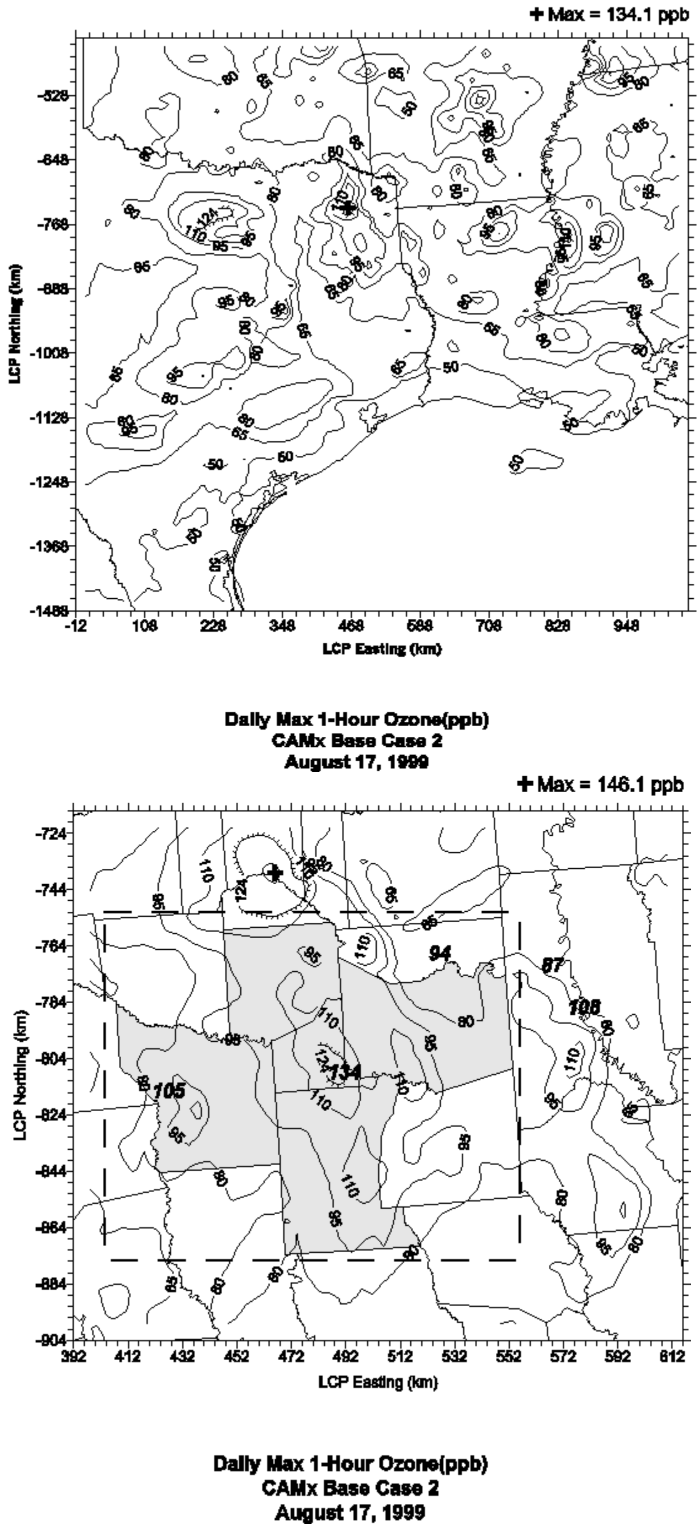


Figure 6-3. Base case 2 daily maximum 1-hour ozone on August 17th, 1999 for the 12 km (top) and 4 km (bottom) grids.

Diagnostic Tests for Base Case 2

A series of diagnostic tests were performed to investigate how changing CAMx inputs and model configuration influenced ozone predictions in Base Case 2. Tests diag1 - diag4 were based on the modeling protocol. The other tests were chosen to investigate potential causes for the tendency to underpredict ozone levels in the 4 km grid. The tests and results are summarized in Tables 6-3 and 6-4.

Table 6-3. CAMx diagnostic simulations performed starting from Base Case 2

Run	Description	Conclusion
Base2	Base case 2	Tendency to underpredict 4 km grid ozone levels by ~10 ppb on average
diag1	Base2 with zero anthropogenic emissions	Ozone levels were much lower without anthropogenic emissions
diag2	Base2 with 30% cut in biogenic emissions	Reducing biogenic VOCs resulted in lower ozone levels
diag3	Base2 with high 36 km grid boundary conditions (Ozone = 60 ppb rather than 40 ppb)	20 ppb higher ozone BCs increased ozone in the 4 km grid by about 15 ppb
diag4	Base2 with no plume in grid option	Small ozone sensitivity in 4 km grid
diag5	Base2 with sensitivity Kvs. A Kv profile was prescribed for the 4 km grid that gave a maximum PBL depth of 1500 m	Moderate ozone sensitivity in 4 km grid but no systematic improvement in ozone bias
diag6	Base2 with drought stress effects on dry deposition rates	Lower deposition rates lessened the ozone underprediction bias
diag7	Base2 using the more accurate chemistry solver option (IEH rather than CMC)	IEH solver slightly reduces ozone underprediction bias. Model run times were doubled.
diag8	diag7 with higher CAMx top (~10 km rather than ~4 km) and every MM5 layer mapped directly to CAMx (23 layers rather than 12)	Runs diag8 - diag12 systematically investigated sensitivity to CAMx layer structure and model top. Several runs were needed to separate confounding effects. Raising the model top from 4 km to 10 km had little impact on ozone. Using more layers had some impact, tending to raise daytime ozone and lower nightime ozone. This effect was mainly due to lowering the surface layer thickness from 40 m to 20 m. The change in model timesteps that resulted from raising the model top from 4 km to 10 km was not important.
diag9	diag7 with higher CAMx top (~10 km) and 15 layers in CAMx	
diag10	diag7 with higher CAMx top (~6 km) and 13 layers in CAMx	
diag11	diag8 with longer timesteps (CFL number increased to 0.9 from 0.5) to determine whether timesteps were the difference between diag7 and diag8	
diag12	diag7 with original CAMx top (~4 km) and every MM5 layer mapped directly to CAMx (15 layers rather than 12)	

Table 6-4. Peak 1-hour ozone levels in the NETAC area for base case 2 and diagnostic tests.

Date	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
Observed peak 1-hour ozone in Northeast Texas(ppb)								
Observed	95	124	134	91	101	99	107	107
Modeled peak 1-hour ozone in Northeast Texas (ppb)								
base2	77	122	129	125	122	86	90	105
diag1	31	35	33	29	30	24	30	32
diag2	74	109	113	116	111	85	85	96
diag3	84	128	136	128	126	90	95	110
diag4	77	122	129	127	123	86	91	106
diag5	74	107	126	129	133	87	87	105
diag6	85	130	137	132	133	98	99	114
diag7	78	122	130	126	124	87	91	106
diag8	78	119	127	127	122	89	90	106
diag9	78	119	125	126	124	88	90	106
diag11	82	123	131	129	129	91	91	108
diag12	79	123	136	129	129	88	91	106
Difference in modeled 1-hour peak ozone from base case 2 (ppb)								
diag1	-46.5	-86.6	-96.1	-95.9	-91.9	-62.8	-60.1	-72.6
diag2	-3.0	-12.1	-16.0	-8.5	-11.2	-1.3	-5.0	-8.4
diag3	6.9	6.4	6.8	3.2	3.2	3.1	4.4	5.2
diag4	-0.3	0.2	0.2	2.4	0.5	-0.3	0.4	0.8
diag5	-3.2	-14.7	-2.9	3.7	10.7	0.5	-2.8	0.0
diag6	7.6	8.5	7.9	7.2	10.3	11.2	8.4	9.0
diag7	0.7	0.7	0.8	1.5	1.2	0.5	0.7	1.2
diag8	1.1	-3.0	-1.2	2.2	0.0	2.8	-0.5	1.3
diag9	0.9	-2.8	-3.5	1.2	1.9	1.2	-0.2	1.2
diag11	4.2	1.5	2.7	4.2	6.8	4.6	1.0	3.5
diag12	1.6	0.9	6.8	4.3	6.2	1.6	0.6	1.3

Note: The NETAC area was defined by the dashed box surrounding the 5 counties shown in Figure 6-3.

The following recommendations resulted from the Base Case 2 diagnostic simulations:

- The more accurate IEH chemistry solver was selected for use based on run diag7. This has a small effect on ozone, but the IEH solver is technically superior. Changing the chemistry solver does not change the chemical reactions, only the numerical scheme used to solve the chemistry.

- The CAMx vertical layer structure was changed from 12 layers to 15 layers with the model top at 4 km in both cases (as in run diag12). With the 15-layer configuration, the CAMx layers correspond 1:1 with the MM5 layers. The important change is reducing the thickness of the surface layer from 40 m to 20 m. This change tends to increase daytime ozone peaks and reduce nighttime ozone minimums.

- Modify the dry deposition rates to reflect the drought conditions that existed during the summer of 1999 (based on run diag8). This change is discussed in more detail below.

Drought Stress Change

The drought stress sensitivity test was conducted because base case 2 ozone levels were underpredicted, because dry deposition is a significant removal process for ozone at the regional scale, and because dry deposition rates to vegetation are modified by drought. The physical process by which vegetation removes ozone (dry deposition) is that ozone diffuses into leaf cuticles through the stomata and is destroyed by contact with the leaf tissue (Weseley, 1989). One response of plants to moderate drought is to partially close leaf stomata in an attempt to reduce water loss. The GloBEIS biogenic emissions model (ENVIRON, 2001) models the effects of drought stress on biogenic emissions and includes a relationship between the stomatal conductance and the Palmer drought index (SPI) calculated by the Dept. of Agriculture. Figure 6-3 presents the SPI map for August 1999 and shows that much of the CAMx domain was in drought conditions in August 1999.

The drought stress change to CAMx was to apply a 50% reduction to the stomatal conductance term in the dry deposition algorithm. This required a change to the CAMx source code and had the effect of applying the drought stress change across the whole modeling domain. A more refined drought stress adjustment could be developed in the future by enabling CAMx to read the SPI map (Figure 6-2) and adjusting the stomatal conductance using the GloBEIS algorithm (Figure 6-3).

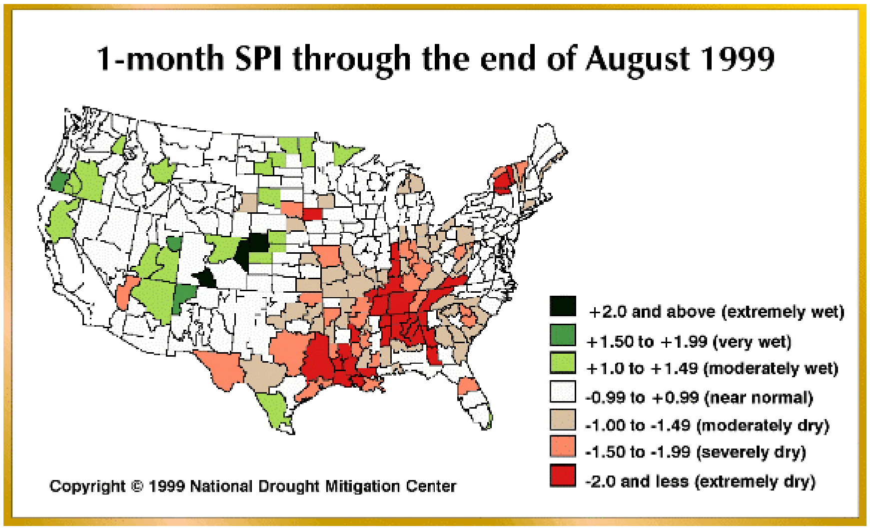


Figure 6-4. 1-month Standardized Precipitation Index ending in August 1999, indicating levels of drought relative to climatological norms in each climate zone.

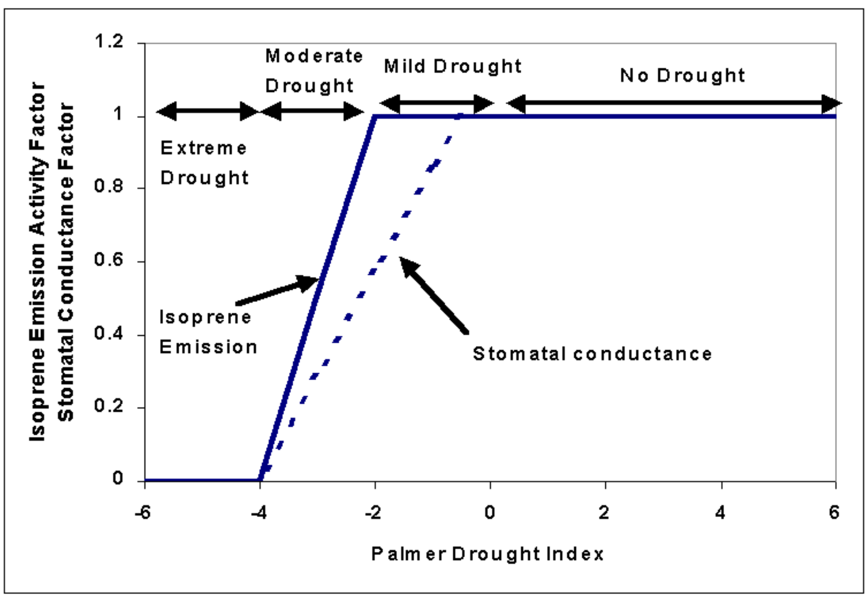


Figure 6-5. The GloBEIS3 relationship between leaf stomatal conductance and drought stress.

BASE CASE 3

CAMx base case 3 used MM5 meteorology from a new run (run5b) and CAMx changes selected from the base case 2 diagnostic tests. The MM5 radiation transfer scheme was changed to "RRTM" in run5b from the "Cloud Radiation Scheme" used in MM5 run5 and run3b (used for CAMx base cases 2 and 1, respectively). The RRTM improved performance for surface temperatures and had relatively little impact on other parameters (winds, mixing, etc.) and so MM5 run5b was preferred over MM5 run5.

Other changes between base case3 and base case 2 were: (1) Increased the number of CAMx vertical layers from 12 to 15, including a 20 m deep surface layer; (2) Used the more accurate IEH chemistry solver, and; (3) Modified the dry deposition to account for drought stress. These changes were discussed above.

The base case 3 normalized bias results for the 12 and 4 km grids are shown in Table 6-5. The bias statistic for the 4 km grid was calculated for just the Northeast Texas sites and excludes Shreveport monitors. Timeseries plots for the ozone monitoring sites in the 4 km grid are shown in Figure 6-6. Daily maximum 1-hour ozone plots for August 17th, 1999 are shown in Figure 6-7.

Table 6-5. Normalized bias for base case 3 12 km and 4 km grid results.

Grid	Aug 15	Aug 16	Aug 17	Aug 18	Aug 19	Aug 20	Aug 21	Aug 22
12 km	-9.2	-4.9	-8.4	3	5.6	-4.8	-17.6	-9.4
4 km NE Texas	-5	-14.6	-3.3	13	-1	-20.5	-25.4	-7.8

Note: Cells shaded gray fail the EPA performance goal of +/-15%

There were some improvements in model performance for ozone in base case 3 relative to base case 2. Ozone levels were generally higher in base case 3 than base case 2 reducing or eliminating the bias toward under-prediction seen in the normalized bias statistics for the 12 km and 4 km grids (Tables 6-5 and 6-2). For the 4 km grid, the normalized bias met the EPA goal on 6 of 8 days in base case 3 rather than 4 of 8 days in base case 2, but remained excessively low on August 20th and 21st. For the 12-km grid, ozone performance was acceptable for regional modeling in both base cases 2 and 3.

Although base case 3 showed less tendency toward ozone under-prediction (as shown by improved bias statistics) this was accompanied by some very high modeled peak ozone levels in the 4 km grid. Table 6-6 shows the modeled and observed peak ozone levels in Northeast Texas for base case 3. The modeled peaks exceeded the level of the 1-hour ozone standard (124 ppb) on August 16th-19th and the accuracy of the peak statistic failed the performance goal on August 18th and 19th. The very high modeled ozone levels on August 17th and 19th (147 ppb and 150 ppb) were a cause for concern because they were much higher than the highest observed level (134 ppb) during this entire period.

Table 6-6. Base case 3 modeled and observed peak ozone levels in Northeast Texas.

	Aug 15	Aug 16	Aug 17	Aug 18	Aug 19	Aug 20	Aug 21	Aug 22
Observed	95	124	134	91	101	99	107	107
Predicted	83	131	147	130	150	97	100	116
Accuracy	-13%	6%	10%	43%	49%	-2%	-7%	8%

Note: Cells shaded gray fail the EPA performance goal of +/-20%

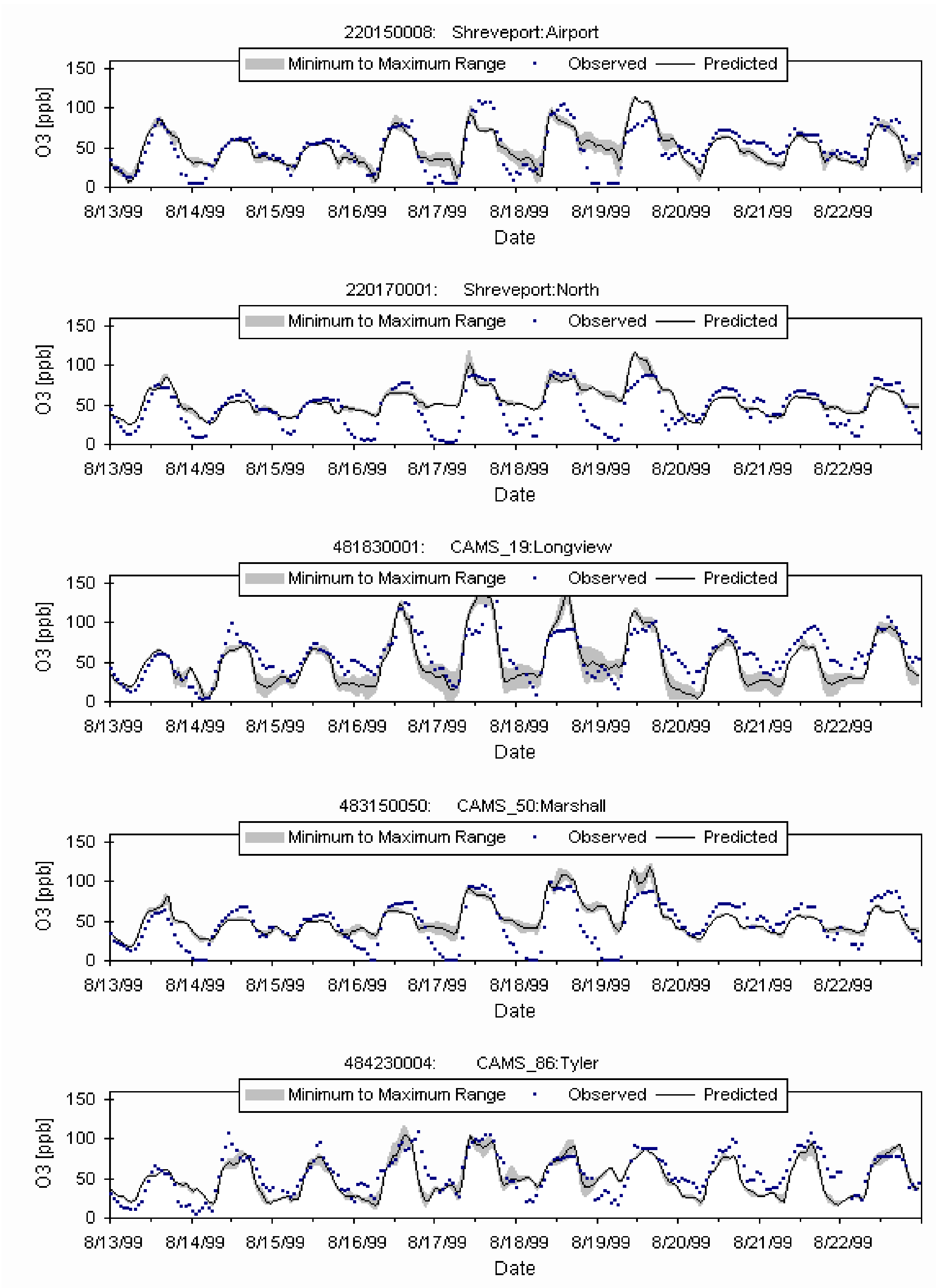


Figure 6-6. Time series of 1-hour ozone for the 4 km grid for 1999 base case 3.

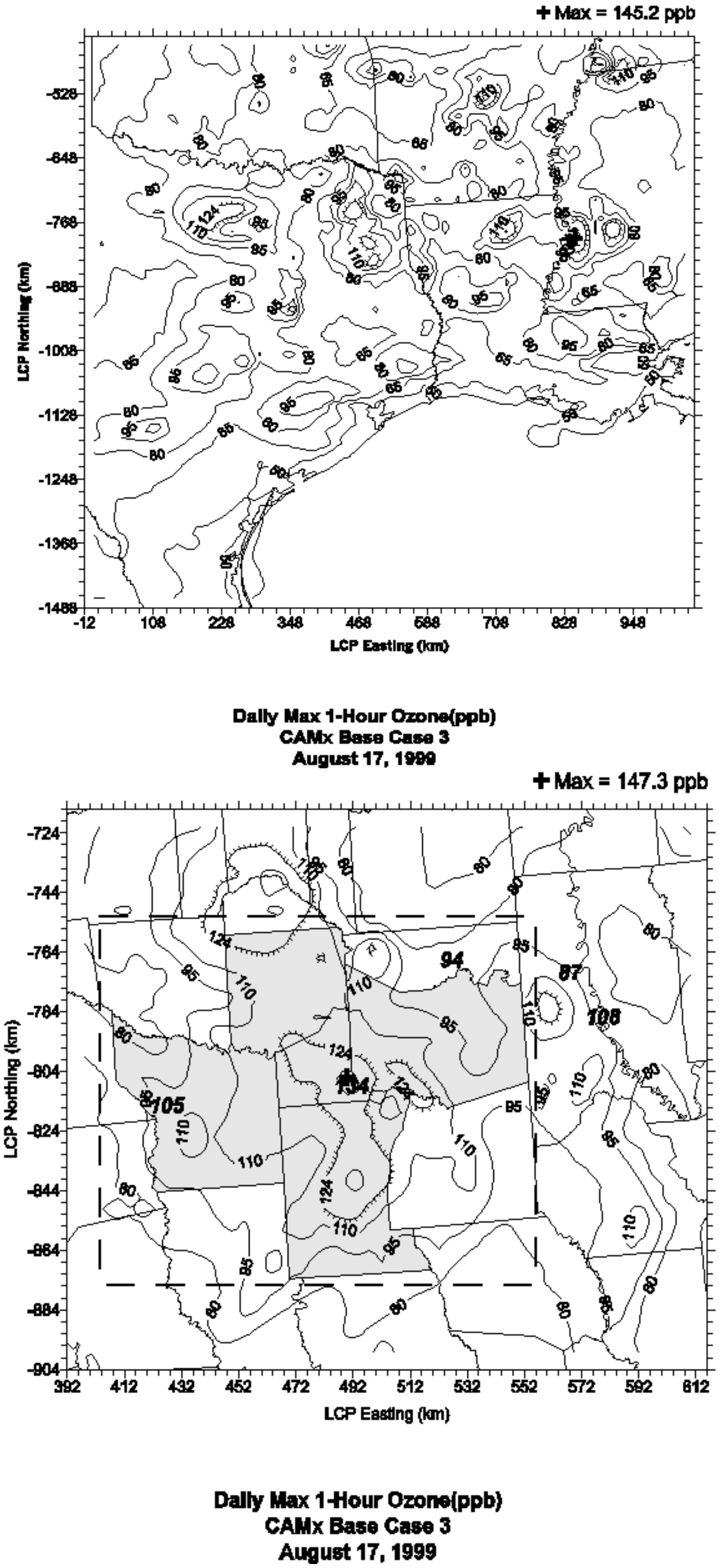


Figure 6-7. Base case 3 daily maximum 1-hour ozone on August 17th, 1999 for the 12 km (top) and 4 km (bottom) grids.

Base Case 3 Emissions Sensitivity Tests

A series of emissions sensitivity tests was conducted with base case 3 to characterize the response of ozone to emissions changes. The same tests were used as in previous work for the June 1995 and July 1997 ozone models (ENVIRON, 1999) and the same sensitivity test names were retained. The tests and the results are summarized in Tables 6-7 and 6-8.

The emissions sensitivity tests applied across the board 50% cuts to anthropogenic emissions from different sources. Biogenic emissions were not cut because biogenic emissions are considered non-controllable. A 50% reduction level was used in all cases to provide a simple basis for comparison, but this does not mean that feasible strategies exist to provide 50% reductions for all source types. Tests sens6a to sens6d reduced emissions across the entire modeling domain, whereas sens7d reduced emissions in just the 4 km grid. Comparing the results of sens7a and sens6a indicates the importance of reducing local emissions (i.e., within the 4 km grid) versus more distant emissions.

The impacts of the sensitivity tests on maximum 1-hour ozone levels in Northeast Texas area are shown in Tables 6-8. The NETAC area was defined by a rectangular box around the 5 county area, shown as a dashed line in Figure 6-3. This sub-regional analysis was used to focus on high ozone levels in the area for which NETAC is developing ozone control strategies rather than adjacent areas, such as Shreveport. The relative effects of the emissions sensitivities on 8-hour ozone were similar to 1-hour ozone and are not shown here.

Table 6-7. Summary of base case 3 emissions sensitivity tests.

Test	Description	Impact on peak 1-hour ozone
Sens6a	50% cut in all anthropogenic emissions.	Peak ozone levels reduced 21 to 37 ppb, depending upon the day.
Sens6b	50% cut in anthropogenic VOC emissions.	Peak ozone levels reduced 0 to 6 ppb, depending upon the day. VOC reductions ineffective (less than 3 ppb reduction) on all days but August 16th and 17th.
Sens6c	50% cut in anthropogenic surface NOx emissions.	Peak ozone levels reduced 6 to 18 ppb, depending upon the day. Surface NOx reductions effective on all days.
Sens6d	50% cut in elevated point NOx emissions.	Peak ozone levels reduced 4 to 17 ppb, depending upon the day. Elevated point NOx reductions effective on all days.
Sens7a	50% cut in all anthropogenic emissions outside the 4 km grid.	Peak ozone levels reduced 2 to 8 ppb, depending upon the day. Reduction greater than 3 ppb on only two days, August 20th and 23rd.

Table 6-8. Peak 1-hour ozone levels in the NETAC area for base case 3 and sensitivity tests.

Date	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
Observed peak 1-hour ozone in Northeast Texas(ppb)								
Observed	95	124	134	91	101	99	107	107
Modeled peak 1-hour ozone in Northeast Texas (ppb)								
base3	83	131	147	130	150	97	100	116
sens6a	62	104	117	100	113	67	73	92
sens6b	83	128	141	128	148	97	100	115
sens6c	72	120	136	112	134	78	86	110
sens6d	79	123	138	124	135	90	94	100
sens7a	81	129	144	126	148	89	97	112
Difference in modeled 1-hour peak ozone from base case 3 (ppb)								
sens6a	-21	-27	-30	-29	-37	-30	-27	-25
sens6b	0	-4	-6	-2	-2	0	0	-1
sens6c	-11	-11	-11	-18	-15	-18	-14	-6
sens6d	-4	-8	-10	-6	-14	-7	-6	-17
sens7a	-2	-2	-3	-3	-2	-8	-3	-5

Note: The Northeast Texas area was defined by the dashed box surrounding the 5 counties shown in Figure 6-3.

The conclusions from the emissions sensitivities for base case 3 were:

- Emissions reductions in the 4 km grid were much more effective than reductions outside the 4 km grid (compare sens6a and sens7a).
- Reductions in NOx were much more effective than reductions in VOC (compare sens6b with sens6c and sens6d).
- Two days showed some sensitivity to VOC reduction, namely August 16th and 17th. These were days when the peak modeled ozone was very close to CAMS19 and Texas Eastman. However, NOx reduction was still more effective than VOC reduction on these days.
- Reductions in both surface and elevated point source NOx were effective (compare sens6c and sens6d).

Base Case 3 Diagnostic Tests

Two diagnostic tests were conducted with base case 3 to confirm results from base case 2 diagnostic tests. The base case 3 diagnostic tests confirmed the impacts of the drought stress adjustment and changing the chemistry solver from CMC to IEH. The differences in daily maximum 1-hour ozone for the 4 km grid on August 17th are shown in Figures 6-8 and 6-9, respectively. These diagnostic tests did not change any conclusions from base case 2, discussed above.

Recommendations from Base Case 3

Base case 3 showed generally higher ozone levels in the 4 km grid which generally improved the normalized bias statistic. However, the higher ozone levels in the 4 km grid also were associated with some very high 1-hour ozone levels (up to 150 ppb) in Northeast Texas on August 16th – 19th. The peak 1-hour ozone levels were significantly overpredicted on August 17th and 18th. The high peak 1-hour ozone levels were a cause for concern because they were much higher than the observed peak 1-hour ozone of 134 ppb during this period. Further analysis of the meteorological modeling results suggested that the very high 1-hour ozone peaks resulted from excessive stagnation in the modeled meteorology during August 16th – 19th. The excessive stagnation was traced to the meteorological data being used for analysis nudging with the MM5 data assimilation (4DDA) scheme. New MM5 modeling was undertaken to develop a revised CAMx base case.

Two emission inventory issues also were identified after base case 3 was completed:

Shreveport Emissions: The Louisiana Department of Environmental Quality (LADEQ) provided emission inventories for the Shreveport area. In reviewing the base case 3 modeling emissions, it was noticed that area source NOx emissions were reported as zero for Bossier and Caddo Parishes. Further investigation showed that the LADEQ area source inventory included NOx emissions only for prescribed burning and wildfires. These emissions categories are not included in ozone modeling inventories so the LADEQ area source NOx emissions were effectively zero. To correct this problem, the LADEQ area and offroad emissions were replaced by EPA's NET99 emission inventory. This change increased area plus offroad NOx emissions from 12.4 to 84.4 tons/day and area plus offroad VOC emissions from 19.5 to 50.9 tons/day in the Shreveport 4 parish area.

Texas Eastman Emissions: The emission inventory for Texas Eastman in base case 3 was based on version 6b of the TCEQ Point Source Database (PSDB). Errors in the Texas Eastman emission inventory were found and corrected in the PSDB and the corrected version 12b inventory was available for modeling. The CAMx emission inventory was updated to version 12 b of the PSDB after base case 3. The update did not change Texas Eastman's NOx emissions (14.4 tons/day) but reduced VOC emissions from 12.3 to 10.6 tons/day. Also, the detailed VOC speciation was completely revised to reflect the version 12b PSDB inventory, as described in section 3.

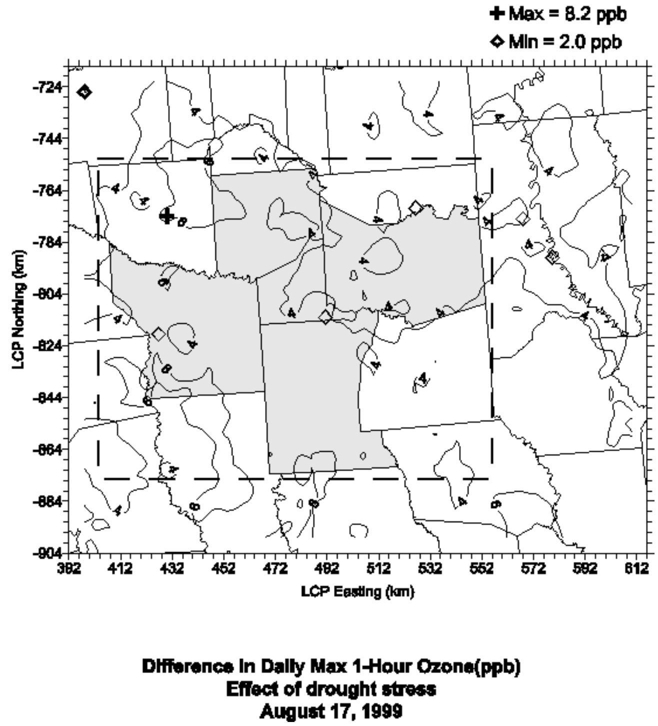


Figure 6-8. Effect of modifying the dry deposition for drought stress in base case 3. Change in daily maximum 1-hour ozone in the 4 km grid on August 17th, 1999 (Drought Stress – No Stress).

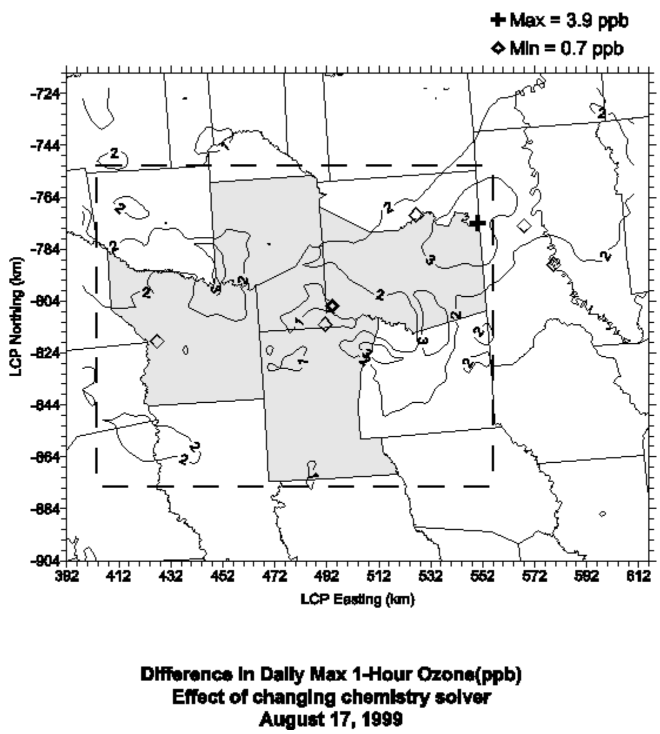


Figure 6-9. Effect of the chemistry solver from CMC to IEH in base case 3. Change in daily maximum 1-hour ozone in the 4 km grid on August 17th, 1999 (IEH – CMC).

BASE CASE 4

Base case 4 evaluated the impacts of the Texas Eastman emission inventory update recommended after base case 3 using meteorology from MM5 run 6. This emission inventory change had negligible impact on daily maximum 1-hour ozone levels (less than 0.1 ppb impact on all days) and so no results are shown here. The Texas Eastman emissions change had little impact on ozone because only VOC emissions changed and ozone is mostly sensitive to NOx emissions.

BASE CASE 5

The changes between base case 5 and base case 3 were:

- Updated the meteorology from MM5 run 5b to run 6.
- Changed the Shreveport area and offroad emissions from LADEQ data to EPA NET99 data adding about 72 tons/day of NOx and 31.4 tons/day of VOC in the Shreveport 4 parish area.
- Updated the Texas Eastman emission inventory from version 6b to version 12b of the TCEQ PSDB reducing VOC emissions from 12.3 to 10.6 tons/day and updating the speciation for VOC emissions.

Complete 1-hour ozone model performance statistics for base case 5 are shown in Table 6-9 for the 4 km grid and Table 6-10 for the 12 km grid. Timeseries plots for the 4 km grid monitors are shown in Figure 6-10 and the same data are shown as a scatter plot in Figure 6-11. A scatter plot of observed and modeled 1-hour ozone values for 12 km grid monitors is shown in Figure 6-12. Isopleth plots of daily maximum 1-hour ozone are shown for the 4 km grid in Figure 6-13 and for the 12 km grid in Figure 6-14. Isopleth plots of daily maximum 8-hour ozone are shown for the 4 km grid are shown in Figure 6-15.

For the 4 km grid, model performance statistics were calculated for the Northeast Texas area defined by the dashed box in Figure 6-3. Thus, the Shreveport monitors were excluded from the calculation of model performance statistics in order to focus on Northeast Texas. The accuracy of the peak statistic met the EPA performance goal on 6 of 8 days (Table 6-9). The predicted peak was too high and outside the EPA range on August 18th (136 ppb) and August 19th (133 ppb). However, given the small number of ozone monitors in Northeast Texas, these predicted peak ozone levels are not unreasonable and they are comparable to the peak observed during this episode period (134 ppb). The normalized bias and gross error statistics on August 18th and 19th are very good and are well within the target ranges. The normalized gross error was within the target range on all days and was well within the range (less than 20%) on 5 of 8 days. The normalized bias was within the target range on 5 of 8 days. The bias was too low and outside the target range on August 16th, 20th and 21st.

Timeseries of 1-hour ozone for sites in the 4 km grid are shown in Figure 6-10. The modeled ozone levels generally tracked the observed levels well, and the scatter plot of modeled and observed ozone levels for the 4 km grid sites (Figure 6-11) also shows generally good agreement between modeled and predicted levels.

For the 12 km grid, the model performance statistics for 1-hour ozone (Table 6-10) show that the normalized gross error was well within the target range on all 8 days and the normalized bias was within the target range on 5 of 8 days. The normalized bias was outside the target range on August 17th, 20th and 21st. The accuracy of peak statistic was within the target range on only 4 of 8 days. The 12 km grid peak ozone is not expected to be accurate for regional modeling because the peaks occurred in urban areas (Dallas or Houston) that are not well represented at 12 km resolution. The daily maximum ozone isolpleth plots for the 12 km grid (Figure 6-14) show that high ozone levels were modeled in areas surrounding Northeast Texas throughout the episode period. A scatter plot of observed and modeled ozone levels (Figure 6-12) for the 12 km grid shows generally good agreement between the modeled and observed levels with no clear tendency toward underpredicting the ozone levels in the 12 km grid except at the highest observed levels (above about 90 ppb). The normalized bias statistic for the 12 km grid was negative (underprediction) on all days, however this statistical comparison was calculated for observed values above 60 ppb and is heavily influenced by the highest observed levels which are not expected to be reproduced well using a 12 km grid.
Model performance in the 12 km grid is acceptable for characterizing ozone levels in the areas around the 4 km grid.

Table 6-9. Base case 5 model performance statistics for 1-hour ozone for the 4 km grid in Northeast Texas.

	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
Peak ozone in Northeast Texas (ppb)								
Observed	95	124	134	91	101	99	107	107
Predicted	84	105	136	136	133	109	98	106
Accuracy of Peak in Northeast Texas: EPA Goal +/-20%								
	-11	-15	2	50	32	10	-9	-1
Normalized Bias (%): EPA Goal +/-15%								
	-9	-24	-13	7	-6	-18	-24	-8
Normalized Gross Error (%): EPA Goal 35%								
	14	25	20	12	12	19	24	15

Notes: Shaded values are outside the EPA performance goal.
The normalized bias and gross error are calculated for observed values greater than 60 ppb.
The Northeast Texas area was defined by the dashed box surrounding the 5 counties shown in Figure 6-3 and does not include the Shreveport monitors.

Table 6-10. Base case 5 model performance statistics for 1-hour ozone in the 12 km grid.

	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
Peak ozone (ppb)								
Observed	185	144	150	131	136	127	161	107
Predicted	120	111	115	137	152	116	117	104
Accuracy of Peak: EPA Goal +/-20%								
	-35	-23	-23	5	12	-9	-28	-3
Normalized Bias (%): EPA Goal +/-15%								
	-10	-8	-17	-11	-7	-19	-23	-12
Normalized Gross Error (%): EPA Goal 35%								
	19	19	24	23	24	26	26	18

Notes: Shaded values are outside the EPA performance goal.
The normalized bias and gross error are calculated for observed values greater than 60 ppb.
The predicted peak is the peak value within 50 km of the observed peak on each day.

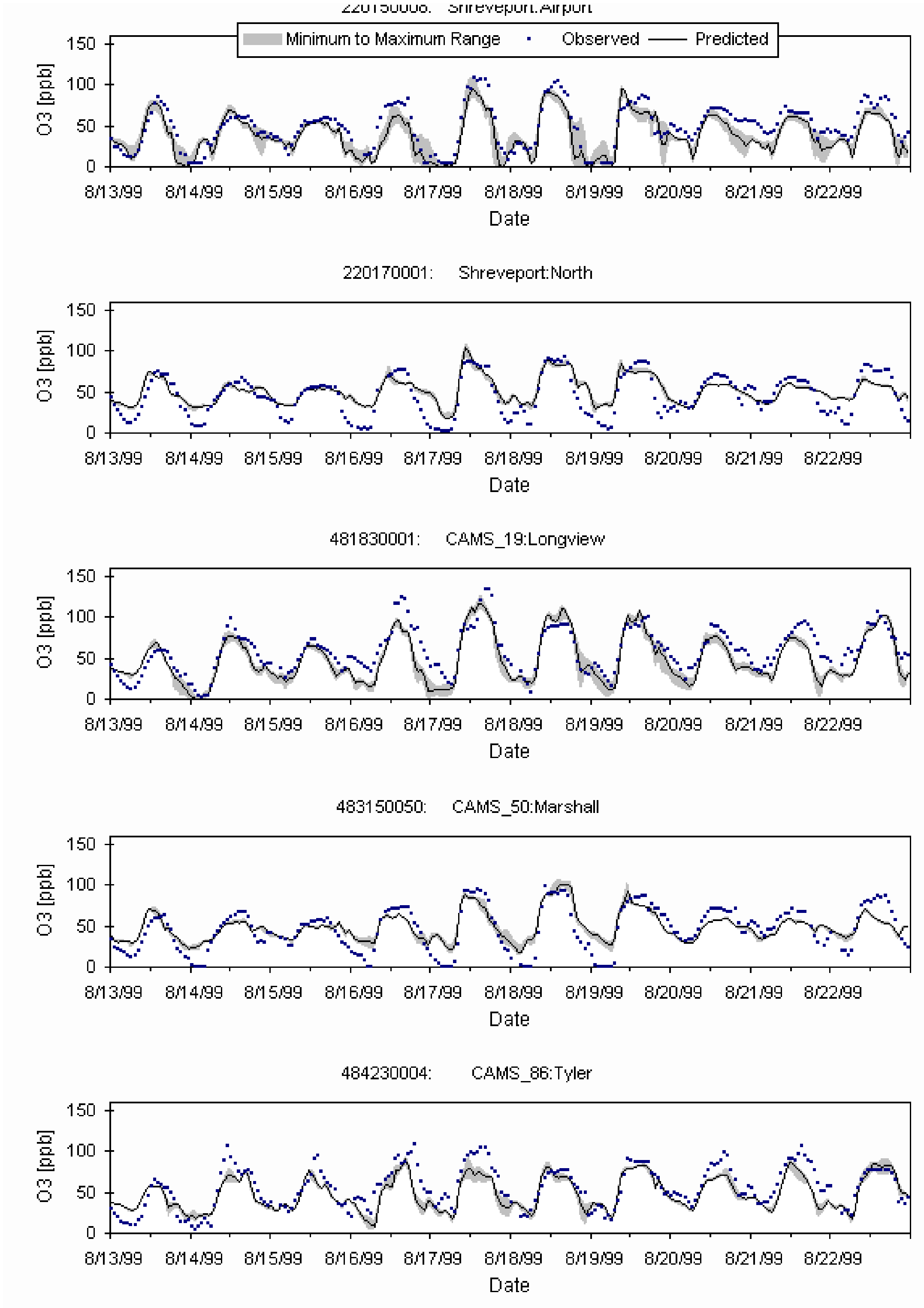


Figure 6-10. Time series of 1-hour ozone for the 4 km grid for 1999 base case 5.

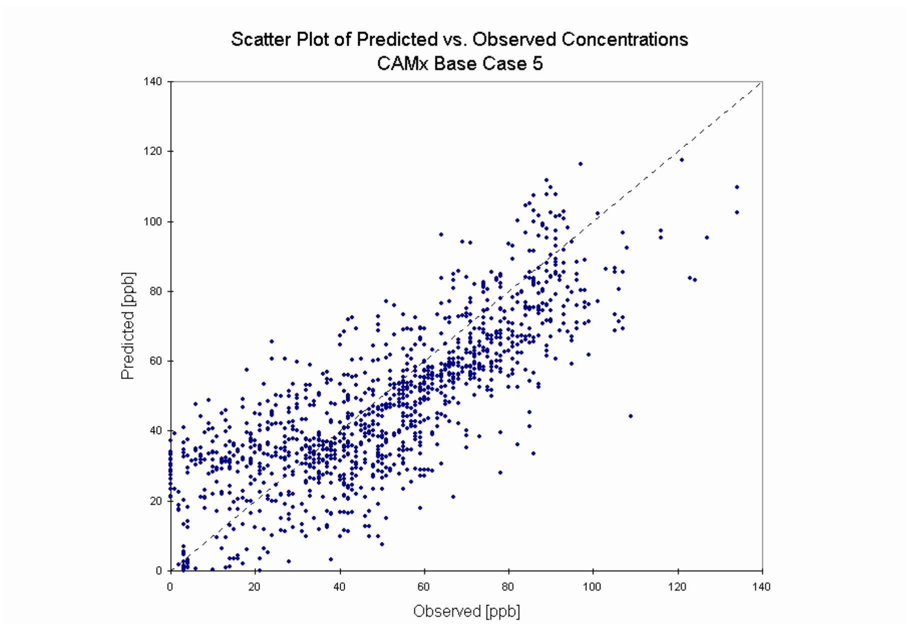


Figure 6-11. Base case 5 scatter plot of predicted and observed 1-hour ozone concentrations at Northeast Texas monitoring sites for August 13-22, 1999.

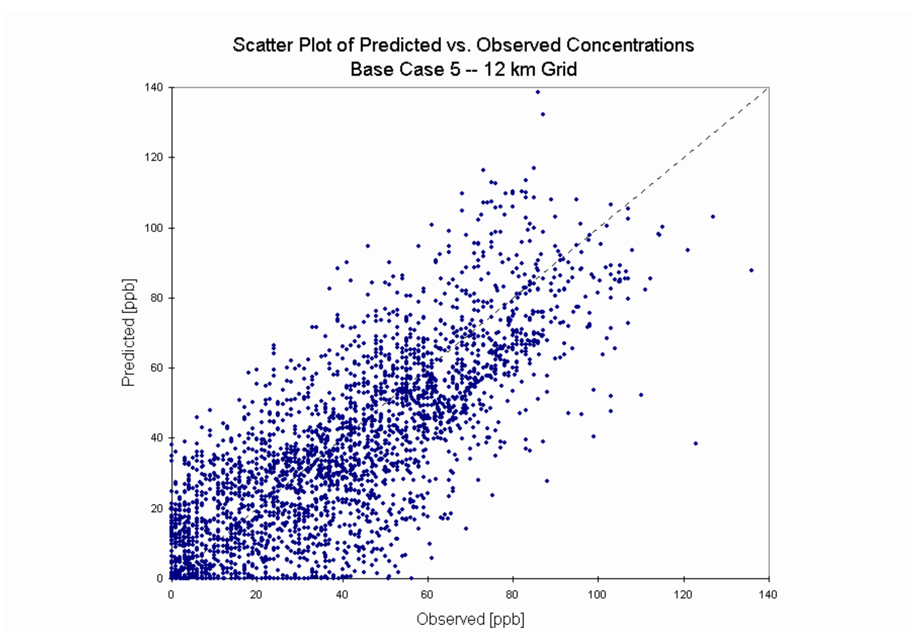


Figure 6-12. Base case 5 scatter plot of predicted and observed 1-hour ozone concentrations at all 12 km grid monitoring sites for August 13-22, 1999.

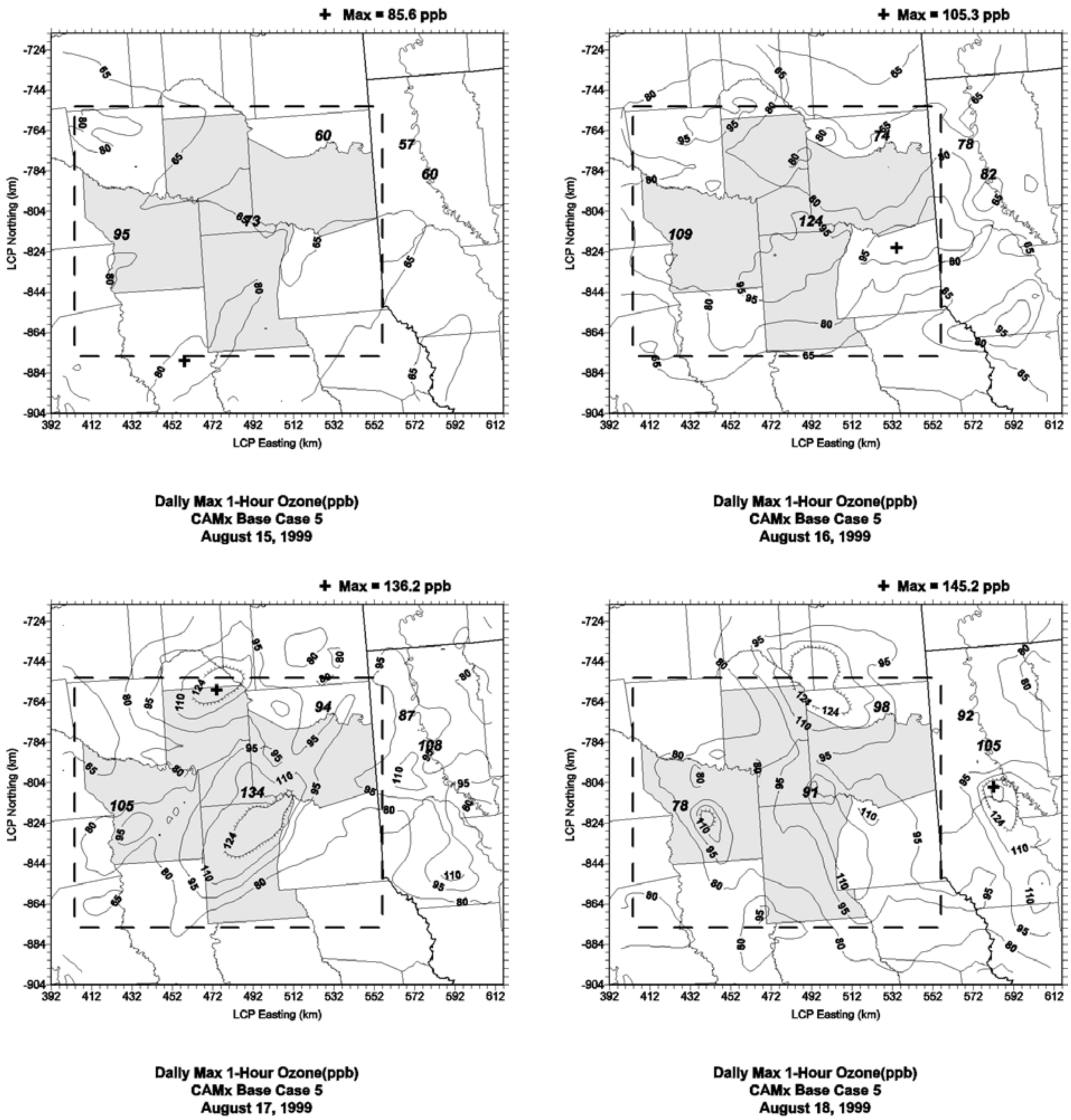


Figure 6-13. 1999 base case 5 daily maximum 1-hour ozone for the 4 km grid.

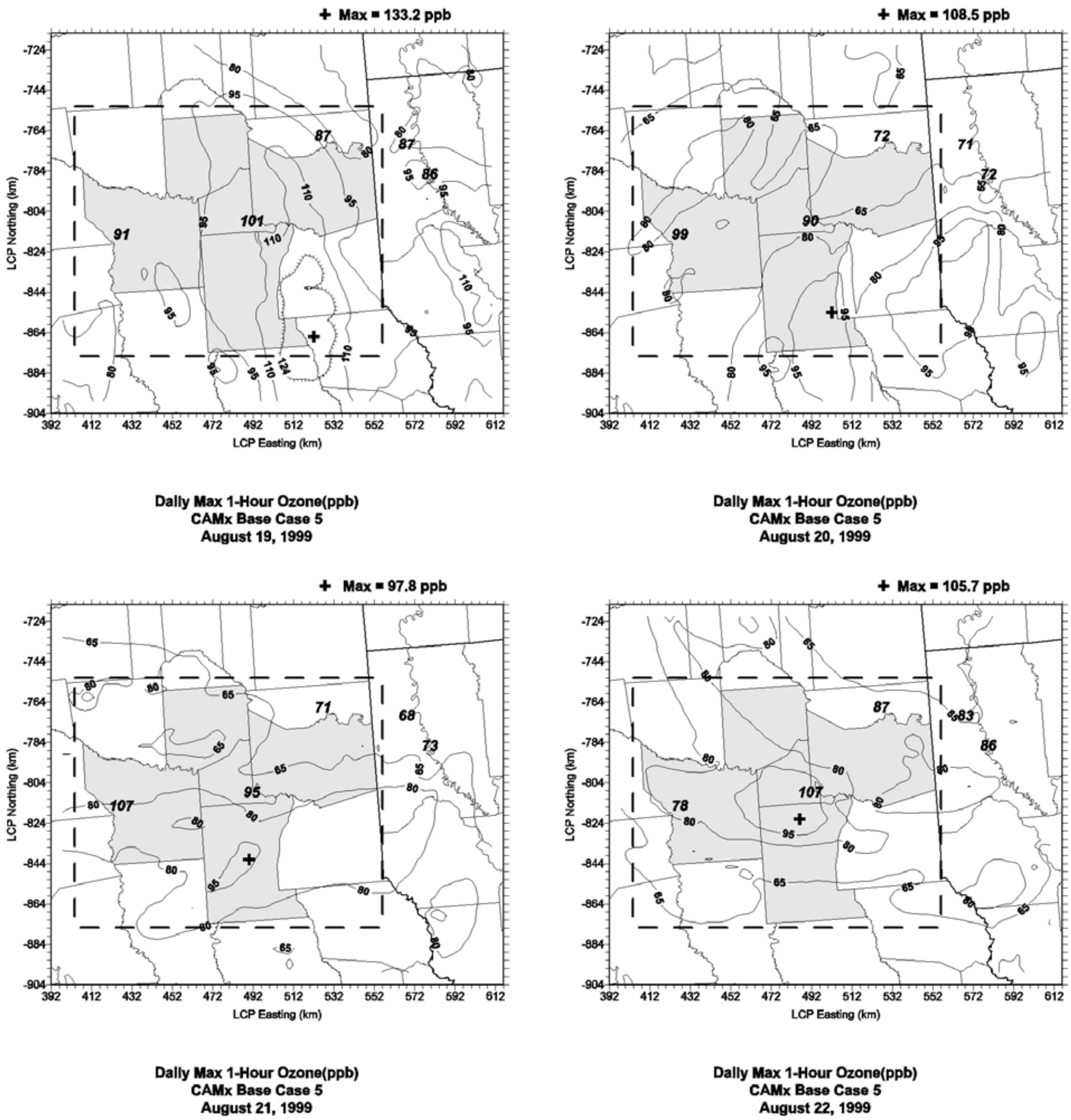


Figure 6-13 (concluded). 1999 base case 5 daily maximum 1-hour ozone for the 4 km grid.

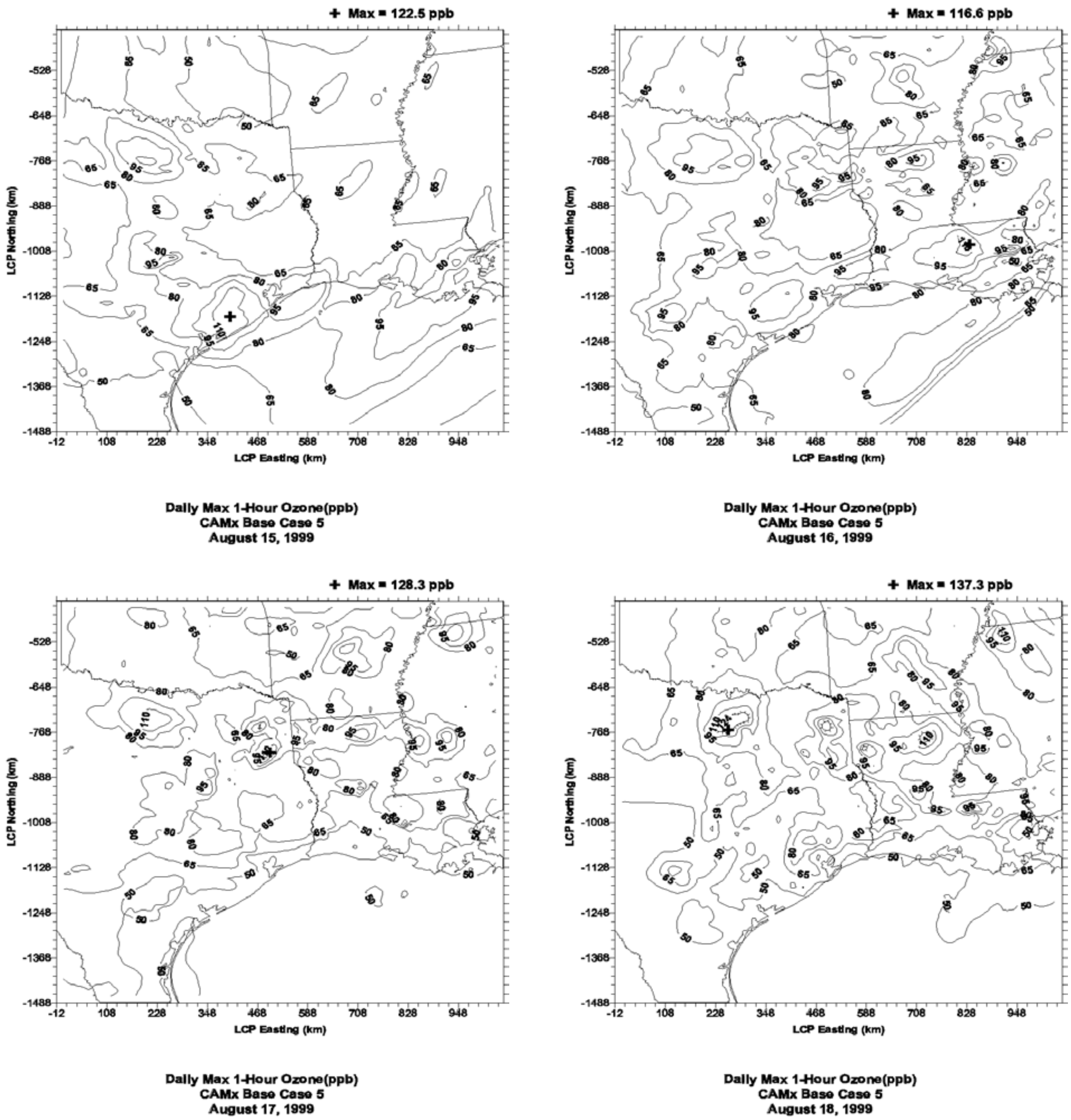


Figure 6-14. Base case 5 daily maximum 1-hour ozone for the 12 km grid.

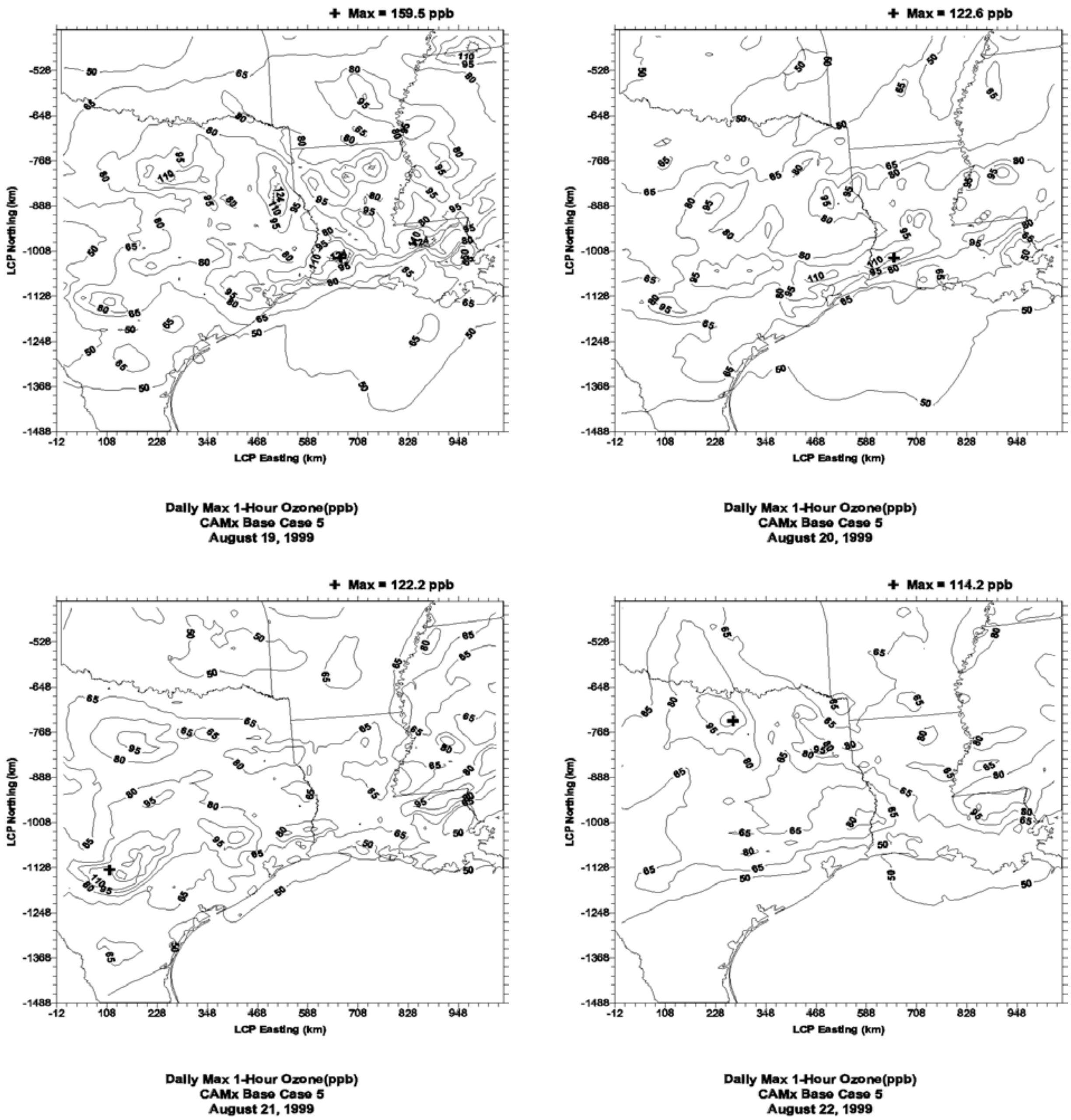


Figure 6-14 (concluded). Base case 5 daily maximum 1-hour ozone for the 12 km grid.

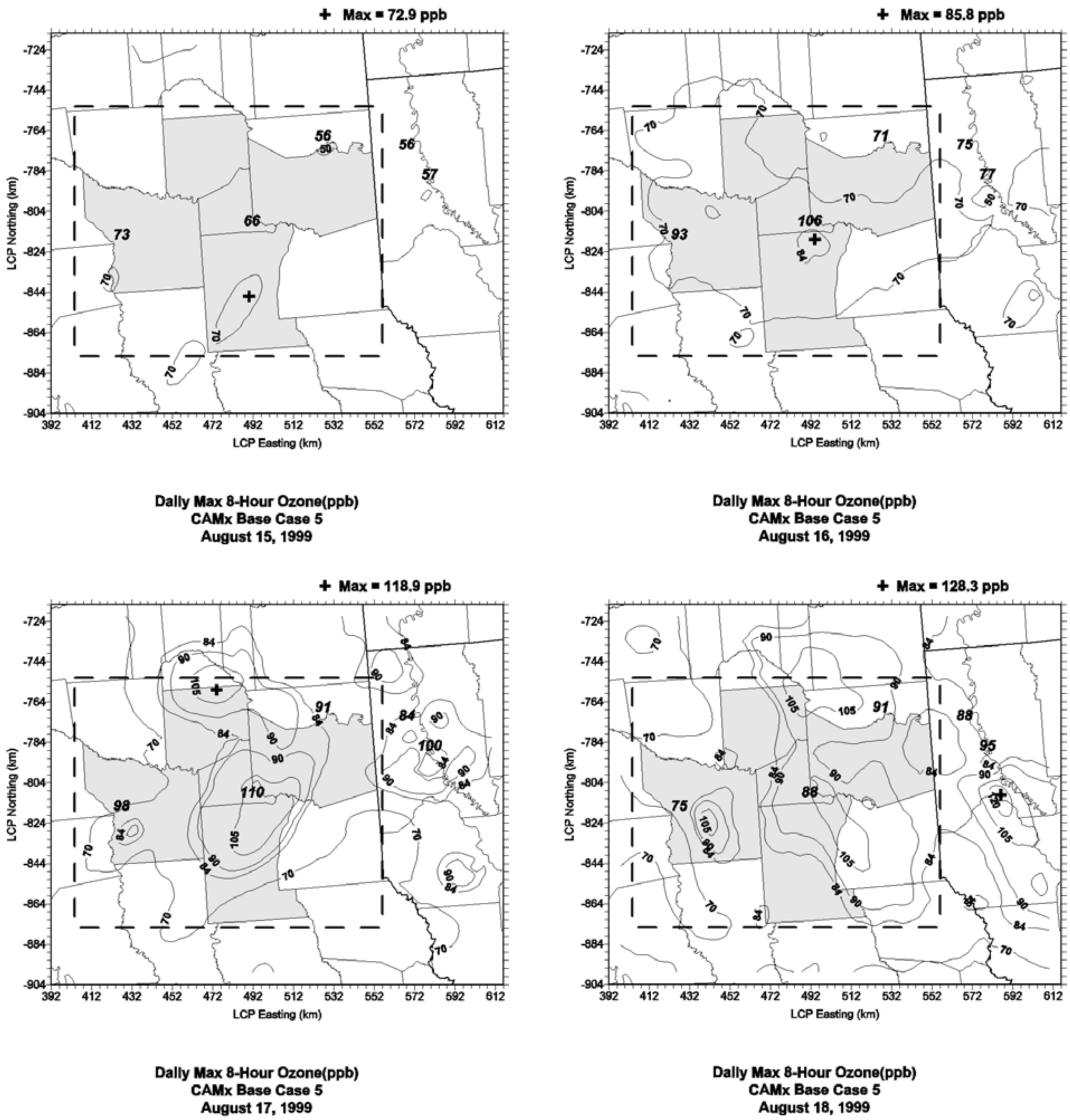


Figure 6-15. 1999 base case 5 daily maximum 8-hour ozone for the 4 km grid.

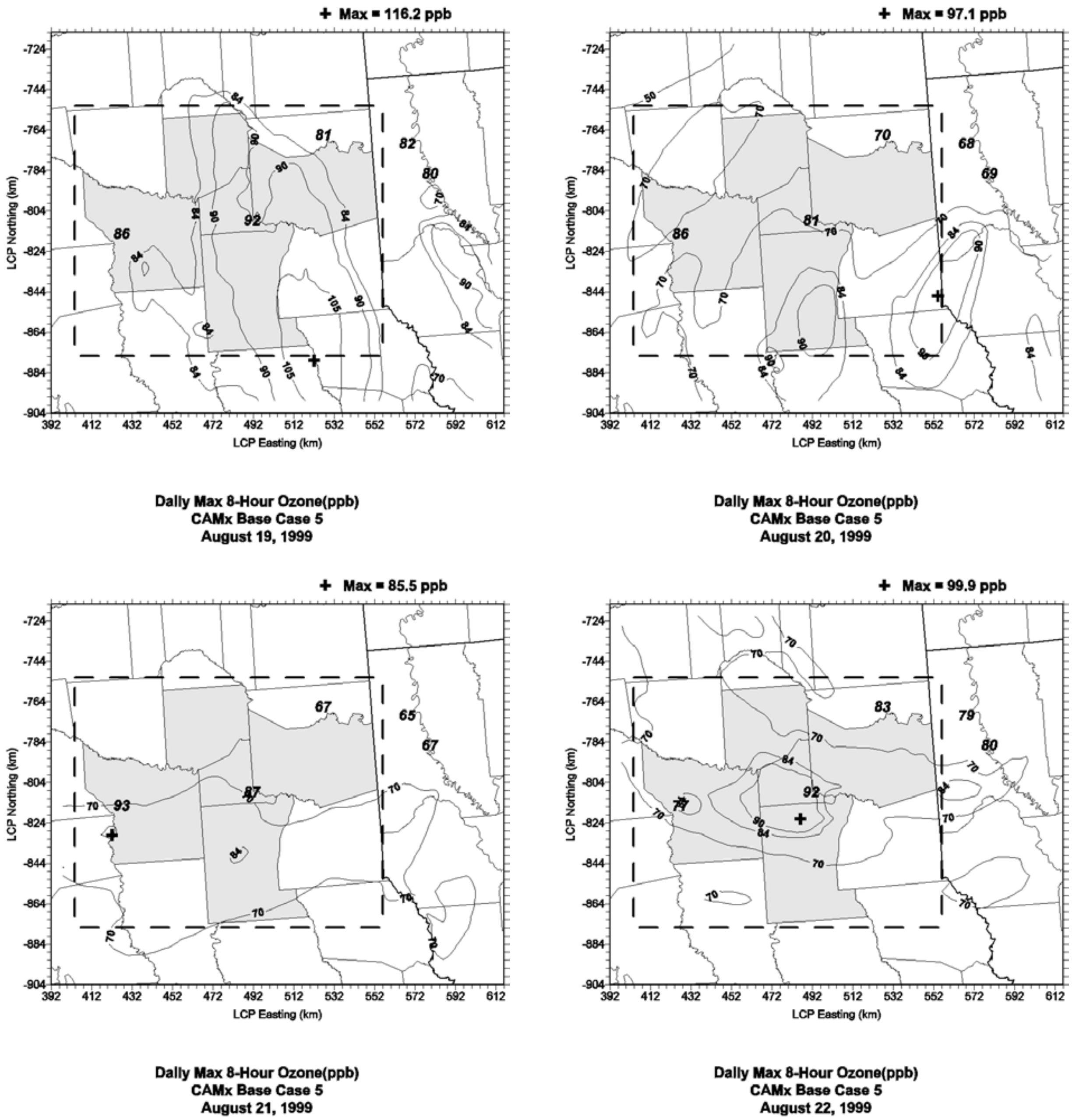


Figure 6-15 (concluded). 1999 base case 5 daily maximum 8-hour ozone for the 4 km grid.

CANDIDATE DAYS FOR OZONE ATTAINMENT DEMONSTRATIONS

1-Hour Ozone

The 1-hour ozone standard was exceeded once during the August 15-22, 1999 period, at Longview on August 17th. The model performance for August 17th met all of the EPA statistical performance criteria (Table 6-9) and this day can be used in a 1-hour ozone attainment demonstration. The modeled 1-hour peak ozone on this day (136 ppb) was very similar to the observed peak (134 ppb). The modeled peak occurred in northern Upshur county away from monitor locations whereas the observed peak was at Longview, however the model did predict an area of 1-hour ozone greater than 124 ppb in Rusk county just south of the Longview monitor. There are no other days suitable for 1-hour attainment demonstration modeling in the August 1999 episode.

8-Hour Ozone

For 8-hour ozone modeling, there are no clear guidelines to determine which modeling days could be used in an attainment demonstration. The 8-hour ozone modeling guidelines are less rigid in model performance because the 8-hour attainment demonstration methodology is believed to be more accommodating of model error and bias. The 8-hour ozone attainment demonstration methodology is discussed in detail below. The overpredicted peak 1-hour ozone levels on August 18th and 19th (Table 6-9) are a concern for 1-hour attainment demonstration modeling, but are not a major concern for 8-hour attainment demonstrations because the relative reductions in modeled ozone levels are important, not the absolute levels. The negative bias for 1-hour ozone in the 4 km grid on August 16th, 20th and 21st (Table 6-9) may be a concern if ozone levels are relatively unresponsive to emission reductions on these days, thus damping the relative reduction factors (RRFs) used in the 8-hour attainment demonstration. All 8 days were carried forward and evaluated using the 8-hour ozone attainment demonstration methodology, and the responsiveness of August 16th, 20th and 21st to emission reductions was investigated to determine whether these days behaved differently from the other days (they did not, as discussed below). All 8 days (August 15th-22nd, 1999) are recommended for use in evaluating 8-hour ozone control strategies and in 8-hour attainment demonstration modeling.

2007 BASE CASE

The 2007 base case modeling used the same version of the CAMx model and the same model inputs as the 1999 base case (base 5) with the exception of changes to the emission inventory which were described in section 3.

Summary of the 2007 Emission Inventory

The emission inventory for the 2007 base case was adjusted from 1999 levels to reflect growth in emissions due to increased activity levels (economic activity, vehicle driving, new industrial sources, etc.) as well as reductions in emissions due to control measures. The 2007 emissions are described in Section 3 which includes detailed emissions summary tables. Briefly, the following emissions control measures are included in the 2007 base case:

- Federally mandated reductions for onroad mobile sources (estimated using EPA's MOBILE5 model), offroad mobile sources (estimated using EPA's NONROAD model) and other EPA rules (including the NOx SIP Call) as evaluated by EPA in a recent rulemaking for heavy duty diesel engines.

- Texas emission reductions included in State Implementation Plans for ozone nonattainment areas in the eastern part of the state, including TCEQ rules for the Dallas/Fort-Worth, Houston/Galveston and Beaumont/Port-Arthur areas and associated regional rules for major sources such as utilities.

- Northeast Texas emission reductions included in the SIP revision submitted to EPA in 2002, including reductions at AEP power plants (Knox Lee, Pirkey, Welsh, Wilkes), Texas Eastman and TXU power plants (Martin Lake, Monticello, and Stryker Creek).

The changes in episode average NOx emissions for major point sources in Northeast Texas are shown in Table 6-11 and source locations are shown in Figure 6-16. The total emissions reduction for the major sources listed in Table 6-11 is –94.2 tons/day. The emission changes in Table 6-11 reflect the combined impact of the Northeast Texas SIP revision and TCEQ regional rules, and reflect the changes between August 13-22, 1999 actual emissions and the projected 2007 peak ozone season emissions. The 2007 peak ozone season emissions for utility sources were estimated from July 1997 average heat input levels combined with the 2007 emission factors.

In modeling the effects of emissions growth, new sources in Northeast Texas were included if they had received permits. The new sources include:

- A co-generation facility operated by AEP at the Texas Eastman site. Since Texas Eastman agreed to offset the emissions from this new source, the cogen emissions are included in the Texas Eastman emission inventory for 2007.

- Four new electrical generating units (listed in Table 6-12 and shown in Figure 6-16) with combined NOx emissions of 13.9 tons/day. Table 6-12 shows the permit level emissions for the new sources. Some of these projects may not move forward to completion.[1]

Table 6-11. Change in episode average NOx emissions from major point sources in Northeast Texas between the 1999 and 2007 base cases.

Facility Name	Episode Average NOx Emissions (tons/day)		
	1999	**2002**	**Change**
AEP			
Knox Lee	8.7	5.9	–2.8
Pirkey	23.4	18	–5.4
Welsh	69.2	29.2	–40
Wilkes	14.1	7	-7.1
Texas Eastman	14.4	10.5	–3.9
TXU			
Martin Lake	78.5	57.5	–21
Monticello	62.8	48.4	–14.4
Stryker Creek	13.7	14.1	0.4
Total	**284.8**	**190.6**	**–94.2**

[1] As of December 6th, 2002, a Texas Public Utility Commission (PUC) report shows that the Tenaska Gateway project came on-line in July 2001. The Entergy Power Ventures project in Harrison County projects an in-service date of June 2003. The Gateway Power Project in Upshur County is listed as cancelled. The project listed here as LG&E in Palestine, Anderson County appears to be the same as the Palestine Power Project by Newport Generation, which the PUC lists as cancelled.

Table 6-12. 2007 NOx emissions (tons/day) from new sources in Northeast Texas.

Facility Name	County	NOx
Entergy Power Ventures	Harrison	0.9
Gateway Power Project	Upshur	4.1
LG&E Power	Anderson	5.1
Tenaska Gateway	Rusk	3.8

Note: Some of these projects may not move forward to completion.

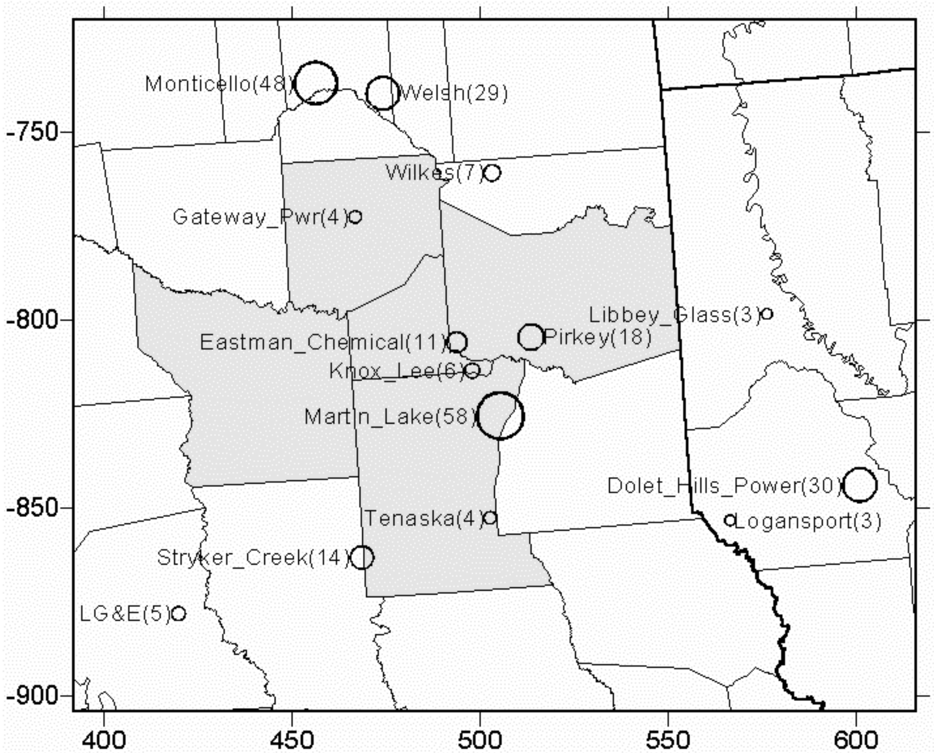


Figure 6-16. 2007 average episode day NOx emissions (tons/day) for major point sources in the 4 km grid.

Base Case 1

A preliminary 2007 base case (07base1) was modeled but the emission inventory was incorrect and so no results are shown here.

Base Case 2

The final 2007 base case was called 07base2. The daily maximum 1-hour and 8-hour ozone levels for the 4 km grid are shown in Figures 6-17 and 6-18, respectively. Evaluating the 2007 ozone levels comes down to looking at the changes between 2007 and 1999 and their relationship to the emissions changes, which is discussed next.

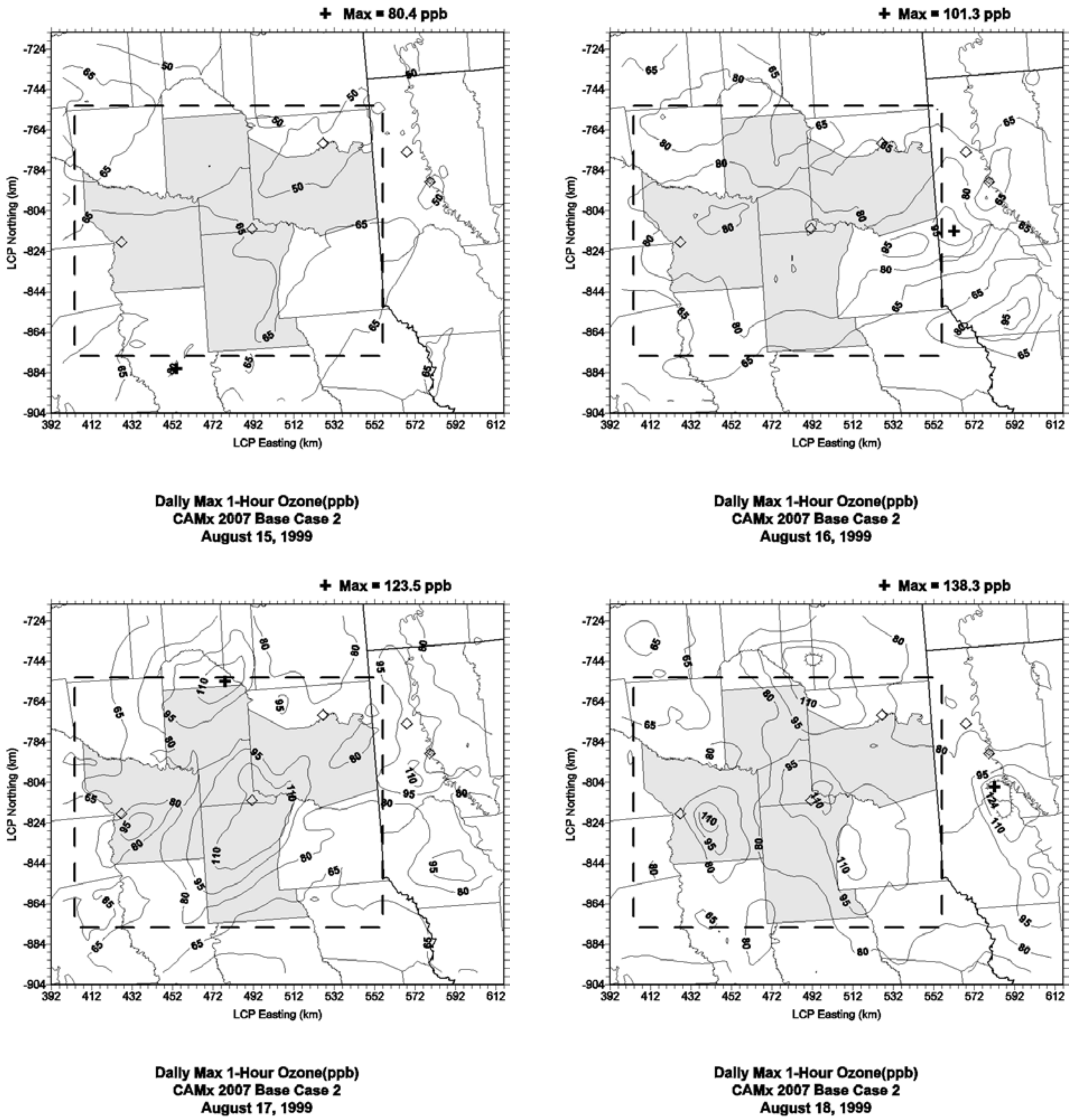


Figure 6-17. 2007 base case 2 daily maximum 1-hour ozone for the 4 km grid.

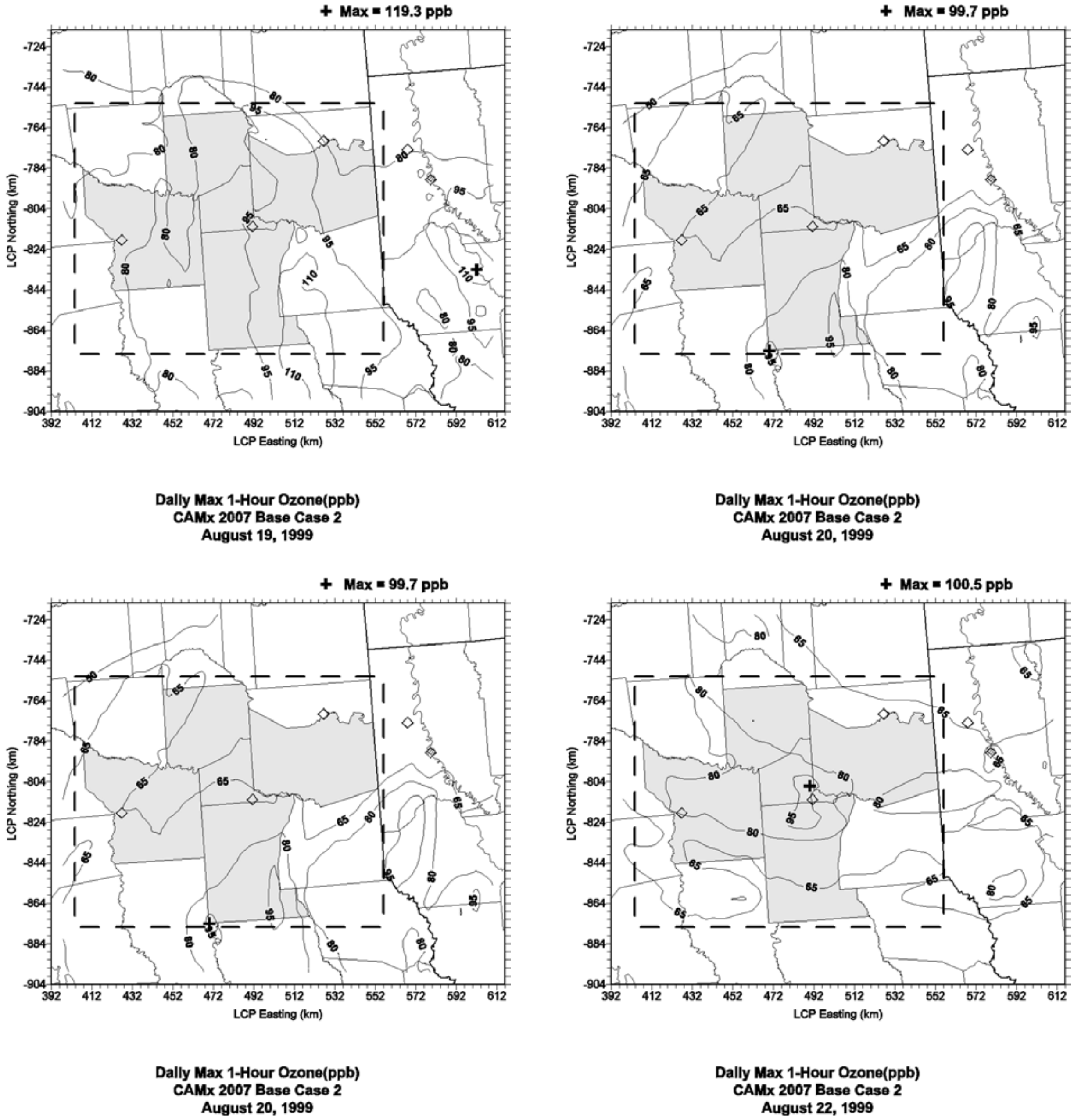


Figure 6-17 (concluded). 2007 base case 2 daily maximum 1-hour ozone for the 4 km grid.

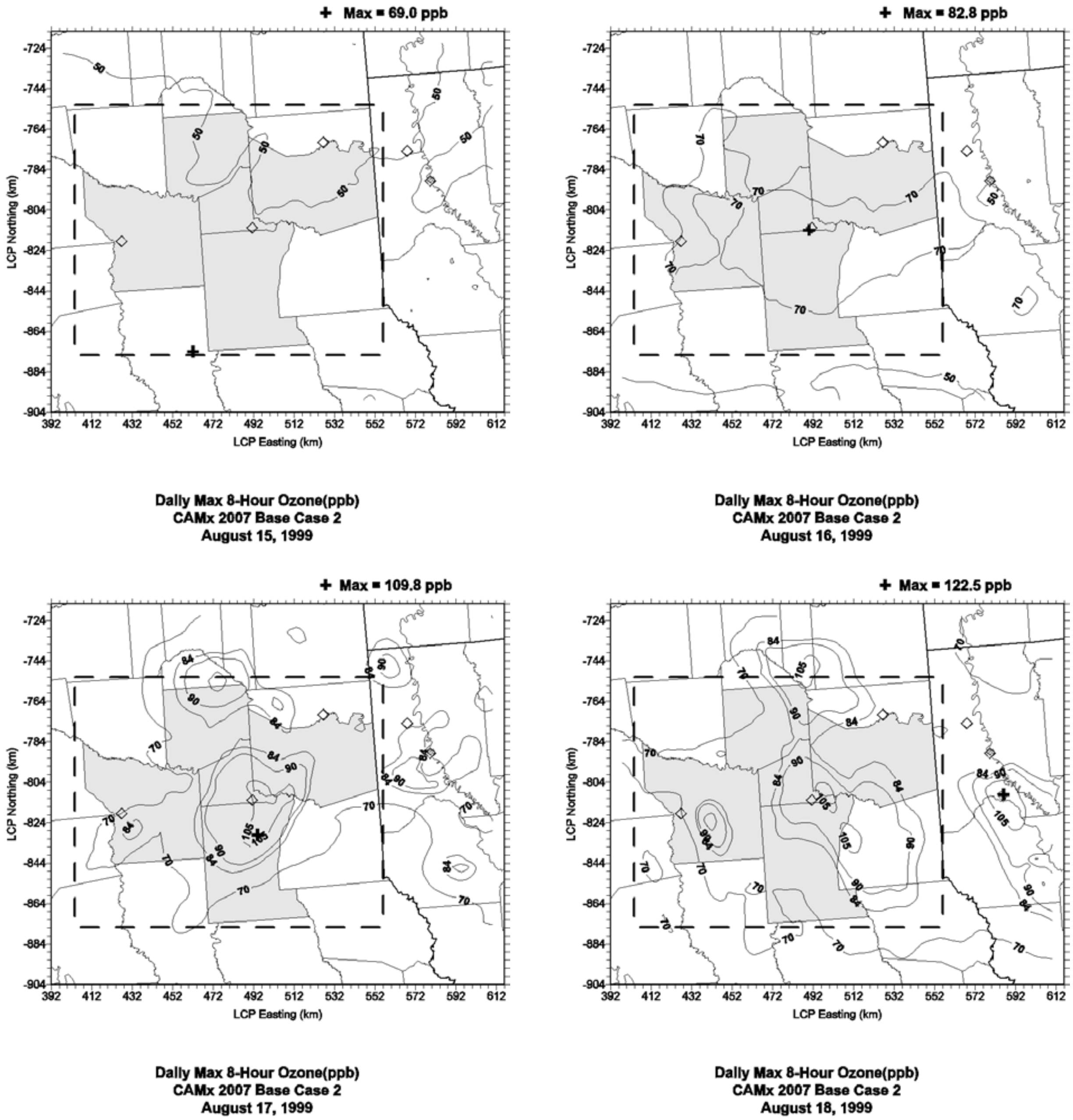


Figure 6-18. 2007 base case 2 daily maximum 8-hour ozone for the 4 km grid.

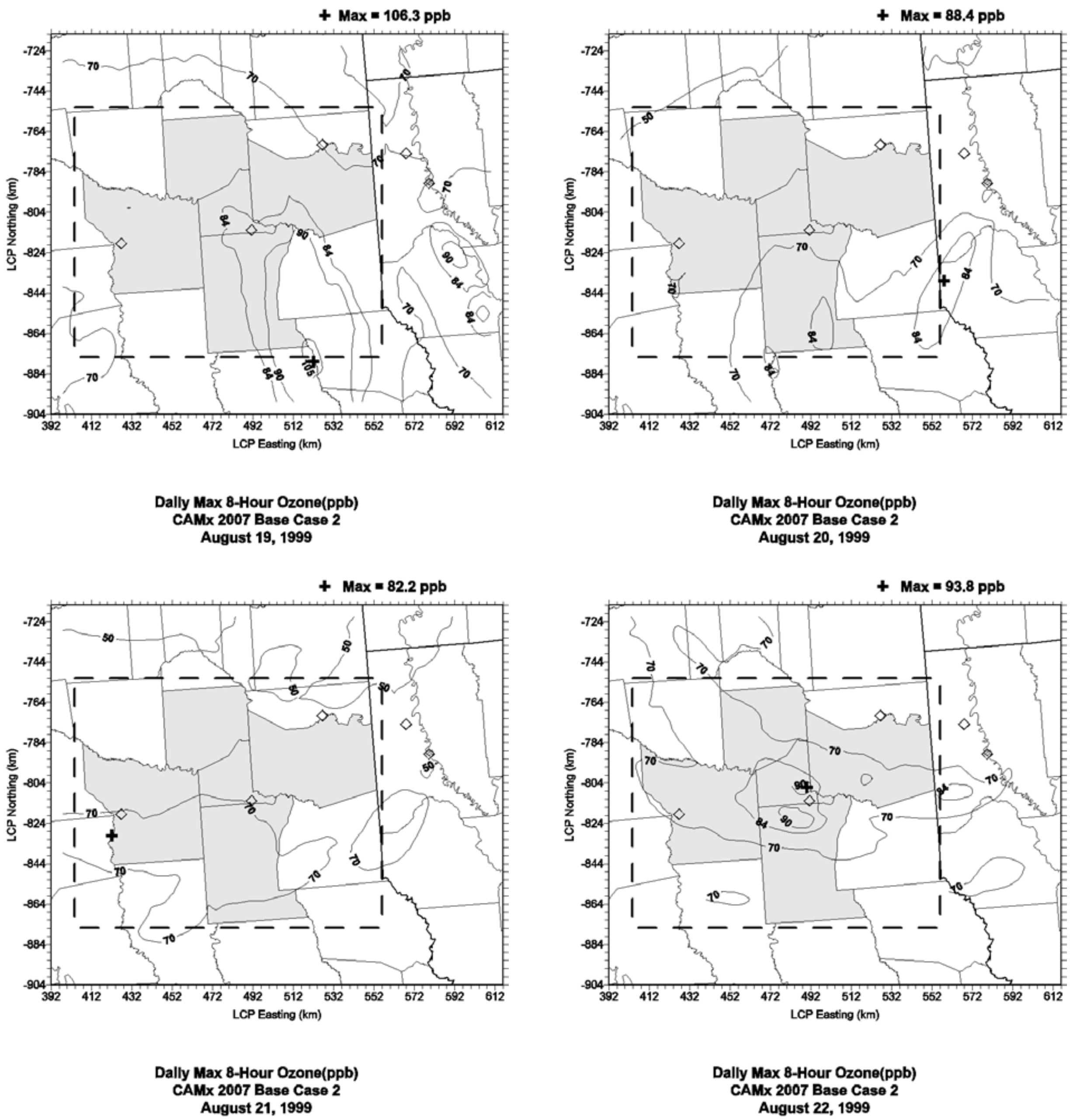


Figure 6-18 (concluded). 2007 base case 2 daily maximum 8-hour ozone for the 4 km grid.

2007 OZONE REDUCTIONS FROM 1999 LEVELS

The differences in daily maximum 1-hour and 8-hour ozone for the 4 km grid are shown in Figures 6-19 and 6-20, respectively. These figures show the difference between 2007 base case 2 (07base2) and 1999 base case 5 (base5). The only difference between the base5 and 07base2 model runs was in the emissions inventory, as discussed above.

There were widespread decreases in daily maximum 1-hour and 8-hour ozone levels in Northeast Texas resulting from emissions reduction measures instituted between 1999 and 2007. The decreases in peak 1-hour ozone in Northeast Texas ranged from –4.2 ppb to –15.1 ppb, depending upon the day (Table 6-13). The largest decreases occurred on the days that also had the highest base year ozone peaks (August 17th-19th). These were days when stagnation caused high ozone levels related to local emissions sources, and so these days also were responsive to the reductions in local emission included in the 2007 base case (Table 6-11). Figures 6-19 and 6-20 show some increases in daily maximum ozone levels between 1999 and 2007, but these were localized to single grid cells that contained NOx point sources and resulted from reduced scavenging of ozone by NOx in 2007. These highly localized ozone increases do not have any impact on the peak ozone levels in 2007.

The 2007 peak 8-hour ozone in Northeast Texas decreased from 1999 levels by –3.0 ppb to –9.9 ppb, depending upon the day (Table 6-13). The areas of 8-hour ozone decrease were closely related to the areas of 1-hour ozone decrease showing that the emissions control measures shown in Table 6-11 benefit both 1-hour and 8-hour ozone.

The 2007 base case demonstrated attainment of the 1-hour ozone standard because the peak 1-hour ozone on August 17th was less than 124 ppb. As discussed above, the August 17th modeling day was the only day determined to be suitable for use in 1-hour ozone attainment demonstration modeling and also is the only day that actually exceeded the 1-hour ozone standard during this episode. The 2007 modeled peak ozone was 126.4 ppb on August 18th, but peak ozone levels on this day were over-estimated by more than 20% in the 1999 base case precluding the use of this day for determining attainment of the 1-hour ozone standard.

Determining whether the 2007 base case demonstrated attainment of the 8-hour ozone standard requires application of the EPA design value scaling methodology, which is discussed next.

Table 6-13. Reductions in peak 1-hour and 8-hour ozone levels in Northeast Texas between the 1999 and 2007 base cases.

Day	1999 Peak Ozone (base 5)			2007 Peak Ozone (07base2)			Ozone Difference (ppb)
	Cell	Hour	Ozone (ppb)	Cell	Hour	Ozone (ppb)	
1-hour Ozone							
15-Aug	(24,13)	15	84.4	(17,8)	14	80.2	–4.2
16-Aug	(36,21)	16	105.3	(42,23)	14	100.7	–4.6
17-Aug	(21,37)	15	136.2	(22,38)	13	123.4	–12.8
18-Aug	(25,38)	15	135.9	(13,21)	13	126.4	–9.5
19-Aug	(33,10)	15	133.2	(31,13)	14	118.1	–15.1
20-Aug	(28,13)	13	108.5	(20,8)	11	99.7	–8.8
21-Aug	(25,16)	14	97.8	(24,16)	14	91.1	–6.7
22-Aug	(24,21)	14	105.7	(25,25)	15	100.5	–5.2
8-hour Ozone							
15-Aug	(25,15)	11	72.9	(18,8)	12	69	–3.9
16-Aug	(26,22)	12	85.8	(25,23)	11	82.8	–3.0
17-Aug	(21,37)	12	118.9	(26,19)	12	109.8	–9.1
18-Aug	(25,37)	11	119.5	(13,21)	11	113	–6.5
19-Aug	(33,8)	11	116	(33,8)	11	106.1	–9.9
20-Aug	(41,15)	11	97.1	(42,17)	11	88.4	–8.7
21-Aug	(8,19)	11	85.5	(8,19)	11	82.2	–3.3
22-Aug	(24,21)	12	99.9	(25,25)	11	93.8	–6.1

Note: The Northeast Texas area was defined by the dashed box surrounding the 5 counties shown in Figure 6-3.
Cell gives the (x,y) grid cell numbers of the peak location in the 4 km grid.
Hour gives the start time (CST) of the 1 or 8 hour period of the peak.

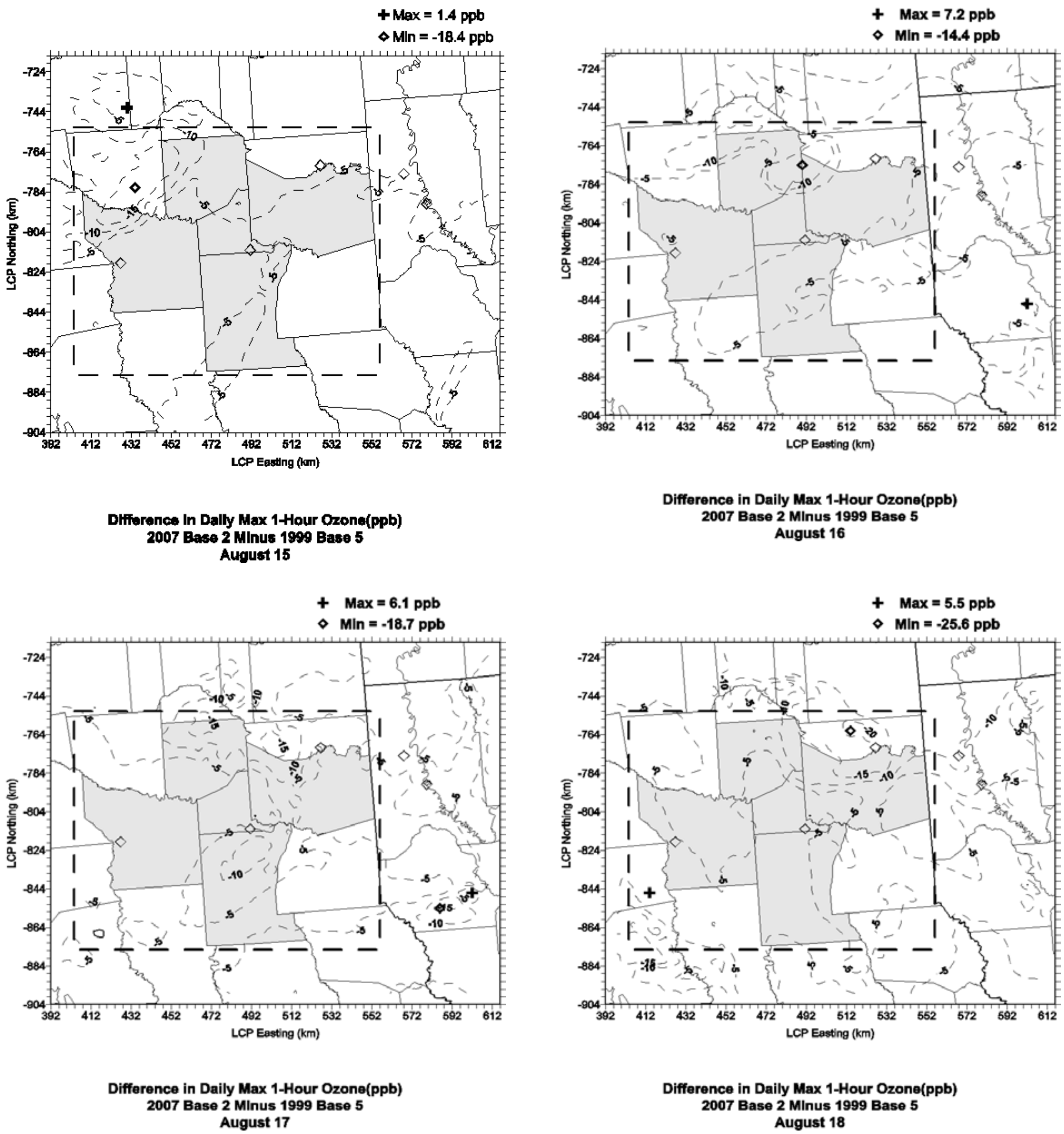


Figure 6-19. 2007 reductions in daily maximum 1-hour ozone for the 4 km grid (2007 base case 2 – 1999 base case 5).

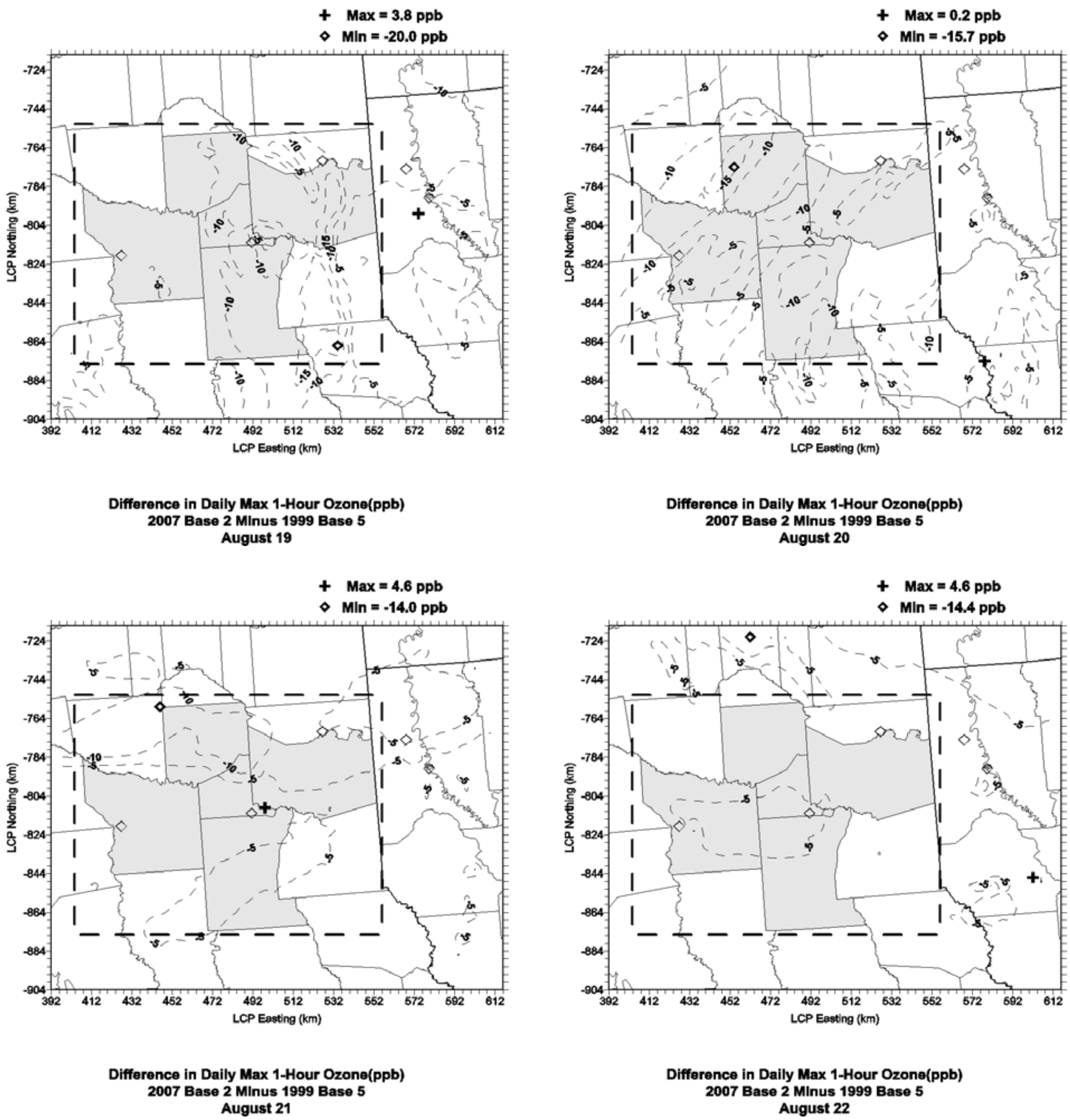


Figure 6-19 (concluded). 2007 reductions in daily maximum 1-hour ozone for the 4 km grid (2007 base case 2 – 1999 base case 5).

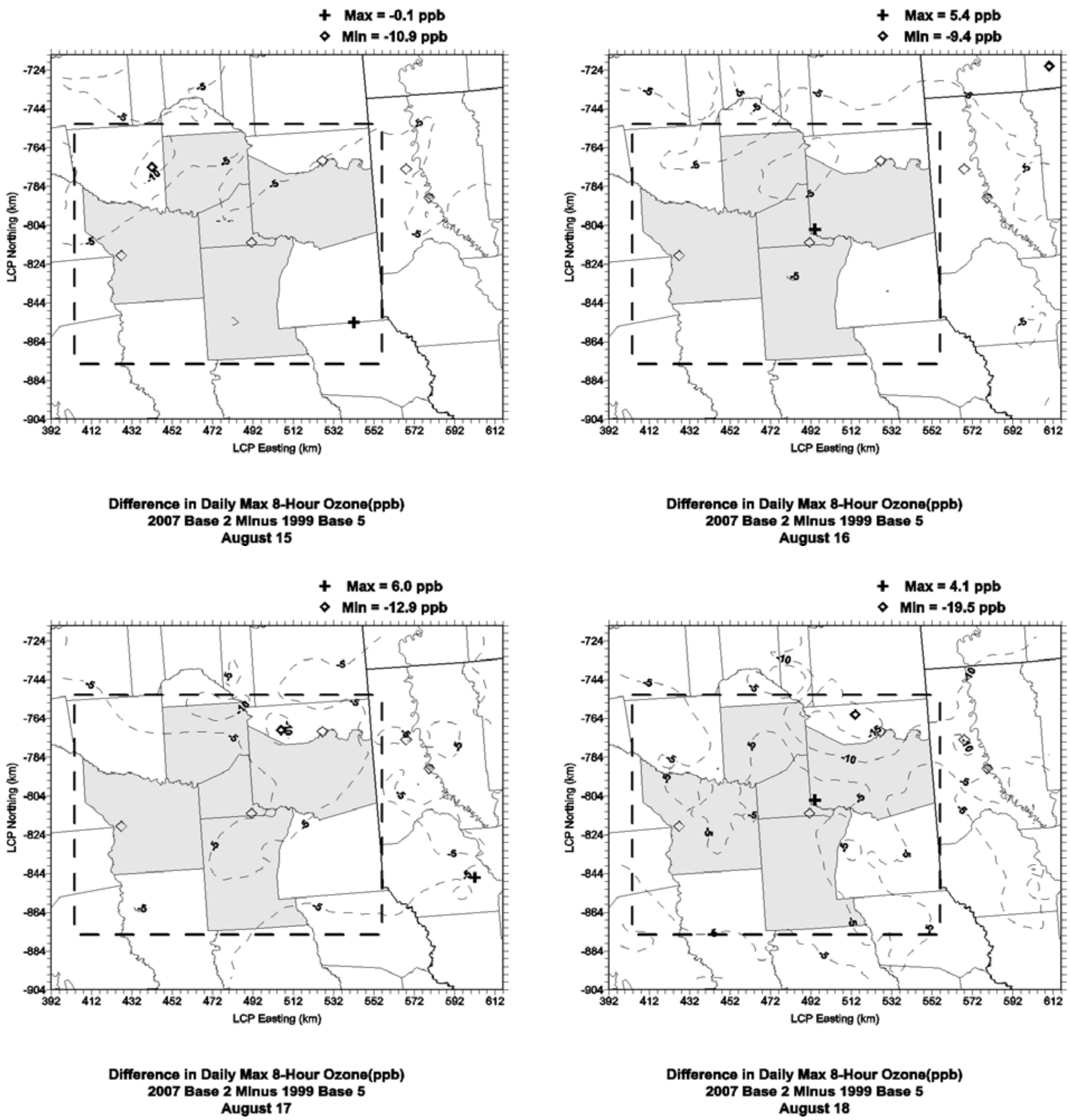


Figure 6-20. 2007 reductions in daily maximum 8-hour ozone for the 4 km grid (2007 base case 2 – 1999 base case 5).

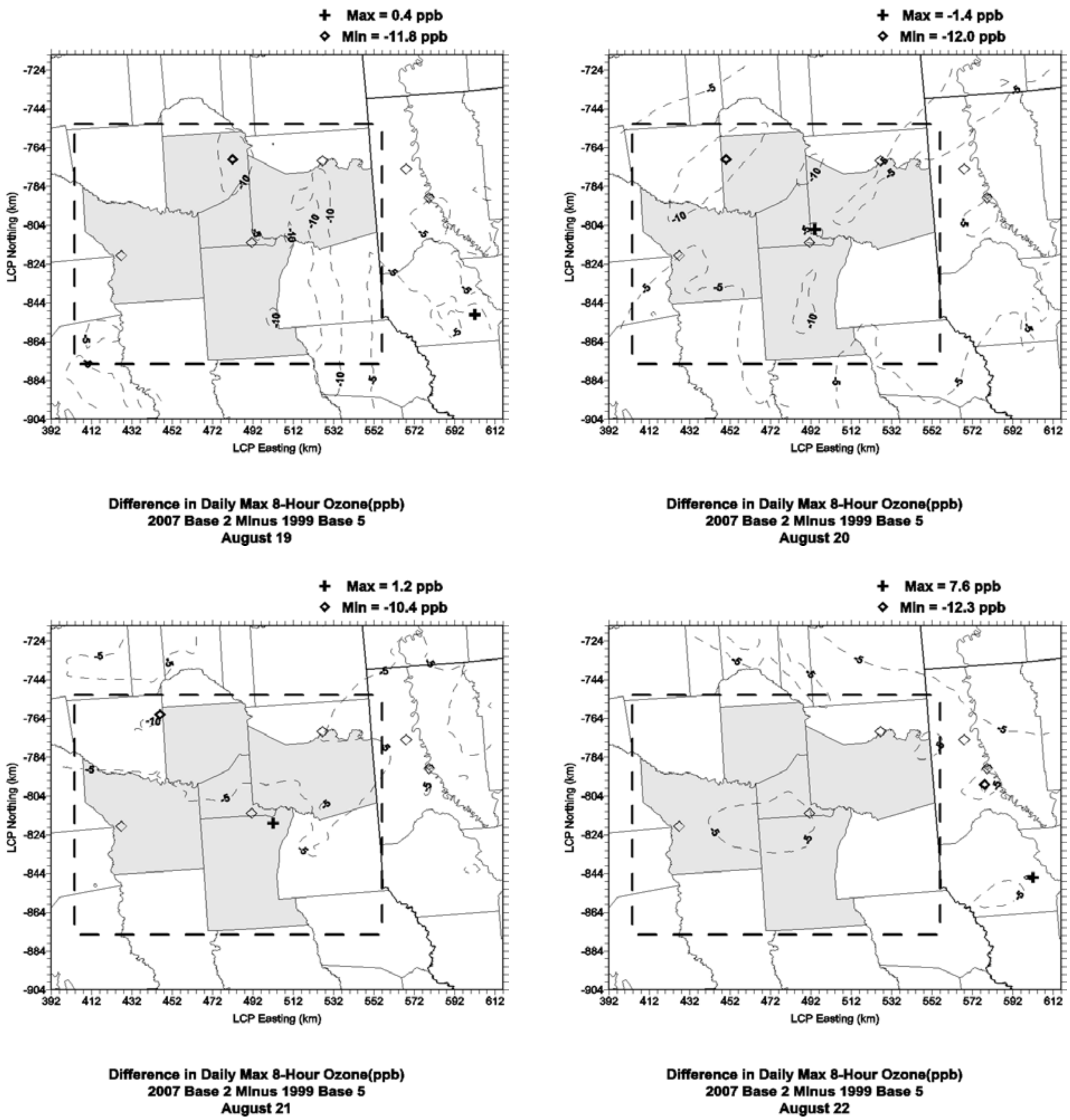


Figure 6-20 (concluded). 2007 reductions in daily maximum 8-hour ozone for the 4 km grid (2007 base case 2 – 1999 base case 5).

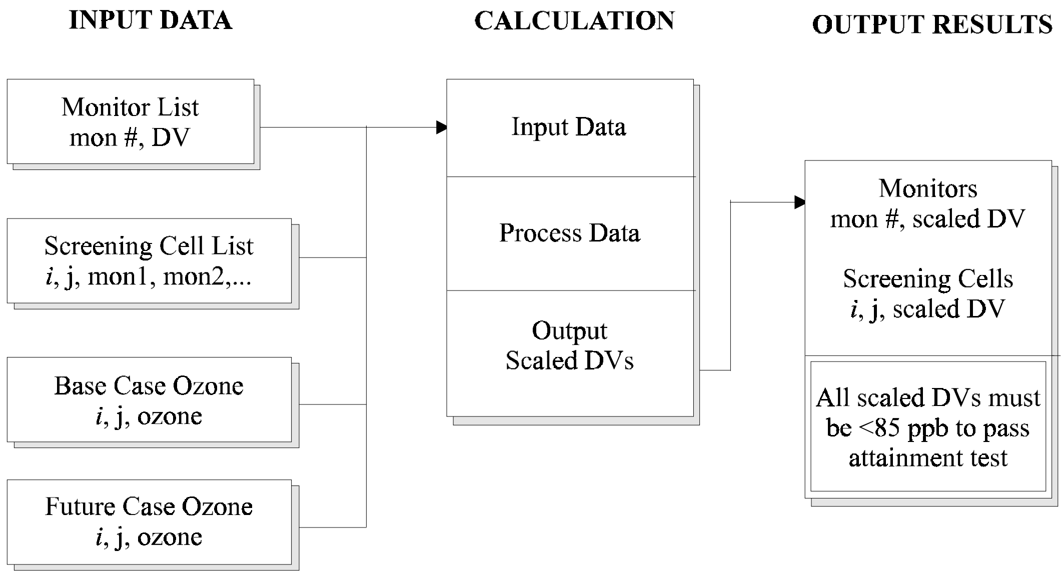


Figure 6-21. Overview of the 8-hour ozone attainment test methodology.

The details of the calculations are as follows:

- Monitor DV Scaling

1. For each monitor, find the daily maximum 8-hour ozone in an *n* x *n* block of cells around the monitor for both the base and future case. Repeat for each modeling day being used for control strategy development. For a 4 km grid, *n*=7 according to the guidance.
2. Exclude days when the base case daily maximum 8-hour ozone was below 70 ppb.
3. Average the daily maximum 8-hour ozone across days for the base and future year.
4. Calculate the RRF = (average future daily max) / (average base daily max).
5. Calculate the scaled DV = base year DV x RRF.
6. Repeat 1-5 for each monitor

- Screening Cell DV Scaling

7. For each grid cell on the screening cell list, count the number of days where the modeled daily maximum 8-hour ozone is at least 5% greater than the modeled daily maximum 8-hour ozone at any “associated” monitor, and at least 70 ppb.
8. If the number of days is 50% or greater of the total days, treat this cell as if it were a monitor – this is a “screened cell.”
9. The base year DV to be used for a screened cell is the maximum of the base year DVs for any “associated” monitor.
10. Calculated the scaled DV for each screened cell as if it were a monitor (steps 1-5 above).
11. Repeat 7-10 for each grid cell on the screening cell list.

8-HOUR OZONE DESIGN VALUE SCALING

The methodology for the 8-hour ozone attainment test was described in draft guidance modeling guidance issued by EPA (EPA, 1999). The methodology calls for scaling base year design values (DVs) using relative reduction factors (RRFs) from a photochemical model in order to estimate future design values using the following equations:

$$\text{Future Year DV} = \text{Base Year DV} \times \text{RRF}$$

$$\text{RRF} = \text{Future Year Modeled Ozone} / \text{Base Year Modeled Ozone}$$

This methodology is conceptually simple, but the implementation is complicated and is described in detail below. This methodology was implemented in a computer program to automate the calculation for efficiency and reliability.

Calculating RRFs

RRFs are calculated for each monitor location. In addition, since high ozone can also occur away from monitor locations, a screening calculation is also carried out to identify grid cells with consistently high ozone. If any screening cells are identified, RRFs are then calculated for the screened grid cells. The idea behind the screening cells is to account for any areas with consistently high modeled ozone that are not captured by the monitoring network. Since there is no base year DV for a screening cell, the DV from a nearby representative monitor must be used. The attainment test is passed when all the future year scaled DVs are 84 ppb or less.

Figure 6-20 shows a schematic outline of the calculations and identifies the input data required to complete the calculation. These are:

1. A monitor list – the list of monitors along with base year DVs for each monitor.
2. A screening cell list – the list of cells to be considered in the screening cell calculation along with the monitors that are considered to be associated with that grid cell. This list may be a sub-set of the modeling grid covering just the area for which controls are being developed. The significance of associating monitors with each grid cell is in the selection of an appropriate base year DV for the grid cell and in setting concentration thresholds for including the grid cell in the screening calculation, discussed below. There are no firm criteria for deciding how to associate monitors with grid cells.
3. Base case ozone – gridded 8-hour daily maximum ozone for the base year.
4. Future case ozone – gridded 8-hour daily maximum ozone for the future year.

2007 Scaled Design Values

Application of the EPA design value scaling methodology showed that no screening cells need to be considered for the August 15th through 22nd episode period. The 2007 scaled design values for the Longview and Tyler monitor locations are shown in Table 6-14. These scaled design values are calculated from the model predicted RRFs and the observed 1998-2000 design value. The 1998-2000 design values must be used with RRFs calculated from the 1999 model because they are centered on the modeling year, and are higher than the design values for 1997-1999 and 1999-2001. Design value scaling was not conducted for the Marshall monitor location because it does not have a design value.

Table 6-14. 2007 scaled 8-hour ozone design values for Longview and Tyler.

Monitor	RRF	Base Year 1998-2000 Design Value (ppb)	Scaled 2007 Design Value (ppb)
Longview (CAMS 19)	0.937	102	96
Tyler (CAMS 82)	0.956	91	87

In the model performance evaluation it was recommended that all 8 episode days (excluding the spin-up period) should be considered for use in the design value scaling. There was concern that three days (August 16th, 20th and 21st) might be unresponsive to emission reductions because ozone levels were underpredicted on these days. To evaluate whether this influenced the calculation shown in Table 6-14, RRFs were also calculated for each individual episode day as shown in Tables 6-15 and 6-16. The RRFs for August 16th, 20th and 21st were not systematically different from the other episode days and so were retained in the design value scaling. No RRF was calculated for August 15th because the observed ozone levels on this day did not fit the criteria built into the EPA method.

Table 6-15. Details of the design values scaling for Longview.

Day	RRF	Base Year 1998-2000 Design Value (ppb)	Scaled 2007 Design Value (ppb)
Aug 15	---	102	---
Aug 16	0.965	102	98
Aug 17	0.934	102	95
Aug 18	0.968	102	99
Aug 19	0.912	102	93
Aug 20	0.883	102	90
Aug 21	0.955	102	97
Aug 22	0.939	102	96
Episode	0.937	102	96

Table 6-16. Details of the design values scaling for Tyler.

Day	RRF	Base Year 1998-2000 Design Value (ppb)	Scaled 2007 Design Value (ppb)
Aug 15	---	91	---
Aug 16	0.968	91	88
Aug 17	0.973	91	88
Aug 18	0.970	91	88
Aug 19	0.926	91	84
Aug 20	0.937	91	85
Aug 21	0.961	91	87
Aug 22	0.952	91	87
Episode	0.956	91	87

Consistency with 1995/1997 Episodes

The 2007 scaled design values with 07base2 emissions were 96 ppb for Longview and 87 ppb for Tyler. These represent projected reductions in the 8-hour design value of 6.3% and 5.4% from the 1998-2000 levels (this follows simply from the RRFs being 0.937 and 0.956). These reductions are consistent with previous modeling for Northeast Texas completed using 1995 and 1997 episodes (ENVIRON, 1999). The previous modeling evaluated essentially the same 2007 emissions control measures in Northeast Texas and obtained RRFs of 0.930 at Longview and 0.929 at Tyler. The earlier RRFs showed slightly more reduction than found here, which may be because they started from higher base year emission levels for 1995/97 than 1999.

Consistency with Recent Air Quality Trends

The 2007 scaled design values of 96 ppb for Longview and 87 ppb for Tyler are above the level of the 8-hour ozone standard meaning that the 2007 base case does not project attainment of the 8-hour ozone standard. However, the scaled 2007 design values contrast with recent trends in the 8-hour ozone design values at Longview and Tyler shown in Table 6-17. Based on the preliminary 2002 ozone season data, the 2000-2002 design value for Longview will be 88 ppb and for Tyler 84 ppb. These values are well below the projected 2007 design values shown in Table 6-14.

Table 6-17. Trends in recent 8-hour ozone design values at Longview and Tyler.

Design Value Years	Longview	Tyler
1997-1999	100	91
1998-2000	102	91
1999-2001	95	88
2000-2002	88	84

Note: The 2000-2002 design values include 2002 data that are not yet final.

The recent declines in 8-hour ozone levels may be due to emissions reductions, differences in the meteorology, or a combination of these factors (it is unlikely that any other factors contribute significantly). Many of the local emissions reduction measures included in the Northeast Texas SIP revision submitted in 2002 were already in place during the 2002 ozone season and will have contributed to lower ozone levels. The following actions are recommended to understand the recent ozone trends and improve consistency between the 2007 control strategy modeling and recent air quality data.

- The recent trends in ozone levels and design values should be evaluated relative to changes in meteorology, emissions and precursor levels. This could be done in an update to the conceptual model for ozone formation in Northeast Texas.

- This updated conceptual model should be compared to the modeled ozone differences between 1999 and 2007. Modeling the August 1999 episode for an intermediate year, such as 2002, would be helpful.

- Modeling for the August 1999 episode with 2002 emissions should be coupled with 2002 design values (2000-2002 or 2001-2003) and used to project scaled 2007 design values from "current" emissions and air quality data. EPA's 8-hour modeling in guidance recommends the use of current data ozone attainment demonstrations.

SUMMARY AND CONCLUSIONS

A regional scale ozone model has been developed for the August 15th to 22nd, 1999 episode. The base case ozone model performance was evaluated in accordance with EPA guidance using statistical and graphical methods combined with diagnostic and sensitivity tests. Model performance was refined through updated meteorological modeling, revised emission inventories and improvements the air quality model configuration. The final base case (base5) includes days with good model performance for 1-hour and 8-hour ozone and provides a basis for both 1-hour and 8-hour attainment demonstration modeling. August 17th, 1999 is the day that can be used for 1-hour attainment demonstration modeling and this was the only day that actually exceeded the 1-hour ozone standard (at Longview) during this episode period. All 8 days (August 15th to 22nd, 1999) are suitable for 8-hour ozone attainment demonstration modeling.

Future year ozone levels were evaluated for 2007 using a base case emissions scenario that included the effects of emissions growth and existing emissions controls. There were widespread reductions in both 1-hour and 8-hour ozone levels between the 1999 and 2007 base cases. The existing emissions control measures (including the Northeast Texas SIP revision submitted in 2002) demonstrated attainment of the 1-hour ozone standard in 2007, consistent with the existing ozone modeling for 1995 and 1997 episodes (ENVIRON, 1999). The effects of existing control measures on 8-hour ozone levels also were consistent with the previous modeling for 1995 and 1997 episodes. The 2007 base case did not demonstrate attainment of the 8-hour ozone standard, and the projected 2007 ozone design values for Longview and Tyler were higher than the current (2000-2002) design values. A course of action was proposed to address this issue:

1. The recent trends in ozone levels and design values should be evaluated relative to changes in meteorology, emissions and precursor levels. This could be done in an update to the conceptual model for ozone formation in Northeast Texas.

2. This updated conceptual model should be compared to the modeled ozone differences between 1999 and 2007. Modeling the August 1999 episode for an intermediate year, such as 2002, would be helpful.

3. Modeling for the August 1999 episode with 2002 emissions should be coupled with 2002 design values (2000-2002 or 2001-2003) and used to project scaled 2007 design values from "current" emissions and air quality data. EPA's 8-hour modeling in guidance recommends the use of current data ozone attainment demonstrations.

The sensitivity of 8-hour ozone levels to emissions from forty separate geographic areas and source categories was evaluated using ozone source apportionment (OSAT) modeling, as described in the next section of the report.

7. SOURCE CONTRIBUTIONS TO OZONE

One of the unique features of CAMx is the availability of several "probing tools" to provide additional diagnostic and sensitivity information for an ozone simulation. The probing tools can be used to answer questions such as:

- Which emissions cause high ozone?
- How will ozone levels respond to emission changes?
- How important are the initial and boundary conditions?
- What are the influences of different model processes (chemistry, deposition, etc.) on ozone levels at a specific location?

The probing tools can also provide information for ozone precursors. The tools that are available have differing capabilities and uses. This section briefly describes the available probing tools and then presents results from the application of ozone source apportionment to the 1999 and 2007 base case simulations for Northeast Texas.

SUMMARY OF CAMx PROBING TOOLS

The probing tools available in version 3.1 of CAMx are:

- Ozone Source Apportionment Technology (OSAT) and related methods (APCA).
- The Decoupled Direct Method (DDM) for sensitivity analysis.
- Process Analysis.

OSAT provides information about the relationships between ozone concentrations and sources of precursors in the form of ozone source apportionments. Source apportionment means that the sum of the source contributions adds up to exactly 100% of the total ozone and so all of the ozone is accounted for. OSAT attributes ozone among all of the potential sources of ozone in the simulation, namely emissions, boundary conditions and initial conditions. Ozone formation from VOC and NOx precursors is tracked separately. The emissions contributions can be broken down by geographic area and/or source category. The OSAT methods are described in the CAMx User's Guide (ENVIRON, 2002) and in Dunker et al., (2002b).

Because ozone formation chemistry is a non-linear process, there is no unique way of apportioning ozone back to precursor sources. The OSAT methods attribute ozone formation to precursors that were present at the time the ozone was formed. There are two schemes for doing this called OSAT and APCA. The OSAT or APCA results are just like any other ozone source apportionment in that they are not exact. However, OSAT and APCA are very helpful for estimating the relative importance of different sources and guiding control strategy development.

The difference between the OSAT and APCA schemes can be summarized as follows. OSAT apportions ozone formation based solely on what precursors were present when the ozone is formed. OSAT determines whether ozone formation is NOx or VOC limited in each grid cell at each time step, and attributes ozone production according to the relative contributions of the limiting precursor (VOC or NOx) from different sources present at that time. APCA modifies the OSAT method to account for the fact that biogenic emissions are not considered to be controllable, and therefore attributes ozone to controllable (anthropogenic) emissions whenever possible. The differences between OSAT and APCA are discussed in more detail below.

The DDM provides similar types of information to OSAT, but in terms of sensitivity coefficients rather than source apportionments. Sensitivity coefficients describe how ozone will change if a precursor source is changed and thus are useful for predicting the effects of control strategies. CAMx can calculate "first-order" sensitivity coefficients, which are the likely to be the most important sensitivities, and are somewhat similar to source apportionments. There are two major differences between DDM sensitivities and OSAT source apportionments: (1) Sensitivity coefficients can be negative, meaning that reducing emissions will increase ozone, whereas as source apportionments are never negative. An example would be an area with high NOx emissions where reducing NOx emissions will increase ozone and DDM will obtain negative ozone sensitivities to local NOx whereas OSAT will have zero or small ozone apportionments to local NOx. (2) Adding up all the first-order sensitivities over all sources of ozone and precursors usually explains only about 60% of the total ozone. The modeled ozone that is "unexplained" by the first-order sensitivity coefficients can be explained by higher-order sensitivities, but they are more difficult to calculate and difficult to interpret. An advantage of DDM sensitivity coefficients is that they are rigorously defined (mathematically) and so are unique. The value of this uniqueness is weakened if the sensitivities are interpreted as source apportionments because of the significant portion of the ozone that is "unexplained" by the first-order sensitivities. Further information on DDM is provided in Dunker et al. (2002 a and b) and the CAMx User's Guide (ENVIRON, 2002).

Process analysis (PA) is a method for obtaining more information on how CAMx predicted concentrations at a specific place and time. The CAMx concentrations are determined by numerous model processes (such as emissions, transport, chemistry, deposition) but the separate contribution of each process is hidden within the final concentration output. Process analysis allows the contribution of each process to be output and used in diagnostic analyses. This is useful for explaining "how the model got the answer it got" and thus understanding model performance issues. Process analysis is not well suited for understanding source contributions to ozone or predicting responses to emissions changes. Further information on process analysis is provided in the CAMx User's Guide (ENVIRON, 2002) and references therein.

Anthropogenic Precursor Culpability Assessment (APCA)

Applications of OSAT to the Eastern US consistently identify biogenic emissions as a major contributor to ozone formation. This is not surprising as biogenic VOC emissions are very reactive and dominate regional VOC emissions in the Eastern US, but this finding is not "policy relevant" for designing anthropogenic emissions ozone control plans. The APCA methodology was developed from OSAT to address this issue. APCA stands for Anthropogenic Precursor Culpability Assessment, and differs from OSAT in recognizing that certain emission groups are not controllable (i.e., biogenic emissions) and that apportioning ozone production to these emissions does not provide control strategy relevant information. To address this, in situations where OSAT attributes ozone formation to a non-controllable source category when it was due to the interaction of ozone precursors from a non-controllable (i.e., biogenic) and controllable emissions source, APCA re-directs the ozone attribution to the controllable precursor. In practice, biogenic emissions are the uncontrollable source category and APCA only attributes ozone production to biogenic emissions when ozone formation is due to the interaction of biogenic VOC with biogenic NOx. When ozone formation is due to biogenic VOC interacting with anthropogenic NOx under VOC-limited conditions (where OSAT would attribute ozone production to biogenic VOC's), APCA directs the attribution to the anthropogenic NOx precursors present. The result of using APCA instead of OSAT is that more ozone formation is attributed to anthropogenic NOx sources and little ozone formation is attributed to biogenic sources. APCA is not called a "source apportionment" technique because it expresses biases as to which sources should be implicated (i.e., those that are controllable), hence it is referred to as a "culpability assessment."

STRENGTHS AND LIMITATIONS OF OSAT AND APCA

The main advantage of OSAT and APCA is providing a clear apportionment of ozone concentrations among all of the sources of ozone precursors in CAMx. These precursor sources (emissions, boundary conditions and initial conditions) can be sub-divided into categories to provide refined analyses. For example the emissions can be sub-divided based on emissions category and/or geographic area. This information provides a clear understanding of which sources are involved in forming the ozone present at a specific place and time. The apportionments are based on the participation of precursor emissions in the ozone formation process.

The main limitation of OSAT and APCA is that, because ozone formation is not a linear process, the source contributions can not be used to exactly calculate what emission reductions are needed to achieve a specific target ozone level. As ozone precursor emissions are reduced, the efficiency of ozone formation changes and controls may become more or less effective than expected. Thus, OSAT and APCA should be used as a guide for designing control strategies, but can not provide an exact control strategy solution.

SOURCE APPORTIONMENT ANALYSIS DESIGN

The OSAT and APCA probing tools were used for the source apportionment analyses. The APCA results are expected to be more useful because of the high contribution biogenic emissions in Northeast Texas. Emissions were divided into 4 source categories and 10 geographic areas as defined in Tables 7-1 and 7-2, respectively. The source areas are also shown as maps for the 36-km, 12-km and 4-km CAMx grids in Figure 7-1. This means that ozone was attributed back to VOC and NOx emissions from 40 source groups, in addition to the initial and boundary conditions. Source contributions were analyzed for the grid cells containing the Longview, Tyler and Marshall monitors, and over all grid cells in the NETAC 5 county area combined.

Table 7-1. Emissions source category definitions for the OSAT and APCA analysis.

Source Category	Category Definition
BIO	Biogenic emissions
MV	Motor vehicle emissions
PT	Point source emissions (elevated and low level)
OAN	Other anthropogenic emissions (i.e, area plus offroad mobile)

Table 7-2. Emissions source area definitions for the OSAT and APCA analysis.

Area Number	Area Abbreviation	Area Definition
1	NETAC	NETAC area (Harrison, Gregg, Rusk, Smith, Upshur)
2	NET11	11 Counties surrounding NETAC (Camp, Cherokee, Franklin, Henderson, Marion, Morris, Nacodosches, Shelby, Titus, Wood, Van Zandt)
3	SHRV	Shreveport area (Caddo, Bossier, De Soto, Webster)
4	LA	Louisiana (excluding Shreveport)
5	AR	Arkansas
6	OK	Oklahoma
7	DFW	Dallas/Fort-Worth (8 Counties)
8	HGBPA	Houston/Galveston/Beaumont/Port-Arthur (11 Counties)
9	TX	Texas (excluding areas 1, 2, 7 and 8)
10	OTH	Other areas

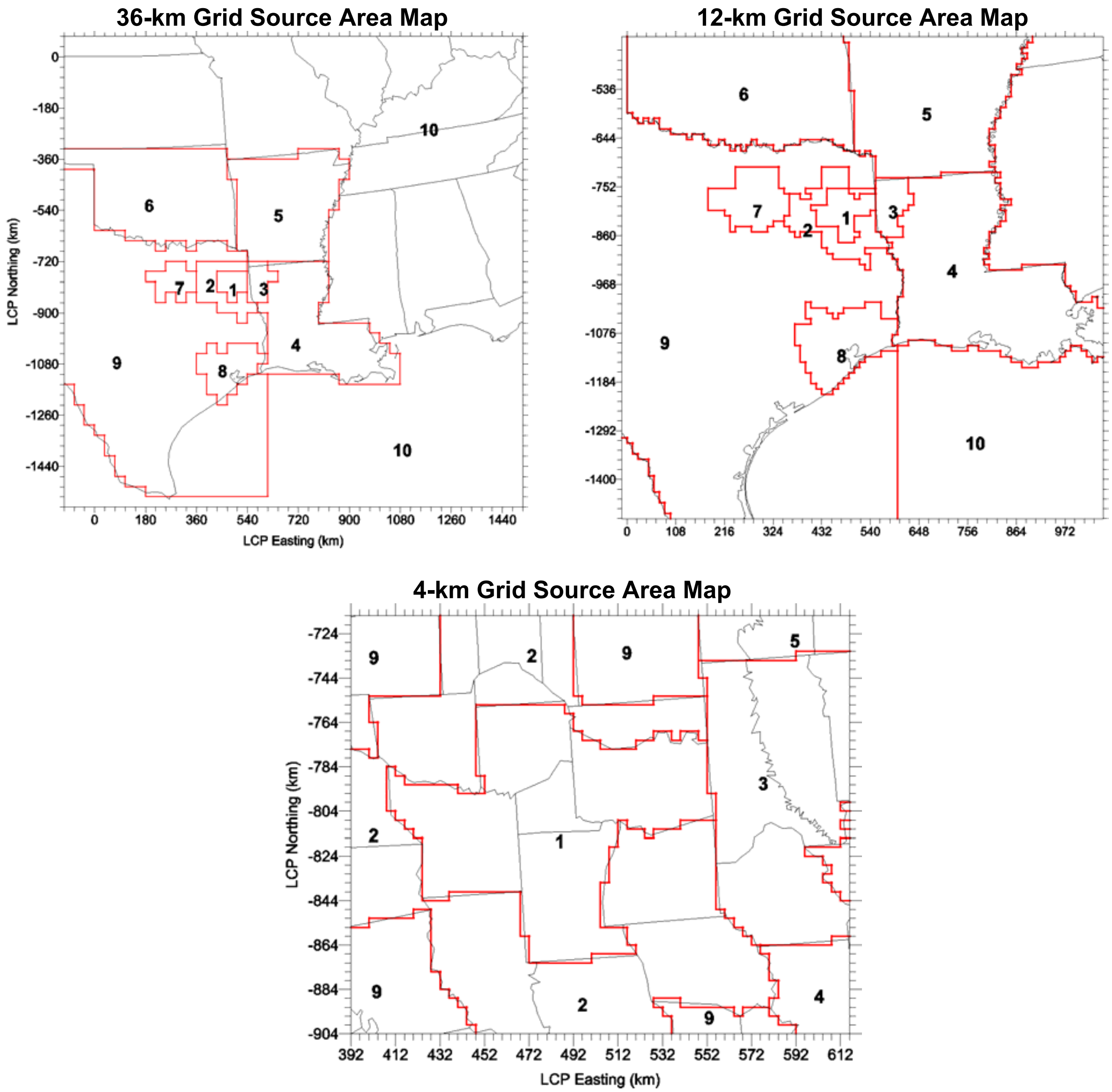


Figure 7-1. Maps showing the emissions source areas for the APCA analysis.

CAMx CODE IMPROVEMENTS

In the publicly available version of CAMx 3.1, the APCA source areas must be defined in terms of coarse grid cells (36-km in this case). Figure 7-1 shows that the NETAC 5 county area is very poorly resolved at 36-km resolution. Therefore, CAMx was modified to allow the APCA source areas to be defined at each grid resolution. This means that the finest resolution information takes precedence and, for example, the NETAC area was defined a 4-km resolution whereas Dallas and Houston were defined at 12-km resolution, etc. This CAMx code improvement will be included in the next public release following CAMx version 3.1.

OZONE CONTRIBUTIONS FOR 1999

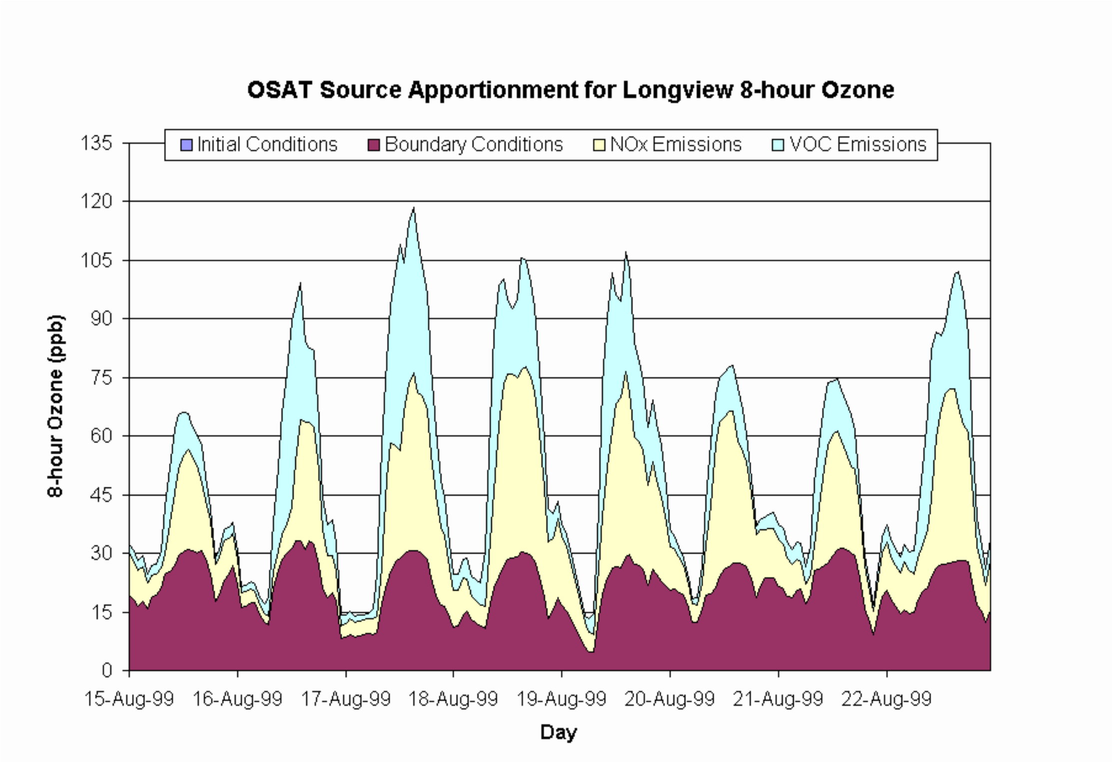
The 1999 base case (base5) was analyzed using both the OSAT and APCA algorithms in order to compare the resulting ozone source apportionments. The 1999 OSAT and APCA simulations used exactly the same model inputs and the only difference was the source apportionment algorithm in CAMx. As discussed above, APCA is designed to minimize attribution of ozone to biogenic emissions because they are not controllable.

Comparing OSAT and APCA

Figure 7-2 (top) shows the OSAT source apportionment for 8-hour ozone at Longview to initial conditions, boundary conditions, VOC emissions and NOx emissions. The contribution of initial conditions is negligible because the spin-up days have removed the influence of the initial conditions by August 15th. The contribution of the boundary conditions ranges from about 10 ppb to 30 ppb throughout the episode. An ozone boundary condition of 40 ppb was used for the 1999 base5 scenario, and the contribution of the boundary conditions at Longview is lower than 40 ppb because some ozone is lost to chemical reactions and deposition between the boundaries and Longview. Emissions are the main contributor to ozone at Longview, especially at times of high 8-hour ozone. NOx emissions contribute substantially more to ozone than VOC emissions on moderately high ozone days (August 15th, 20th, 21st), but the relative contributions of NOx and VOC emissions are comparable on the remaining very high ozone days. This shift from NOx limited ozone formation on moderately high ozone days toward more balanced contributions from NOx and VOC on very high ozone days is a response to the stagnant meteorology on the high ozone days. The stagnation leads to less dispersion of NOx emissions, which in turn leads to more VOC sensitive ozone formation. However, comparing the OSAT and APCA results shows that the VOCs involved in forming ozone under VOC limited conditions are predominantly from biogenic sources.

Figure 7-2 (bottom) shows the APCA source apportionment for 8-hour ozone at Longview to initial conditions, boundary conditions, VOC emissions and NOx emissions. The contributions of initial and boundary conditions are essentially the same as in the OSAT analysis. APCA attributes almost all of the remaining ozone formation to NOx emissions. This shows that the ozone attributed to VOCs by OSAT was in fact due to biogenic VOCs. Since biogenic VOCs are not controllable, APCA redirects this ozone attribution to biogenic VOCs to the NOx emissions that were present. The small amount of ozone attributed to VOC emissions by APCA was formed under VOC limited conditions and was either (1) formed by anthropogenic VOCs, or (2) formed by biogenic VOCs and biogenic NOx. Figure 7-3 will show that the second explanation applies in this case.

Figure 7-3 compares the OSAT and APCA apportionments for 8-hour ozone at Longview to the four emissions categories (biogenic, motor vehicle, area/offroad and point source) plus boundary and initial conditions. The initial and boundary conditions were discussed above. Biogenic emissions are identified by OSAT as a major contributor to ozone formation reflecting the high contribution of biogenic emissions to VOC emissions. APCA reduces the apportionment of ozone to biogenic emissions to almost zero and increases the apportionments to anthropogenic emissions to compensate. The small APCA contribution for biogenic emissions is from biogenic VOCs interacting with biogenic NOx, and is limited by the small contribution of biogenics to total NOx. The relative contributions of the anthropogenic emission categories will be discussed in more detail below. The remaining discussion uses just the APCA results.



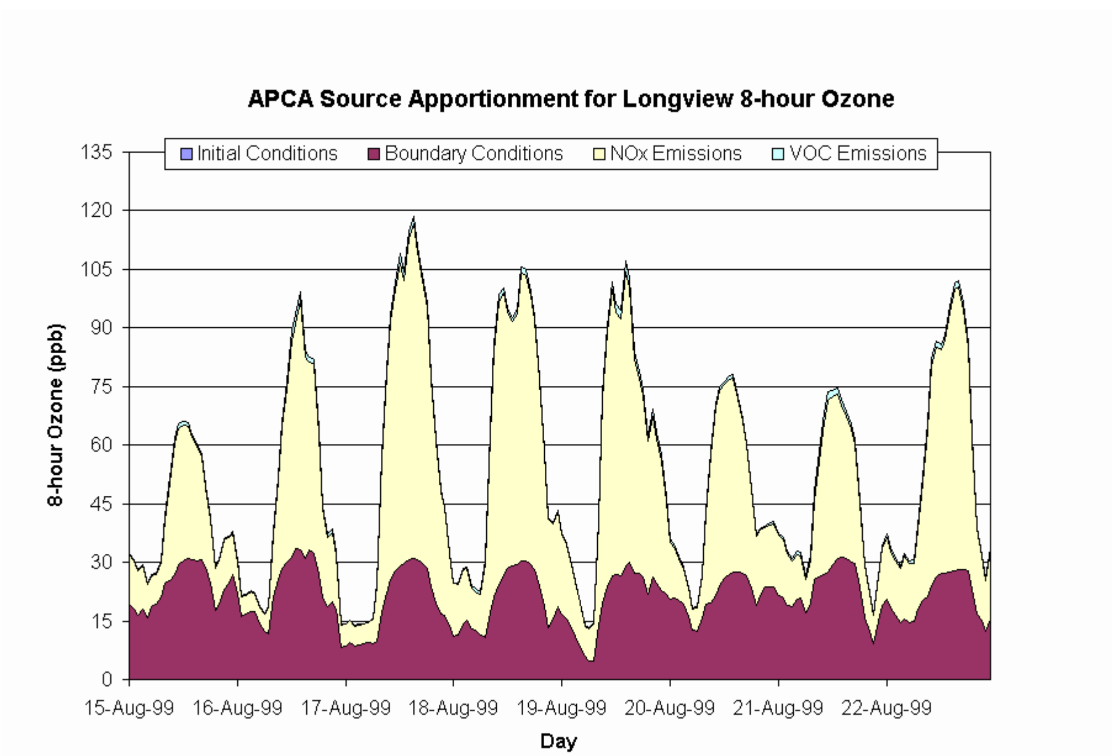
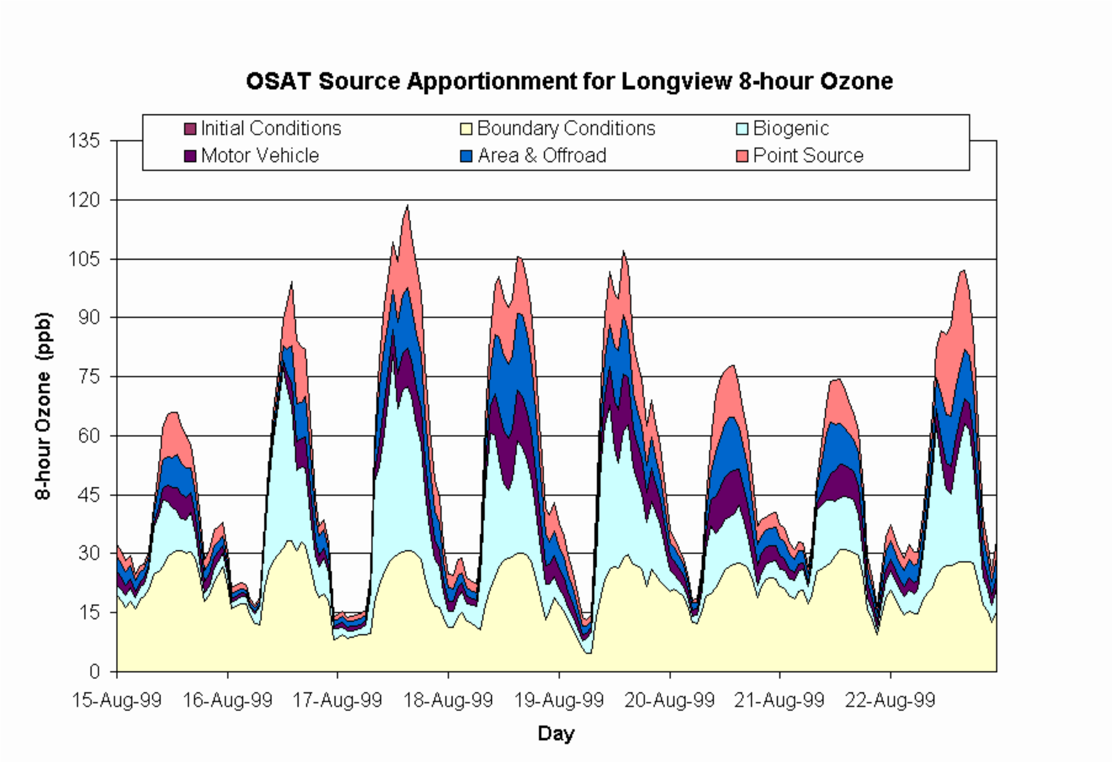


Figure 7-2. Source apportionment of Longview 8-hour ozone to VOC and NOx emissions using OSAT (top) and APCA (bottom).



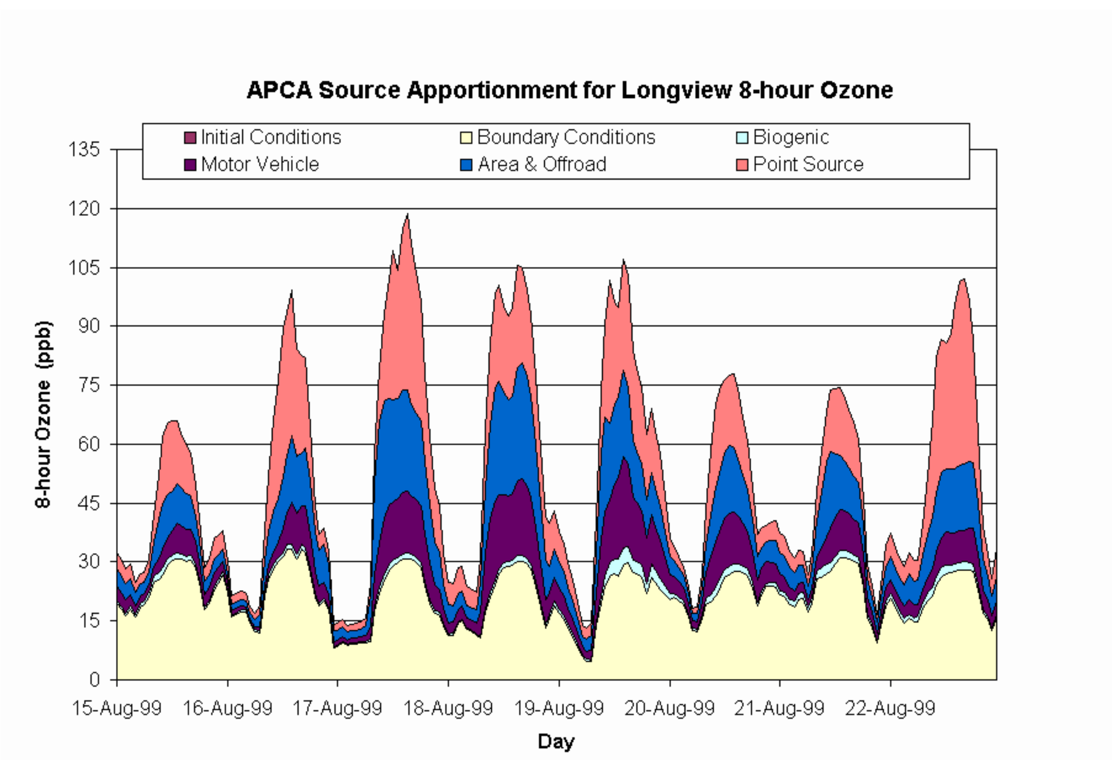


Figure 7-3. Source apportionment of Longview 8-hour ozone to source categories using OSAT (top) and APCA (bottom).

APCA Ozone Contributions for 1999

The analysis focused on identifying the contribution of anthropogenic emissions to ozone levels exceeding the level of the 8-hour ozone standard. The analysis was restricted to hours when 8-hour ozone was 85 ppb or higher in the 1999 base case. The analysis was conducted for the grid cells containing the Longview, Marshall and Tyler monitors, and for all grid cells in the 5 county NETAC area (Figure 7-1). The APCA source contributions were averaged over all grid cells and hours matching this criterion. The contributions for the whole 5 county NETAC area are probably more representative because they include a larger number of grid cells and hours (Table 7-3), however the individual receptors were also included to reveal any differences between Longview, Tyler and Marshall. Tables 7-4 to 7-6 summarize the emission totals (tons/day) by source area and are discussed in more detail below. The contributions of NOx and VOC to high 8-hour ozone are summarized in Tables 7-7 to 7-9 (these contributions are dominated by NOx rather than VOC, as discussed above).

Table 7-3. Number of grid cells and hours with modeled 8-hour ozone of 85 ppb or higher in 1999.

Receptor	Number of grid cell hours
5 NETAC Counties	9124
Longview (CAMS 19)	36
Tyler (CAMS 82)	5
Marshall (CAMS 50)	12

The total ozone amounts shown in Tables 7-7 and 7-8 should not be confused with ozone design values. The total ozone in these tables is just the average over those grid cells and hours when ozone was greater than 85 ppb in the 1999 modeling. Whether or not this value exceeds 85 ppb does not indicate whether the receptor is projected to attain the 8-hour ozone standard. The projected 2007 design values were discussed in section 6. The results shown in Table 7-7 to 7-9 do indicate which sources contribute to high 8-hour ozone levels in the modeling, and are helpful for designing 8-hour ozone control strategies.

Table 7-7 shows the average contributions to high 8-hour ozone in 1999 broken out to 40 emissions groups (ten areas by 4 categories) plus the initial and boundary conditions. The average contribution of initial conditions was 0.1 ppb or less and the average contribution of boundary conditions was 28 to 29 ppb, depending upon the receptor. This shows that the contribution of initial conditions is unimportant, and the contribution of boundary conditions is not dominant and is consistent with clean background levels. The majority of the high 8-hour ozone (more than 65 percent) was attributed to anthropogenic emissions.

The largest emissions contributors to high 8-hour ozone in the NETAC 5 county area (Table 7-7, top left) was from nearby NOx sources. Nearby means emissions from within the 5 county NETAC area, followed by emissions in the surrounding 11 counties, followed by Louisiana emissions. NOx emissions within the 5 county area contributed 33% of the high 8-hour ozone and NOx emissions in the surrounding 11 county area contributed another 14%. The contribution from Louisiana NOx emissions was 7%, which was split about evenly between the Shreveport 4 parish area (3%) and the rest of the Louisiana (4%). NOx emissions from the rest of Texas (including DFW and HGBPA) contributed 8% and NOx emissions in all other states (including Arkansas and Oklahoma) also contributed 8% of high 8-hour ozone in the 5 county area.

At Longview and Tyler, emissions from NOx sources within the NETAC 5 county area were the largest emissions contributor to high 8-hour ozone, similar to the result for the 5 county area. However, at Marshall the largest contributor was emissions from the 11 county area surrounding NETAC. This difference for Marshall is due to the proximity of the Marshall monitor to utility point source sources in Titus County (Monticello and Welsh) and Marion County (Wilkes) combined with the wind conditions during the episode.

The contribution of NOx emissions was broken out between 3 sources of anthropogenic emissions: point sources, mobile sources and other sources (i.e., area plus offroad). For the NETAC 5 county area (Table 7-7, top left) the ranking of these source categories was point sources (32%) followed by other anthropogenic (21%) followed by mobile sources (15%). However, this ranking varies between monitor locations within the 5 county area. The Longview and Marshall monitor locations are similar to the 5 county area as a whole, but point sources are less important at Tyler where the ranking changes to other anthropogenic (24%) followed by point sources (22%) followed by mobile sources (18%).

Table 7-4. 1999 Emission totals for August 17th summarized for the source categories and source areas used in the OSAT and APCA analyses.

Source	NOx				VOC			
Area	BIO	MV	PT	OAN	BIO	MV	PT	OAN
NETAC	2	51	149	69	1152	28	29	91
NET11	5	48	188	68	2351	25	15	88
SHRV	4	38	68	84	1066	20	20	51
LA	102	398	1151	978	9003	256	245	601
AR	120	300	335	442	11513	205	101	571
OK	217	409	642	374	7175	312	139	471
DFW	52	656	153	231	728	320	41	291
HGBPA	21	345	709	275	1975	179	259	287
TX	948	782	1180	946	18102	455	172	1320
OTH	1991	3791	7569	4441	75740	2561	1548	5579
Total	3462	6816	12145	7910	128804	4362	2569	9349

Table 7-5. 2007 Emission totals for August 17th summarized for the source categories and source areas used in the OSAT and APCA analyses.

Source	NOx				VOC			
Area	BIO	MV	PT	OAN	BIO	MV	PT	OAN
NETAC	2	38	117	72	1152	25	34	92
NET11	5	35	142	57	2351	22	18	93
SHRV	4	33	56	84	1066	16	9	41
LA	102	272	1047	973	9003	171	194	488
AR	120	220	274	417	11513	133	44	464
OK	217	284	647	331	7175	200	80	370
DFW	52	330	89	147	728	166	41	290
HGBPA	21	223	663	246	1975	115	290	299
TX	948	577	1007	871	18102	385	222	1463
OTH	1991	2653	3376	4278	75740	1516	971	4550
Total	3462	4665	7418	7477	128804	2751	1903	8150

Table 7-6. Ratio of 2007/1999 Emission totals for August 17th summarized for the source categories and source areas used in the OSAT and APCA analyses.

Source	NOx				VOC			
Area	**BIO**	**MV**	**PT**	**OAN**	**BIO**	**MV**	**PT**	**OAN**
NETAC	1.00	0.76	0.79	1.03	1.00	0.89	1.17	1.01
NET11	1.00	0.73	0.76	0.84	1.00	0.85	1.17	1.06
SHRV	1.00	0.88	0.82	1.00	1.00	0.79	0.46	0.81
LA	1.00	0.68	0.91	0.99	1.00	0.67	0.79	0.81
AR	1.00	0.73	0.82	0.94	1.00	0.65	0.44	0.81
OK	1.00	0.69	1.01	0.88	1.00	0.64	0.58	0.79
DFW	1.00	0.50	0.58	0.64	1.00	0.52	1.00	1.00
HGBPA	1.00	0.64	0.93	0.89	1.00	0.64	1.12	1.04
TX	1.00	0.74	0.85	0.92	1.00	0.85	1.29	1.11
OTH	1.00	0.70	0.45	0.96	1.00	0.59	0.63	0.82
Total	1.00	0.68	0.61	0.95	1.00	0.63	0.74	0.87

Note: The source areas are defined in Table 7-2 and the emission categories are defined in Table 7-1

Table 7-7. Average contributions to high 8-hour ozone for 1999 (base5).

5 NETAC Counties

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	14.0	6.8	9.6	0.2			30.7
NET11	8.9	1.4	3.0	0.2			13.5
SHRV	1.0	0.6	1.4	0.1			3.1
LA	1.5	0.9	1.3	0.2			3.9
AR	0.5	0.5	0.8	0.2			1.9
OK	0.5	0.5	0.4	0.1			1.6
DFW	0.3	1.4	0.6	0.1			2.4
HGBPA	0.3	0.2	0.2	0.0			0.6
TX	1.2	1.3	1.2	0.6			4.4
OTH	1.8	0.9	1.3	0.4			4.4
N/A					28.5	0.1	28.6
Total	30.0	14.4	19.8	2.1	28.5	0.1	95.0

(Source Category: PT, MV, OAN, BIO, BC, IC)

Longview

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	19.9	8.6	13.3	0.2			42.0
NET11	4.5	0.9	2.7	0.1			8.2
SHRV	1.2	0.5	1.0	0.1			2.8
LA	1.7	1.0	1.5	0.3			4.5
AR	0.5	0.5	0.8	0.2			1.9
OK	0.3	0.3	0.2	0.1			0.8
DFW	0.2	0.8	0.3	0.1			1.4
HGBPA	0.3	0.2	0.2	0.0			0.6
TX	0.9	0.9	0.8	0.4			3.0
OTH	2.0	0.9	1.4	0.5			4.8
N/A					28.4	0.1	28.5
Total	31.4	14.6	22.2	1.9	28.4	0.1	98.5

Tyler

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	10.5	11.2	11.6	0.3			33.6
NET11	1.4	0.5	2.3	0.1			4.2
SHRV	1.4	0.4	1.0	0.1			2.9
LA	1.8	0.9	1.7	0.3			4.7
AR	1.3	1.1	1.9	0.4			4.7
OK	0.1	0.1	0.1	0.0			0.4
DFW	0.0	0.0	0.0	0.0			0.1
HGBPA	0.2	0.1	0.1	0.0			0.4
TX	0.2	0.4	0.4	0.1			1.0
OTH	2.3	1.1	1.9	0.7			6.0
N/A					28.7	0.0	28.7
Total	19.2	15.9	20.9	2.0	28.7	0.0	86.7

Marshall

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	7.1	2.9	4.3	0.1			14.4
NET11	20.6	2.5	8.4	0.3			31.7
SHRV	1.0	0.8	1.7	0.1			3.5
LA	1.3	0.9	1.4	0.2			3.8
AR	0.2	0.5	0.7	0.2			1.6
OK	0.1	0.1	0.1	0.0			0.4
DFW	0.1	0.5	0.2	0.1			0.8
HGBPA	0.1	0.0	0.0	0.0			0.2
TX	1.4	2.0	2.4	0.4			6.2
OTH	1.7	0.8	1.1	0.4			3.9
N/A					28.8	0.1	28.8
Total	33.6	11.0	20.1	1.7	28.8	0.1	95.3

Note: Contributions are averaged over all grid cells and hours that had 8-hour ozone of 85 ppb or higher in the 1999 base case.

OZONE CONTRIBUTIONS FOR 2007

The analysis of the 2007 base case (07base2) results (Table 7-8) was designed to be consistent with the 1999 analysis so that source contributions can be compared directly between years. In order to obtain a direct comparison, the ozone contributions must be averaged over the same set of grid cells and hours in 2007 as in 1999. Therefore, the 2007 source contributions were averaged for the grid cells and hours when the 1999 ozone levels were 85 ppb or higher.

Table 7-8. Average contributions to high 8-hour ozone for 2007 (07base2).

5 NETAC Counties

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	12.5	5.4	10.7	0.3			28.8
NET11	6.7	1.1	2.8	0.2			10.8
SHRV	0.8	0.6	1.5	0.1			3.0
LA	1.6	0.6	1.4	0.2			3.8
AR	0.4	0.4	0.8	0.2			1.8
OK	0.6	0.4	0.3	0.1			1.4
DFW	0.2	1.0	0.5	0.2			1.8
HGBPA	0.3	0.1	0.2	0.0			0.6
TX	1.5	1.0	1.0	0.7			4.2
OTH	0.9	0.6	1.4	0.5			3.4
N/A					28.4	0.1	28.5
Total	25.5	11.3	20.4	2.4	28.4	0.1	88.0

Longview

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	18.2	6.7	15.0	0.3			40.2
NET11	3.7	0.7	2.6	0.1			7.2
SHRV	1.0	0.5	1.2	0.1			2.7
LA	1.9	0.7	1.6	0.3			4.5
AR	0.5	0.4	0.8	0.2			1.8
OK	0.3	0.2	0.2	0.1			0.7
DFW	0.1	0.6	0.3	0.1			1.1
HGBPA	0.3	0.1	0.2	0.0			0.6
TX	1.0	0.7	0.7	0.4			2.8
OTH	0.9	0.7	1.5	0.6			3.7
N/A					28.4	0.1	28.5
Total	27.9	11.2	24.0	2.1	28.4	0.1	93.7

Tyler

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	10.2	9.4	11.6	0.3			31.5
NET11	1.3	0.4	2.3	0.1			4.1
SHRV	1.1	0.4	1.7	0.1			3.3
LA	2.3	0.7	1.8	0.3			5.1
AR	1.1	0.9	1.8	0.5			4.3
OK	0.2	0.1	0.1	0.0			0.4
DFW	0.0	0.0	0.0	0.0			0.0
HGBPA	0.3	0.1	0.1	0.0			0.4
TX	0.3	0.3	0.4	0.1			1.0
OTH	1.0	0.9	2.0	0.8			4.6
N/A					28.4	0.0	28.4
Total	17.7	13.0	21.7	2.2	28.4	0.0	83.0

Marshall

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	5.8	2.4	5.2	0.2			13.5
NET11	12.6	2.2	5.6	0.3			20.6
SHRV	0.8	0.8	1.6	0.1			3.3
LA	1.6	0.6	1.4	0.2			3.8
AR	0.3	0.4	0.7	0.2			1.6
OK	0.1	0.1	0.1	0.0			0.3
DFW	0.1	0.3	0.2	0.1			0.6
HGBPA	0.1	0.0	0.0	0.0			0.1
TX	2.3	1.6	2.0	0.5			6.3
OTH	0.8	0.6	1.1	0.4			2.9
N/A					28.4	0.1	28.5
Total	24.4	8.8	17.9	1.9	28.4	0.1	81.4

(Source Category: PT, MV, OAN, BIO, BC, IC)

Note: Contributions are averaged over all grid cells and hours that had 8-hour ozone of 85 ppb or higher in the 1999 base case.

Emissions Changes Between 1999 and 2007

One of the outputs from a CAMx OSAT or APCA analysis is a summary of the emissions for each source grouping. Tables 7-4 to 7-6 show the emissions summaries for 1999 and 2007 and the ratios of 2007/1999 emissions. The emission summaries are all for the August 17th episode, other days may be different. These emissions summaries are prepared from the gridded emissions, and so areas are defined geographically to the nearest grid cell boundary, which means that emission totals may not exactly match those reported in Section 3. Finally, it is impossible to exactly calculate tons of VOCs from model ready inventories (because the model ready emissions are in moles, not tons) so the VOC emission totals will differ from those reported in Section 3.

Mobile source emissions decreased over all by 32% for NOx and 37% for VOC between 1999 and 2007. These reductions result from improvements in vehicle technology and fuels in response to EPA rules (plus local measures in nonattainment areas). The vehicle technology and fuel improvements are offset by growth in VMT. Larger percentage reductions occurred in the DFW and HGBPA nonattainment areas due to local SIP measures. Decreases in mobile source emissions in the NETAC 5 county area are similar to the rest of Texas (outside the nonattainment areas). The Texas mobile emissions were estimated by TTI for the TCEQ. All other mobile source emissions were estimated by EPA except for Shreveport, which was estimated by the LADEQ. All the mobile source emissions are based on MOBILE5.

Point source emissions decreased over all by 39% for NOx and 26% for VOC between 1999 and 2007. The largest NOx reductions occurred in the states outside TX, LA, AR and OK and are due primarily to the effects of EPA's "NOx SIP call." NOx emissions in the NETAC 5 county area decreased by 24% (for August 17th) and NOx emissions in the surrounding 11 counties decreased by 27%. The decreases in Northeast Texas point source NOx resulted from the Northeast Texas SIP and TCEQ rules for Eastern Texas. The percentage decrease in point source NOx in Northeast Texas was larger than in the rest of Texas except for the DFW nonattainment area (The HGBPA nonattainment area reductions appear suspect, as discussed below). The percentage decrease in point source NOx in Northeast Texas also was larger than for LA, AR and OK. The percent changes in point source VOC were highly variable, and are not discussed because ozone in Northeast Texas is sensitive to point source NOx rather than point source VOC. The point source emission changes for Northeast Texas were estimated in this report, for the remainder of Texas by TCEQ, and for all other areas by EPA.

Other anthropogenic (i.e., area plus offroad) emissions decreased over all by 5% for NOx and 13% for VOC between 1999 and 2007. These percentage reductions are smaller than for mobile sources and point sources. In the NETAC 5 county area, other anthropogenic emissions increased slightly because the effects of growth outweighed the effects of controls. The only area to see large reductions in emissions from area plus offroad sources was DFW (for NOx emissions) because of the effects of rules in the DFW SIP. All the offroad source emissions are based on the EPA's NONROAD model.

There were no changes in the biogenic emissions between 1999 and 2007.

Emission reductions for the Texas nonattainment areas (DFW and HGBPA) were estimated by this study or the TCEQ, depending upon the emissions category. The TCEQ estimated the mobile and point source emission reductions, and this study estimated the reductions for other sources based on the published SIPs for Texas. For DFW, there were large reductions in NOx emissions for all anthropogenic emissions categories (36% to 50%) but VOCs were reduced only for mobile sources. This is partly because the SIP lists only the NOx reductions for many rules. It is likely that there are additional VOC reductions for DFW (e.g., VOC reductions associated with measures designed to reduce NOx) that are not reflected in this inventory. The DFW reductions will be reviewed by the TCEQ and DFW in the near future when they begin using the August 1999 episode for SIP modeling.

The emissions reductions were smaller than expected for the HBPBA nonattainment area. In particular, point source NOx decreased by only 7% and point source VOC increased by 12%. The HGBPA emissions reductions are smaller than expected because the 2007 point source emissions from the TCEQ are higher than expected and because the SIP does not detail all of the expected reductions for other sources. The HGBPA emissions reductions will be reviewed by the TCEQ in the near future when the August 1999 episode for DFW SIP modeling. Uncertainties in the HGBPA emissions reductions have little impact on the ozone modeling results for the August 1999 episode in Northeast because there was almost no contribution from the HGBPA area to high 8-hour ozone levels in Northeast Texas under these meteorological conditions.

Changes in Ozone Between 1999 and 2007

The changes in ozone contributions between 1999 and 2007 are shown in Table 7-9 and illustrated using bar charts in Figure 7-4.

NETAC 5 County Area

For the NETAC 5 county area the total reduction in high 8-hour ozone was –6.9 ppb (Table 7-9, top left). There were reduced contributions from point source NOx (–4.5 ppb) and mobile source NOx (–3.2 ppb) but a small increase in the contribution of other anthropogenic NOx (0.6 ppb).

Looking at the geographic contributions to ozone reductions, the largest reductions were from the NETAC area (–1.9 ppb) and the 11 counties surrounding NETAC (–2.7 ppb) with smaller reductions from the DFW area (–0.6 ppb) and the states outside of TX, LA, AR and OK (–1.0 ppb). These areas combined accounted for 90% of the total reduction of –6.9 ppb.

Looking in detail at the ozone reductions from emissions sources in Northeast Texas, the largest reductions were from point sources (–3.8 ppb) and mobile sources (–1.6 ppb), which is consistent with the NOx emissions reductions shown in Table 7-9. The ozone contribution from other anthropogenic NOx emissions increased by 0.7 ppb, which is partly explained by the small increase in other anthropogenic NOx emissions (3%, Table 7-9). However, reducing the point and mobile source NOx emissions also causes more efficient ozone formation from the remaining NOx and contributes to the increase in ozone from other anthropogenic NOx. This is an example of the non-linear relationship between ozone and NOx emissions.

Longview

The total reduction in high 8-hour ozone at Longview (–4.7 ppb, Table 7-9, top right) was smaller than for the NETAC 5 county area. This is partly because the decreases in contributions of local point source NOx emissions (–1.7 ppb) and mobile source NOx emissions (–1.9 ppb) were offset by increase in the contributions from other anthropogenic NOx emissions (1.7 ppb). As discussed above, this is due to the non-linear relationship between ozone and NOx caused by the high level of NOx emissions around the Longview monitor. The consequence is that high 8-hour ozone levels at Longview are resistant to NOx reductions, even though NOx reduction is the most effective strategy. The solution is further control of NOx emissions from as many significant sources as possible.

Tyler

The total reduction in high 8-hour ozone was –3.7 ppb at Tyler (Table 7-9, bottom left), which was smaller than for the NETAC 5 county area and for Longview. The reduction in ozone from Northeast Texas emissions was –2.3 ppb, which was mostly due to reductions from mobile sources of –1.9 ppb. There was a 0.7 ppb increase in ozone from Louisiana sources that was not seen at the other receptor locations and is related to the particular wind conditions during periods of high modeled 8-hour ozone at Tyler and may not be representative.

Marshall

The total reduction in high 8-hour ozone was –13.8 ppb at Marshall (Table 7-9, bottom right), which was much larger than for the other receptor areas. This large reduction was due to a large decrease of –8.0 ppb in the contribution of point source NOx in the 11 counties surrounding NETAC. This is related to the proximity of the Marshall monitor to utility point sources in Titus County (Monticello and Welsh) and Marion County (Wilkes). The emissions reductions at these sources (from Section 3) are Monticello (23%), Welsh (58%) and Wilkes (50%) averaged over all episode days. The relatively large ozone reduction at Marshall is consistent with the large emissions reductions at the contributing upwind utility point sources.

Table 7-9. Change in average contributions to high 8-hour ozone between 1999 (base5) and 2007 (07base2).

5 NETAC Counties

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	–1.6	–1.4	1.0	0.0			–1.9
NET11	–2.2	–0.2	–0.3	0.0			–2.7
SHRV	–0.2	0.0	0.1	0.0			–0.1
LA	0.2	–0.3	0.0	0.0			0.0
AR	0.0	–0.1	0.0	0.0			–0.1
OK	0.0	–0.2	–0.1	0.0			–0.2
DFW	–0.1	–0.5	–0.1	0.0			–0.6
HGBPA	0.0	–0.1	0.0	0.0			0.0
TX	0.3	–0.3	–0.2	0.1			–0.2
OTH	–1.0	–0.2	0.1	0.1			–1.0
N/A					–0.1	0.0	–0.1
Total	–4.5	–3.2	0.6	0.2	–0.1	0.0	–6.9

Longview

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	–1.7	–1.9	1.7	0.0			–1.9
NET11	–0.8	–0.2	–0.1	0.0			–1.0
SHRV	–0.2	0.0	0.2	0.0			–0.1
LA	0.2	–0.3	0.1	0.0			0.0
AR	0.0	–0.1	0.0	0.0			–0.1
OK	0.0	–0.1	0.0	0.0			–0.1
DFW	0.0	–0.3	–0.1	0.0			–0.4
HGBPA	0.0	–0.1	0.0	0.0			0.0
TX	0.1	–0.2	–0.1	0.0			–0.2
OTH	–1.1	–0.3	0.1	0.1			–1.1
N/A					0.1	0.0	0.1
Total	–3.4	–3.3	1.8	0.2	0.1	0.0	–4.7

Tyler

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	–0.2	–1.8	–0.1	0.0			–2.1
NET11	–0.1	–0.1	0.0	0.0			–0.2
SHRV	–0.4	0.0	0.7	0.0			0.3
LA	0.5	–0.3	0.1	0.0			0.4
AR	–0.1	–0.3	–0.1	0.0			–0.4
OK	0.0	0.0	0.0	0.0			0.0
DFW	0.0	0.0	0.0	0.0			0.0
HGBPA	0.1	0.0	0.0	0.0			0.0
TX	0.1	–0.1	0.0	0.0			0.0
OTH	–1.3	–0.3	0.1	0.1			–1.4
N/A					–0.3	0.0	–0.3
Total	–1.5	–2.9	0.8	0.2	–0.3	0.0	–3.7

Marshall

Source Area	PT	MV	OAN	BIO	BC	IC	Total
NETAC	–1.3	–0.6	0.9	0.0			–0.9
NET11	–8.0	–0.4	–2.8	0.0			–11.1
SHRV	–0.2	0.0	0.0	0.0			–0.2
LA	0.2	–0.3	0.0	0.0			0.0
AR	0.1	–0.1	0.0	0.0			0.0
OK	0.0	0.0	0.0	0.0			0.0
DFW	0.0	–0.2	–0.1	0.0			–0.2
HGBPA	0.0	0.0	0.0	0.0			0.0
TX	0.8	–0.4	–0.4	0.1			0.1
OTH	–0.9	–0.2	0.1	0.1			–1.0
N/A					–0.3	0.0	–0.3
Total	–9.2	–2.2	–2.3	0.2	–0.3	0.0	–13.8

Note: Contributions are averaged over all grid cells and hours that had 8-hour ozone of 85 ppb or higher in the 1999 base case. Negative values mean a smaller contribution in 2007 than 1999.

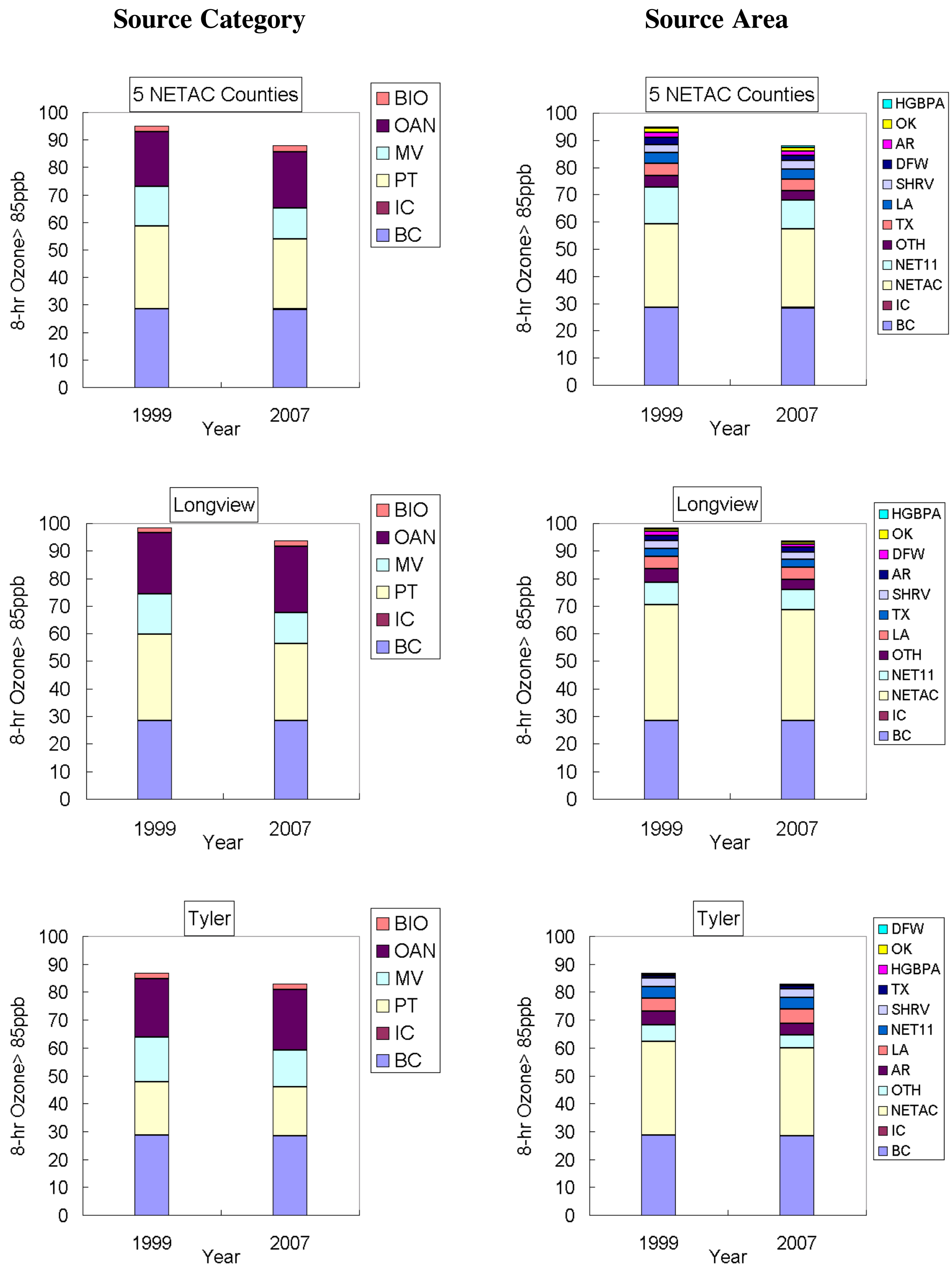


Figure 7-4. Comparison of 1999 and 2007 average contributions to 8-hour ozone of 85 ppb and higher using APCA.

SUMMARY AND CONCLUSIONS

The ozone source apportionment analysis provides insight into the sensitivity of modeled ozone levels to emissions, boundary conditions and initial conditions in 1999 and 2007. This information leads to the following conclusions about the model configuration, the sources that contribute to high ozone and the effectiveness of emissions reductions.

Model Configuration

- Initial conditions were unimportant. This shows that the model spin-up period was sufficient.

- Boundary conditions contributed about 30 ppb to 8-hour ozone levels above 85 ppb in Northeast Texas in both 1999 and 2007. Since the boundary condition for ozone was set to 40 ppb, about 25% of the boundary ozone was destroyed by chemistry and deposition before reaching Northeast Texas. This level of influence from the boundary conditions is appropriate and shows that the modeling is not overly influenced by boundary condition assumptions.

- Emissions in states outside of Texas, Louisiana, Arkansas and Oklahoma contributed about 3 to 6 ppb to 8-hour ozone above 85 ppb in Northeast Texas. This contribution is less than 10% of the high 8-hour ozone which shows that:

    - High 8-hour ozone levels in Northeast Texas are primarily due to emissions from within a “1-state” distance upwind.

    - The 36-km regional modeling domain is large enough to capture virtually all of the influence from upwind emissions.

    - The 12-km modeling domain captures most of the important upwind emissions influence from Texas, Louisiana, Arkansas and Oklahoma.

- Emissions from Northeast Texas (NETAC 5 counties plus surrounding 16 counties) and Shreveport contributed about 47 ppb of 8-hour ozone above 85 ppb in Northeast Texas in 1999. This shows that the 4-km modeling domain is large enough to capture more than 50% of the important emissions influences.

Ozone Sensitivity to Emissions

- The majority (more than 65%) of high 8-hour ozone in the NETAC 5 county area in 1999 was attributed to anthropogenic emissions sources. This means that 8-hour ozone can be reduced by controlling the appropriate emissions sources.

- Controlling NOx emissions is the only effective strategy for reducing high 8-hour ozone. Ozone formation is predominantly NOx sensitive on moderately high 8-hour ozone days, but on the highest ozone days (i.e., with the most stagnant meteorology) ozone is sensitive to both NOx and VOCs. However, because the VOCs are dominated by biogenic emissions, NOx control is the only effective strategy on all days.

Source Contributions

- The largest emissions contributions to high 8-hour ozone in the NETAC 5 county area come from nearby NOx emissions. Nearby means emissions from within the 5 county NETAC area, followed by emissions in surrounding counties, followed by emissions from Louisiana. The contribution from Louisiana is split about evenly between the 4 parish Shreveport area and the rest of the state.

- The relative importance of different source categories of NOx emission varies by location within the NETAC area. For the 5 county region as a whole, as well as the Longview and Marshall monitors, point sources are the largest contributor followed by area/offroad sources followed by motor vehicles. At Tyler the ranking is different and changes between 1999 and 2007, but all three source categories have similar contributions in both years at Tyler.

- The contribution to high 8-hour ozone in the NETAC 5 county area from emissions in the 5 Counties was 30.7 ppb and from the surrounding 11 Counties was 13.5 ppb.

- The contribution to high 8-hour ozone in the NETAC 5 county area from Dallas/Fort Worth was 2.4 ppb, from Houston/Galveston/Beaumont/Port Arthur was 0.6 ppb and from the rest of Texas was 4.4 ppb.

- The contribution to high 8-hour ozone in the NETAC 5 county area from Shreveport was 2.9 ppb, the rest of Louisianna was 4.7 ppb, Arkansas was 1.9 ppb and Oklahoma was 1.6 ppb.

- The contribution to high 8-hour ozone in the NETAC 5 county area from states outside Texas, Louisiana, Arkansas and Oklahoma was 4.4 ppb.

Emissions Changes between 1999 and 2007

Emissions changes were analyzed for the August 17th episode day and may slightly be different for other episode days.

- NOx emissions in the NETAC 5 county area decreased by 24% for mobile sources and 21% for point sources, but increased by 3% for other anthropogenic sources (area plus offroad).

- The emissions reductions for Dallas/Fort Worth should be reviewed by the TCEQ. There may be additional VOC emission reductions that are not included in the current analysis. This will not significantly change the results of the modeling because ozone is limited by anthropogenic NOx emissions rather than anthropogenic VOCs, and because the Dallas/Fort Worth had relatively little impact on ozone in Northeast Texas.

- The emissions reductions for the Houston/Galveston/Beaumont/Port Arthur nonattainment areas should be reviewed by the TCEQ because the reductions are smaller than expected. This will not significantly change the results of the modeling because ozone from the Houston area was not transported to Northeast Texas under the wind conditions of this episode period.

Ozone Changes between 1999 and 2007

- High 8-hour ozone in the NETAC 5 county area was reduced by –6.9 ppb between 1999 and 2007. There were reduced contributions from point source NOx (–4.5 ppb) and mobile source NOx (–3.2 ppb) but a small increase in the contribution of other anthropogenic NOx (0.6 ppb).

- The 0.6 ppb increase in the ozone contribution from other anthropogenic NOx emissions is explained partly by the small (3%) increase in other anthropogenic NOx emissions in the NETAC 5 county area. However, another cause is more efficient ozone formation from NOx emissions as total NOx levels are reduced. This is an example of the non-linear relationship between ozone and NOx emissions.

- The non-linear relationship between ozone and NOx is most pronounced in areas with relatively high NOx emissions, such as the Longview monitor area. The consequence is that high 8-hour ozone levels at Longview are resistant to NOx reductions, even though NOx reduction is the most effective strategy. In other words, an X% reduction in local NOx emissions will lead to less than an X% reduction in ozone at Longview.

- The contribution to high 8-hour ozone in the NETAC 5 county area from Dallas/Fort Worth decreased by –0.6 ppb and from the rest of Texas decreased by –0.2 ppb.

- There was little change between 1999 and 2007 in the contributions to high 8-hour ozone in the NETAC 5 county area from Shreveport (–0.1 ppb), the rest of Louisianna (0 ppb), Arkansas (–0.1 ppb) and Oklahoma (–0.2 ppb).

- Although the contribution of emissions from states outside Texas, Louisiana, Arkansas and Oklahoma was small (4.4 ppb in 1999), this contribution was reduced by –1.0 ppb showing benefits from emissions reductions strategies for the Eastern U.S. such as EPA's "NOx SIP call."

REFERENCES

Coulter-Burke, S., D. Calkins and G. Yarwood. 2002. "Analysis of Emission Reduction Control Measures for Attaining The 8-Hour Ozone NAAQS in the Tyler/Longview/ Marshall Near Nonattainment Area." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. August.

Dudhia, J., 1993. "A Non-hydrostatic Version of the Penn State/NCAR Mesoscale Model: Validation Tests and Simulation of an Atlantic Cyclone and Cold Front", *Mon. Wea. Rev.*, Vol. 121. pp. 1493-1513.

Emery, Tai and Jia, 2003. "Revised Meteorological Modeling of the August 13-22, 1999 East Texas Ozone Episode." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. January 23.

Emery and Tai, 2002. "Meteorological Modeling and Performance Evaluation of the August 13-22, 1999 Ozone Episode." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. August.

ENVIRON. 2002a. "User's Guide to the Comprehensive Air Quality model with extentsions, version 3.10" available from www.camx.com. April.

ENVIRON. 2001b. "User's Guide to the extended Emissions Processing Systems version 2 (EPS2x)." ENVIRON International Corporation, 101 Rowland Way, Novato, CA. 94945. August.

ENVIRON. 2001a. "Ozone Modeling Protocol for FY 2000/2001 Projects in the Tyler/Longview/Marshall Area of East Texas." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. August.

ENVIRON. 2000. "Conceptual Model for 8-Hour Ozone in East Texas and Episode Selection for New Photochemical Modeling." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. 12 September.

ENVIRON. 1999b. "A Biogenic Emission Inventory for the Tyler/Longview/Marshall Area Based on Local Data." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. March.

ENVIRON. 1999a. "Ozone Modeling for the Tyler-Longview-Marshall Area of East Texas." Prepared for the East Texas Council of Governments by ENVIRON International Corporation, 101 Rowland Way, Novato, CA 94945. 12 November 1999 and revised for errata 3 August 2001.

EPA. 1999. "Draft Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-Hour Ozone NAAQS". EPA-454/R-99-004. EPA Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. May.

EPA. 1996. "Guidance on Use of Modeled Results to Demonstrate Attainment of the Ozone NAAQS". EPA-454/B-95-007, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

EPA. 1991. "Guideline for Regulatory Application of the Urban Airshed Model". EPA-450/4-91-013, U.S. Environmental Protection Agency Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. July 1991.

Guenther, A., C. Wiedinmyer, B. Baugh, S. Shepard, U. Ganesh, and G. Yarwood. 2002. "Biogenic VOC Emission Estimates for the TexAQS 2000 Emission Inventory: Estimating Emissions During Periods of Drought and Prolonged High Temperatures and Developing GloBEIS3". Prepared for Texas Natural Resource Conservation Commission, Austin, TX. April.

Madronich, S. 2002. The Tropospheric visible Ultra-violet (TUV) model web page. http://www.acd.ucar.edu/TUV/.

Madronich, S. 1993. "UV radiation in the natural and perturbed atmosphere", in Environmental Effects of UV (Ultraviolet) Radiation (M. Tevini, ed.), Lewis Publisher, Boca Raton, pp. 17-69.

Pollution Solutions. 2002. Tyler/Longview/Marshall Flexible Attainment Region Emission Inventory. Ozone Precursors, VOC and NOx 1999 Emissions. Prepared for the East Texas Council of Governments by by Pollution Solutions, 3000 Taku Road, Cedar Park, TX 78613. May.

Yarwood, G. G. Mansell, G. McGauhey, and W. Vizuete. 2001. "Biogenic Emission Inventories For Regional Modeling of 1999 Ozone Episodes In Texas". Final Report to the Texas Natural Resource Conservation Commission, Austin, TX. April.

Yarwood, G., G. Wilson, C. Emery, and A. Guenther. 1999b. "Development of GLOBEIS - A State of the Science Biogenic Emissions Modeling System". Final Report to the Texas Natural Resource Conservation Commission, Austin, TX. Available from http://www.globeis.com.

Yarwood, G., G. Wilson, S. Shepard, and A. Guenther. 1999a. User's Guide to the Global Biosphere Emissions and Interactions System - Version 2.0. Available from http://www.globeis.com.

Appendix A

Spatial Surrogates for Emissions Modeling

Introduction

Spatial surrogates are needed for the emissions modeling performed with EPS2x as described in Section 3 of this report. They are used to allocate county total emissions to individual grid cells within the county. For example, a county population surrogate is the fraction of county total population within each grid cell that contains part of the county.

Data Source & Processing

Land use data were obtained from the USGS EROS Data Center web site[1] and are a subset of the National Land Cover Dataset (NLCD). This dataset provides dominant land use data for each state at a spatial resolution of 30 meters. The files downloaded from the site in March 2001 are listed in Table 1, and the 21 categories and codes utilized in the NLCD are presented in Table 2. More detailed descriptions of the NLCD land use types are available from the USGS web site! These eight bit binary files were converted to ASCII format and the land use codes were modified to follow a sequential numbering system, also shown in Table 2. The ASCII files were processed using a FORTRAN code to aggregate adjacent pixels to generate files with land use data at 450 meter resolution. In addition to a dominant land use file, 21 category-specific files were created for each state to preserve some of the detail provided by the initial dataset. These category-specific files contain the fractional coverage of that category for each 450 meter cell. Next, the files were processed in Arc/Info to create polygon coverages. These coverages were then intersected first with state and county boundary files and then with the appropriate grid file. The final grid intersections were exported for use as gridded surrogates in the emissions modeling with EPS2. After export, the land use codes were assigned to those recognized by EPS2 as shown in Table 3.

The 1999 population distribution was based on the 1990 Census of Population and Housing except for data provided by the Alamo Area Council of Government for Bexar, Comal, Guadalupe, Hays, Kendall, Travis, Williamson, Wilson Counties.

[1] http://edcwww.cr.usgs.gov/pub/edcuser/vogel/states

Table A-1. Files downloaded from USGS EROS Data Center.
All file names are of the form [state name]_NLCD_flat_[version date].bin.gz

NLCD File Names
alabama_NLCD_flat_031600.bin.gz
florida_NLCD_flat_032000.bin.gz
georgia_NLCD_flat_032000.bin.gz
illinois_NLCD_flat_052000.bin.gz
indiana_NLCD_flat_031600.bin.gz
kansas_NLCD_flat_050700.bin.gz
kentucky_NLCD_flat_050300.bin.gz
louisiana_NLCD_080300_flat.bin.gz
missouri_NLCD_flat_072100.bin.gz
mississippi_NLCD_flat_032000.bin.gz
north_carolina_NLCD_flat_042200.bin.gz
nebraska_NLCD_flat_050700.bin.gz
ohio_NLCD_flat_031600.bin.gz
oklahoma_NLCD_091400_flat.bin.gz
south_carolina_NLCD_flat_031600.bin.gz
tennessee_NLCD_flat_050500.bin.gz
texas_n_NLCD_092600_flat.bin.gz
texas_se_NLCD_092800_flat.bin.gz
texas_sw_NLCD_092800_flat.bin.gz
virginia_NLCD_flat_042400.bin.gz
west_virginia_NLCD_flat_062000.bin.gz

Table A-2. Land use categories and codes utilized in the NLCD.

NLCD Category Code	NLCD Category Description	In-House Category Code
11	Open Water	1
12	Perennial Ice/Snow	2
21	Low Intensity Residential	3
22	High Intensity Residential	4
23	Commercial/Industrial/Transportation	5
31	Bare Rock/Sand/Clay	6
32	Quarries/Strip Mines/Gravel Pits	7
33	Transitional	8
41	Deciduous Forest	9
42	Evergreen Forest	10
43	Mixed Forest	11
51	Shrubland	12
61	Orchards/Vineyards/Other	13
71	Grasslands/Herbaceous	14
81	Pasture/Hay	15
82	Row Crops	16
83	Small Grains	17
84	Fallow	18
85	Urban/Recreational Grasses	19
91	Woody Wetlands	20
92	Emergent Herbaceous Wetlands	21

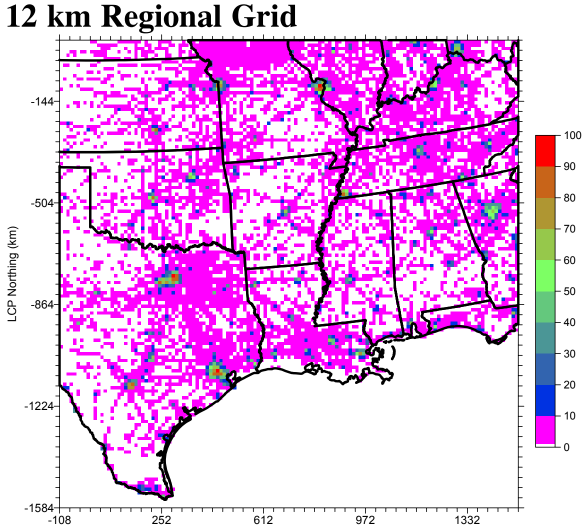
Table A-3. Land use descriptions and codes recognized by EPS2 and internal codes mapped to those categories.

EPS2 Land Use Description (and code)	In-House Category Codes Mapped to EPS2 Category
Urban (4)	3, 4, 5, 19
Agriculture (5)	13, 15, 16, 17
Range (6)	12, 14, 15, 16, 17, 18
Deciduous Forest (7)	9
Coniferous Forest (8)	10
Mixed Forest (9)	11
Water (10)	1, 2
Barren (11)	6, 7, 8
Nonforested Wetlands (12)	20, 21
Mixed Agriculture (13)	12, 13, 14, 15, 16, 17, 18
Rural (15)	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

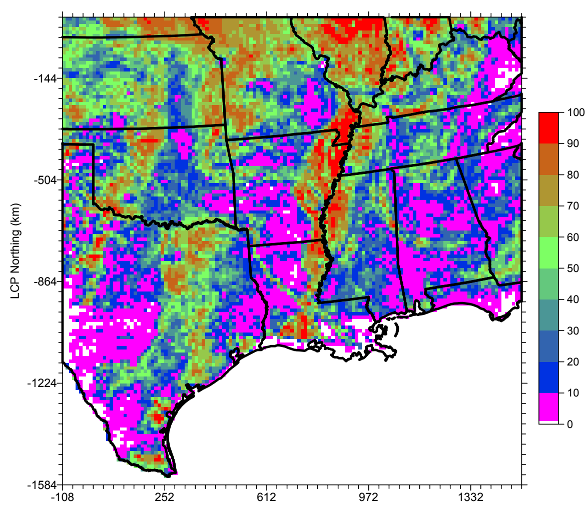
Data Displays

The EPS2 spatial surrogates are shown below for the grids that will be used in emissions modeling. These grids are in a Lambert Conformal projection centered at 100° W and 40° N. The regional grid covers a multi-state area and is shown at 12 km resolution. The regional grid covers part of Mexico and no surrogates were developed for this area. This will not cause a problem in the emissions modeling because no emissions data will be available for Mexico. The 4km grid covers the NETAC area of East Texas.

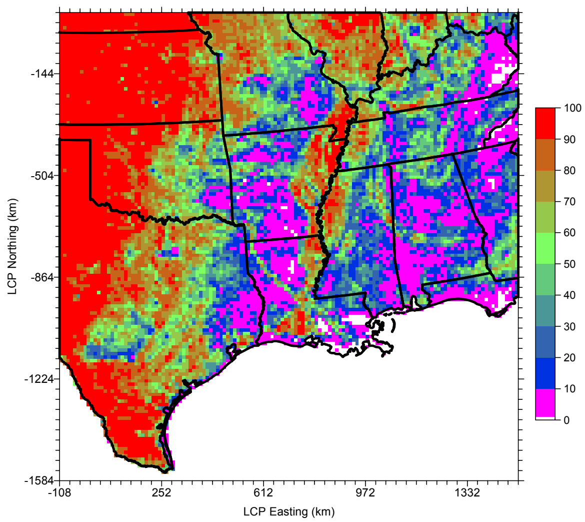
12 km Regional Grid



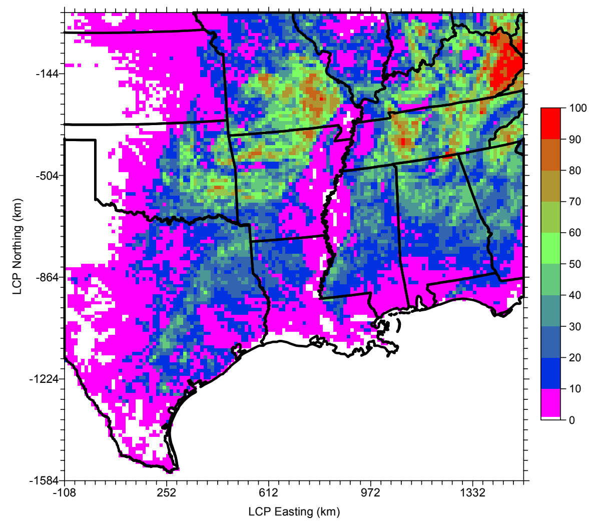
Percentage of Urban Land Use (4)



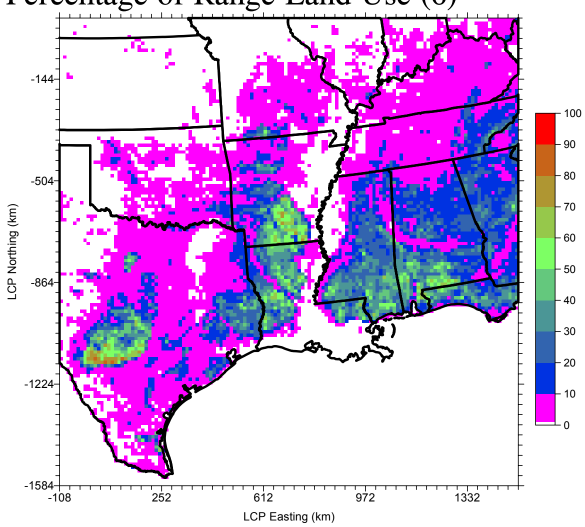
Percentage of Agricultural Land Use (5)



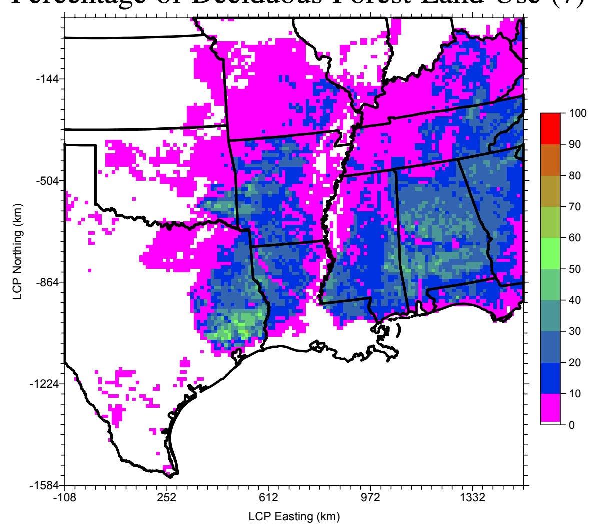
Percentage of Range Land Use (6)



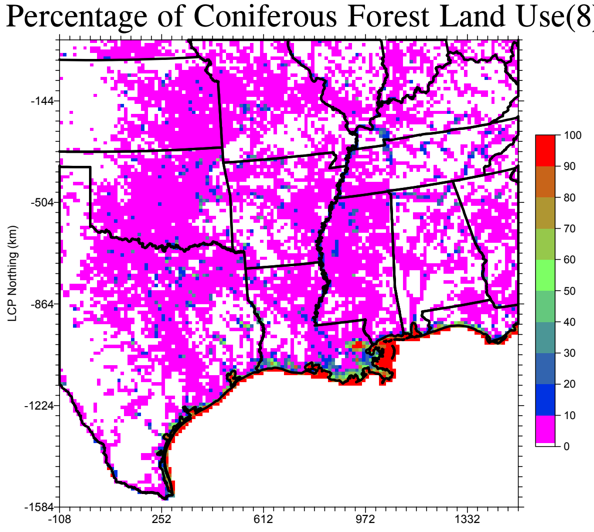
Percentage of Deciduous Forest Land Use (7)



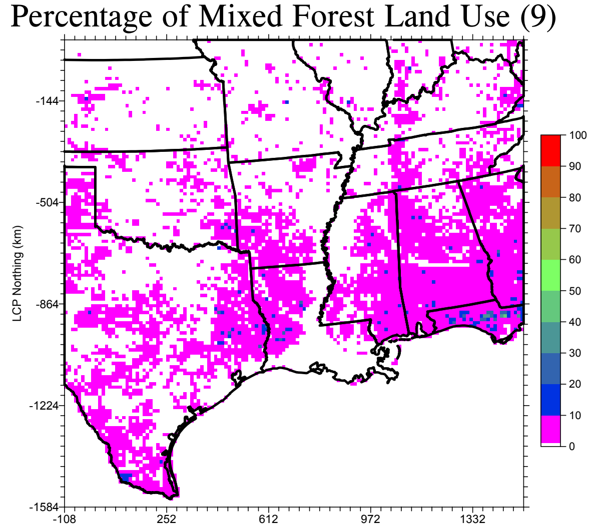
Percentage of Coniferous Forest Land Use(8)



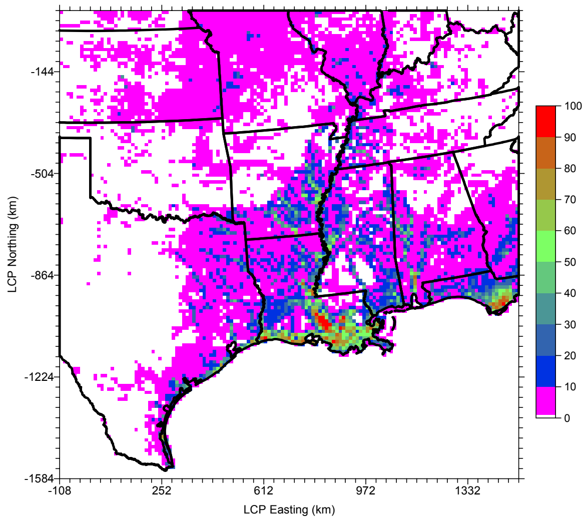
Percentage of Mixed Forest Land Use (9)



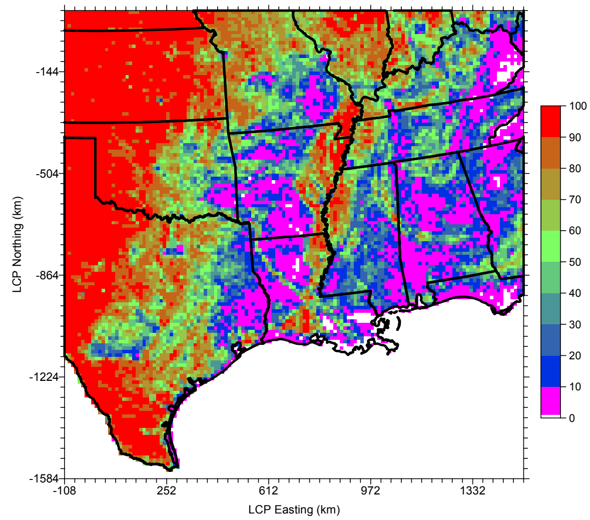
Percentage of Water Land Use (10)



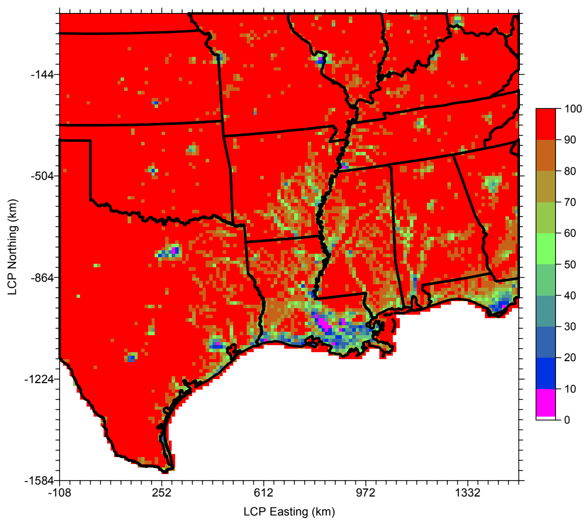
Percentage of Barren Land Use (11)



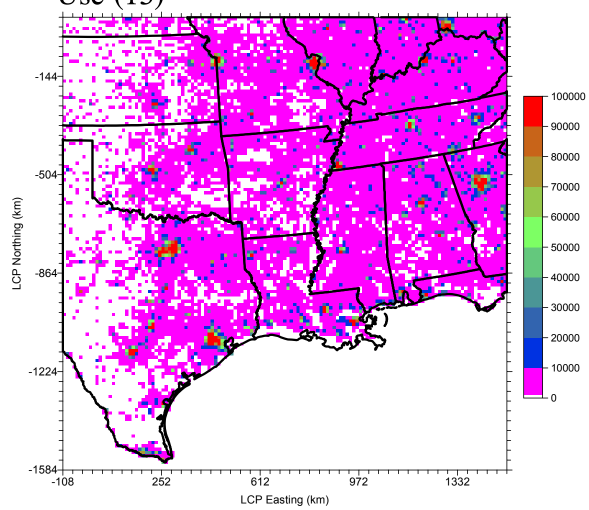
Percentage of Non-forested Wetlands Use (12)



Percentage of Mixed Agricultural Land Use (13)

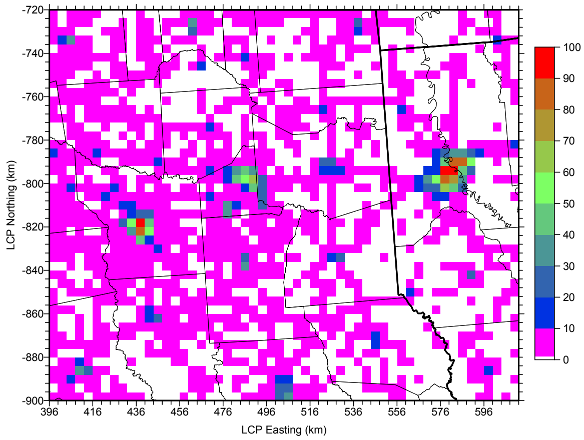


Percentage of Rural Land Use (15)

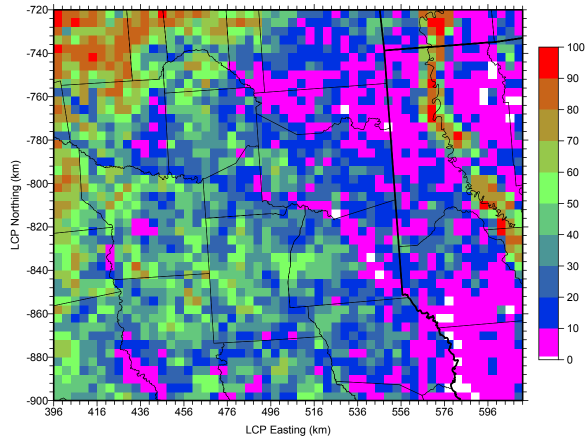


Population Distribution (2)

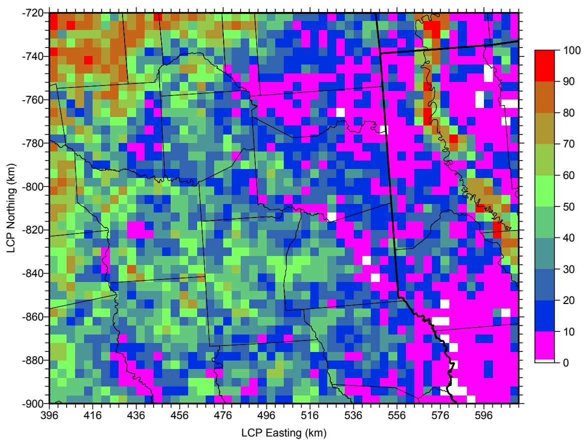
4 km East Texas Grid



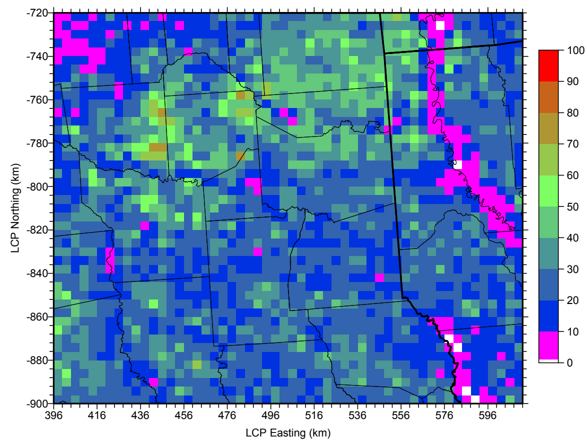
Percentage of Urban Land Use (4)



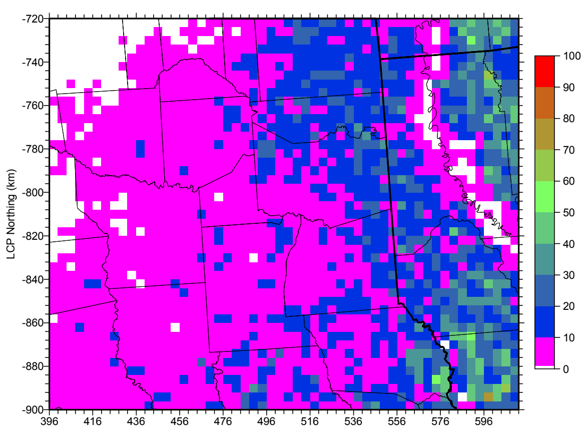
Percentage of Agricultural Land Use (5)



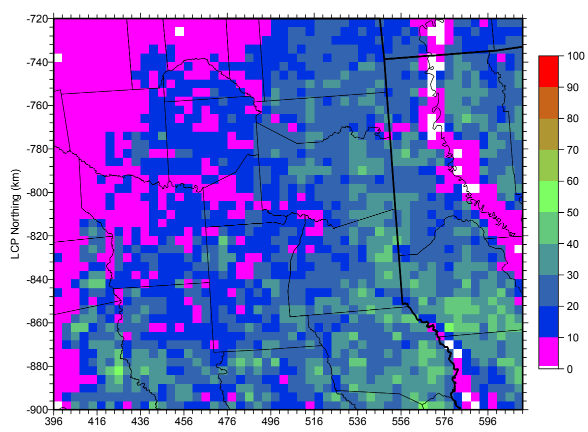
Percentage of Range Land Use (6)



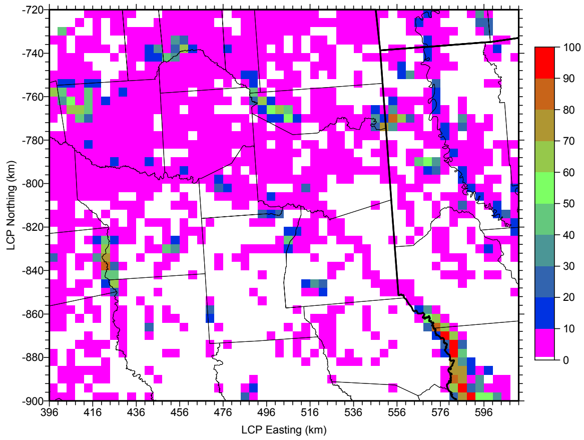
Percentage of Deciduous Forest Land Use (7)



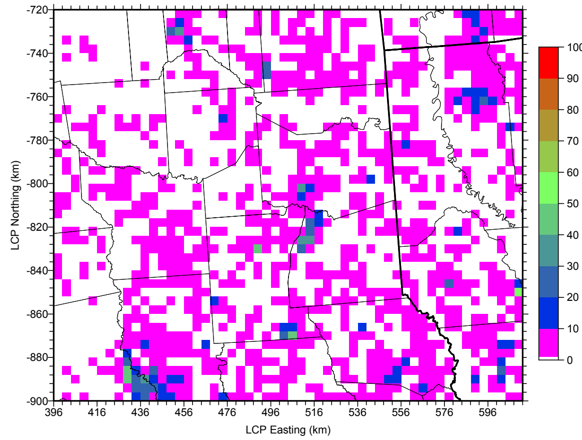
Percentage of Coniferous Forest Land Use (8)



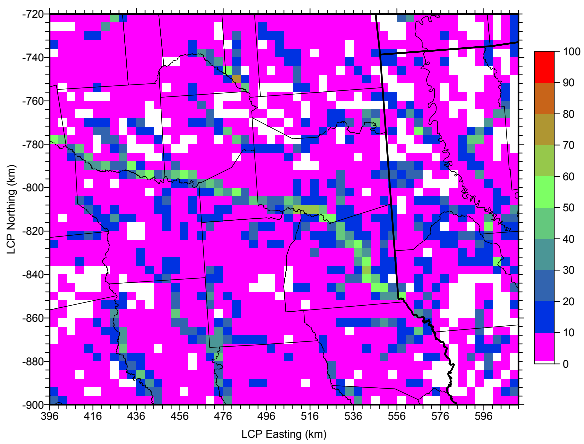
Percentage of Mixed Forest Land Use (9)



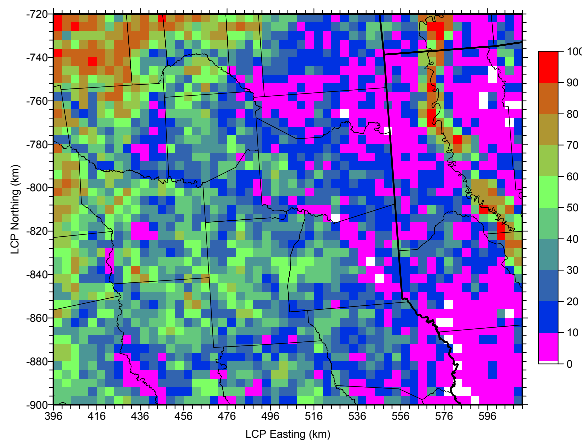
Percentage of Water Land Use (10)



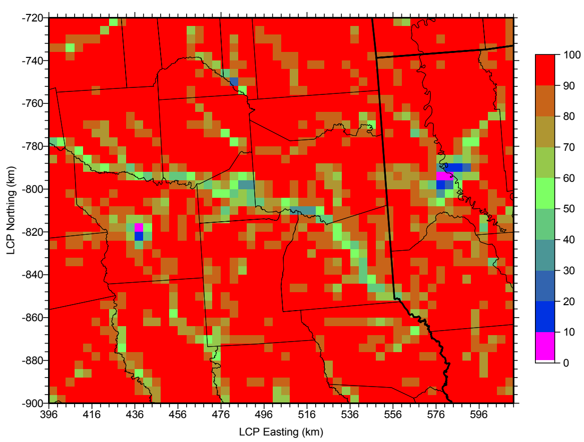
Percentage of Barren Land Use (11)



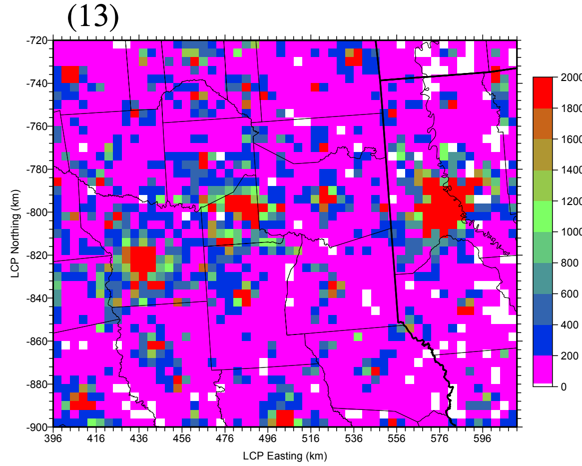
Percentage of Non-forested Wetlands Use (12)



Percentage of Mixed Agricultural Land Use (13)



Percentage of Rural Land Use (15)



Population Distribution (2)